CONSULTING SERVICES BY ENVIRONMENTAL RESOURCES LIMITED

REPORT

London Underground Limited

Jubilee Line Extension:
Environmental Statement

March 1990

ERL

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GUIDE TO THE USE OF THIS DOCUMENT

This document, entitled an 'Environmental Statement', presents the conclusions of a study process known as Environmental Assessment. This is a rigorous, internationally-recognised procedure for studying the likely environmental impacts of proposed major development projects like the Jubilee Line Extension.

The Environmental Statement is presented as follows. It begins with an Executive Summary, the main body of the report is divided into four parts, and it concludes with three Annexes. Key data tables throughout the Statement have been printed on **grey paper** to distinguish them from text pages, and they are listed for reference in a List of Data Tables, after the Table of Contents.

Executive Summary
Printed on **blue paper**, this provides an overall summary of the conclusions of the Environmental Statement.

Background Information on the Environmental Statement
Marked with a **grey tab bar**, this first part of the main report explains the objectives of the Environmental Statement, and describes the approach and scope of the Environmental Assessment, as carried out by the consultants, Environmental Resources Limited.

The Extension and its Potential Environmental Effects
Marked with **grey tab bar**, this second part of the main report describes the proposed Extension, giving details of features which influence its impacts on the environment, and provides an initial overview of the potential environmental effects of the scheme.

Environmental Impacts: Section by Section Along the Route
Starting with a **grey tab bar, followed by series of six coloured tab bars**, this third part of the main report takes the reader along the proposed route from Green Park to Stratford, section by section, describing the context within which the development will take place, summarising the impacts predicted along the route, and identifying any site-specific recommendations for mitigation. In this part of the report, each route section is associated with a colour reflected in the tab bar and in the various maps used to illustrate the text.

Summary of the Specialist Studies by Subject Area
Marked with a **grey tab bar**, this fourth part of the main report summarises the findings of a series of specialist investigations carried out during the Jubilee Line Extension Environmental Assessment. In the third part of the report, impacts were divided by route section; in this part of the report, impacts for the whole route are divided into the following specialist topics:

- Land use and property impacts arising from the temporary or permanent occupation of land and from settlement during tunnelling, and impacts affecting areas or features of historical or archaeological importance.
- Impacts of noise and vibration arising during construction and subsequently during operation.
- Impacts cause by changes in traffic and transport infrastructure.
- Impacts arising from transport and disposal of spoil, and risks associated with the possible presence of contaminated sites along the route.

- Impacts on air quality during construction and operation.
- Temporary and permanent impacts on the visual environment.
- Impacts on sites of interest for wildlife and nature conservation.
- Impacts on the aquatic environment.

Annexes
These three final parts of the report provide a list of persons consulted during the Assessment, a bibliography of materials and publications used, and identifies the members of the project team.

The Executive Summary from this report has been produced as a separate booklet, available from the Jubilee Line Extension Project Office, 8-12 Old Queen Street, London SW1H 9HP. Further copies of this Environmental Statement can be obtained at a cost of £25.00 from the same address.

CONTENTS

KEY DATA TABLES

ACKNOWLEDGEMENTS

We would like to thank the following organisations for their assistance in the preparation of this Environmental Statement:

- Jubilee Line Extension Project Office (JLEPO)
- London Regional Transport
- London Underground Limited
- Mott MacDonald Group, Tunnels Division
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- Montagu Evans
- Halcrow Fox & Associates
- Terraquest
- HSAG

EXECUTIVE SUMMARY

Introduction

In January 1989, the Minister of Transport commissioned the East London Rail Study, to examine the best route for a new railway linking Docklands with Central London. In July, the report of the study recommended that the new line should be an extension of the Jubilee Line, and it suggested two alternative routes through the central area of London, and two alternatives at the eastern end. Subsequently, it was decided that the route that should be adopted should run from Green Park to Stratford, via Westminster, Waterloo, London Bridge, and the Isle of Dogs. Regular services would be withdrawn from the existing section of the Jubilee Line between Green Park and Charing Cross.

The main purpose of the railway extension is to improve passenger communications between Docklands and the central area of London, but it would also improve accessibility between Waterloo and London Bridge main line stations and London's West End. In addition, the extension would give the residential areas served south of the Thames better links to the West End and to Docklands, and would provide an alternative route for passengers travelling to parts of the central area of London from East London via the interchanges at West Ham and Stratford.

An independent assessment

Proposals for the Jubilee Line Extension have been submitted to Parliament in the form of a Private Bill. Under the European Community Directive on Environmental Assessment, projects authorised by Act of Parliament do not require Environmental Assessment. However, paragraph 80 of the Report of the Joint Select Committee on Private Bill Procedure (HC625 of Session 1987-88) recommended that both Houses of Parliament should incorporate the requirement for an Environmental Assessment in their standing orders for private bills.

London Regional Transport (LRT) and London Underground Limited (LUL) agreed on the importance of taking into account potential environmental effects when planning major construction projects.

In August 1989, London Underground Limited commissioned the independent consulting group Environmental Resources Limited (ERL) to undertake an Environmental Assessment of the Jubilee Line Extension.

What is Environmental Assessment?

Environmental Assessment is a rigorous, internationally-recognised procedure for studying the environmental impacts of major development projects. It aims to shape the project by highlighting environmental sensitivities, minimising the likelihood of adverse effects, and enhancing the scheme's

general acceptability. Although the procedure is now well established, Environmental Assessment became a routine part of project planning in the UK only two years ago.

Description of the project

The extension of London Underground's present Jubilee Line would run from Green Park Station in Central London, to Stratford in East London, progressing via Waterloo and London Bridge main line stations, and via the Surrey Docks and the Isle of Dogs areas in London's Docklands. The extension would provide direct links between a number of existing British Rail and London Underground stations, with important rail interchanges at Westminster, Waterloo, London Bridge, Canada Water (on the East London Line), Canary Wharf, Canning Town, West Ham, and Stratford.

In planning the new line, the objectives were:

- To provide a new railway that meets the best modern standards of safety, convenience, and quality, including speedy access for the large number of people who will use the line
- To construct the line as rapidly as possible, in order to meet the urgent transport needs arising from the existing development schedule for London's Docklands
- To construct and operate the line with minimum disturbance to local infrastructure, communities, and the environment.

The proposed route

The proposed route is illustrated in the diagram on the following page. The 11 new Jubilee Line stations, from west to east, would be as follows:

- **Westminster** Proposed new Jubilee Line platforms at Westminster would connect with the existing Westminster Station, presently serving the Circle and District Lines. Siting the Jubilee Line at Westminster would give passengers improved access to Whitehall and Parliament Square. The design of the enlarged station would be fully integrated with the overall redevelopment that is now taking place in the area around the existing station.

- **West Ham** It is proposed that the station at West Ham be expanded to accommodate the new Jubilee Line platforms and ticket hall, providing interchanges with the District and Metropolitan Lines, British Rail's proposed reinstated Fenchurch Street main line platforms, and the North London Line.

- **Stratford** The proposed Jubilee Line platforms would be located to the south of the existing British Rail and Central Line platforms, alongside the North London Line platforms. Stratford is also a terminus for the Docklands Light Railway, a bus interchange, and the site of two multi-storey car parks.

Mostly underground

The proposed Jubilee Line Extension would run underground for about 12 kilometres from Green Park to Canning Town, where it would surface and run within the existing North London Line corridor for about 3.5 kilometres to Stratford. At an average depth of 25 metres (82 feet), the underground section of the line would be deeper than most of the present London Underground system. This would allow the line to pass beneath the existing London Underground tunnels at Waterloo and at London Bridge, and beneath the Blackwall Road Tunnels.

A predominantly underground route was identified as the only means by which a high-capacity public transport link could be provided through Central London without resulting in substantial disruption or loss of property.

However, some parts of the proposed development would be sited above-ground. Where the line runs above-ground from Canning Town to Stratford, it would be sited within the existing North London Line corridor. The parcel of land formerly used for Stratford Market would become a depot for the stabling, daily maintenance and minor repair of Jubilee Line trains. In addition, a limited number of permanent surface sites will be needed for station entrances, and for ventilation and escape shafts.

Building the line

Although changes in the plans may need to be made (such as the possible omission of one or two of the least-used stations), London Underground Limited considers that the scheme outlined above would satisfy the project's objectives. In particular, the route selected will improve passenger communications between the Docklands area and other parts of London, especially the central area of London, two important British Rail main line stations, and East and Northeast London.

The design also allows for a possible further extension of the railway, branching to the Royal Docks and then under the River Thames to Woolwich.

Once the scheme receives Royal Assent, construction would take four to five years. Most of the actual construction work will take place underground, except for the surface section from Canning Town to Stratford, and the depot at Stratford. However, a number of temporary surface construction sites will be needed to service the underground works, for the removal of spoil (earth and other materials removed by excavation), and for the construction of the railway, the stations, and the ventilation and emergency shafts.

The Environmental Assessment

The proposal comprises a major civil engineering project: the construction of a new railway; expansion of the existing stations at Westminster, Waterloo, London Bridge, West Ham, and Stratford; building new stations at Southwark, Bermondsey, Canada Water, Canary Wharf, Brunswick, and Canning Town; and constructing a depot at Stratford Market. As with any large inner-city construction project, these works cannot be carried out without causing some disturbance. In the case of the Jubilee Line Extension, however, disturbances are expected to be generally less than those normally caused by traditional surface building projects, because the majority of the Jubilee Line work is to take place underground.

The Environment Assessment of the Jubilee Line Extension had two principal aims:

- To identify the nature and scale of the environmental effects that are likely to result from the construction and operation of the railway
- To identify measures that should be taken to minimise those effects and monitor their future levels.

Organisation of the Assessment

For clarity and convenience, the issues addressed by the Environmental Assessment were considered under two broad categories:

Impacts during construction

- o Disturbance from noise, dust, and vibration, affecting local residents and other sensitive land users
- o Risks of ground settlement affecting properties along the route
- o Effects on groundwater

- Disposal of tunnel seepage and site drainage
- Loss of property during construction of the railway
- Temporary loss of amenity during construction
- Impacts arising from the transport and disposal of tunnelling spoil, and from the delivery of construction materials.

Impacts of the completed railway and its operation

- Impacts of noise and vibration from train movements, ventilation shafts, station and depot operations, and maintenance operations
- Visual impacts of the completed scheme
- Impacts on cultural and historical features, on archaeological features, on land and water, and on ecology during both construction and operation.

In each of these categories, the Environmental Statement aims to describe the likely impacts of the project, the measures that are available to minimise adverse impacts, and any monitoring or follow-up that may be necessary. In the following pages, this summary presents the key findings of the Environmental Statement.

Impacts during construction

The main sites proposed for constructing the new stations and the depot, for tunnelling, and for installing ventilation and emergency escape shafts, are as follows. (Numbers refer to the map locations illustrated on page xii.)

Constructing stations and the depot

- **Parliament Square and Westminster Station** (4, 5) Sites for constructing Westminster Station. The sites will occupy the central open area of Parliament Square, and part of the existing station, integrated with the PSA development. The works will also involve the temporary decking of the road junction at the northeast corner of the square.

- **Waterloo Station, Tenison Way, Waterloo Bridge Roundabout** (7, 8, 9) Sites for construction work at Waterloo Station. The Tenison Way site is presently occupied by about 15 shops.

- **Joan Street /The Cut** (11) Site for constructing Southwark Station. The site is now occupied by a restaurant, British Telecom office and office parking, and vacant railway arches.

- **Railway Approach, Duke Street Hill and Joiner Street** (16) Sites for construction works at London Bridge Station. The sites occupy a vacant plot of land at the upper level, an underground car park, and railway arches.

- **Major Road/John Roll Way** (20) Site for the construction of Bermondsey Station. The site comprises a block of derelict shops and their yards or gardens.

- **Canada Water** (22) Site for the construction of the Canada Water Station. The site occupies open land, car parking, and a strip of landscaped shoreline in Canada Water Dock.

- **Canary Wharf** (26) Site for building Canary Wharf Station. The site would use the middle of West India Dock, Eastwood Wharf, and parts of Canary Wharf and Heron Quay.

- **Brunswick** (28) Site for the construction of the Brunswick station. The site includes a currently vacant plot of land, formerly the site of Brunswick Power Station.

- **Canning Town** (31) Site for constructing Canning Town Station. The site now comprises vacant land belonging to British Rail, land occupied by the existing station and tracks, workshops and offices, light industrial premises, a church, and a former public house.

- **West Ham Station** (32) Site for construction works at West Ham Station. The site occupies parts of the existing station, a depot and truck/container storage, and three shops with residences behind.

- **Stratford Market** (33) Site for the construction of the depot. The site includes a fruit and vegetable market (much of which is disused) and goods yard, a public house, warehouses, offices, a skill centre for the disabled, and two residences.

- **Stratford Station** (34) Site for construction works at Stratford Station. The site occupies a British Rail engineering yard and two warehouses.

Tunnelling

- **St James's Square** (2) Site for the construction of the connection between the Jubilee Line Extension and the existing Jubilee Line. The site would occupy public parking spaces on the west side of the square.

- **Jubilee Gardens** (6) Site for tunnelling and spoil removal by river transport. The site presently comprises a riverside park and car park adjacent to the South Bank complex.

- **Ewer Street** (14) Site for tunnelling works. The area is presently vacant and derelict. Another site on Union Street (13), which is presently used as a public car park, is proposed for use as site offices for the Ewer Street tunnelling works.

- **Old Jamaica Road** (18) Site for tunnelling works. The site currently consists of a lorry park, a vehicle yard, railway arches, and an area of public open space and private land.

- **Durands Wharf** (24) Site for tunnel drive and the construction of an emergency escape shaft. The site was recently developed as a riverside park.

- **Blackwall Way** (27) Site for tunnel drive and the construction of a ventilation and emergency escape shaft. The site is presently a vacant area of riverside land.

- **East India Dock Basin** (29) Site for the construction of an underground tunnel junction for a possible future branch of the Jubilee Line to Woolwich. It is also a possible for a short tunnel drive to Canning Town. The area is currently a vacant dockside site.

Ventilation and emergency escape shafts

- **Blue Ball Yard** (1) Site for modifications to the existing ventilation shaft, to be carried out from within the existing Underground facilities.

- **Storey's Gate** (3) The site occupies the garden of the police lodge in the southeast corner of St James's Park, and a small area of the park itself.

- **Victoria Embankment** (5) The site would use a small part of the riverside walkway, adjoining the Westminster Station underpass.

- **Joan Street** (10) The proposed site is presently occupied by a printing works and warehousing, under the railway viaduct just to the west of Blackfriars Road.

- **Scoresby Street** (12) The site is currently occupied by a courier/chauffeur company and an electrical shop under the railway viaduct, just to the east of Blackfriars Road.

- **Wardens Grove** (15) The site comprises railway arches now used by a car repair shop.

- **Druid Street** (17) The site would occupy railway arches presently being used for storage, scaffolding and vehicle repairs.

- **Ben Smith Way** (19) The proposed site would use a current play area and nearby garages adjacent to Jamaica Road.

- **Southwark Park** (21) The site includes parkland at the eastern end of Southwark Park.

- **Downtown Road** (23) The proposed site consists of a small area of the Russia Dock woodland park adjacent to this road.

Noise

Particular measures to reduce noise could include:

- o Screening or enclosure of fixed plant such as pumps, compressors, and ventilation fans (site buildings can provide useful screening)

- o Scheduling unavoidably noisy operations to avoid daytime or night-time working, as appropriate to the local land uses concerned

- o Use of the quietest practicable piling methods

- o Screening sites by hoardings
- o Fitting and maintaining effective silencers on all diesel-engined vehicles and plant, and the use of electrically-powered equipment instead, where practicable.

By applying these measures it is considered that noise at most locations bordering the construction sites can be kept to acceptable daytime levels. The acceptable daytime level proposed for this assessment by ERL [suggested by the Department of the Environment Advisory Leaflet AL72 (1976) and applying British Standard BS 4142 Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas (1967)], is an equivalent continuous sound level (L_{eq}) at the facade of a sensitive property of 75 dB(A), or 10 dB(A) above background (L_{90}), whichever is the stricter. For night-time working, ERL proposed an acceptable level of 55 dB(A) to avoid sleep disturbance. Where the above measures do not prove effective in reducing noise to an acceptable level, the fitting of secondary glazing to affected residential properties may need to be considered.

Many properties close to the proposed sites already experience daytime average noise levels in the 70-75 dB(A) range, but special noise problems could arise close to the sites at Joan Street/The Cut, Ewer Street, Old Jamaica Road, Major Road/John Roll Way, Canada Water, Durands Wharf, and Blackwall Way, because of the need for 24-hour working. Special precautions may be needed at these sites to prevent night-time disturbance.

Noise monitoring performed by ERL of tunnelling activity for the Docklands Light Railway indicates that no perceptible noise or vibration should generally occur at the surface above the tunnelling of the Jubilee Line Extension. This is largely because of the depth proposed for the line. There could be a

small amount of ground-borne noise in a few properties (eg, where unusual soil conditions are found), but this should persist for only a few days because of the speed of tunnelling work (an average of 50 metres per week in the London Clay that underlies most properties on the proposed route). It is likely there would be no perceptible noise from trains carrying spoil in the tunnels.

Some disturbance from noise would be caused by the construction of about 3.5 kilometres of surface track from Canning Town to Stratford. Measurements taken by ERL indicate that the maximum noise level from tracklaying should generally be below 75 dB(A). Higher noise levels are likely at a few places where the track would pass within 25 metres of dwellings and offices, although this noise should not continue for more than a short period at any one site. Tracklaying, as well as construction work at the Stratford Depot, should be confined to daylight working hours, to avoid night-time disturbance.

Dust

Measures to prevent dust could include:

- Enclosing material stockpiles, and using water sprays to damp down dusty materials
- Spraying the surface of long-term stockpiles with chemical bonding agents
- Hard surfacing of busy areas, on-site routeing of vehicles, and enforced speed limits
- Sheeting of all vehicles carrying spoil and other dusty materials, and wheel-washing
- Operational controls (eg, a limit on drop heights from conveyors).

Vibration

With regard to vibration during construction, the main problem is likely to occur with percussive piling, particularly at the Southwark, London Bridge, Bermondsey, Canada Water, Canary Wharf, and Stratford stations, and at the Downtown Road and Durands Wharf work sites. Experience at similar sites shows that vibration from piling, while perceptible at 100 metres from the point of impact, is unlikely to cause annoyance in dwellings at more than 60 metres. Percussive piling also presents a risk of damage to property. A 'no risk' level could be exceeded where the point of impact is within 30 metres of property. This does not imply significant risk of damage; however, an investigation of the structure of any properties within 30 metres of piling should be carried out to identify any building protection measures or changes to construction techniques that may be needed.

Risks of ground settlement

Underground excavation may cause some settlement of the overlying ground. This is caused by the removal of spoil and the lowering of the groundwater level. A detailed survey should be carried out to establish the likely extent of settlement above the route.

Experience with other deep level rail lines indicates that settlement above the line should be confined to a 'settlement zone' affecting a corridor with a width equivalent to about three times the depth of the tunnels, dependent on ground conditions. The main settlement connected with the Jubilee Line Extension is likely to result from the more extensive excavation at the bored station sites: Westminster, Waterloo, Southwark, London Bridge, and Bermondsey. Particular attention is being given to identifying sensitive properties, including Listed Buildings, so that specific action to prevent damage can be included in the construction contracts. In addition, the following general measures are available to minimise the effects:

- Routeing the tunnel so as to avoid passing directly under very sensitive properties, where practicable
- The use of modern, purpose-built tunnelling machines and special tunnelling techniques, where possible, to minimise ground settlement
- Uninterrupted tunnelling, avoidance of overcutting (ie, minimising the tunnel diameter excavated by the cutting machinery), and rapid grouting of each tunnel section to help reduce settlement
- Special measures, including underpinning, to protect sensitive buildings
- Continuous monitoring to ensure that immediate remedial action is taken where unacceptable settlement occurs
- Provision for effective communications to deal with queries and complaints.

Effects on groundwater

Any tunnelling operation on the scale of the proposed Jubilee Line Extension is likely to cause some temporary lowering of adjacent groundwater levels. This could be most noticeable in the saturated strata around the eastern section of the line. Construction techniques are available to minimise 'drawdown'; these could include 'compressed air' and 'earth pressure balance' tunnelling, and the rapid lining and back grouting of each section of tunnel as it is excavated.

Measures could also be taken to prevent the contamination of groundwater by construction materials and machinery lubricants, and by possible contaminated residues from previous uses of the land. Any contamination that may occur would be restricted to a narrow zone close to the tunnel. No public or private water abstraction from any of the aquifers involved is likely to be affected.

Disposal of tunnel seepage and site drainage

Tunnel seepage and site drainage would be collected and discharged to sewers or directly to surface watercourses. All such discharges must be approved by NRA-Thames Region and would be subject to consent conditions established to protect the receiving waters or sewage treatment plant. Measures should be taken as necessary to ensure these conditions are met, and could include: the provision of settling lagoons and oil interceptors for construction site drainage, and oil interceptors at station and depot sites.

Loss of property

Most of the proposed construction sites are either on open space, much of it now derelict, or on areas where the existing buildings are either unoccupied or only in temporary use.

Demolition works would be required at about half of the work sites. Permanent loss of business premises will occur at the following sites: Westminster Station, Tenison Way, Waterloo Station, Joan Street, Joan Street/The Cut, Scoresby Street, Wardens Grove, London Bridge Station, Druid Street, Old Jamaica Road, Major Road/John Roll Way, Pioneer Wharf, Canning Town Station, West Ham Station, Stratford Market, and Stratford Station.

It is expected that five residential properties would be lost as a result of the development. These are located to the rear of shops at the West Ham Station site and within the Stratford Market depot site. The Lighthouse Pentecostal Church, at Canning Town, and a skills centre for the disabled, at Stratford Market, would also be lost.

The closure of businesses as a result of construction may lead to the immediate loss of jobs where employers choose not to relocate. It is not possible to predict how employers would respond to closure, but statutory compensation provisions allowed for in the Private Bill on the Jubilee Line Extension are intended to be sufficient to enable the re-establishment of businesses in alternative locations.

Temporary loss of amenity

A number of existing open spaces would be needed as construction sites. However, most of these losses would be temporary, and the sites should be fully reinstated when the new Jubilee Line is completed. Nevertheless, their use would cause temporary visual impacts, and in some cases a significant temporary loss of recreation space, particularly south of the Thames. The construction sites at which visual disturbance and loss of space are most likely to be noticed are:

- **A small portion of St James's Park** An area in the south-east corner of the park, which would be used as a construction site for an emergency escape shaft.

- **All of the central area of Parliament Square** The proposed main site for the reconstruction of Westminster Station. Together with its surrounding historic buildings, this is one of Britain's most important cultural and tourist areas. Even with the most careful site management and screening, there will be a serious loss of visual amenity during the three-to-four year construction period.

- **Jubilee Gardens and part of the adjoining car park** Proposed as one of the main sites for transferring tunnelling spoil to river barges. (However, plans now being drawn up for the redevelopment of the adjacent County Hall could involve even greater changes to the Jubilee Gardens; the impact of Jubilee Line construction should be seen in this context.)

- **About half-an-acre of land at Old Jamaica Road** An area now used for informal recreation, which would be occupied by a tunnelling site.

- **An area adjacent to Canada Water** Site proposed for the contruction of a new Jubilee Line Station. Work is presently underway to develop Canada Water as a wildfowl habitat; part of the newly-created shoreline would be temporarily lost for about three years.

- **Part of Durands Wharf** An area recently cleared and laid out as a public riverside park, which is a preferred tunnelling site because it would give direct access to the river for the transfer of spoil to barges. A significant, although temporary, loss of a local amenity.

The contractors would need to take particular care in managing all of these sites, and in reinstating them after the railway is completed.

Impacts from the transport of spoil and materials

The construction of tunnels, shafts, and stations would generate a large volume of excavated earth and other material, known as 'spoil'. Much of the spoil from the western section of the tunnel would be London Clay, which could be used at other engineering sites, if appropriate schemes were underway during the Jubilee Line Extension construction period - for example on the Docklands sites or on other sites in south-east London. Spoil from the eastern section of the line, drawn from Woolwich, Reading, and Thanet Beds, could be used for backfill, but it would generally be less useful and probably need to be transported for disposal at more distant sites.

Spoil, and the construction materials required for the project, can be moved by road, rail, or river. Road and river transport have been identified as the most practical options for this project. Movement by river barge, where practicable, would be more advantageous from an environmental point of view, since it would allow spoil and materials to be moved 24 hours a day without the road congestion and with less of the noise and pollution likely from road vehicles. It is estimated that about 45% of the spoil from the project could be moved from five river loading sites - at Jubilee Gardens, Durands Wharf, Canary Wharf, Blackwall Way and Brunswick.

Spoil removal from the remaining sites (comprising about 55% of the spoil), and the delivery of materials, would need to be by road. On average, this will involve about 40 to 50 lorry movements (half arrivals and half departures) at each site per day. However, at the main tunnelling sites away from the river (ie, Ewer Street and Old Jamaica Road), during the peak construction period, about 200 lorry movements per day would be needed and would continue for up to 20 weeks. Strict control of lorry movements can help minimise the disturbance and traffic congestion this might cause; this should include:

- Local authority agreement on access routes to each site; the shortest route to the nearest trunk road should be used if possible, and narrow residential streets should be avoided

- Scheduling the collection of spoil and the delivery of construction materials to avoid night-time movement or overnight parking; there is already a ban on night-time lorry movement on many of the roads likely to be used

- Minimising nuisance from mud and dust by sheeting down all lorries carrying spoil and by wheel washing all vehicles leaving worksites

- The operation and enforcement of a delivery docket system to prevent fly-tipping.

Even with such precautions, it is likely there would be a noticeable increase in traffic noise and lorry nuisance on some local roads during the peak construction period, in particular those near to the construction sites at St James's Square, Old Jamaica Road, Ewer Street, and Canada Water. Most of the other proposed sites are directly adjacent to roads on the primary road network serving London; these roads are already congested, and the traffic from the construction sites would not significantly increase this congestion.

The main trunk roads likely to be used are the A102(M), the A2, and the Blackwall Tunnel from the sites in Central London and south of the Thames; and the A13 and M25 from the eastern sites north of the river. A small number of road closures may be unavoidable; closure would probably not significantly increase traffic congestion in the area, a road should be closed only if local consultation shows that there is no practicable alternative.

Disposal of contaminated spoil

Whichever method of transport is used, special precautions would need to be taken with spoil that has been contaminated through previous activities on the excavated sites. In many cases, this contamination cannot be predicted in advance because of the lack of good historical records in many of the areas along the proposed route. A preliminary survey has indicated that there may be contamination at a number of sites, including Jubilee Gardens (toxic metals, oil, and contaminated river silts), Canada Water (organic and inorganic wastes, and coal and coke residues), and Stratford Market (organic and metal contamination, and asbestos). Before construction work starts on any site, an investigation should be carried out of potential contamination, based on Department of Environment 'trigger values' for the chemical analysis of soil and water samples. This would determine whether special practices were needed. These practices could include:

- Adherence by workers to site practice control (ie, hygiene and protective clothing)
- The removal and disposal of 'hot spots' of contamination under a strict consignment note system, to sites agreed with the local Environmental Health Department and the London Waste Regulatory Authority
- Where contamination is at a low level, capping and covering the area with temporary or permanent 'hard-standing'
- Where practicable, mixing small quantities of contaminated spoil with larger amounts of inert material before normal disposal as landfill
- Providing additional protection to new construction, such as sulphate-resistant cement, where aggressive contaminants are present

- o Before and during operations at certain sites, monitoring for methane gas - a toxic and explosive by-product of the decomposition of organic wastes; large quantities of wastes have been dumped over many years on proposed sites, especially south of the Thames
- o Measures to prevent the contamination of watercourses as a result of the disturbance to soils during excavations.

Impacts of the completed railway and its operation

The operation of the new line would also have environmental implications, including:

- o Noise and vibration from the passage of trains, from the ventilation shafts , from operations at the stations and the depot, and from rail maintenance
- o Traffic impacts
- o Visual impacts of the new stations and of the ventilation and emergency escape shafts
- o Impacts on sites and features of cultural and ecological interest.

Noise and vibration from operations

People living and working close to the Jubilee Line Extension could experience noise and vibration from several sources, including: train movements in the tunnel and on the surface part of the new line; movement of air from ventilation shafts; and maintenance work.

Train movements

For train movements underground, ERL proposes a noise 'complaint threshold' for inside residential properties of 40 dB(A). In LUL's experience, complaints are unlikely with noise levels below this threshold. For train movements at the surface, ERL has proposed a noise 'acceptability threshold' for outside residential properties of 70 dB(A). This figure was derived from previous studies of community disturbance from train noise.

Noise measurements taken by ERL above the existing Jubilee and Piccadilly Lines indicate that peak ground-borne noise levels in the basement and ground-floor rooms of about 500 residential buildings, mainly between London Bridge and Canada Water, could exceed the 40 dB(A) complaint threshold. This is based on the same sort of track as the existing London Underground lines, but with continuously-

welded rails. It is recommended that a programme be set up to design a resilient trackform which would reduce ground-borne noise to acceptable levels. Trains on the new line may be audible in a greater number of properties, but this would not be expected to cause annoyance. Noise from the surface section of the Jubilee Line Extension would not exceed ERL's proposed 70dB(A) 'acceptability threshold' for surface train movements at any residential properties along the route.

Ventilation shafts

Experience of noise from existing ventilation shafts indicates that external noise levels are generally low. If unacceptable noise were experienced from any shaft on the Jubilee Line Extension, silencers should be fitted. London Underground have had no complaints about the quality of air emissions from its existing ventilation shafts.

Station and depot operations

There should be little noise or vibration impact from the new and increased passenger activity at the stations serving the underground section of the proposed line. Some increase in noise, however, is likely at the surface stations at Canning Town, West Ham, and Stratford, resulting from the movement of passengers and from station announcements. All practicable mitigation measures should be taken. The layout and operation of the new Stratford Depot should also seek to minimise noise and disturbance - for example, noisy fixed equipment should be sited away from dwellings, the position of buildings could help screen noise sources, tight radius bends in track layout should be avoided, and trains should operate at low speeds around the depot.

Rail maintenance

In general, the main source of noise from maintenance would be the grinding of the rail surfaces. If carried out on the proposed line, this grinding would take place before the railway opens, and thereafter every two to three years. This is an unavoidably noisy operation, and after the railway opens it would most likely be carried out at night. However, the noise would last only a short time in any one location, and the ensuing benefits in reduced wheel/rail noise would be considerable. As is normal practice on the London Underground, local residents likely to be affected should be notified prior to night-time maintenance operations.

Traffic impacts

The proposed line runs through Inner and Central London, and the majority of new stations are proposed at existing public transport interchanges. The additional road traffic that would result from operating

the extended line is expected to be negligible in relation to existing flows arounds these interchanges, although it could lead to extra pressures on car parking in the streets surrounding stations. Most passengers using the new Jubilee Line Extension would probably join or leave the line via other London Underground lines, British Rail lines, or buses; this likelihood should be reinforced by the deliberate absence of additional car parking facilities on the extended line. It is also likely that the extended line would result in the substitution of rail journeys for road journeys, resulting in an overall net decrease in London road traffic.

Visual impacts of the completed scheme

Most of the proposed line would run underground, and the main visible features would be the stations and ventilation and escape shafts, the surface line from Canning Town to Stratford, and the Stratford Depot.

At Westminster, Waterloo, and London Bridge stations, the new Jubilee Line facilities would be incorporated within the existing stations. At Waterloo and London Bridge, it is not anticipated that there would be any new potential sources of visual impact, other than visually minor modifications to the existing structures. At Westminster, modifications are planned to the existing station, with new stair access to a ticket hall under Parliament Square. The Jubilee Line works would be incorporated within the redevelopment over the existing station, and once the works are complete, there could be an overall improvement in the appearance of the station and its environs.

The new stations at Southwark, Bermondsey, and Canning Town should have little visual impact on the existing built-up area. The remaining underground stations, at Canada Water, Canary Wharf, and Brunswick, would be designed within the overall development plans for their surrounding areas. Construction of the surface stations at West Ham and Stratford, both of which would be extensions of existing British Rail/London Underground stations, could result in visual improvement. The proposed Stratford Depot is similar in scale and composition to the existing sidings and industrial properties, and so should cause little visual change.

A number of the ventilation and emergency escape shafts would be directly incorporated into the new stations, but approximately 13 shafts would need to be free-standing. Although the exact locations of these have not yet been decided, wherever possible they will be concealed within existing structures, such as railway viaducts along the route. All the shafts should be designed in consultation with local authorities so as to minimise visual intrusion - particularly, for the shaft proposed for Storey's Gate, at the corner of St James's Park; here there is a possibility of constructing it within a purpose-built extension to the existing police station, which is a Listed Building.

As noted in the previous discussion on impacts during construction, work at the construction sites would lead to the temporary loss of a number of features and amenities in London. The contracts should specify that these sites must be fully reinstated and, where possible, enhanced. Particular importance should be given to reinstating the sites at St James's Park, Parliament Square, Canada Water, Downtown Road and Durands Wharf. The exact requirements for reinstatement at Jubilee Gardens will depend on the other, possibly more extensive, developments planned around the site.

Cultural and ecological impacts

Architectural and historical features

While some sites along the route would suffer immediate environmental effects, there could be a wider and less immediately-evident impact on buildings as a result of settlement, dust, and intrusion from new structures. ERL therefore identified all the buildings and other works which could be at risk because of their proximity to the Jubilee Line Extension, and which are included in the Department of Environment List of Buildings of Special Architectural and Historical Interest. Among the approximately 100 entries are:

- Several Grade I and Grade II buildings in the St James's Square area
- The police station (Grade II) at the corner of Horse Guards and Birdcage Walk
- The buildings surrounding Parliament Square, including Westminster Abbey, and the statues in the square (certain of these statues would need to be removed and stored)
- Buildings and the statue of Boadicea on the Victoria Embankment, where a ventilation facility is proposed
- County Hall (Grade II)
- St James's Church (Grade I) in Old Jamaica Road.

The evaluation of settlement risk is not yet complete. Although the depth of the proposed tunnel suggests that there would be little settlement along the line, there is some risk of settlement close to proposed station works. Particular attention should therefore be given to preventing settlement during construction work which is close to important buildings. There should be continuing liaison with local authorities to prevent damage in locally-designated Conservation Areas.

Archaeological features

As evidenced by the recent discovery of the foundations of the Rose Theatre in Southwark, the area of London just south of the Thames has a long, but largely unrecorded, history of habitation. It is possible that construction on particular parts of the Jubilee Line Extension could be delayed by an Archaeological Inspector acting under the Ancient Monuments and Archaeological Areas Act and the more recent National Heritage Act. The Inspector could halt construction and require a prior investigation for archaeological remains. To minimise the possibility of such delays, a thorough archaeological assessment of each construction site on the line should be carried out well before construction is due to begin. This would allow time, if needed, for the development of an 'action plan' for excavation and a 'watching brief' during construction. Five sites of potential archaeological importance have already been identified in the course of discussions with local authorities and the Museum of London; these include the site of a Roman/ Medieval town in North Southwark, and of a Saxon/Medieval settlement in Rotherhithe.

Ecological impacts

The main part of the proposed line would pass through or beneath areas of minimal importance for nature conservation and wildlife. Nevertheless, nine sites have been identified where there could be some disturbance to local ecology:

St James's Park is an area of great amenity and scenic value, which is designated as a site of Metropolitan Importance for Nature Conservation. Although a small area in the corner of the park would be lost to an escape shaft, this would have little effect on the park's wild-life. However, special care should be taken to avoid damage to trees during construction. Several open areas carry the 'ruderal' vegetation (dominated by plants such as Rosebay Willowherb and London Pride) which is characteristic of sites with intermittent urban activity. These include sites in **Ewer Street, Old Jamaica Road**, the **Limmo** Peninsula, **Stratford Market**, and land alongside **the overground part of the railway from Canning Town to Stratford.** Of these, only the Limmo site is considered to be of nature conservation importance, as it supports a range of invertebrates and birds which are uncommon in London. Construction of the new line would directly affect about 10% of the Limmo area, but it could cause disturbance over a wider area, particularly to birds.

Canada Water Dock is being developed as a wildfowl site by London Dockland Development Corporation's 'Wildlife in Docklands' project. Construction works associated with Canada Water Station could require

the temporary loss of some of the recently-created landscape shoreline of the dock. As little of this area should be used as is practicable, and it should be fully reinstated when the works are complete.

Two other sites are noted for their wildlife potential:

- The filled-in area of **Russia Dock**, adjacent to Downtown Road, has been planted as woodland with ponds to create a wildlife habitat. A small part of this would be lost for a ventilation and escape shaft; but any young trees removed could be readily replaced, perhaps with a wider range of tree species than were used in the original planting.

- The temporary loss of land in the park at **Durands Wharf** has already been noted, but this should have little effect on wildlife.

Overall, there will be little loss of important plant or wildlife habitat during the construction of the Jubilee Line Extension. Measures should be taken to minimise any risks that do emerge - for example, by fencing sites before works begin, so as to prevent workers entering sensitive areas and to avoid the casual tipping of soil. Building works may require the loss of one mature tree in Parliament Square, which is protected by a Tree Preservation Order. Damage to other trees near construction sites should be minimised - for example, by pruning lower branches and protecting trunks with paling. Transplanting (into neighbouring areas which are not affected) can also be used to maintain plant species considered to be at risk.

A1. BACKGROUND TO THE ENVIRONMENTAL STATEMENT

A1. BACKGROUND TO THE ENVIRONMENTAL STATEMENT

A1.1 Objectives

This Environmental Statement presents the results of an assessment of the environmental impacts associated with London Underground Limited's (LUL) proposal to extend the Jubilee Line.

The objectives of the Environmental Assessment can be summarised as follows.

1) To identify the potential environmental impacts of the proposed Extension to the Jubilee Line taking account of its characteristics, the sensitivity of the local environment and the concerns of interested parties.

2) To predict and evaluate the extent and significance of the potential impacts.

3) To identify measures that should be taken to mitigate adverse impacts and to monitor their effects.

Environmental Resources Limited (ERL) was asked by LUL to provide an independent assessment. ERL takes responsibility for the information and recommendations contained in this Statement and believes it provides a proper assessment of the likely effects of the scheme.

A1.2 The Requirements for Environmental Assessment

Although environmental assessment is not a legal requirement for this project, an assessment has been carried out and the results presented in an Environmental Statement (ES), which has been prepared having full regard to the requirements of the Environmental Assessment Regulations[1] implementing the EC Directive[2], the UK Department of the Environment Circular[3] and the recently published booklet on EA[4].

A1.3 Content of the Environmental Statement

Paragraph 2 of Schedule 3 of the UK EA Regulations sets out the information that must be provided in an Environmental Statement:

" (a) a description of the development proposed, comprising information about the site and the design and size or scale of the development;

(b) the data necessary to identify and assess the main effects which that development is likely to have on the environment;

(c) a description of the likely significant effects, direct and indirect, on the environment of the development, explained by reference to its possible impact on:

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(1) The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988. Statutory Instrument No. 1199; in force July 1988.

(2) Council Directive of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment (85/337/EEC) OJEC L175; 5.7.85.

(3) Joint Circular from the Department of the Environment and Welsh Office on Environmental Assessment, Circular No. 15/88, 23/88.

(4) Department of the Environment and Welsh Office; Environmental Assessment; A Guide to the Procedures, HMSO 1989.

- flora;
- fauna;
- soil;
- water;
- air;
- climate;
- the landscape;
- the inter-action between any of the foregoing;
- material assets;
- the cultural heritage.

(d) where significant adverse effects are identified with respect to any of the foregoing, a description of the measures envisaged in order to avoid, reduce or remedy those effects; and

(e) a summary in non-technical language of the information specified above. "

Careful consideration has been given to these information requirements in defining the scope of the assessment; the Consultants believe that the full range of topics has been addressed within this Environmental Statement. It should be noted that this ES only addresses potential impacts associated with routine normal operating conditions.

A1.4 <u>The Scope of the Assessment</u>

A number of points should be made regarding the scope of this Statement and the assessment on which it is based.

o **The Project.** The assessment has been carried out on the basis of information about the proposed Extension provided to ERL. The planning and design of the Extension is a continuing process; inevitably the assessment focusses on a snapshort in time within that process. Certain assumptions have had to be made and these are identified. Information regarding the project presented in this report should not therefore be taken as committing LUL to any particular course of action.

o **Scope of Assessment.** In line with the UK EA regulations, the Assessment has focused on the identification of potential adverse environmental effects associated with the scheme, and the generation of measures aimed at avoiding, reducing or remedying those effects. Whilst the implications of the scheme for employment and other socio-economic or financial aspects have been briefly addressed, it is considered that any detailed examination of these factors, and in particular any economic evaluation, is beyond the scope of the assessment.

o **Treatment of alternatives.** Paragraph 3 of Schedule 3 of the UK EA Regulations states that an environmental statement may include, by way of explanation or amplification, information on:

"(in outline) the main alternatives (if any) studied by the applicant ..... and an indication of the main reasons for choosing the development proposed, taking into account the environmental effects".

Over the course of planning for a new railway in Central and East London, a number of alternatives have been considered. We have not, however, examined these within the framework of this assessment, as the justification for the basic principles of the Jubilee Line Extension were established in the East London Rail study.

o **The Moving Baseline.** It is anticipated that the construction of the railway will take 4-5 years. It is to be expected that there will be changes to a number of areas along the route during this time, whether or not a railway is built; changes will occur in, for example, neighbouring

land uses and the use of the existing transport network. Because of the difficulty of forecasting how these developments will affect the impacts of this project, we have adopted the present situation as the baseline for the assessment. We have however noted where substantial changes are likely to take place which affect our assessment of the significance of impacts.

- **Uncertainty.** Even with a fixed scheme and an unchanging environment, potential impacts are difficult to predict with accuracy. The specific predictions should thus be treated as providing a general indication of the extent of impact, rather than providing a precise value.

- **Interaction with Project Design.** It is made clear in the Department of the Environment Circular that EA should not be seen as an end in itself but as a tool for better project design. It should be used to highlight areas of concern so that modifications to mitigate impacts can be made at an early stage.

- **Consultations.** The Department of the Environment Circular also states "there are often benefits to developers in designing the scheme if consultations are undertaken with the planning authority and other interested bodies during the preparatory stages".

  At the request of LUL, the Consultants have held consultations with local authorities and other interested parties as part of LUL's overall consultation programme, and the interests and concerns expressed have been taken into account in preparing the Environmental Statement.

  A list of Consultees is provided in Annex I at the end of the Statement.

- **Future Environmental Provisions:** In addition to the mitigation measures described in this Environmental Statement, it should be noted that additional environmental protection measures may be incorporated within the scheme as it is progressed; for example, from undertakings given during the passage of the Bill through Parliament, and the requirements of the local authorities concerned regarding construction practices.

A2. THE EXTENSION AND ITS POTENTIAL ENVIRONMENTAL EFFECTS

A2.2.4 Stations

The Jubilee Line Extension will include 11 stations. Their locations are shown in Figure A2.2(a) and they are described in outline in Table A2.2(a) overleaf.

A2.2.5 Tunnel Ventilation and Escape Shafts

A ventilation system will be provided for draught relief, climate control and emergency smoke exhaust. Emergency escape shafts will also be provided in stations and running tunnels to meet the requirements of the Railway Inspectorate.

The locations of ventilation and escape shafts are shown in schematic form in Figure A2.2(b). In addition to draught relief shafts at each end of the stations, there will be the following permanent shafts between stations:

- escape shaft at Storey's Gate Lodge;
- ventilation and escape shaft at Wardens Grove;
- ventilation and escape shaft at Druid Street;
- ventilation and escape shaft in Southwark Park;
- ventilation and escape shaft at Downtown Road;
- escape shaft at Durands Wharf;
- ventilation and escape shaft at Pioneer Wharf;
- ventilation and escape shaft at Blackwall Way;
- ventilation and escape shaft at the Limmo site.

The exact nature of the shafts has yet to be determined, but it is anticipated that they will require an overall area of approximately 45m^2 for a combined ventilation and escape shaft, and 15-20m^2 for an escape-only shaft. The height above ground level will be determined by location and architectural factors.

A2.2.6 The Stratford Market Depot

It is proposed that a depot be provided at the Stratford Market site for the stabling of approximately 40 trains (see Figure A2.2(c)). Facilities will also be provided for the washing and day-to-day maintenance of these trains and also for emergency repair work.

A2.3 The Construction Phase and its Effects

A2.3.1 Activities during Construction of the Scheme

The overall construction programme is expected to last 4-5 years, with a provisional earliest start date in 1991. The main types of construction activity taking place during the period will be:

- tunnelling operations;
- underground and surface station works;
- ventilation/escape shaft construction;
- surface line works;
- track laying;
- station finishing;
- mechanical and electrical works.

Table A2.3(a) presented at the end of this section provides information on construction sites along the route; it contains summary information on the locations of planned work sites, the main activities taking place at each site, and key information on the surrounding land-uses at each location. Further details are given in Section A3. The locations of the construction sites are shown in Figure A2.3(a). Construction periods at shaft only locations will be up to 2 years. In general, major works at other construction sites will take 3-4 years.

In addition to sites needed for sub-surface station works, six construction sites have been identified as possible tunnelling sites. These are:

- Jubilee Gardens;
- Ewer Street;
- Old Jamaica Road;
- Durands Wharf;
- Blackwall Way;
- East India Dock Basin.

Table A2.2(a) **Proposed Stations (for locations see Figure A2.2(a))**

Westminster	Proposed new Jubilee Line platforms at Westminster would connect with the existing Westminster Station, presently serving the Circle and District Lines. Siting the Jubilee Line at Westminster would give passengers improved access to Whitehall and Parliament Square. The design of the enlarged station would be fully integrated with the overall redevelopment that is now taking place
Waterloo	The Jubilee Line platforms at Waterloo would be constructed beneath the present British Rail main line station. This would provide an interchange with British Rail's Network Southeast services, the proposed Channel Tunnel Terminal, the Northern and Bakerloo Lines, and the Waterloo and City Line.
Southwark	A new London Underground station is proposed here, to be sited near the junction of Blackfriars Road and The Cut. The station would serve the local area and provide an interchange with buses.
London Bridge	The proposed Jubilee Line platforms would be built beneath the present British Rail station, allowing passengers to connect to main line trains as well as to the Northern Line. The proposal would link with plans to improve the capacity of the Northern Line and to provide a new station entrance on Borough High Street.
Bermondsey	A new London Underground station is proposed at the junction of Keeton's Road and Jamaica Road, to serve the local residential areas and provide an interchange with bus services on Jamaica Road.
Canada Water	This proposed new London Underground station would be sited at the north end of the Surrey Quays development. An interchange is proposed with a new station on the East London Line. Bus interchange facilities are also proposed as part of the station complex.
Canary Wharf	A new London Underground station is proposed within the Canary Wharf development currently under construction. It would be built directly beneath the old West India Docks, and would enable interchange with the Canary Wharf station of the Docklands Light Railway. The station is intended to service the large commercial and residential development at Canary Wharf and Heron Quays, as well as other new developments on the Isle of Dogs.
Brunswick	This new London Underground station would be built at the site of the old Brunswick Power Station on the north bank of the Thames, to serve new developments proposed for the area.
Canning Town	This proposed new London Underground station would form part of a new station arrangement at Canning Town adjacent to the A13. The arrangement will incorporate the existing British Rail station and the proposed Docklands Light Railway station.
West Ham	It is proposed that the station at West Ham be expanded to accommodate the new Jubilee Line platforms and ticket hall, providing interchanges with the District and Metropolitan Lines, British Rail's proposed reinstated Fenchurch Street main line platforms, and the North London Line.
Stratford	The proposed Jubilee Line platforms would be located to the south of the existing British Rail and Central Line platforms, alongside the North London Line platforms. Stratford is also a terminus for the Docklands Light Railway, a bus interchange, and the site of two multi-storey car parks.

Table A2.3(a) - Continued
Construction Activities along Railway Route

Construction Site Location	Existing Use	Construction Activities	Surrounding Land Use
Joan Street (10)	Printing/Warehousing	Construction of draught relief shaft for Southwark station. Possible construction of passenger connection between BR Waterloo East Station and Southwark Station.	Telephone exchange, residential properties, workshops, warehousing.
Joan Street/The Cut (11)	Restaurant, car park, offices, workshops, warehousing.	Construction of Southwark Station.	Residential properties, workshops/ warehousing, offices, railway viaduct.
Scoresby Street (12)	Courier/chauffeur company and electrical shop	Construction of draught relief shaft for Southwark Station.	Residential properties, railway viaduct, workshops, warehousing, British Library stores.
Union Street (13)	Car park.	Site offices to support Ewer Street tunnelling site.	Rowland Hill House (flats), number of offices, public house, workshops under British Rail viaduct.
Ewer Street (14)	Derelict site.	Possible tunnelling site for western section of route; spoil removal operations, tunnel lining and track delivery and off loading.	Disused Metal Box works, at present being renovated, light industrial units, workshops, public house, with residences above.
Wardens Grove (15)	Vehicle repair shops.	Construction of ventilation and escape shaft.	Commercial industrial area, number of flats in Union Street, close to Thrale Street Conservation Area.
London Bridge Station/ (16) Joiner Street west/ Railway Approach	Underground car park, vacant plot at upper level.	Site for constructing London Bridge Station; access to work area below existing station; construction of extension to existing ticket halls and associated concourse.	Station area, bus te minus, offices, Guys Hospital and associated residences, Southwark Cathedral.
Duke Street Hill (16)	Railway arch and adjoining footpath	Site for constructing new street access.	Station area, bus terminus, offices, Guys Hospital associated residences.
Joiner Street east (16)	Series of bonded warehouses.	Construction of London Bridge passenger concourse and escalators to link new underground to existing BR ticket hall. Construction of draught relief shaft.	Warehousing.
Druid Street (17)	Warehousing/Workshops.	Construction of ventilation and escape shaft.	Light industrial area.

Small work sites will also be needed for construction of intermediate ventilation and escape shafts; these will be located at:

- Storey's Gate;
- Wardens Grove;
- Druid Street;
- Southwark Park;
- Downtown Road;
- Pioneer Wharf;
- The Limmo.

A small work site will also be required in St James's Square for the underground works at the junction of the existing and new Jubilee Line tunnels.

A2.3.2 Tunnelling Works

The railway will run in tunnel over a distance of about 12km at an average depth of 25m. The geological nature of the strata to be tunnelled is a key factor in determining the tunnelling methods employed. Geological conditions change considerably along the railway route; the western section is predominantly in London Clay, the eastern sections are chiefly in the Woolwich and Reading Beds and Thanet Beds.

- o The London Clay is typically a stiff silty clay, generally homogeneous, with sandy laminations.

- o The Woolwich and Reading Beds range from plastic clays to dense sands, being generally more clayey in the west and more sandy in the east of the route.

- o The Thanet Beds are fine-grained sands containing clay and silt layers.

Tunnelling conditions in London Clay are generally good and conventional methods are envisaged. The Woolwich and Reading Beds present more difficult ground conditions because of the presence of water bearing sand, and special tunnelling techniquesare likely to be necessary.

A number of techniques are available including the use of bentonite slurry or earth pressure balance shields, and compressed air tunnelling.

The rate of tunnelling is dependent on a number of factors, including ground conditions, and will vary along the route. Average tunnelling rates of the order of 50 metres per week are anticipated.

Tunnelling is usually carried out on a 24 hour basis for both economic and safety reasons.

Most of the tunnel will be lined with precast concrete segments, delivered to the tunnelling sites identified in A2.3.1. Cast iron linings may be used for certain sections.

A2.3.3 Other Works

The construction of the Extension will necessarily require diversions and protective works to Statutory Undertakers' and other services, such as electricity, water and gas supplies and telecommunications. These works will be carried out by or under the supervision of the relevant utility/authority, and where appropriate, parallel systems should be provided before disconnection of the existing service, in order to minimise any disruption.

A2.3.4 Construction Material Supplies

Bulk materials will include precast concrete and cast iron tunnel lining segments, and concrete. The sources of these materials have not yet been determined.

Concrete is likely to be supplied both from local ready-mix plants and from on-site contractor's batching plants. Other construction materials including rails, escalators, machinery etc., will come from a variety of sources.

A2.3.5 Construction Employment

The number of construction workers is difficult to estimate with any accuracy as it will depend on the eventual contractor's method of working. It would however be expected to be in the order of 2500-3000, including site management. The main part of the workforce will comprise tunnellers and heavy civil engineering workers.

Some will be recruited locally but the tunnel men and skilled craftsmen are likely to come from elsewhere. No special provision for housing of workers is expected to be necessary.

A2.3.6 Identification of Potential Environmental Impacts During Construction

The possible impacts that could arise during construction of the Jubilee Line Extension, and which have therefore been considered in this Statement, are presented as a checklist in Table A2.3(b) below.

The main issues to be considered during construction are:

- disturbance (noise, dust, visual) to local residents and other sensitive land uses (schools, hospitals, churches, playgrounds, shops and offices) caused by on-site construction activities;
- loss of public amenity and loss or damage to properties through construction activities and tunnelling;
- disruption caused by construction traffic;
- disturbance or loss of existing natural or semi-natural habitats;
- impacts arising from the disposal of tunnelling spoil and disturbance of contaminated soils.

Table A2.3(b): Checklist of Possible Construction Impacts

Activity	Impact to be Investigated
Occupation of construction sites	o Loss of or disturbance to existing land uses and property o Loss of or disturbance to existing ecology
Site preparation and construction activities (demolition of buildings, breaking up of existing foundations, cutting operations, creation of work site island at Canary Wharf, piling, excavation, materials handling and storage, etc)	o Noise, dust, visual impacts o Soil/sludge contamination o Changes in surface and groundwater regime • Run-off and water quality impacts; effects on groundwater recharge o Disruption to road and pedestrian access.
Tunnelling and tunnel lining operations (incl. tunnel drainage)	o Noise and vibration o Risks of settlement o Changes in ground water conditions and effects on abstractions and discharges to surface water o Water quality impacts (from e.g. dewatering activities)
Transport of construction materials/equipment/workers	o Traffic noise and disturbance • Impacts on transport networks
Presence of temporary structures, plant and equipment on site	o Visual impact
Spoil removal and disposal	• Increased pressures on transport networks • Dust o Water quality impacts o Impacts on local disposal capacity for tunnel spoil, construction debris and special wastes.

A2.4 The Operating Phase and its Effects

A2.4.1 Traffic on the Jubilee Line Extension

The Extension is assumed to operate for 19 hours a day, from 0530 to 0030 hrs on Mondays to Saturdays and for shorter hours on Sundays. This is the same as traffic on the existing line. The estimated number of train movements[1] expected on the extension in 1995 is as follows:

Green Park - Canary Wharf

Peak Hours (5½ hrs/day)	27 trains/hr each way
Off Peak Hours (13½ hrs/day)	15 trains/hr each way
Total Movements	702/day

Canary Wharf - Stratford

Peak Hours (5½ hrs/day)	21 trains/hr each way
Off Peak Hours (13½ hrs/day)	15 trains/hr each way
Total Movements	636/day

For the purpose of the assessment we have assumed that all trains running on the Extension will be the same as those operating on the existing line (e.g. with regard to noise characteristics). Additional rolling stock will be introduced, and if this is of a new design, could have improved noise and vibration characteristics, but this has not been taken into account in predictions relating to the Extension.

A2.4.2 The Stations and Depot

As noted above 11 stations are proposed on the Extension. Eight of the stations will provide interchanges with other lines; three new stations will be provided at locations with no existing or planned stations (at Southwark, Bermondsey and Canada Water). It is currently anticipated that new bus interchange facilities will be provided at Canada Water and Canning Town.

The depot at Stratford Market will provide stabling facilities for about 40 trains and for cleaning and day-to-day maintenance. Most of this activity will take place at the beginning and end of the morning and evening peak periods when trains are moving in and out of the depot. Maintenance and cleaning will mostly be carried out during the day. Major maintenance work will be carried out at existing facilities.

A2.4.3 Shafts

There will be draught relief shafts at all stations, and at 9 intermediate locations there will be ventilation and/or escape shafts. Ventilation shafts are provided for pressure relief in the tunnels and to provide cooling. For the latter purpose they will be fitted with fans to extract air when necessary. The extent to which these fans will be used has not yet been established, but it is likely that they will need to operate in hot summer weather. They will also be used for emergency removal of smoke in the event of a fire, and will need to be tested at intervals for that purpose. A structure will be required at the surface for each ventilation shaft. The design of these has not been considered in detail as yet, but ventilation shafts elsewhere on the Underground are housed in a wide variety of structures, from simple housings to park lodges and terraced houses. Two dedicated escape shafts are also planned at Storey's Gate and Durands Wharf. In the normal course of events all escape shafts will be sealed by emergency doors.

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(1) Train, lorry and car movements: the term 'movement' refers to a 'one way' journey only. Therefore the outward and return journeys of a single train would be counted as two train movements, and similarly for cars, lorries and buses.

Environmental Protection Act

PGA 1990 c. 43

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CORRECTIONS

Section 155

Page 153, in section 155, the marginal citation should read "1968 c. 73".

Schedule 15

Page 223, in paragraph 9 "the Hovercraft Act 1986" should read "the Hovercraft Act 1968".

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A2.4.4 Maintenance

The most significant maintenance activity is rail grinding which, if carried out on the proposed line, will be performed during commissioning of the line and every 2 - 3 years. It is likely to be carried out at night by special track-grinding trains.

A2.4.5 Operational Employment

The number of new railway jobs generated by the operation of the Extension is estimated to be in the region of 370. This will consist of:

Train Operators	130
Station Staff	100
Depot Staff	100
Service Control	20
Management and Adminstration	20
Total	370

A2.4.6 Identification of Potential Impacts

A checklist of possible impacts during operation of the Extension is given in Table A2.4(a) below, and these have been investigated in the assessment.

The main issues associated with operation are:

- the impacts of noise and vibration from underground operations;
- the impacts of noise, and other emissions and visual intrusion, from ventilation/escape shafts on neighbouring sensitive land uses;
- the noise and vibration impacts of near ground and surface sections of the line, surface stations and the depot, on residential properties and other sensitive land uses.

Table A2.4(a)
Checklist of Possible Operational Impacts

Activity	Impact to be Investigated
Operation of underground stations and section of the line	o Noise and vibration from trains and track maintenance.
	o General disturbance to local residents from increased activity in vicinity of stations (passengers, vehicle movements, etc)
	o Visual impacts of permanent surface entrance halls and ventilation and escape shafts.
	• Sub-surface drainage.
	o Air emissions from vent shafts and tunnel portal.
	o Permanent landtake for surface works.
Operation of surface section of the line	• Noise and vibration
	• Visual impacts.
	o General disturbance to local residents from station activities.
	o Surface wastes drainage.
	o Permanent landtake.
Operation of depot	o General disturbance (noise, dust, visual).
	o Site drainage and impacts on water quality.

A3. SUMMARY OF IMPACTS ALONG THE ROUTE

Table A3.1
General Route-Wide Mitigation Measures

Land Use and Property Impacts	o Full reinstatement of all temporary working areas either to their original form or to a new form decided in consultation with local authorities. o Full compensation, as required by the provisions of the Land Compensation Acts, for acquisition of property permanently taken for the Extension. o General condition surveys of all property considered to be subject to risk of damage from settlement, to establish its condition prior to tunnelling. o Full structural survey of Listed Buildings considered to be subject to risk of damage from settlement. o Establishment of programme for archaeological investigation/"watching brief" prior to and/or during site preparation at all work sites in accordance with relevant codes of practice.
Construction	o Avoidance of night-time surface working wherever practicable and where night-time working is essential, careful control over noisy activities, e.g. lorry movements. o Establishment of strict standards of practice for activities on and in the immediate vicinity of work sites, to control, inter alia dust, noise, vibration, site drainage, movement of personnel and vehicles, encroachment into neighbouring areas. o Screening of construction sites with appropriate hoardings and posting of site notices explaining the reasons for the work and its expected duration.

Table A3.1 - Continued
General Route-Wide Mitigation Measures

	o Establishment of a contact point with local residents at all work sites and at the Project Office and regular provision of information, including prior warning of especially noisy events such as percussive piling. o Prior investigation of all structures within 30m of all proposed percussive piling operations to determine the risk of structural damage and the appropriate measures. o Agreement of a general Code of Practice for construction activities with all local authorities. o Agreement of a specific Code of Practice for individual sites with the appropriate local authorities. o Establishment of a programme to monitor dust and noise levels around construction sites.
Tunnelling	o Adoption of appropriate tunnelling methods to control inflow of water in areas of saturated ground and immediate impermeable lining and grouting of tunnels. o Minimising risks of settlement during tunnelling by continuous working, insofar as this is consistent with objectives relating to control of night-time disturbance.
Noise and Vibration	o Establishment of a programme to design a resilient track form suited to the Jubilee Line Extension, to reduce noise from tunnels to acceptable levels. o Establishment of design aims of peak noise level of 40dB(A) in properties above tunnels, and 24 hour L_{eq} of 70dB(A) at the facade of properties adjacent to the surface line. o Establishment of a design aim for ventilation shafts that fan noise at the nearest sensitive property should not exceed the background noise level (L_{90}) by more than the level of "marginal significance" established in British Standard 4142 (noise suppression equipment to be fitted as appropriate).

Table A3.1 - Continued
General Route-Wide Mitigation Measures

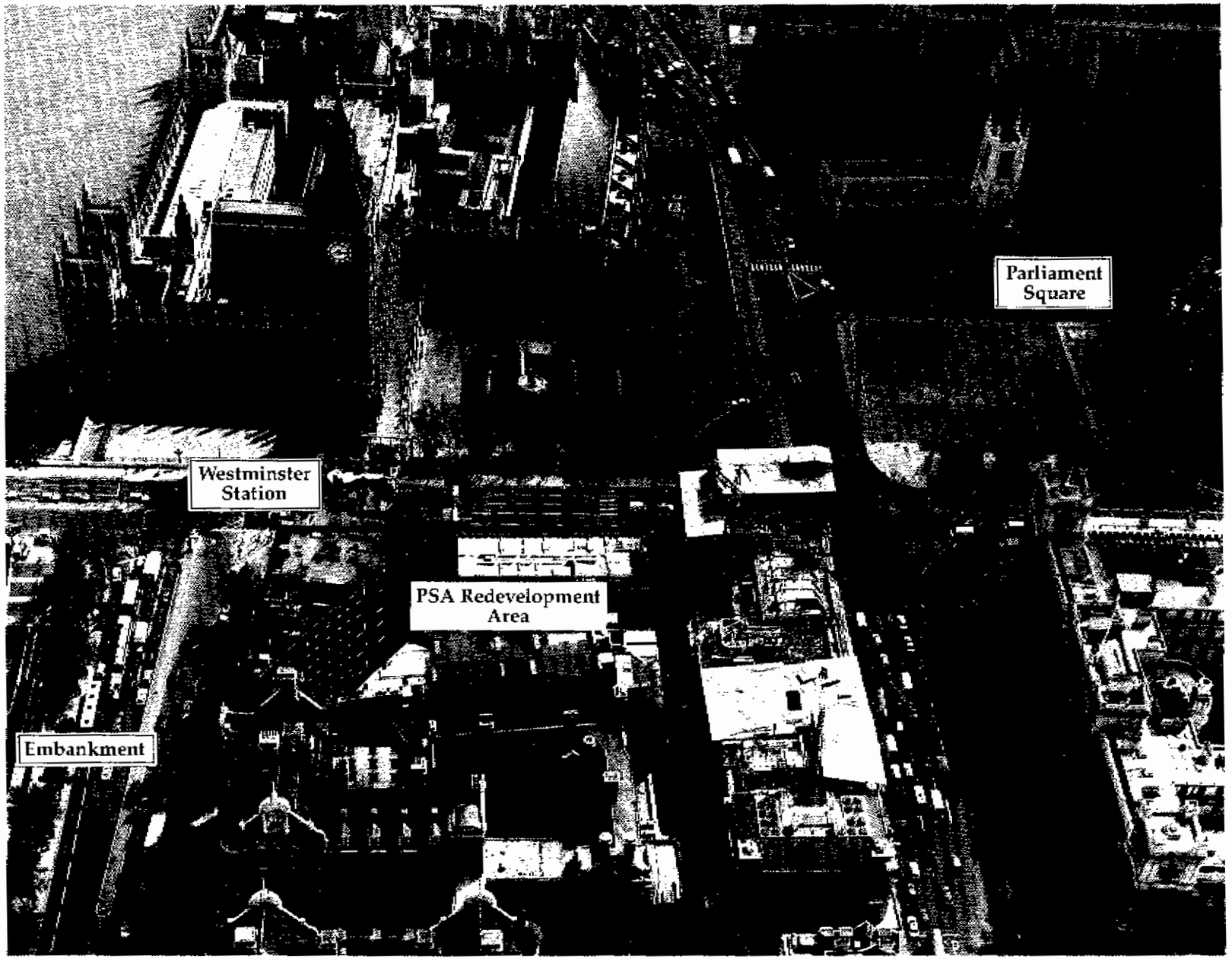
	o Design of surface station p.a. systems to minimise noise intrusion at adjacent properties; use of concrete surfaces for stairs, etc. in surface stations to avoid noise amplification effects associated with wooden or metal structures. o Provision of information to residents on timing of maintenance works on the line.
Transport and Traffic	o Provision of alternative routes or means of access, wherever practicable, where road and footpath closure or narrowing is unavoidable, in consultation with local authorities. o Use of barge transport for spoil removal and materials delivery where practicable. o Consultation on scheduling and routeing of vehicles with local authorities and establishment of a vehicle identification system. o Minimising night-time lorry movements and overnight lorry parking.
Spoil Disposal	o Maximising use of spoil in construction or for other purposes and dewatering of spoil slurries to maximise usability. o Disposal of all surplus spoil in accordance with the requirements of the Control of Pollution Act 1974 and subsidiary regulations. o Establishment of a consignment notice system for spoil transport to prevent fly-tipping. o Prior investigation of all sites identified as possibly containing contaminated soils and identification of appropriate treatment measures.

Table A3.1 - Continued
General Route-Wide Mitigation Measures

	o Provision for separation of contaminated spoil and for separate handling and disposal, including arrangements for chemical analysis. o Establishment and enforcement of strict standards for work with contaminated soils to minimise risks to workers, the project, and the external environment.
Visual Impacts	o Screening of all construction sites, with particular attention to sensitive areas. o Sensitive design of all surface structures in keeping with surrounding land uses and existing views.
Urban Ecology	o Measures to prevent encroachment from construction sites into adjacent areas of wildlife interest (fencing). o Protection of mature trees on and around work sites; use of selective lopping, root matting and palings to minimise damage to trees.
Aquatic Impacts	o Compliance with consent conditions for all discharges to water; monitoring according to the requirements of the National Rivers Authority.

ROUTE SECTION 1

GREEN PARK TO WATERLOO



The worksites at Parliament Square and Westminster Station

Station entrances are proposed on the north eastern corner of the square, on Great George Street, on either side of Parliament Street and of Bridge Street, and on Victoria Embankment.

On the completion of the works, Parliament Square should be reinstated to its pre-construction condition, or to an alternative style, agreed in consultation with Westminster Council and the House Authorities.

- **Jubilee Gardens** is an area of landscaped open space shown on Figure A3.2(c). It lies within a Conservation Area on the east bank of the River Thames, immediately to the north of County Hall (a Grade II* Listed Building). The gardens, which form part of the South Bank riverside walkway, are a popular recreational area and provide the venue for many festivals and events, particularly during the summer months. The bank of the Thames is identified as an area likely to be of archaeological importance as a result of its long history of industrial and residential use.

  Past industrial activities in the area of Jubilee Gardens have included an iron foundry, and a lime and cement wharf. It has therefore been identified as likely to contain contaminated soils which may require special treatment.

  Approximately 2.4ha (65%) of Jubilee Gardens will be used for the excavation of a crossover junction on the railway to the west of Waterloo Station. It is also intended to be used as a tunnelling site for the 1700m tunnelling drive to Green Park; an alternative site for this activity could be Ewer Street. It is intended that the spoil arising from these operations will be removed by barge from a temporary pontoon sited in the River Thames, immediately adjacent to the site. If used only for the construction of the crossover junction, Jubilee Gardens will be required for up to 2 years. Should the site be used for tunnelling it will be occupied for major works for approximately 3-4 years.

  Following construction works, Jubilee Gardens should be fully reinstated either to its previous condition, or to an alternative use to be agreed with the local authorities.

  The South Bank area is currently the subject of several development proposals, including the redevelopment of County Hall and construction at Waterloo Station.

  These proposals also involve the use of Jubilee Gardens for material delivery and spoil disposal. The possibility of joint phased use of the Gardens by the contractors involved in the Jubilee Line Extension and other schemes is currently being explored, to minimise the total period of disturbance and the total number of sites affected.

- **Waterloo.** The Waterloo construction area comprises three sites, shown on Figure A3.2(c) and accompanying photograph: the area of arches below the Waterloo Main Concourse, an area of hardstanding with 15 shop units on Tenison Way, to the north of the Main Line Terminus, and the central (sunken) portion of the Waterloo Bridge roundabout. The area is one of very mixed commercial and residential character undergoing substantial redevelopment. The Tenison Way site is proposed for redevelopment as offices.

  The Waterloo roundabout lies within the South Bank Conservation Area, and the Waterloo Station and Tenison Way sites are adjacent to the South Bank, Waterloo and Roupell Street Conservation Areas.

  These sites will be used for the construction of a new ticket hall, access stairways/escalators and draught relief shafts associated with the Jubilee Line interchange to be provided at Waterloo. Major works at these sites will take approximately 3½ - 4 years.

  Waterloo Station itself will undergo extensive redevelopment over the next 5 years, notwithstanding that associated with the Jubilee Line Extension. British Rail was granted planning permission to develop Waterloo as the first Channel Tunnel

At this stage of design the risk of damage to most buildings is considered to be slight and limited to superficial cracking which may be easily repaired.

Services in this area may also be subject to disturbance and settlement from the station and tunnel construction. Critical and sensitive services will need to be diverted before construction starts. Elsewhere regular monitoring should be adequate to detect excessive settlement and enable protective works to be carried out before damage occurs.

Noise and Vibration during Operation

The assessment has considered the potential for complaint about noise and vibration from operation of trains through tunnels.

o **Noise.** In this section of the route, noise levels which could give rise to complaints from residents may be experienced in basement and ground floor rooms in properties lying within corridors of the following widths above the route centre line (with standard trackform):

175m - west of St James's Park;
100m - between St James's Park and The River Thames;
125m - east of The River Thames.

It has not been possible to identify specific residential use of properties within these corridors, but no significant impact would be expected when such spaces are used for general purposes, e.g. building services, kitchens. It is possible that some noise sensitive uses may exist. In view of the potential for noise disturbance above the tunnels if standard trackform is used, it is recommended that a programme be set up to design a resilient trackform to reduce noise to acceptable levels.

There are no ventilation shafts on this section of the route in close proximity to sensitive land uses and thus measures to reduce fan noise are not expected to be necessary.

o **Operational Train Vibration.** Vibration from train passage is not expected to reach levels which could give rise to adverse comment anywhere along this route section.

A3.2.8 Conclusions

Special requirements for mitigation within this section of the route have been identified as follows:

- a Grade II Listed Building, at No's 1-2 Bridge Street, Westminster, will require special measures to avoid settlement damage if it is not demolished to accommodate works at Westminster station;

- prior site investigations will be required at Jubilee Gardens to establish whether contaminated soils, likely to require special treatment, are present;

- prior investigation and/or a "watching brief" for excavations will be required in areas of archaeological significance at Westminster and along the bank of The Thames at Jubilee Gardens.

Consideration should be given to scheduling construction activities at Tenison Way so as to minimise disturbance of activities in St John's Church.

There will be a particular need in this area to observe strict standards for construction activities, because of the historic and cultural sensitivity of the surrounding area. LUL should comply with the requirements of Westminster Council's Considerate Builders Scheme.

Key issues associated with the works in this section of the route are considered to be:

- the temporary loss of Parliament Square and Jubilee Gardens and possible increases in traffic congestion during peak construction periods in Westminster;

- the requirement for construction of an extension to the Grade II Listed police station on the corner of Storey's Gate, to house an escape shaft;

- the loss of local shops and commercial units in the railway arches north of Waterloo, although there are already proposals to redevelop this site;

- the temporary loss of an unofficial sleeping area for the homeless beneath Waterloo Bridge Roundabout;

- the possible temporary closure of parts of the pedestrian underpass/subway system beneath Waterloo Bridge roundabout.

Table A3.2.5: Impacts of Construction: Green Park to Waterloo

Main Sites

Parliament Square and Westminster Station (construction of Westminster Station)

The Jubilee Line construction sites for Westminster Station include the central area of Parliament Square (approx 0.5ha), forming the junction of Great George Street, Parliament Street, Bridge Street, St Margaret Street and Broad Sanctuary. The site is close to several Listed Buildings of historical importance; approximately 45m from the Houses of Parliament (Grade I), Middlesex Guildhall (Grade II*), 35m from St Margaret's Church (Grade I) and 65m from Westminster Abbey (Grade I), and lies within a Conservation Area, a special archaeological priority area, and an Area of Special Character of metropolitan importance. These buildings attract large numbers of visitors to the area, particularly during the summer months. Construction works will also take place within the existing station itself and on Victoria Embankment.

Land Use and Property Impact	Depending on the redevelopment option selected by the Government Property Services Agency, a number of shops, and several Government offices may be lost at Westminster Station during the redevelopment of the station area and the incorporation of the Jubilee Line facilities. The shops and offices may be reinstated following construction depending on the final PSA development design. This impact results primarily from the PSA development. The central open area of Parliament Square (approximately 0.5ha) will be used for major works for approximately 3½-4 years. At the completion of construction works, it should be reinstated to its previous condition, or to an alternative style, to be agreed with Westminster Council. An area of approximately 800m^2 on the Thames Embankment to the north of Westminster Bridge, adjacent to the statue of Boadicea, will be required for major works over a period of up to 2 years. This area should also be reinstated following construction.
Noise and Vibration	Noise levels at the facades of buildings within the Square are presently high, due to high levels of road traffic; measurements suggest that during the day the noise level exceeds 67 dB(A) 90% of the time. Worst case noise levels at Parliament Square during the early phase of construction may reach 73 dB(A) for short periods. More typically noise levels will be between 61 and 68 dB(A). This is not expected to cause intrusion against the background level of c.67 dB(A).
Dust and Visual Impacts	Strict standards of construction practice, in accordance with Westminster Council's Considerate Builder Scheme, should be adopted to minimise any adverse effects of dust. The Extension works are unlikely to increase dust deposition noticeably in the area, because of the high levels of traffic and other construction activity already taking place. In view of the sites' location within an Area of Special Character, and the area's popularity for tourists, particular care should be taken in the design and decoration of screening around the sites. Permanent surface works (access stairways and the ventilation facility) should be designed taking full account of the character and significance of the area; two of the station entrances will be incorporated within the PSA redevelopment.
Access and Traffic Aspects	The Parliament Square site is expected to be accessed from Broad Sanctuary, with approximately 140 vehicle movements per day at peak. With the existing poor traffic conditions due to heavy vehicle flows and congestion, significant increases in congestion or lengthening of journey times are not expected. Partial carriageway and footpath closures are required within Parliament Square to facilitate the construction of the work site 'umbrella'. These partial closures will occur during off-peak overnight periods over a period of six months. Alternative routes include Lambeth Palace Road, York Road and Horse Guards. Total closure of Parliament Square for approximately 3 days will be necessary for the installation of the 'umbrella'; this could be carried out over a Bank Holiday weekend to minimise disruption. Alternative routes via the Albert Embankment or Horse Guards are available. One lane of the southbound carriageway of the Victoria Embankment, and both footpaths, may be temporarily closed between Bridge Street and Derby Gate during the construction period. To avoid significant pedestrian disruption, the footpaths would not be closed simultaneously (alternative routes are available via Whitehall and Richmond Terrace). No simple traffic detour is apparent, however, and traffic congestion during peak hours is likely.

Table A3.2.5 (Continued) Impacts of Construction: Green Park to Waterloo

Main Sites

Access and Traffic Aspects (contd)	The footpath on Broad Sanctuary, on the south side of Parliament Square, will be temporarily closed to allow access to the Parliament Square construction site. Alternative routes are available via the remaining footpaths on Parliament Square, and thus little disruption to flows is expected. Sixty metres of the eastern footpath of Cannon Row, from its junction with Bridge Street, will be temporarily closed to allow access to Westminster Station, but alternative routes are available via Whitehall. Cannon Row is currently closed for site access to the PSA redevelopment on the corner of Whitehall and Bridge Street; its long term future has yet to be decided.
Cultural Resources	As noted above, and indicated in Figure A3.2(b), there are a number of Listed Buildings in the vicinity of the Parliament Square work site, and the site is located within a Conservation Area. Strict on and off-site controls will be required to ensure that none of these buildings are adversely affected. The statues within Parliament Square, and if necessary, that of Boadicea on the Victoria Embankment, should be protected or removed for safe keeping and possible refurbishment during the construction period. The Grade II Listed lampposts on Cannon Row should also be suitably protected or removed. The incorporation of the Jubilee Line facilities within the PSA redevelopment at Westminster Station may require the demolition of Number 1 and 2 Bridge Street (Grade II Listed). If retained, this building may require special engineering measures to support it. In view of the special archaeological interest of the area from Storey's Gate to the Thames, particular emphasis should be placed on the archaeological assessment of this site and the development of appropriate investigation/watching brief schemes prior and during construction.

Jubilee Gardens (tunnelling)

The site is located within Jubilee Gardens, immediately to the north of County Hall on the east bank of the River Thames. The work site will occupy approximately 2.4ha (65%) of the Gardens, comprising approximately 1.9ha of landscaping, paths and green space, and approximately 0.5ha of car parking. County Hall is approximately 10m from the southern boundary of the site. Other land uses in the area are predominantly commercial. Two other developments have identified Jubilee Gardens as a potential construction site.

Land and Property Impact	Approximately 1.9ha of open space, pathways and landscaping will be lost during the construction period, leaving approximately 0.5ha of similar area, the remainder of the Gardens being given over principally to car parking. Following construction, the gardens should be fully reinstated to their previous, or an alternative condition, to be agreed with the local authority. Approximately 100 parking spaces (0.5ha) will be lost during the construction period, but alternatives are available within the Jubilee Gardens area immediately to the north of the work site; little disruption is thus expected to result.
Noise and Vibration	Daytime noise levels within the Gardens are low compared to other Central London sites, because they are away from major roads. Current background levels range from about 58 dB(A) at the riverside, to about 62 dB(A) in the vicinity of Belvedere Road. During construction these levels will be substantially increased; in the noisiest period of site preparation levels could reach 79 dB(A). Typically the noise levels will be between 66 and 74 dB(A). The principal impact will be on users of the riverside walk. Impact on County Hall will depend on progress with its redevelopment. There is no residential property near the site and the South Bank complex is separated from the site by a mainline railway.

Table A3.2.5 (Continued) Impacts of Construction: Green Park to Waterloo

Main Sites	
Dust and Visual Impacts	Strict standards of construction practice will be required to minimise dust impacts. No specific additional measures are recommended at this site for control of dust. The location of the site within an area of high amenity value and its high degree of visibility from the River Thames require that particular attention be paid to the sensitive design and decoration of screening around the site to minimise visual impacts to river and inland views.
Access and Traffic Aspects	Access to the site will be via York Road and Belvedere Road, although the majority of materials will be brought to and from the site by barge, via a temporary pontoon to be moored in the Thames. Peak vehicle activity during the construction period is expected to reach approximately 50 vehicle movements/day, which will not cause significant traffic impacts. Two footpaths will be temporarily closed during the construction period. The western footpath of Belvedere Road will be closed to provide access to the work site; alternative access is available via the eastern footpath. The Albert Embankment footpath along the river front may have to be closed for the 180m section immediately to the north of County Hall, where the work site fronts onto the river, to provide access to the jetty. The eastern footpath of Belvedere Road may provide alternative access from the south, via the County Hall access road, or the Jubilee Gardens car park area from the north.
Cultural Resources	The site lies within the South Bank Conservation Area, and so particular care will be required to ensure that the specific conditions laid down for construction work in such areas are met. Immediately adjacent to the Jubilee Gardens work site are County Hall (Grade II*) and the Belvedere embankment and boundary wall (Grade II) which are Listed structures; strict site practice controls should be adopted to ensure that these structures are properly protected, and will not be adversely affected by the construction work.
Waterloo (construction of Waterloo Station)	
The three Waterloo Station construction sites are grouped in an area of mixed commercial and residential use undergoing substantial redevelopment. The Tenison Way site fronts onto Waterloo Road with the BR Railway viaduct to the rear. The Waterloo Bridge roundabout site forms the central sunken portion of the Waterloo Road, York Road, Stamford Street interchange. St John's Church, and the office blocks of Elizabeth House and Waterloo Bridge House are approximately 40m from the work sites. The third site is within the existing station area.	
Land and Property Impact	Fifteen small local shop units and four commercial units under the railway viaduct will be lost at the Tenison Way site. The site will be available after construction. Four commercial storage premises under the arches beneath the main Waterloo concourse will be permanently lost to the main station works, and the station taxi rank will be temporarily restricted. Use of the Waterloo roundabout site will result in the temporary loss of an unofficial sleeping area for the homeless; the local authorities and community groups should be consulted regarding the provision of alternative arrangements for the people affected.
Noise and Vibration	Daytime mean noise levels at these sites are presently high due largely to road traffic. Outside St John's Church on Waterloo Road the background noise level was measured as 57 dB(A). Predicted levels during construction range from 62 to 68 dB(A) with possible peaks up to 72 dB(A) at the Church. If these peaks coincide with times when the Church is in use, disturbance may occur. Consideration should be given to scheduling of activities on this site. The nearest dwellings are 150m away and no disturbance is expected.

Table A3.2.5 (Continued)	Impacts of Construction: Green Park to Waterloo
Main Sites	
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise dust impacts to adjacent properties. No particular additional measures are considered to be necessary at these sites. Visual impacts should be avoided by the provision of appropriate screening.
Access and Traffic Impacts	The sites will be accessed from Waterloo Road and Mepham Street with, at peak, approximately 130 vehicle movements (65 trips) per day for the combined sites. This will not result in significant increases in congestion or lengthening of journey times for other traffic. Two roads, Whichcote Street and Buckley Street, and their associated footpaths will be temporarily closed from the British Rail viaduct to Tenison Way during the works on the Tenison Way site. These routes only provide access to the shop units within the proposed work site, and thus little disruption of local flows is expected to result from the closures. Alternative footpath routes are available via Mepham Street. The footpath on Tenison Way between Mepham Street and Boyce Street will also be temporarily closed during the works on the Tenison Way site. Again alternative routes via Mepham Street are available. The use of the Waterloo roundabout area may require the temporary closure of parts of the pedestrian underpass/subway system beneath the roundabout; if closures are required, they should be planned in consultation with the local authorities and community groups.
Cultural Resources	St John's Church (Grade II*) and the Royal Waterloo Hospital (Grade II) are Listed Buildings in the vicinity of the Waterloo work sites. All three sites are within or immediately adjacent to Conservation Areas. Strict on and off-site controls should be adopted to ensure that these buildings and Conservation Areas are not adversely affected.
Other Sites	
Blue Ball Yard (ventilation shaft alterations)	
Blue Ball Yard is located in an area of St James's, predominantly used for office accommodation, with a small proportion of residential and retail uses. The existing Jubilee Line ventilation shaft within Blue Ball yard will be modified as part of the works associated with the Jubilee Line Extension, but since this work is expected to be carried out from the existing below ground facilities, a surface work site will not be required.	
Land and Property Impact	None. Work will be carried out from below ground.
Noise and Vibration	Ground borne noise and vibration from the works within the shaft may be detectable at properties within the Yard, but will not reach levels which cause annoyance.
Dust and Visual Impacts	None. Work will be carried out from below ground.
Access and Traffic Impacts	None. The shaft will be accessed from underground.

Table A3.2.5 (Continued) Impacts of Construction: Green Park to Waterloo

Other Sites

Cultural Resources	Blue Ball Yard lies within the St James's Conservation Area, and numbers 9 - 18, and 20 Blue Ball Yard are Grade II Listed Buildings. However, these buildings will not be adversely affected by the ventilation shaft works.

St James's Square (construction of junction onto exdsting Jubilee Line)

This site will occupy an area of car parking on the west side of the Square, with major works being carried out for up to 2 years. The Square lies within a Conservation Area and contains many Listed Buildings. Buildings fronting onto the Square are predominantly used for offices, hotels and private clubs; The Army and Navy Club, Junior Carlton Club, East India Sports Club and Insurance Company offices are across the road 15 - 20m from the site boundary. Buildings on the northern and eastern sides of the Square are currently being modernised/refurbished.

Land and Property Impact	The site will occupy 30 public parking spaces (out of a total of 125 within the Square) and the eastern carriageway of the west side of the Square. Following the construction works, the site should be restored to its original condition. There will be no permanent structures on the site.
Noise and Vibration	Current daytime background noise levels in the Square are typically about 62 dB(A). Noise levels at nearest buildings during construction will be 62 - 71 dB(A), possibly reaching 76 dB(A). Noise will cause disturbance only exceptionally.
Dust and Visual Impacts	Strict site practice methods should be adopted to minimise dust impacts, including those required by Westminster City Council's 'Considerate Builder Scheme'. Appropriately decorated screening, as currently being used elsewhere in the Square, should be provided to minimise the visual intrusion of the works.
Access and Traffic Aspects	The site is likely to be accessed from St James's Street/King Street, or directly from Pall Mall. Lorry movements to and from the site are likely to be intermittent during occupation of the site, with a maximum of approximately 80 lorry movements (i.e. 40 loads) per day. This is likely to cause sporadic noticeable increases in traffic noise and conflict between vehicles and pedestrians/cyclists. This should be minimised by agreeing with the Westminster Authorities the specific routes to be used, and the hours of the day during which lorry movements to and from the site will be permitted. The temporary loss of the eastern carriageway and footpath on the west side of the Square is not expected to cause appreciable traffic congestion, as St James's Square is 'one way'; pedestrian access will be maintained via the western footpath.
Cultural Resources	St James's Square lies within the St James's Conservation Area, and a number of Listed Buildings lie in the immediate vicinity (15 - 20m) of the work site; (numbers 12, 13 and 14 (Grade II), 15 (Grade I), 16, 18 (Grade II) and 20-21 (Grade I) St James's Square). Strict on and off-site practice should be adopted to ensure that adverse impacts to these buildings are avoided. The 41 lampposts within the Square are also Listed (Grade II); the 4 lampposts within the work site should be appropriately protected or removed for safe keeping (and alternative lighting provided) during the construction works.

Table A3.2.5 (Continued) Impacts of Construction: Green Park to Waterloo

Other Sites

Storey's Gate (escape shaft construction)

The site is located to the rear of Storey's Gate Lodge Police Station (a Grade II Listed Building) at the south east edge of St James Park, on the corner of Birdcage Walk and Horse Guards. Government Offices (Grade II* Listed) are located to the south and east of the site, approximately 20m from the site margin. The site lies on the boundary of the Government Precinct Conservation Area; the Government offices referred to above are within it.

Land and Property Impact	The site will occupy approximately 300m^2 of parkland and 200m^2 of the police station precinct with major works lasting for up to 2 years. At the completion of works, the parkland and police station precinct should be reinstated. The surface structure of the escape shaft will occupy approximately 20m^2 of the police station precinct. Use of the site is not expected to require the removal of any of the trees, and measures should be taken to protect them from damage. Removal of certain lower branches of the trees by a tree surgeon may be necessary to avoid damage from construction vehicles. St James's Park lake, 75m from the work site, is designated by the London Ecology Unit as a site of Metropolitan Importance for Nature Conservation because of its large and varied population of water birds, and its popularity with the public. In view of the distance from the work site to the lake and the already high levels of disturbance in the area from visitors and traffic, the works are not generally expected to disturb the birdlife of the park, but initial surface works during the bird's breeding season (March to May) should be avoided if possible.
Noise and Vibration	Current daytime background noise levels in the park are about 50 dB(A). Noise levels during the early stages of the construction period could reach 83 dB(A) at the police station and in the park immediately adjacent to the work site. More typically levels will range between 57 and 74 dB(A). During the early stages of construction this could cause disturbance to park users and the police station.
Dust and Visual Impacts	In view of the sensitive nature of the park, and the site's location on the boundary of a Conservation Area, strict standards of construction practice will be required to minimise adverse effects of dust in the park, including Westminster City Council's Considerate Builders Scheme. To minimise visual intrusion, the work site should be screened and the permanent structure of the escape shaft should be designed to appear as an extension of the Lodge, in keeping with the character of the area.
Access and Traffic Aspects	The site will be accessed from Birdcage Walk, with a maximum of approximately 15 lorry movements/day. This will not result in significant increases in congestion or lengthening of journey times. To provide access to the site, 50m of the northern footpath of Birdcage Walk, at the junction with Horse Guards, will be closed. Alternative routes are available via the southern footpath of Birdcage Walk, or the footpaths through the park, and little disruption will result.
Cultural Resources	The site is immediately adjacent to Storey's Gate Lodge, a Grade II Listed Building; the neighbouring office buildings are Grade II* Listed. These office buildings lie within the Government Precinct Conservation Area, although the site itself is just outside it. Strict on and off-site practice controls, and sympathetic design of the permanent escape shaft to the rear of the Lodge, should ensure that adverse impacts to the quality and character of the area are avoided.

ROUTE SECTION 2

WATERLOO TO LONDON BRIDGE

A.3.3 Route Section 2: Waterloo to London Bridge

A.3.3.1 The Proposals

This section of the route runs from Waterloo Station to just east of London Bridge Station via Southwark. The line typically runs at a depth of 25-30 m. Figures A.3.3(a) & (b) illustrate the tunnel depths and positions at the proposed Southwark and London Bridge stations. Surface structures required on this section include ticket halls and station entrances associated with the proposed station at Southwark, new exit points at London Bridge Station, station draught relief shafts at Southwark and London Bridge, and an interstation combined ventilation and escape shaft at Wardens Grove. The route section follows the existing British Rail line for most of its length and all the shafts are located within the existing railway viaduct or, in the case of London Bridge, within the existing station complex.

A.3.3.2 Context

The land use above the tunnel and surrounding surface work sites is mixed in character, with pockets of well established residential use interspersed with offices and commercial premises.

There are a significant number of office developments proposed, committed or under development in the area, making use of the underutilised land and buildings in Southwark and around London Bridge.

A.3.3.3 Main Sites

There are three main work sites on this section of the route, one of which, Ewer Street, may not be required, depending on the final plans for tunnelling.

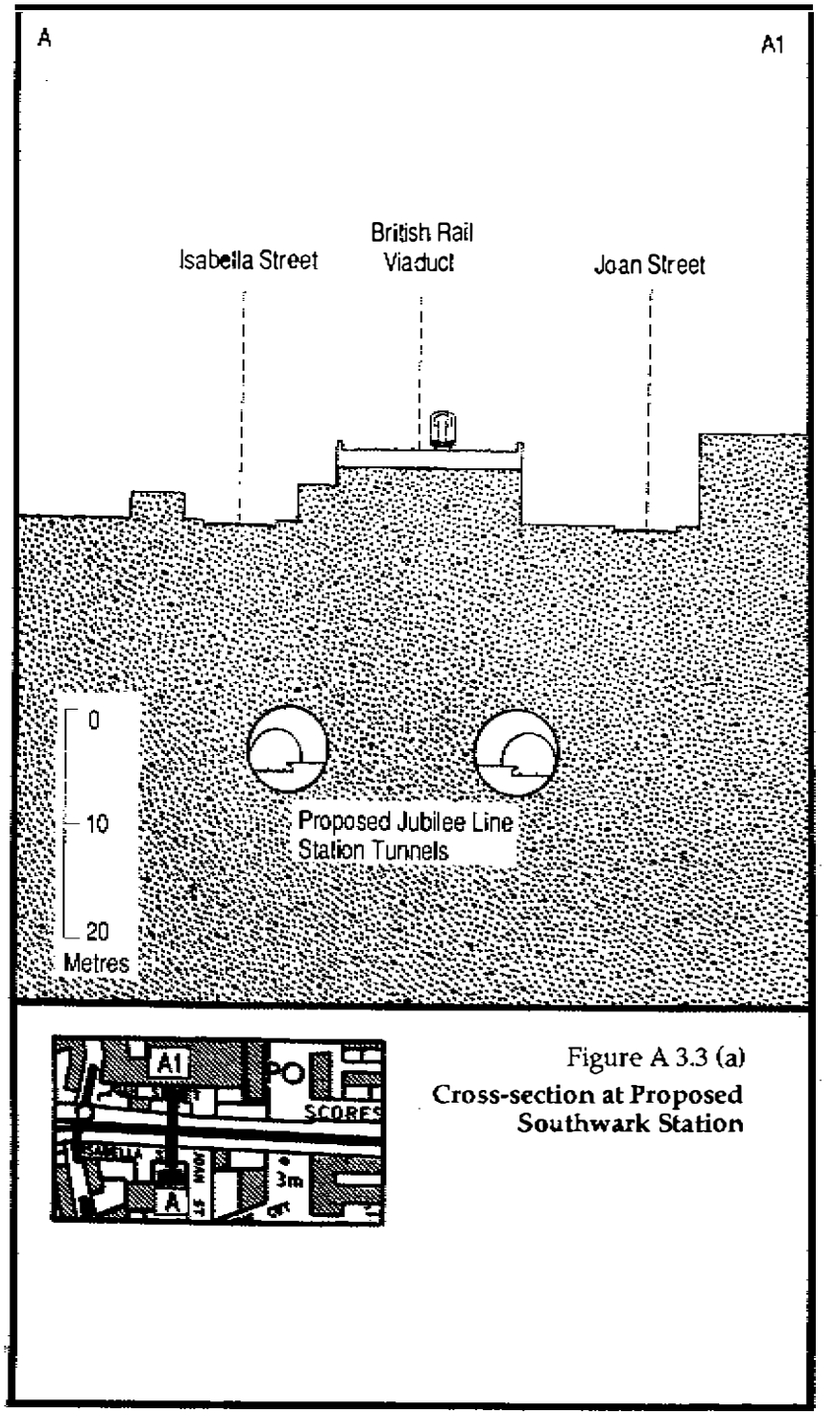


Figure A 3.3 (a)
Cross-section at Proposed Southwark Station

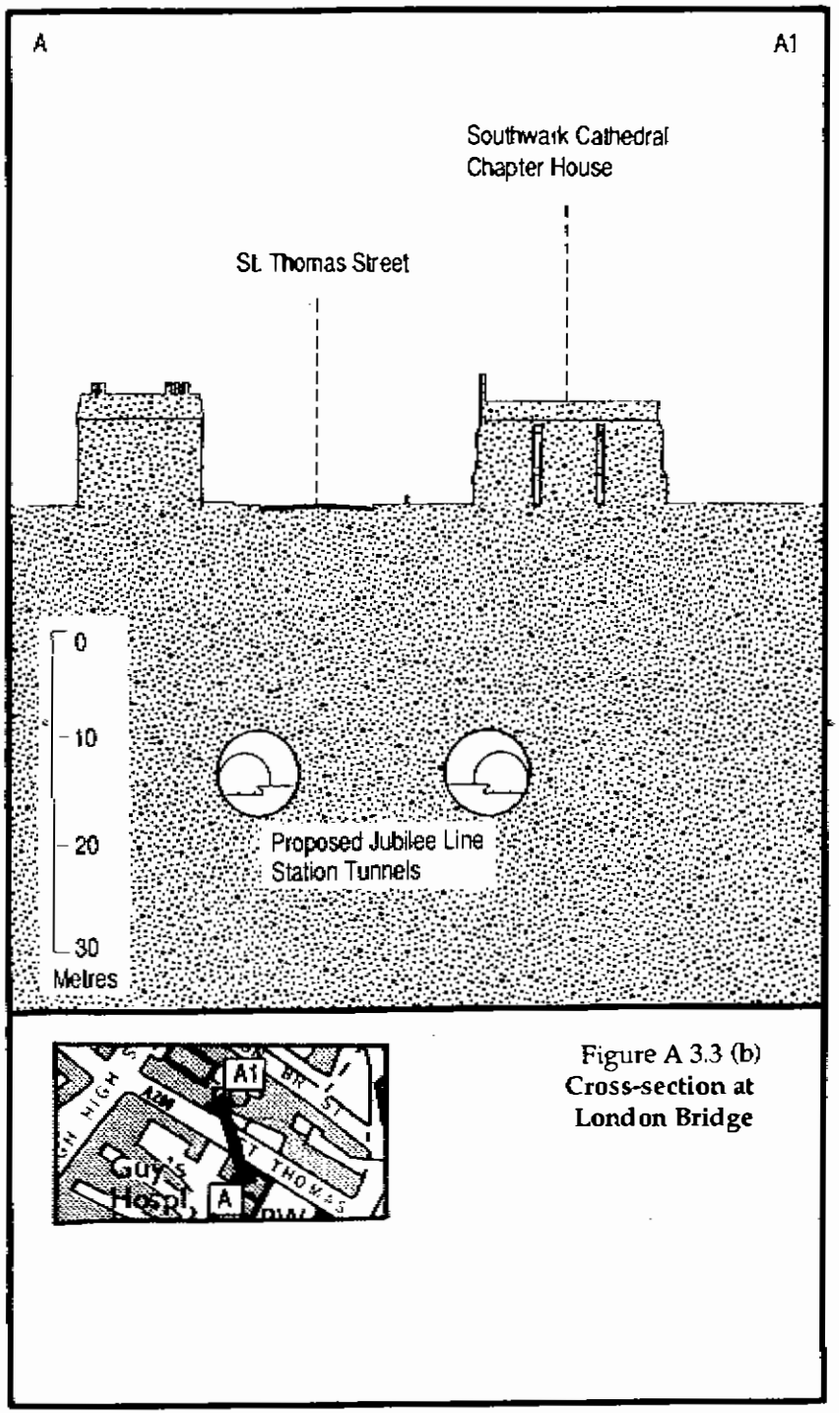


Figure A 3.3 (b)
Cross-section at London Bridge

o **Southwark**

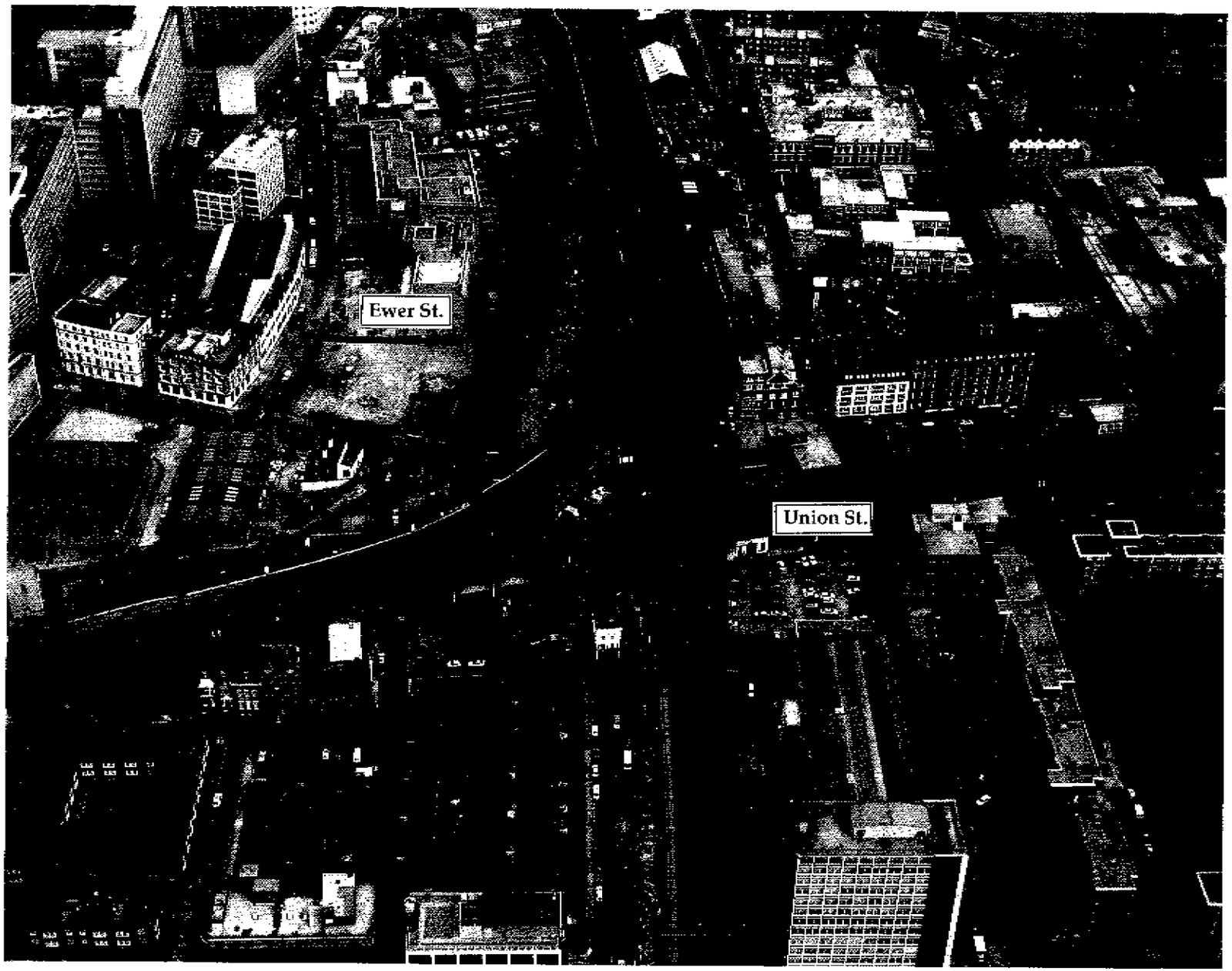
Three sites are needed for the construction of the new station at Southwark. These are shown in Figure A.3.3(c) and on the accompanying photograph. The central site consists of a car park and adjacent office buildings (owned by British Telecom), a restaurant and vacant railway arches. This site will be used for the main station works (construction of the station entrance, ticket hall, escalator/access stairs and underground platforms). Two areas of railway arches either side of this site, at Joan Street and Scoresby Street, will be used to build and house the station draught relief shafts. The Joan Street site may also be used to construct a passenger link between the Jubilee Line Southwark Station and the existing BR Waterloo (East) Station. The main works involved would be the construction of passenger access facilities, which are expected to take about 3½-4 years.

The arches at Joan Street are used as workshops and warehousing. The arches at Scoresby Street are occupied by a courier/chauffeur company and electrical shop.

The surrounding land use is a mixture of residential and commercial. The sites lie within a borough-designated office area. Immediately west of the main station site (about 10m from the site boundary) is an area of low rise housing. The Roupell Street Conservation Area and Waterloo Conservation Area lie about 80m west of the Joan Street site.

o **Ewer Street**

Ewer Street, which is also shown in Figure A.3.3(c) and the accompanying photograph, is a derelict site bounded to the south by the railway viaduct. It lies within a borough-designated industrial area and surrounding land uses include a disused Metal Box works which is at present being renovated as offices, light industrial units and workshops.



The worksites at Ewer St. and Union St.

The site may be used as a tunnelling site for the western section of the route. The main activities at this site would then include support to tunnelling activity, spoil removal operations, tunnel lining and track delivery and off loading. The site would be used for major works for about 3-4 years and would be available for use after development.

Access to the higher level of the Ewer Street site would be provided by a private access road from Dolben Street which is at present unused. The private road provides access to the upper level of the site close to the railway viaduct. Access to the lower level of the site would be from Lavington Street.

Past industrial activities on the site include starch, iron and printing works and it has therefore been identified as likely to contain contaminated soils which may require special treatment.

o **London Bridge**

Four work sites will be used to carry out the necessary station works at London Bridge. These are shown in Figure A.3.3(d) and are: at high level, the presently vacant plot of land bounded by the Railway Approach, New London Bridge House and the bus terminus; at low level a railway arch, and adjoining footpath on the southern side of Duke Street Hill; an area of land west of Joiner Street presently occupied by New London Bridge House car park; and an area east of Joiner Street under the existing railway arches, presently being used for storage.

The high level and Joiner Street west sites will be used for the construction of the extension to the existing LUL ticket hall, upper escalator and intermediate concourse. The Duke Street Hill site will be used to construct an access to the new ticket hall from the street.

The Joiner Street east site will be used to construct the lift shaft to the BR concourse and emergency exit shaft to Joiner Street. These will be used as temporary access shafts for construction of the lower concourse and lower escalators and other station connections. Spoil generated from the station works will be removed from this site.

The sites will be used for major works for about 3½-4 years.

The land use pattern in the London Bridge Station area is complex, with mixed residential, office and commercial uses. Guy's hospital, to the south of London Bridge Station, dominates the land use pattern close to the site and is the main sensitive feature here.

The station site itself is situated within a borough designated office area. There are two Conservation Areas immediately adjacent to the station, Tooley Street and Borough High Street.

There are a large number of office and other development projects currently proposed or underway in the London Bridge area; these include extensive works to the station itself, involving improvements to the Northern Line (railway realignments, new ticket hall, subway, escalators etc).

London Bridge has been identified as a site where contaminated soils may be present which could require special treatment.

A.3.3.4 Other Sites

o **Union Street**

A small car park close to the railway viaduct on the junction of Union Street and Gambia Street will be used for the Ewer Street site offices (see Figure A.3.3(c) and accompanying photograph). This will be occupied for

The likelihood of this cannot be assessed at this stage, but geotechnical investigations should be carried out over the course of detailed design, which will provide further information.

o **Settlement**

An assessment has identified buildings and other structures which may be subject to some settlement as follows:

- the BR Viaduct, arches and adjacent structures along the route;
- buildings and light industrial premises on both sides of viaduct;
- Union Jack Club;
- Telephone Exchange and Post Office on Blackfriars Road;
- Orbit House;
- Church of the Most Precious Blood;
- Hop Exchange;
- offices/shops, etc. on both sides of London Bridge Street and St. Thomas Street;
- New London Bridge House;
- Price Waterhouse Tower;
- London Bridge Station.

Use of appropriate tunnelling techniques and good working practices will minimise the degree of settlement. Where necessary, protective measures such as ground stabilisation and underpinning techniques should be used. The detail design will identify the extent and details of such measures. All sensitive structures should be monitored on a regular basis to detect any departure from predicted behaviour and enable corrective action to be implemented at the earliest opportunity. At this stage of design the risk of damage to most buildings is considered to be slight and limited to superficial cracking which may be easily repaired.

Services in this area may also be subject to disturbance and settlement from the station and tunnel construction. Critical and sensitive services will need to be diverted before construction starts. Elsewhere, regular monitoring should be adequate to detect excessive settlement and enable protective works to be carried out before damage occurs.

A3.3.7 Noise and Vibration during Operation

The assessment has considered the potential for complaint about noise and vibration from trains operating in tunnels.

o Noise. In this section of the route, noise levels which could give rise to complaints from residents may be experienced in basement and ground floor rooms in properties lying within corridors of the following widths above the route centre line (with standard trackform):

- 130m wide at Cornwall Road;
- 120m wide at Gambia Street;
- 115m wide at Great Suffolk Street;
- 110m wide at Southwark Street;
- 90m wide at Storey Street;
- 120m wide at Bermondsey Street;
- 125m wide at Tower Bridge Road.

Approximately 120 residential buildings have been estimated to lie within this corridor in this section, at the following streets:

- Roupell Street (south);
- Ospringe House (Wootton Street);
- Scoresby Street;
- Union Street;
- White's Grounds Estate;
- Druid Street.

The Church of the Most Precious Blood and part of Guy's Hospital are also within the corridor.

In view of the potential for noise disturbance above the tunnels, it is recommended that a programme be set up to design a resilient trackform to reduce noise to acceptable levels.

There are no ventilation shafts in this route section in close proximity to sensitive land uses and measures to reduce fan noise are not expected to be necessary.

o **Operational Train Vibration**

Vibration from train passage is not expected to reach levels which could give rise to adverse comment anywhere along this route section.

A3.3.8 Conclusions

Special requirements for mitigation within this section of the route have been identified as follows:

- screening of piling activity at Joan Street and London Bridge Station;
- measures to prevent night-time disturbance if 24hr working is carried out at Joan Street and Ewer Street;
- special attention to access arrangements to Ewer Street (if used) to prevent damage to 43 - 44 Dolben Street (Grade II Listed);
- prior site investigations at Ewer Street and London Bridge to establish whether contaminated soils, likely to require special treatment, are present.

The key issues along this section of the route are considered to be:

- the loss of commercial premises under railway arches at Joan Street, Joan Street/The Cut, Scoresby Street, Wardens Grove, and London Bridge;
- traffic impacts on access roads to the Ewer Street site, if this is used for tunnelling.

Table A3.3.5: Impacts of Construction: Waterloo to London Bridge

Main Sites

Joan Street/The Cut (construction of Southwark Station)

The three Southwark Station work sites are grouped in an area under or close to the existing British Rail viaduct. The surrounding area is a mixture of light industrial, commercial and residential. The main station site makes use of a car park and adjoining office buildings. The two smaller sites, for construction of the draught relief shafts and connections with the BR Waterloo (East) line, use railway arches.

Land and Property Impact	The British Telecom car park and offices at the junction of The Cut and Blackfriars Road will be permanently lost to the main Southwark Station site. The restaurant to the north of this site will also need to be demolished. The railway arches at the main station site are presently vacant. Three railway arches will be needed at Joan Street to construct a station draught relief shaft and possible passenger link to the BR Waterloo (East) Line. These arches will be permanently lost if both these works take place. If the BR link is not made, one of the arches will be available after construction. Three arches will be needed to construct, and two of them needed permanently to house, the second station draught relief shaft at Scoresby Street. The six arches to be used at these two sites are all at present occupied by small businesses which will need to be closed for the works.
Noise and Vibration	Present daytime background noise levels in the area are about 64 dB(A). During most of the construction period noise levels at nearest building facades will be 66 - 73 dB(A). Exceptionally, levels could reach 79 dB(A) during site preparation and short term disturbance could result. Consideration should be given to measures to prevent night-time disturbance at the nearest dwellings (c.10m away). If piling is required at this site, consideration should be given to screening or other measures to reduce noise.
Dust and Visual Impacts	The adoption of strict standards of construction practice should minimise adverse impacts on adjacent properties. Special measures to control dust are not expected to be required at this site. Visual impacts should be minimised by the provision of appropriate screening. The Southwark Station site is in a built-up area and no significant permanent visual impacts are anticipated.
Access and Traffic Aspects	Total lorry movements associated with the combined Southwark sites during peak construction will be about 100 movements per day. The sites will be accessed from Joan Street and Isabella Street from Blackfriars Road and The Cut. The additional vehicle movements will not result in significant increases in congestion or lengthening of journey times.
Cultural Resources	The nearest Listed Buildings to the site are in Blackfriars Road (Nos. 74-78, Grade II). These are 30m from the site, but well screened by buildings in The Cut; they will not be affected by the site works. Roupell Street Conservation Area and Waterloo Conservation Area lie to the west of the site, but the distance from the site make it unlikely that these Conservation Areas will be affected.

Table A3.3.5 (Continued) Impacts of Construction: Waterloo to London Bridge

London Bridge (construction of London Bridge Station)

The four London Bridge Station construction sites are grouped together in the existing London Bridge Station complex. The surrounding land use is a mixture of commercial and residential. The area immediately south of the sites is dominated by Guy's Hospital.

Land and Property	The majority of the works will take place within the existing station complex. New London Bridge House car park will be lost to the station works. The area of the car park that will be available after construction will depend on the final configuration of the escalator and whether an alternative access to the car park can be found. One railway arch on Duke Street Hill, which is at present being used as a commercial unit, will be permanently lost to provide a new northern access to the station. An area of railway arches east of Joiner Street will be temporarily lost to the Extension; these are being used for storage at present. The vacant plot of land bounded by Railway Approach to the north, New London Bridge House to the west and the bus terminus in front of the existing BR entrance to the east will also be temporarily occupied.
Noise and Vibration	Daytime background noise levels in the area are currently about 60 dB(A). During construction noise levels at nearest buildings will be typically 67 - 74 dB(A), possibly reaching 83 dB(A) on occasions as a worst case during the early stages of construction. The nearest properties are offices which are not expected to be adversely affected other than possibly during early in the construction period. Piling may be required at the site and consideration should be given to screening/scheduling of works.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise impacts on adjacent properties. No special measures are considered necessary at these sites. Visual impacts should be minimised by the provision of appropriate screening. The Jubilee Line Extension facilities will be incorporated within the existing station and it is not anticipated that there will be any new potential sources of visual impact other than visually minor modifications to the existing structures.
Access and Traffic Aspects	The sites will be accessed via Joiner Street and Duke Street Hill, London Bridge Street and the Railway Approach. Total lorry movements at the combined sites during peak construction will be about 160 vehicles per day. The additional vehicle movements in Borough High Street and Tooley Street will not result in any significant increases in congestion or lengthening of journey times. Existing flows on the local roads close to the site are already relatively heavy due to the gyratory system in St Thomas Street. It is not expected that vehicle movements from the work site will cause any significant additional impacts. The existing alignment of Duke Street Hill will be displaced northwards to allow widening of the southern footway. Little disruption is expected to occur provided that the new alignment can be opened at the time of the Duke Street Hill closure. The Railway Approach road will be temporary closed for the works. This provides access to the station which will be limited and may therefore cause some localised accessibility problems. The area outside London Bridge Station is used as a bus station and taxi rank and congestion may affect the operation of these services. The footway between Railway Approach and London Bridge Street and the north footpath of London Bridge Street will need to be temporarily closed for the works.

Table A3.3.5 (Continued) **Impacts of Construction: Waterloo to London Bridge**

Cultural Resources	A number of Listed Buildings can be identified in the area around the site; these include the Post Office at the rear of 4 London Bridge St. (Grade II), a range of Grade II & II* properties in St. Thomas Street, part of Guy's Hospital, London Bridge Station itself, a number of Grade II properties in Tooley Street and Southwark Cathedral (Grade I). These buildings are however well screened from the work sites by other buildings and no adverse impacts from surface works are expected. Close liaison with Southwark Borough Council should take place to ensure that account is taken of specific provisions to protect the Conservation Areas near the site.

Ewer Street (possible tunnelling site)

The Ewer Street tunnelling site is a derelict site bounded to the south by the railway viaduct and situated in a light industrial area. The requirement for this site has not been confirmed.

Land and Property Impact	The site will make use of a presently derelict, vacant site and unused private access road from Dolben Street. Both will be available after development. The Ewer Street site was identified as one of the sites with some ecological interest. The site, however, supports only a small area of ruderal vegetation which is unexceptional in character; its loss would not constitute a significant impact.
Noise and Vibration	Background noise levels in the area during the day are about 65 dB(A). Noise levels at dwellings about 15m from the site boundary will be typically 63 - 72 dB(A), possibly reaching 79 dB(A) during site preparation. Measures to reduce night-time disturbance w illbe required.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise impacts on adjacent properties. No special measures to control dust are considered necessary at this site. Visual impacts should be minimised by the provision of appropriate screening.
Access and Traffic Aspects	This site is one of the possible main tunnelling sites for the Extension. If used, total lorry movements associated with the site would be about 200 movements per day at peak. The site would be accessed from Lavington Street and by a private access road from Dolben Street to the upper level of the site. Existing flows of heavy vehicles in these streets are relatively high because of nearby land uses (eg post office depot in Union Street). The increase in traffic noise and congestion is not likely to be significant. Noticeable increases in pedestrian/cycle conflict with vehicles and in lorry nuisance are however expected. Discussions should take place with Southwark transport planners to agree routes whereby lorries from the Ewer Street site join the primary network as soon as possible to minimise any impacts.
Cultural Resources	43-44 Dolben Street, directly opposite the private access road to the site, is Grade II Listed. Special care should be required by lorries accessing the site to ensure that no physical damage is caused to these premises.

Table A3.3.5 (Continued) **Impacts of Construction: Waterloo to London Bridge**

Other Sites

Wardens Grove

The Wardens Grove interstation shaft site is located in 2 railway arches on the junction of Wardens Grove and Great Guildford Street. The immediate surrounding land use is light industrial.

Land and Property Impact	Two railway arches, presently being used as a vehicle repair shop, will be lost to the works. One of the arches will be available after construction.
Noise and Vibration	There are no properties in the vicinity of this site which are expected to be sensitive to noise from construction activity.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise impacts on adjacent properties. Visual intrusion should be minimised by the provision of appropriate screening.
Access and Traffic Aspects	The site will be accessed to the north via Wardens Grove, and will not involve any road or footpath closures. Lorry movements at the site will be of the order of 5-15 movements per day which are not expected to result in any significant impacts.
Cultural Resources	No Listed Buildings have been identified near the site. Thrale Street Conservation Area lies to the north east of the site, but with the relatively small scale of the construction activity, limited to the area immediately surrounding the proposed shaft, it is not expected to result in any adverse effects upon this Conservation Area.

Union Street (site offices for Ewer Street tunnelling site)

The Union Street site will be used for site offices if tunnelling is carried out at Ewer Street. It is located on a small car park at the junction of Union Street and Gambia Street in a mixed residential, light industrial area.

Land and Property	A small public car park providing parking for about 80 vehicles will be occupied. This site will be available once works are complete.
Noise and Vibration	The site will only be used for offices for the workforce on the Ewer Street tunnelling site. No significant impacts are therefore expected.
Dust and Visual Aspects	No significant impacts are expected.

Table A3.3.5 (Continued)	Impacts of Construction: Waterloo to London Bridge
Access and Traffic Aspects	No significant impacts are expected.
Cultural Resources	No significant impacts are expected.

ROUTE SECTION 3

LONDON BRIDGE TO CANADA WATER

A3.4.7 Noise and Vibration during Operation

The assessment has considered the potential for complaint about noise and vibration from operation of trains in tunnels.

- **Noise.** In this section of the route, noise levels which could give rise to complaints from residents may be experienced in basement and ground floor rooms in properties lying within corridors of the following widths above the route centre line (with standard trackform):

  - 125m wide at Tanner Street;
  - 125m wide at Abbey Street;
  - 115m wide at Old Jamaica Road;
  - 125m wide at Drummond Road;
  - 115m wide at Southwark Park;
  - 100m wide at Neptune Street.

  In this section of the route approximately 300 residential buildings have been estimated to lie within this corridor in the following streets:

  - Druid Street;
  - Sweeney Crescent;
  - Arnold Estate;
  - Old Jamaica Road;
  - Marine Street;
  - Keetons Road;
  - Perryn Road;
  - Drummond Road;
  - Kirby Estate;
  - Neptune Street;
  - Renforth Street.

  St James's Church and St James's School in Bermondsey, and St Olave's Hospital in Southwark are also located within the corridor.

  In view of the potential for noise disturbance above the tunnels if standard trackform is used, it is recommended that a programme be set up to design a resilient trackform to reduce noise to acceptable levels.

  New shafts will be located near dwellings at Druid Street and Ben Smith Way, and adjacent to a play area in Southwark Park. At the stage of detailed design consideration will need to be given to the need for noise suppression in these shafts.

- **Operational Train Vibration.** Vibration from train passage is not expected to reach levels which could give rise to adverse comment anywhere along this route section.

A3.4.8 Conclusions

Special requirements for mitigation along this section of the route have been identified as follows:

- Prior investigation of the sites at Old Jamaica Road and Canada Water to determine whether contaminated soils requiring special treatment are present. The Canada Water site should be monitored for gas generation and if necessary measures taken to vent the site.

- Consideration of requirements for noise suppression at the Druid Street, Ben Smith Way and Southwark Park shafts.

- Special attention to traffic movements at Old Jamaica Road to minimise traffic impacts.

- Special attention to noise mitigation and dust control at Old Jamaica Road, Major Road/John Roll Way, Ben Smith Way and Southwark Park.

Table A3.4.5 (Continued) **Impacts of Construction: London Bridge to Canada Water**

Main Sites

Major Road/John Roll Way (construction of Bermondsey Station)

The work site for Bermondsey Station will occupy an area of approximately 2.5ha fronting onto the heavily trafficked Jamaica Road, in a predominantly residential area. A Conservation Area lies 25m to the north of the site; nearest residential properties providing sheltered accommodation are approximately 15m from the southern boundary of the site.

Land and Property Impact	The site currently comprises 7 derelict properties with gardens/yards which will be demolished to enable the station and a ground level ticket hall to be built.
Noise and Vibration	Present daytime background noise levels at this site are about 55 dB(A). During construction noise levels are estimated to be typically 66 - 73 dB(A), possibly reaching 79 dB(A). These levels would cause disturbance at the sheltered housing to the south and mitigation measures will be required, particularly if night-time working is required and during any piling activity.
Dust and Visual Impacts	Strict site controls should be adopted to minimise dust impacts at adjacent properties. Particular attention may be required for the sheltered housing to the south of the site. Screening should be provided around the site to minimise visual intrusion.
Access and Traffic Aspects	The site will be accessed from Jamaica Road via Major Road, a no through road, so avoiding as far as possible the residential areas to the south of the site, and will require at peak approximately 50 lorry movements per day. This is not expected to result in significant increases in congestion or lengthening of journey times. No footpath or roadway closures are required for this site.
Cultural Resources	The Wilson Street Conservation Area is located on the northern side of Jamaica Road, approximately 25m from the site boundary, and the residential properties of 124-130 (even) Jamaica Road are Grade II Listed Buildings. Strict site practice controls should be applied to ensure that no adverse effects are caused to these features.

Table A3.4.5 (Continued) **Impacts of Construction: London Bridge to Canada Water**

Main Sites

Canada Water (construction of Canada Water Station)

The site is located at the junction of Deal Porter's Way and Surrey Quays Road, in an area of Surrey Docks undergoing major redevelopment. The nearest residential properties are two high rise tower blocks, Columbia Point and Regina Point, approximately 10m from the western site boundary at its nearest point.

Land and Property Impact	The construction site for the station requires an area of approximately 4.2ha, comprising mainly open ground and approximately 4000m^2 of car parking (170 spaces) associated with Surrey Quays Shopping Plaza (from a total of c.1050 spaces) and may require up to 1400m^2 (45%) of the landscaped shoreline of Canada Water Dock. This area will be available following construction, except for the surface entrances to the Jubilee Line and East London Line stations and their respective draught relief and ventilation shafts; these will need to be incorporated within the development proposals for the site. The car parking area will be permanently lost to provide bus interchange facilities. Canada Water dock is currently being developed as a wildfowl refuge by the Wildlife in Docklands Project. The work site may occupy up to approximately 1400m^2 of about 3000m^2 of shoreline that has been created along the western side of the dock. Site fencing and an appropriately designed site drainage system should be provided to minimise encroachment and avoid potential water quality impacts. As little of this area as possible should be used and the area should be reinstated following construction.
Noise and Vibration	Present daytime background noise levels at this site are about 53 dB(A) although this may increase during major redevelopment. During construction, noise levels are estimated to be typically 66-73 dB(A) at the nearest dwellings. This could cause some disturbance but must be viewed against the background of other construction activity in the area. Mitigation measures may, however, be required if piling is necessary.
Dust and Visual Aspects	Strict standards of construction should be adopted to minimise dust impacts at the residential properties adjacent to the site. Particular attention will be required to protect the wildfowl area next to the site. Suitably decorated screening should be provided to avoid visual impacts at ground level, but views of the works from the upper floors of the tower blocks cannot be avoided. Several other work sites are currently visible from the flats.
Access and Traffic Aspects	The site will be accessed directly from Surrey Quays Road, with at peak approximately 50 lorry movements per day. This will not cause significant increases in congestion or lengthening of journey times. Surrey Quays Road may be reduced to half carriageway width for short periods during the construction works. Alternative access to the Rotherhithe peninsula is available via Redriff Road. Access for vans to/from Associated News is particularly important during the night. Deal Porter's Way will be temporarily realigned during the construction period. This is an important access road to the Surrey Quays Shopping Plaza, and two-way access should be maintained between 0900 - 2100 hrs. The landscaped footpath adjacent to the Albion Estate within the northern part of the work site will be temporarily closed during construction. Alternative routes are available via Albatross Way, Needleman Street, Surrey Quays Road, and the Albion Channel footway; the pedestrian footway adjacent to the Albion Channel and Canada Water which skirts inside the boundary of the work site should be maintained through the construction period.

Table A3.4.5 (Continued) Impacts of Construction: London Bridge to Canada Water

Other Sites	
Cultural Resources	A locally designated building, Deal Porter's Lodge on Surrey Quays Road, lies within the proposed site; this building should be dismantled for safe keeping, and reinstated at the completion of the works. One statutorily Listed Building, the Grade II Pumping Station on Renforth Street, is located approximately 25m from the north east boundary of the site. Strict site controls should ensure that no impacts will be caused to this building from construction work.
Druid Street (ventilation and escape shaft construction)	
The site for constructing an interstation combined ventilation and escape shaft at Druid Street is located under the existing railway arches adjacent to Tower Bridge Road. The surrounding area is mixed in character with residential and commercial uses.	
Land and Property Impacts	Two railway arches will be used to construct the shaft. These are presently being used for storage, scaffolding and motor repairs. One of the arches will be available after construction works are complete.
Noise and Vibration	Background daytime noise levels at this site are presently high (c. 65 dB(A)). Noise levels during construction may reach 75 dB(A) which is not expected to cause disturbance.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to ensure that no adverse impacts to adjacent properties occur. Visual impacts should be minimised by the provision of appropriate screening.
Access and Traffic Aspects	The site will be accessed direct from Druid Street. No access restrictions will be necessary. Lorry movements at the site will be of the order of 5 - 15 movements per day and are not expected to result in significant impacts.
Cultural Resources	No Listed Buildings have been identified near the site. Tooley Street Conservation Area lies approximately 200m to the north west, but the small scale of the construction activity, limited to the area immediately surrounding the proposed shaft, is not expected to result in any adverse effects on the Conservation Area.

Table A3.4.5 (Continued) Impacts of Construction: London Bridge to Canada Water

Other Sites

Ben Smith Way (draught relief shaft construction)

This site is located at the rear of Broomfield Court, a low rise residential development off Jamaica Road, and will occupy an area of approximately 500m^2. It is approximately 10m from the nearest dwellings.

Land and Property Impact	A concreted play area (approximately 150m^2) and 7 garages will be temporarily lost for up to two years. At the completion of the works, the play area should be reinstated and consideration given to replacing the garages on what is currently hardstanding immediately to the east of their current location.
Noise and Vibration	Background daytime noise levels at this site are about 55 dB(A). Construction noise levels are expected to be about 56-72 dB(A), possibly reaching 79 dB(A); disturbance could arise at the nearest dwellings, especially if night-time working is required; mitigation measures will be required, and night-time working should be avoided if possible.
Dust and Visual Impacts	Strict site controls should be adopted to minimise dust impacts at the residential properties adjacent to the site. Visual intrusion should be minimised by the provision of decorated screening around the site. The works are likely to remain visible from the upper floors of the flats of Broomfield Court.
Access and Traffic Aspects	The site will be accessed from Ben Smith Way, off Jamaica Road, with 5-15 lorry movements per day at peak. This is not expected to cause significant traffic related impacts.
Cultural Resources	The Wilson Street Conservation Area is located on the northern side of Jamaica Road, approximately 85m from the site, and numbers 124-130 (even) Jamaica Road lie approximately 40m to the east of the site; these buildings and the Conservation Area are sheltered from the work site by intervening properties, and no impacts are expected.

Southwark Park (ventilation and escape shaft construction)

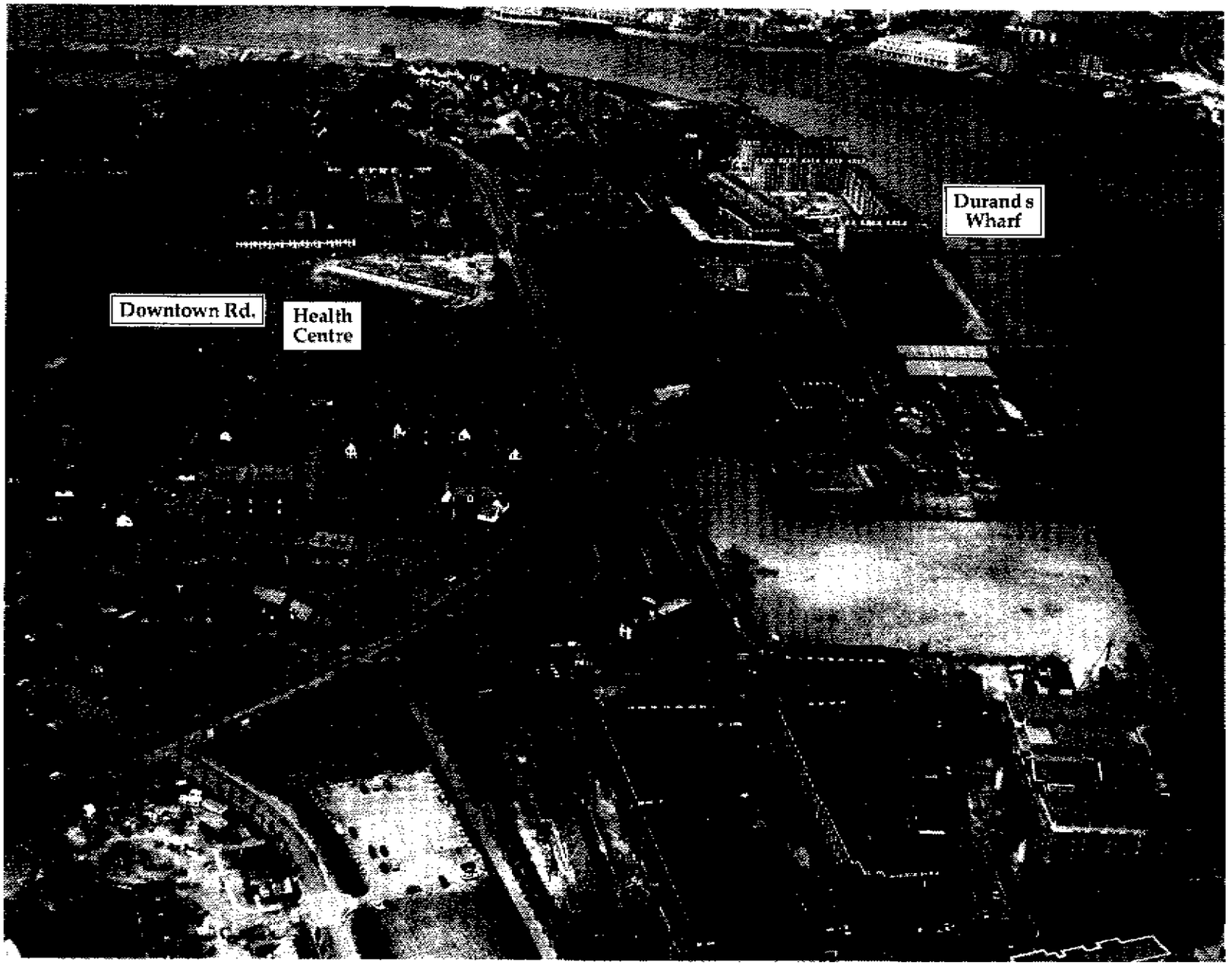
This work site occupies an area of approximately 1400m^2 at the northeast corner of Southwark Park, at the junction of the Lower Road dual carriageway and Culling Road. Rotherhithe Free Church is located approximately 10m from the site boundary, and St Olave's Hospital, currently undergoing extension works, is approximately 55m from the site on the eastern side of the Church.

Land and Property Impacts	An area of 1400m^2 at the edge of Southwark Park will be required for up to two years. After construction the parkland should be reinstated (except for an area of approximately 45m^2 occupied by the ventilation and emergency escape shaft).

Table A3.4.5 (Continued)	Impacts of Construction: London Bridge to Canada Water
Other Sites	
Noise and Vibration	Daytime background noise levels are about 55 dB(A). Noise levels during construction (typically 56 - 72 db(A)) could cause disturbance when Rotherhithe Free Church is in use. Consideration should be given to scheduling activities to minimise disturbance.
Dust and Visual Impacts	Strict site controls should be adopted to minimise dust impacts. Particular attention may be required to reduce dust in the park and at the hospital and Church adjacent to the site. Visual impacts during the construction phase should be avoided by the provision of suitably decorated screening around the site. Long term visual impacts should be minimised through the sensitive design of the surface structure of the shaft to reflect its parkland setting.
Access and Traffic Aspects	The site will be accessed from Culling Road, off the Lower Road dual carriageway, with 5-15 lorry movements per day at peak; this will not cause significant increases in congestion. Access to the funeral directors should be maintained throughout the construction period. The northern footpath of Culling Road will be temporarily closed during the construction period, to provide access to the work site. The southern footpath, adjacent to the Church, will remain open, and hence no significant disruption will be caused.
Cultural Resources	No statutorily or locally Listed Buildings have been identified in the vicinity of the site.

ROUTE SECTION 4

CANADA WATER TO CANARY WHARF



The worksites at Durand s Wharf and Downtown Road

- **Canary Wharf.** Canary Wharf Station will be located under the middle West India Dock, between Canary Wharf and Heron Quay, with pedestrian access to the developments on this wharfage (see Figure A3.5(b), and the accompanying photograph). The work site, needed to construct the station, associated pedestrian accesses and station draught relief shafts, will be located within the confines of the middle West India Dock with surface works on Canary Wharf, Heron Quay and Eastwood Wharf. Construction of the station box is assumed to involve the creation of a temporary 350 m long, 25 m wide island in West India Dock, with the station being built by digging down from this island work site through the bottom of the dock.

  Construction of the station will require removal of dock silts, which are likely to be contaminated because of the long history of industrial use of the docks. Special care will be required during handling and removal of these silts to avoid any adverse impacts to workers or to the water quality of the docks.

  The land surrounding the work site is undergoing extensive redevelopment. Major office, retail and residential developments are underway on Canary Wharf, Heron Quay and neighbouring areas and there is a high level of construction activity here at present. A number of offices and commercial premises have already been completed but the overall programme of works to redevelop this area is expected to last another 10 years.

  Few residential areas exist close to the site at present. Nearest residences are the Cascades riverside apartments to the west (c. 300 m from the site), residences east of Blackwall Basin (300 m), and housing to the south of Byng Street (400 m).

  The Canary Wharf site will be occupied for about 3½-4 years, for the construction of the station.

A3.5.4 Other Sites

- **Downtown Road.** A small section (0.1ha, about 2% of the total parkland) of Russia Dock Woodland, just west of Downtown Road, will be needed to construct an interstation ventilation and escape shaft. The location of the work site is shown in Figure A3.5(a) and on the accompanying photograph. The major works at the site will take up to 2 years. All but 45m^2, required for the shaft, should be reinstated after construction. The site is in a residential area and opposite a local health centre.

- **Pioneer Wharf.** A work site is needed at Pioneer Wharf for the construction of an interstation ventilation and escape shaft. The site is located within the confines of the existing Pioneer Concrete batching plant, which is situated adjacent to the River Thames to the west of West Ferry Road and to the north of the new Cascades high rise residential apartments. The major works at the site will take up to 2 years. All but approximately 45m^2 will be available after construction. The site is in an area undergoing extensive redevelopment; nearest offices are 50m to the east, across West Ferry Road.

  Previous uses of the site as a wharf may mean that the soil is contaminated with oils, lubricants and cargo spillages and may therefore require special treatment.

A3.5.5 Impact of Surface Works

The Table at the end of this section summarises information on the impacts resulting from occupation of, and construction activity at, surface sites in this section.

A3.5.6 **Impacts of Tunnelling**

Two issues have been considered in relation to tunnelling:

o **Noise and Vibration.** The assessment indicates that noise and vibration from tunnelling operations will not normally be perceptible in properties above the tunnel in this section.

There is, however, a possibility of exceptional soil properties being encountered along the route, which could lead to some noise and/or vibration affecting sensitive buildings. The likelihood of this cannot be assessed at this stage, but geotechnical investigations should be carried out over the course of detailed design, which will provide further information.

o **Settlement**

The assessment has identified buildings and other structures which may be subject to some settlement as follows:

- Canada Water and Albion Channel Dock Walls;
- light industrial developments in the Surrey Docks;
- Harmsworth House Printing Works (Associated Press);
- Surrey Docks Health Centre;
- residential developments at Holyoak Court and Lawrence Wharf;
- river walls on the banks of the Thames;
- West India Dock Walls;
- commercial buildings on the north side of Heron Quay;
- DLR viaduct;
- the Canary Wharf development.

Use of appropriate tunnelling techniques and good working practices will minimise the degree of settlement. Where necessary, protective measures such as ground stabilisation and underpinning techniques should be used. The detail design will identify the extent and details of such measures. All sensitive structures should be monitored on a regular basis to detect any departure from predicted behaviour and enable corrective action to be implemented at the earliest opportunity. At this stage of design the risk of damage to most buildings is considered to be slight and limited to superficial cracking which may be easily repaired.

Services in this area may also be subject to disturbance and settlement from the station and tunnel construction. Critical and sensitive services will need to be diverted before construction starts. Elsewhere, regular monitoring should be adequate to detect excessive settlement and enable protective works to be carried out before damage occurs.

A3.5.7 **Noise and Vibration During Operation**

The assessment has considered the potential for complaint about noise and vibration from operation of trains in tunnels.

o **Noise.** In this section of the route, noise levels which could give rise to complaints from residents may be experienced in basement and ground floor rooms in properties lying within corridors of the following widths above the route centre line (with standard trackform):

- 160m wide at Surrey Quays Road (east);
- 125m wide at Quebec Way;
- 130m wide at Downtown Road;
- 130m wide at Rotherhithe Street;
- 110m wide at West Ferry Road.

Approximately 55 residential buildings in the following streets have been estimated to lie within this corridor:

- Holyoak Court;
- Rotherhithe Street;
- Timbrell Road;
- Downtown Road.

In view of the potential for noise disturbance along the Extension, it is recommended that a programme be set up to design a resilient trackform to reduce noise to acceptable levels.

The ventilation and escape shaft at Downtown Road is in close proximity to dwellings and it may prove necessary to install noise suppression to reduce fan noise.

o **Operational Train Vibration.** Vibration from train passage is not expected to reach levels which could give rise to adverse comment in this section of the route.

A3.5.8 Conclusions

Special requirements for mitigation in this section have been identified as follows:

- prior investigation of sites at Durands Wharf, Canary Wharf and Pioneer Wharf to establish whether contaminated soils requiring special treatment are present;

- full reinstatement of Durands Wharf Park on completion of construction;

- special attention to noise and dust mitigation at Durands Wharf and Downtown Road;

- special attention to minimise impacts to water quality and the fish population in West India Dock during works at Canary Wharf.

The only key issue considered to arise in this section is the temporary loss of Durands Wharf Park, a valuable recreational resource in the area.

Table A3.5.5: Impacts of Construction: Canada Water to Canary Wharf

Main Sites

Durands Wharf (tunnelling)

Durands Wharf is a recently created riverside public park on the eastern side of the Surrey Docks peninsula, off Rotherhithe Street. The surrounding land use consists of low density residential and light industrial uses. There are a number of vacant sites awaiting redevelopment in the vicinity of the site.

Land and Property Impacts	Durands Wharf riverside Park, covering an area of about 1ha, will be temporarily occupied. The loss of this area will cause a significant impact as the amenity resources of the local community in the immediate vicinity of the site are limited. The area should be fully reinstated, in consultation with Southwark Borough Council, after construction works are complete. The loss of the park is not significant in ecological terms as the park is new and could be reinstated without loss of character. About 20m^2 of the park will be needed for the permanent shaft. The impact of this land take should be minimised by location of the shaft as close to the park boundary as possible.
Noise and Vibration	Current daytime noise levels in the area are relatively low (background 53 dB(A)) and construction noise levels of 64-72 dB(A), possibly reaching 79 dB(A), would cause annoyance at the nearest dwellings. Special measures may therefore be required to reduce noise, particularly at night and during piling.
Dust and Visual Impacts	Strict standards of site practice should be adopted to minimise dust impacts on adjacent properties. There will be a temporary visual impact during construction through loss of the park. Permanent visual impacts should be minimised by careful siting and design of the shaft within the park setting.
Access and Traffic Aspects	Durands Wharf is one of the main tunnelling sites for the route; lorry movement will however be limited to 50 lorry movements per day during the peak construction activity (for delivery of construction materials) because spoil should be transported away from the site by barge. The additional lorry movements will not result in significant increases in congestion or lengthening of journey times. Access to the site will be via Rotherhithe Street and a new access point will need to be created. It is not expected that this will affect traffic or pedestrians on this road.
Cultural Resources	No Listed Buildings or Conservation Areas have been identified in the vicinity of the site.

Table A3.5.5 (Continued) Impacts of Construction: Canada Water to Canary Wharf

Main Sites

Canary Wharf (station construction)

The Canary Wharf site will be used to construct a new station under the middle West India Dock in the Isle of Dogs between Canary Wharf and Heron Quay. The work site will be located within the confines of the middle dock with surface works on Canary Wharf, Heron Quay and Eastwood Wharf. The land surrounding the site is undergoing extensive redevelopment.

Land and Property Impacts	The middle West India Dock, Eastwood Wharf and parts of Canary Wharf and Heron Quay will be temporarily occupied for station works. The works on Canary Wharf and Heron Quay will be integrated with the construction works already taking place on these sites. No buildings will need to be demolished for the Canary Wharf Station works. The Eastwood Wharf site will make temporary use of the open land presently being used for loose storage of materials and will be available after construction.
Noise and Vibration	Background daytime noise levels at Canary Wharf are high due to existing construction activity which will continue through the Extension construction period. Additional daytime disturbance is not expected to occur as a result of the station works.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise dust impacts. There will be a temporary visual impact with construction of the island in the Dock, but against the backdrop of other developments this is not considered to be significant.
Aquatic Impacts	Measures should be taken to minimise fish losses during the construction of the temporary island within the dock, including steps to maintain the water quality of the dock.
Access and Traffic Aspects	Construction materials deliveries and spoil removal operations will be carried out by barge. Barge access and movements will need to be integrated with those required for other developments on Canary Wharf and Heron Quay. The existing road between Prestons Road and Eastwood Wharf will be maintained in order to provide road access to the site, should this be necessary. No significant impacts associated with vehicle movements from this site are expected.
Cultural Resources	The West India Dock walls and copings and the buttresses to the import and export docks are Grade I Listed. Given the sensitive nature of these structures, all appropriate measures should be taken to maintain their integrity. The Grade I warehouse and general office on North Quay (within West India Dock Conservation Area) is 300m north of the work site and is not expected to be affected by the construction activity. The closest Conservation Area is to the east of the site, Coldharbour, just opposite the access road to Eastwood Wharf. This is not expected to be adversely affected by construction activity.

Table A3.5.5 (Continued) **Impacts of Construction: Canada Water to Canary Wharf**

Other Sites

Downtown Road (ventilation and escape shaft construction)

The Downtown Road site is a small area (0.1ha) of parkland, just west of Downtown Road which will be used to construct an interstation ventilation and escape shaft. The immediate surrounding area is residential, with park land to the west. There is a local health centre opposite the site (c. 20m away).

Land and Property Impacts	0.1ha of newly planted parkland will be temporarily lost to the construction works. The loss of this small area, in Russia Dock Woodland, is not significant in recreational or ecological terms. All but 45m^2 can be restored without loss of character.
Noise and Vibration	Daytime noise levels in the area are generally low (48 dB(A)) and construction work noise levels of 54-70 dB(A), possibly reaching 75 dB(A), are likely to cause disturbance at the nearest homes and the health centre unless measures are taken to reduce noise, especially if piling is required.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise dust impacts at adjacent properties. Permanent visual impacts should be minimised by careful design of the shaft within the woodland setting.
Access and Traffic Aspects	Lorry movements at the site during the peak construction period will be about 5-15 movements per day, which is not expected to result in any significant impacts. Access to the site will need to be created off Downtown Road during construction and also to carry out any maintenance work during operation. This may involve temporary loss of a small section of the footway on the west side of Downtown Road, but will not affect access (by car or foot) to the health centre.
Cultural Resources	No Listed Buildings or Conservation Areas have been identified near the site.

Table A3.5.5 (Continued) **Impacts of Construction: Canada Water to Canary Wharf**

Other Sites

Pioneer Wharf (ventilation and escape shaft construction)

The site at Pioneer Wharf is needed to construct an interstation combined ventilation and escape shaft. The site, which is just west of West Ferry Road in the Isle of Dogs, is in an area under going extensive redevelopment.

Land and Property Impacts	A relatively large area of open land has been provisionally defined for this site to allow flexibility in the location of the construction works and permanent shaft, given the road development works taking place in this area. All but 45m^2 will be available after construction works are complete. A concrete batching plant currently occupying part of the site is to be removed during 1990.
Noise and Vibration	Daytime noise levels at this site are high (about 67 dB(A)) and the estimated construction noise levels of 67-70 dB(A) are not expected to cause any disturbance at the nearest dwellings.
Dust and Visual	Strict standards of construction practice should be adopted to minimise dust. Visual impacts should be minimised by careful siting and design of the shaft.
Access and Traffic Aspects	Total lorry movements during peak construction will be about 5 - 10 movements per day, which is not expected to result in any significant impacts. Access to the site will be from West Ferry Road to the east of the site. Access will need to be created to service the work site and to enable any operational maintenance works to be carried out. No closures to existing roads will be required. The site is close to the section of West Ferry Road which is being reconstructed as part of the highway improvements to provide access to the Enterprise Zone on the Isle of Dogs.
Cultural Resources	The former west entrance lock to the South Docks is Grade II Listed. This is 100m to the south of the site and no adverse impacts to this structure are expected. The Grade I Listed Buildings and adjoining Conservation Area at North Quay, about 350m from the site, will not be adversely affected by the Pioneer Wharf works.

ROUTE SECTION 5

CANARY WHARF TO CANNING TOWN

The East India Dock Basin site will be used for construction of the step plate junctions for a possible future branch to Woolwich and may also be used for a short tunnel drive to Canning Town. The major works at the site are expected to take 3-4 years. No permanent surface structures are envisaged.

Canning Town

There will be two work sites in this area:

- the Canning Town Station work site on Victoria Dock Road, next to the North London Line, used for construction of the Jubilee Line Extension station and bus interchange facilities. The work site (approximately 2.8ha) is located principally along the North London Line tracks. The existing station serves the North London Line and is situated to the north of Newham Way (see Figure A3.6(c) and the accompanying photograph);

- the Limmo work site, an area of vacant land (approximately 1.8ha) used to construct a ventilation and escape shaft and for cut and cover works associated with the tunnel portal.

The sites are bordered to the west by vacant land and Bow Creek. There are a number of light industrial developments on the west side of the North London Line tracks north of Newham Way. Along the east side of the site the land use is mixed, with a large residential area to the east of Silvertown Way. The land between Silvertown Way and Victoria Dock Road contains low rise commercial developments and plots of vacant and underused land. Retail warehousing lies adjacent to the northern end of the site, east of the tracks.

The Limmo site will be occupied for 3-4 years and will be used for the construction of a ventilation and emergency escape shaft, and for cut and cover works associated with the tunnel portal. Following construction, permanent surface works will consist of a low rise ventilation and emergency escape shaft at the western end, and the tunnel portal to the south of Canning Town Station.

Road access from Dock Road or the proposed Lower Lea crossing service roads for maintenance and emergency vehicles will also be required.

Major plans for the station site include the DLR extension which is proposed to run from Poplar to Beckton, and will have a station at Canning Town. Plans for the Jubilee Line Extension station should be co-ordinated with the DLR station. The Canning Town Station work site will also be occupied for about 3-4 years.

A3.6.5 Impacts of Surface Works

The Table on the following pages summarises information on the impacts resulting from occupation of, and construction works on, surface sites in this section.

A3.6.6 Impacts of Tunnelling

Two issues have been considered in relation to tunnelling:

o **Noise and Vibration.** The assessment indicates that noise and vibration from tunnelling operations will not normally be perceptible in properties above the tunnel in this section. There is, however, a possibility of exceptional soil properties being encountered along the route, which could lead to some noise and/or vibration affecting sensitive buildings. The likelihood of this cannot be assessed at this stage, but geotechnical investigations should be carried out over the course of detailed design, to provide further information.

o **Settlement**

The assessment has identified buildings and other structures which may be subject to some settlement as follows:

- West India Dock Walls;
- Mercury Earth Station, Eastwood Wharf;
- warehousing at Eastwood Wharf;

- residential development at Jamestown Harbour Bridge House and accumulator tower at Jamestown Harbour;
- residential and industrial properties between Prestons Road and Blackwall Way;
- the Blackwall Road tunnels and ventilation shafts;
- Graving Docks and new office building at Blackwall Yard;
- East India Dock Basin and River Lea Walls;
- proposed Lower Lea Crossing structures and embankment;
- electricity pylons on the Limmo Site;
- Barking Road and Newham Way bridges and retaining walls at Canning Town.

Use of appropriate tunnelling techniques and good working practices will minimise the degree of settlement. Where necessary protective measures, such as ground stabilisation and underpinning techniques should be used. The detail design will identify the extent and details of such measures. All sensitive structures should be monitored on a regular basis to detect any departure from predicted behaviour and enable corrective action to be implemented at the earliest opportunity. At this stage of design the risk of damage to most buildings is considered to be slight and limited to superficial cracking which may be easily repaired.

Services in this area may also be subject to disturbance and settlement from the station and tunnel construction. Critical and sensitive services will need to be delivered before construction starts. Elsewhere, regular monitoring should be adequate to detect excessive settlement and enable protective works to be carried out before damage occurs.

A3.6.7 Noise and Vibration During Operation

The assessment has considered the potential for complaint about noise and vibration from operation of trains in tunnels.

o **Noise.** In this section of the route, noise levels which could give rise to complaints from residents may be experienced in basement and ground floor rooms in properties lying within corridors of the following widths above the route centre line (with standard trackform):

- 135m wide at Prestons Road
- 125m wide at Blackwall Way
- 80m wide at Orchard Place
- 80m wide at tunnel portal.

Above this section of the tunnels about 70 residential buildings have been estimated to lie within this corridor in the following streets:

- Lancaster Drive
- Bridge House Quay
- St Lawrence Street
- Alberta House.

In view of the potential for noise disturbance along the Extension, it is recommended that a programme be set up to design a resilient track form to reduce noise to acceptable levels. The ventilation and escape shaft at Blackwall Way is in close proximity to dwellings and it may prove necessary to install noise suppression measures to reduce fan noise.

o **Operational Train Vibration.** Vibration from train passage is not expected to reach levels which could give rise to adverse comment in this section of the route.

A3.6.8 Conclusions

Special requirements for mitigation in this section have been identified as follows:

- prior investigation of Blackwall Way, Brunswick, East India Dock and the Limmo work sites to establish whether contaminated soils requiring special treatment are present; monitoring for gas generation at these sites;

- prior archaeological investigation of riverside sites at Blackwall Way and Brunswick;

- special attention to controls on the Limmo site to prevent damage to the adjacent nature conservation site.

The key issue on this section of the route is considered to be the loss of a church, offices, workshops and a garage at Canning Town.

Table A3.6.4: Impacts of Construction: Canary Wharf to Canning Town

Main Sites

Blackwall Way (tunnelling and ventilation and escape shaft construction)

Blackwall Way construction site is situated on a vacant plot presently owned by Anglo United. It fronts onto the River Thames. The new Reuters office development lies to the east and overlooks the site. Residential properties, shops and commercial premises are located on the western edge of the site, across Blackwall Way.

Land and Property Impact	The presently vacant development area will be temporarily lost to the site, and there may be a delay to site redevelopment. There will be a permanent loss of a small area within the site (approximately $45m^2$) to a ventilation and escape shaft.
Noise and Vibration	Noise from construction could give rise to disturbance in dwellings across Blackwall Way, where background levels are presently about 53dB(A). Construction noise levels at these dwellings could reach 71dB(A) or 79dB(A) in exceptional circumstances. Mitigation measures will be required to minimise disturbance to these dwellings.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise dust impacts. Visual impacts should be avoided by the provision of appropriate screening.
Access and Traffic Aspects	The site will be accessed from Blackwall Way with peak traffic being approximately 100 movements (50 trips) per day. This will result in noticeable increases in traffic noise, congestion, pedestrian/cycle conflict with vehicles, and lorry nuisance. There are proposals, however, to remove spoil from the site by barge, which would cut down the vehicle movements by more than half. The footway on the east side of Blackwall Way will be closed temporarily, while temporary access to the work site is being constructed. Permanent access to the proposed ventilation and escape shaft will also be required, and there is a possibility that the east side of the footway will be lost permanently. The footway on the west side of Blackwall Way will remain open, and so pedestrian movement is not expected to be adversely affected.
Cultural Resources	Listed Buildings in the vicinity of the site are Blackwall Dock and St. Lawrence cottages (Nos. 1-6, 7-11 and 12-14) which are locally Listed and the Dry Dock at Blackwall Way, which is statutorily Listed (Grade II). Strict on and off site controls should be adopted to ensure that these buildings are not adversely affected.

Brunswick (station construction)

Brunswick Station construction site is located on Brunswick, a currently vacant plot previously occupied by Brunswick power station. The Reuters office development lies about 80m to the south west of the site. The south east portion of the site has river access. The nearest residential property is more than 250m away. The site will be occupied for major works for a period of 3½-4 years.

Land and Property Impact	Temporary occupation of presently vacant riverside site. Following construction the site will be available for redevelopment.

Table A3.6.4 (Continued) Impacts of Construction: Canary Wharf to Canning Town

Main Sites

Noise and Vibration	No noise impacts are expected at this site.
Dust and Visual Impacts	No impacts expected.
Access and Traffic Aspects	Spoil will be removed from the site by barge, thus reducing the number of vehicle movements required at the site to approximately 16 movements (8 trips) maximum per day. This will not result in significant increases in congestion or lengthening of journey times for other traffic. Enterprise Zone Road 6, is just north of the proposed DLR extension (see Figure A3.6(b)) and a site access may be formed off this road. These works are not expected to result in any adverse effects on existing traffic or pedestrian movement.
Cultural Resources	Listed Buildings in the vicinity of the site include: Blackwall Dock (locally Listed) and the Dry Dock at Blackwall Way, East India Dock wall and gateway, East India Dock wall and pumping station, and Naval Row embankment wall railings and steps (all Grade II Listed). A Conservation Area lies to the north west of the site. Strict site practice controls should be adopted to ensure that the integrity of these structures is maintained and that the Conservation Area is not adversely affected.

East India Dock Basin (construction of junction for future extension of tunnels, possible short tunnel drive)

This site is in an area of currently vacant land, on the east side of the East India Dock Basin. There are no sensitive land uses in the vicinity of the site.

Land and Property Impact	Temporary occupation of presently vacant dockside site.
Noise and Vibration	No noise impacts are expected to occur.
Dust and Visual Impacts	No impact expected.
Access and Traffic Aspects	No impact expected.
Cultural Resources	Trinity Buoy Wharf, Jubilee Wharf and Orchard Dry Dock at Orchard Place, Blackwall Pier and the entrance lock to the former East India Dock Basin, and the East India Dock wall and gateway at Leamouth Road, are Grade II Listed Buildings. Strict on and off site controls should be adopted to ensure that these buildings/structures are not adversely affected.

Table A3.6.4 (Continued) Impacts of Construction: Canary Wharf to Canning Town

Main Sites

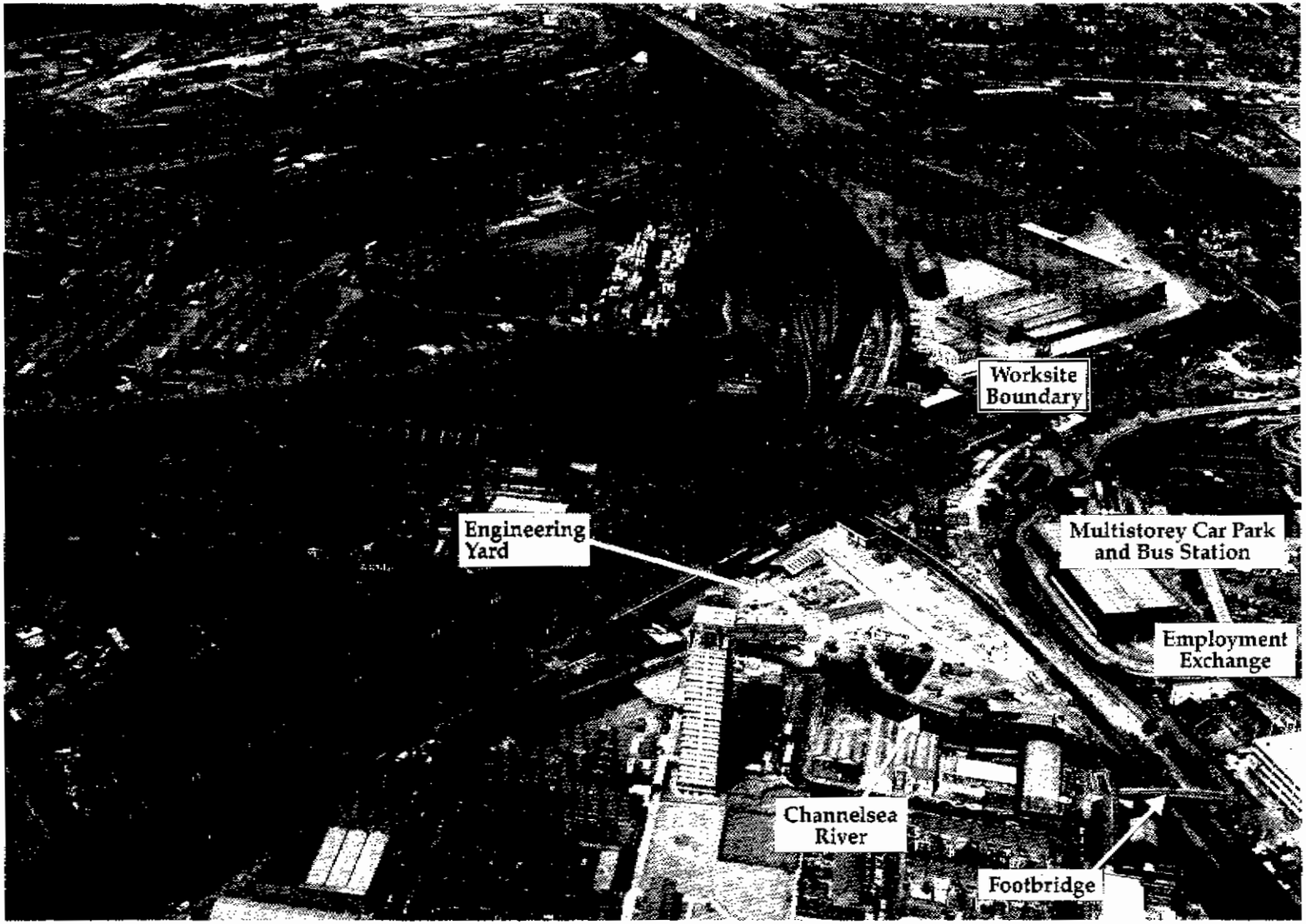
Canning Town (construction of station, ventilation and escape shaft and tunnel portal)

There will be two work sites in this area: the Limmo site and Canning Town Station site, which adjoins the Limmo site and extends northwards along the North London Line (NLL) tracks from the Limmo site and includes the existing NLL station north of Barking Road.

Land and Property Impact	There will be temporary loss and limited permanent loss of open ground at the Limmo site. A number of buildings between Silvertown Way and Victoria Dock Road, south of Barking Road, will be lost to the Canning Town station site; these are four workshops, three with offices above, the Lighthouse Pentecostal Church, a former pub (now vacant), a depot, a cold storage plant, a service station and garage, and offices. The Limmo work site and part of the Canning Town station work site are within a Site of Metropolitan Importance for Nature Conservation (MINC). The Jubilee Line Extension work site will take up 10% of the MINC site, at its northern end; however, the DLR extension and Lower Lea crossing will also take substantial parts of the site. The most valuable part of the MINC site lies to the south of the Jubilee work site, on the Limmo Peninsula, and loss of the area taken by the Extension's work site will not have a fragmenting effect on the surviving part of the site. Care will be required during construction not to encroach upon the Limmo Peninsula.
Noise and Vibration	Daytime background noise levels in the area are currently about 58dB(A). Noise levels during construction are expected to be typically 62-69dB(A) at nearest dwellings, reaching 73dB(A) as a worst case during the early stages of site clearance. The construction works are thus not generally expected to cause disturbance, except possibly for short periods during the early construction stages.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise dust impacts. Visual impacts should be avoided by the provision of adequate screening. At Canning Town Station, the Jubilee Line Extension works will comprise modifications to existing BR facilities. Given the existing use of the site as a BR rail corridor, the works are unlikely to result in long term visual impact.
Access and Traffic Aspects	The work sites will be accessed from Victoria Dock Road, and/or Dock Road. Peak vehicle movements at Canning Town Station will be approximately 16 movements per day. This will not give rise to significant increases in congestion or a lengthening of journey times. Peak vehicle movements at the Limmo site during cut and cover works and shaft construction will be approximately 78 movements per day, which will not give rise to significant traffic impacts. The junction of Dock Road and Tidal Basin Road will be partially closed in order to provide access to the Limmo work site during construction. A permanent road access to the shaft will be required for maintenance purposes, and an access road is intended off Dock Road, as part of the development of the Limmo site.
Cultural Resources	Jubilee Wharf, at Orchard Place, is a Grade II Listed Building in the vicinity of the site. However, its distance from the work sites, approximately 200m, and the fact that it is separated from the work sites by the River Lea makes it unlikely to be adversely affected by the construction works.

ROUTE SECTION 6

CANNING TOWN TO STRATFORD



The worksite at Stratford Station

Other developments in the area include construction of offices (partially complete) just south of the site in High Street. Permanent surface works will include a new access bridge over the North London Line tracks and remodelled entrances to both stations.

The use of the site as a railway yard is likely to have resulted in the soil being contaminated by oils, grease and spillages, which may require special treatment.

A3.7.4 Other Sites

Along this section of the route the Jubilee Line Extension is a surface railway, and the BR route corridor from Canning Town to Stratford has been designated a work site area. The existing BR line effectively divides the surrounding area into two distinct land use types. East of the line is predominantly residential while west of the line, consists largely of industrial, commercial and depot uses.

Use of the North London Line route corridor will be required in order to accommodate the laying of Jubilee Line Extension tracks, power supply and signal facilities.

A3.7.5 Impacts of Surface Works

The Table at the end of this section presents summary information on impacts arising from occupation of, and construction works on, sites in this section of the route, including tracklaying works along the line.

A3.7.6 Noise and Vibration During Operation

Prediction of noise levels during operation along the surface track in this section indicates that no properties will experience facade noise levels in excess of 70dB(A) (24hr L_{eq}) from the railway.

The increase in noise levels (24hr L_{eq}) for properties fronting the route will be of the order of 1dB(A); this may just be noticeable although any impacts would be considered marginal. Peak noise levels from passing trains will be lower than those experienced from present North London Line trains at residential properties fronting the line which are located to the east of the existing tracks.

A3.7.7 Conclusions

Special requirements for mitigation have been identified along this section of the route as follows:

- prior investigation of Stratford Market and Stratford Station sites to establish whether contaminated soils requiring special treatment are present;
- prior investigation of the site of Stratford Langthorne Abbey (1135) at Stratford Market work site;
- consideration to be given to transplanting locally uncommon plant species found at Stratford Market work site.

The significant issues associated with the works in this section are considered to be the loss of five dwellings, a public house and a skills centre for the disabled at West Ham Station and Stratford Market work sites.

Table A3.7.4: Impacts of Construction: Canning Town to Stratford

Main Sites

West Ham (construction of station)

West Ham Station construction site is situated on railway land and a vehicle depot in an area of mainly industrial and commercial use. The area to the south east of the site is residential, with new development taking place off Manor Road. To the south lies a Post Office sorting office and to the north a chemical works.

Land and Property Impact	Three shops on Manor Road with residential property to the rear will be demolished at the West Ham Station site. There will be a temporary loss of depot and truck/container storage on the west side of the existing tracks during construction of the station.
Noise and Vibration	Background daytime noise levelsat this site are of the order of 63dB(A). During construction typical noise levels at the nearest dwellings (approximately 25m to the east of the site) will be 64-70 dB(A), possibly rising to 75dB(A). This is not expected to cause disturbance except possibly for short periods during site preparation.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise dust impacts at adjacent properties. Visual impacts should be avoided by the provision of appropriate screening. West Ham Station will be incorporated into the existing structure and there will be potential for an improvement in its appearance.
Access and Traffic Aspects	The site will be accessed from Manor Road with peak vehicle movements for the site being approximately 16 movements (8 trips) per day. This will not result in significant increases in congestion or lengthening of journey times for other traffic. The existing junction of Manor Road and Durban Road will be permanently closed and a new junction will be provided at Manor Road and Memorial Avenue. Manor Road will be narrowed temporarily. No alternative routes are available for local traffic and shuttle working of traffic with signals will be provided. Minor delays will be experienced for local traffic. Alternative routes via Hermit Road, Orange Road, Upper Road and Plaistow Road are available for other traffic. A section of Crows Road, providing access to the truck/container storage depot, will need to be temporarily closed during the construction works. However, since this depot is required as part of the station work site (involving the relocation of the business) the loss of the access road is not considered significant.
Cultural Resources	No Listed Buildings or Conservation Areas have been identified in the vicinity of the site.

Table A3.7.4 (Continued) **Impacts of Construction: Canning Town to Stratford**

Main Sites

Stratford Market (construction of depot)

Stratford Market site is located in a predominantly commercial and industrial area, some of which is vacant or unused. A large residential area lies across Bridge Road to the east and north east of the site (c25m from the site boundary).

Land and Property Impacts	The site will occupy a former fruit and vegetable market, and a goods yard. Construction works will involve demolition of a public house (the Adam and Eve) and warehouse/offices, both with residential property above, and warehouses and similar premises in the goods yard, one of which is currently used as a skills centre for the disabled. The Stratford Market site has areas of recently abandoned wasteland and, although having little amenity value (there being no public right of entry), supports some locally uncommon plant species, and has been identified as being of some ecological interest. The possibility of transplanting such species to an alternative nearby site should be considered to ensure their survival.
Noise and Vibration	The site is presently relatively quiet (daytime background levels around 50 dB(A)) construction noise levels at the nearest dewellings are estimated to be 64-70 dB(A), possibly reaching 75 dB(A). This would cause disturbance at residential property across Bridge Road, particularly during the early stages of construction. Special attention to noise control will be required at this site.
Dust and Visual Impacts	Strict standards of construction practice should be adopted to minimise dust impacts at nearby properties. Visual impacts should be avoided by the provision of appropriate screening. As the depot facilities are similar in form and scale to the recent use of the site, significant long term visual impacts are not anticipated.
Access and Traffic Aspects	The site will be accessed from Abbey Road. There will be no significant spoil generation at Stratford Market, and traffic flows generated by construction works will be small. A number of partial or complete closures of roads will be required, several of which presently provide access to premises within the site. With the closure of these works, adverse impacts will not arise. New access to the proposed depot from the end of Channelsea Road will be provided. Abbey Road may be narrowed temporarily to regrade the bridge over the North London Line. An alternative route is available via Bridge Road and West Ham Lane to the A11, but increased commuter traffic on these roads may result in delays to local traffic.
Cultural Resources	The site of Stratford Langthorne Abbey (1135) lies partially within the depot area. The boundary of the Abbey is currently under review by the Passmore Edwards Museum and prior investigation of the site may be required. Nos. 1-23 Bakers Row, 329-333 High Street, Burford Road works and Union Street gas depot are locally Listed Buildings in the vicinity of the work site. Nos. 116-130 Abbey Lane (Grade II) and Abbey Road Engine House (Grade II*) are statutory Listed. Strict site practice controls should be adopted to ensure that these buildings are not adversely affected.

Table A3.7.4 (Continued) **Impacts of Construction: Canning Town to Stratford**

Main Sites

Stratford Station (construction of station)

The Stratford Station site includes an engineering yard in an area of predominantly British Rail land and two warehouses. To the south of the site, about 50m away, is a residential area, while the main shopping facilities lie to the east of the site.

Land and Property Impacts	Two warehouses near the corner of Jupp Road and Kennard Road will be demolished at the Stratford Station site. Modification to the Channelsea River culvert at Stratford Station will also be necessary. Marsh plants and scrub habitat for birds associated with the Channelsea River north of the station will be lost as a result of culverting works, but the small size of the area concerned will not give rise to significant ecological impacts. Consultation with NRA Thames Region should take place regarding detailed design of the culverting to ensure that downstream flows and flooding conditions are not adversely affected.
Noise and Vibration	Background daytime noise levels near Stratford Station work site are of the order of 50dB(A). Noise levels of 61-67dB(A), possibly reaching 71 dB(A) at the nearest dwellings (approximately 50m to the south east of the site) during construction would give rise to some disturbance and measures to reduce noise will be required, particularly during piling when noise levels may reach 96 dB(A) at nearest residences.
Dust and Visual Impact	Strict standards of construction practice should be adopted to minimise dust impacts at nearby properties. Visual impacts during construction should be avoided by the provision of appropriate screening. Given the existing use of the area as a British Rail station/depot, the visual appearance of the station site may be improved.
Access and Traffic Aspects	The site will be accessed from Station Street with, at peak, approximately 16 vehicle movements (8 trips) per day. This will not result in significant increases in congestion or lengthening of journey times. The existing footbridge at Jupp Road will be replaced with a new footbridge. Station Street will be partially closed during construction for the provision of access to the work site, but existing traffic movements should not be affected.
Cultural Resources	No's 361 - 371 High Street are locally Listed Buildings within St John's Conservation Area in the vicinity of the Stratford Station site. St John's Conservation Area lies just beyond the southern boundary of the site. Strict site practice controls should ensure that buildings within the Conservation Area are not adversely affected.

Table A3.7.4 (Continued) Impacts of Construction: Canning Town to Stratford	
Other Sites	
Impacts along the Surface Line during Construction	
Land and Property	The land occupied by the new tracks lies within the existing railway corridor to the west of the North London Line tracks. The present wide railway verges are open land colonised by grassy vegetation, characteristic of areas of railway ballast. The railway verge forms the eastern boundary of a wildlife corridor along the Lower Lea Valley. Loss of part of this area is not expected to significantly impair the functioning of the remainder of the corridor as the corridor would not be severed and the verges would not be permanently lost.
Noise and Vibration	Construction works on this section of the route are not expected to disturb the nearest residential properties. The daytime noise level may occasionally reach a level at which disturbance could occur but will be very short lived as the works progress along the line. Night-time working is not expected.
Dust and Visual Impact	Tracklaying operations are not expected to cause dust or visual impacts as the nearest sensitive properties are the other side of the North London Line.
Access and Traffic Movements	No impacts expected.
Cultural Resources	No impacts expected.

B. SUMMARIES OF SPECIALIST FINDINGS

B1. LAND USE AND PROPERTY IMPACTS

B1.1 Introduction

Construction of the Jubilee Line Extension will require acquisition of land and some property for construction and for permanent facilities.

In this section we identify the effects on land and property arising from temporary occupation of the construction sites, and from permanent landtake associated with surface structures.

Each of the sites has been visited and information on present land use and future proposals, obtained by other consultants to LUL, has been checked.

The effects at each of the above ground sites occupied as a result of the proposals are summarised in Table B1.1.

The main issues are summarised in B1.2.

Further information on buildings and sites of historic or archaeological interest, potentially affected by the proposals, is presented in B1.3.

In Section B1.4 we summarise the results of a separate investigation of impacts of settlement on property, carried out by engineering consultants to LUL.

B1.2 Property and Land Use

B1.2.1 Key impacts arising from occupation of land are summarised below.

B1.2.2 **Loss of Homes, Community Buildings and Businesses**

Five residential properties are expected to be lost as a result of the development. These are located to the rear of shops at the West Ham Station site (3 properties) and within the Stratford Market depot site (2 properties).

The Lighthouse Pentecostal Church at Canning Town and a skills centre for the disabled at Stratford Market will also be lost. Two public houses, one at Canning Town and a second, which is closed, at Stratford Market will also be lost.

Statutory compensation provisions should be sufficient to compensate for these losses.

A number of business premises will be lost either temporarily or permanently.

- **Permanent loss:**
  - business premises at Westminster Station;
  - 15 shops at Tenison Way;
  - workshops and warehouses below railway arches between Waterloo and Bermondsey Stations;
  - a restaurant and British Telecom office at Southwark Station;
  - warehouses, garages and depots at Canning Town Station;
  - 3 shops at West Ham Station;
  - offices and warehouses at Stratford Market;
  - warehouses at Stratford Station.

- **Temporary loss:**
  - workshops and warehouses below railway arches between Waterloo and Bermondsey Stations;
  - vehicle yard and workshops at Old Jamaica Road;
  - truck/container storage depot at West Ham Station.

Closure of businesses as a result of construction may lead to the immediate loss of jobs where employers choose not to relocate. It is not possible to predict how employers will respond to

Table B1.1: Summary of Land and Property Impacts at all Surface Sites

LOCATION	PURPOSE AND APPROX. DURATION OF MAJOR WORKS	PRESENT USE AND FUTURE PLANS	IMPACT	AFTER USE
St James's Square	Work site for construction of link to existing line (up to 2 years). No permanent surface structures.	Site occupies public parking spaces on the west side of the Square.	30 parking spaces temporarily lost; c.100 spaces remain. Temporary disturbance to park users.	Returned to present use.
Storey's Gate	Work site for escape shaft construction (up to 2 years). Permanent escape shaft building.	Work site occupies garden of Police lodge in corner of park and c.300m^2 of adjacent parkland. Surface shaft should be constructed as annex to, and in same style as present lodge.	Temporary loss of 300m^2 of St James's Park and part of lodge garden. Temporary disturbance to park users from construction activities. Permanent loss of small area (c. 20m^2) of lodge garden.	Parkland and garden should be fully reinstated. Escape shaft should be housed in extension to lodge.
Parliament Square & Westminster Station	Work site for construction of Westminster Station (3½-4 years). Permanent access points (entrances to stairways) on NE corner of Square and on adjacent roads. A temporary work site is proposed on Victoria Embankment for a permanent ventilation outlet.	The central area of the Square is grassed and whilst not generally used by the public, it forms part of the overall setting of this historic area. Several statues and mature trees are located around the edge of the Square.	Temporary loss of central area of Square; mature trees should be retained wherever possible. Statues should be protected or removed temporarily.	Returned to present use.
	The easterly part of the development, near the existing Westminster Station entrance, will take place as part of the overall redevelopment on Bridge Street, being carried out by the Government Property Services Agency. A number of shops will be temporarily closed, and some permanently lost, and access arrangements will be affected. The exact location and form of the ventilation outlet has not been defined, but it could require diversion of the riverside pathway and temporary removal of the statue of Boadicea. The site should be fully reinstated following construction.			

Table B1.1 - Continued: Summary of Land and Property Impacts at all Surface Sites

LOCATION	PURPOSE AND APPROX. DURATION OF MAJOR WORKS	PRESENT USE AND FUTURE PLANS	IMPACT	AFTER USE
Jubilee Gardens	Work site for tunnel drive and spoil removal by river (3-4 years).	A popular riverside park and car park adjacent to the South Bank complex. The park is already proposed as a work site for other developments in the area.	Temporary loss of the park; (could be reduced by coordinating use with other developers). Disturbance to riverside walk and substantial effect on general amenity of the area; must be viewed against background of other proposals for the area.	The park should be fully reinstated or prepared for alternative use in consultation with local authority.
Tenison Way	Work site for construction of Waterloo Station (3½ - 4 years). No permanent surface structures.	Area between Tenison Way and Mepham Street containing 15 local single storey shop units (one presently unoccupied) and 4 premises under railway arches. Proposals exist for office development of the site.	Permanent loss of local shopping facility and 4 commercial premises. However, site already subject to redevelopment proposals.	After-use subject to redevelopment proposals.
Waterloo Bridge Roundabout	Work site for construction of Waterloo Station (3½ - 4 years). No permanent surface structures.	Central area of roundabout is used for pedestrian access to Waterloo Station, South Bank Centre and London Weekend Television and as an unofficial sleeping area for the homeless.	Temporary loss of sleeping area and possible restrictions to pedestrian access.	Site should be reinstated in consultation with local authority.

Table B1.1 - Continued: Summary of Land and Property Impacts at all Surface Sites

LOCATION	PURPOSE AND APPROX. DURATION OF MAJOR WORKS	PRESENT USE AND FUTURE PLANS	IMPACT	AFTER USE
Waterloo Station	Work site for construction of Waterloo Station (3½ - 4 years). No permanent surface structures.	Site is located beneath Waterloo Station. Part of the area is presently used for retail storage. Site may extend into area of taxi rank.	Permanent loss of premises below railway arches and possible temporary reduction in taxi rank.	After-use subject to overall station redevelopment plans.
Joan Street and Scoresby Street	Work sites for construction of Southwark Station draught relief shafts. Joan Street may also be used to construct a passenger connection between Waterloo East and the new Southwark Station.	Printing workshops warehousing courier/ chaffueur company and electrical shop located beneath six railway arches.	Temporary and limited permanent loss of commercial premises.	Sites should be reinstated in consultation with local authority.
Joan Street/The Cut	Work site for construction of Southwark Station (3½-4 years). Permanent surface access points to station.	Site presently occupied by restaurant, British Telecom office and office parking, vacant railway arches.	Permanent loss of restaurant, office and office parking.	Site will be required for Southwark Station.
Union Street	Site for Ewer Street site offices (3-4 years)	Site occupies public car park.	Approximately 80 parking spaces will be temporarily lost.	Site should be reinstated in consultation with local authority.
Ewer Street	Possible work site for tunnel drive (3-4 years).	Site is presently vacant and derelict. Future development plans are at present uncertain.	Temporary occupation of presently vacant site and unused private access road.	Site and access road will be available after works complete.

Table B1.1 - Continued: Summary of Land and Property Impacts at all Surface Sites

LOCATION	PURPOSE AND APPROX. DURATION OF MAJOR WORKS	PRESENT USE AND FUTURE PLANS	IMPACT	AFTER USE
Wardens Grove	Work site for construction of ventilation and escape shaft (up to 2 years).	Site occupies two railway arches presently being used as a vehicle repair shop.	Temporary and limited permanent loss of commercial premises.	Site should be reinstated in consultation with local authority.
London Bridge Station/Joiner Street West/RailwayApproach.	Site for construction of London Bridge Station (3½-4 years).	Site occupies vacant plot of land bounded by Railway Approach, New London Bridge House and the bus terminus, and underground car park.	Temporary loss of vacant plot. Temporary and some permanent loss of car park. Exact extent will depend on final escalator configuration.	Site should be reinstated in consultation with local authority.
Duke Street Hill	Site for constructing new street access for station (3½-4 years).	Commercial premises in railway area.	Permanent loss of commercial premises.	Site will be required for London Bridge Station.
Joiner Street East	Construction of lift to BR concourse, draught relief shaft and lower concourse works (3½-4 years).	Bonded warehouses under railway arches.	Temporary and limited permanent loss of commercial premises.	Site should be reinstated in consultation with local authority.
Druid Street	Site for construction of a ventilation and escape shaft (up to 2 years).	Site occupies two railway arches presently being used for storage, scaffolding and motor repairs.	Temporary and limited permanent loss of commercial premises.	Site should be reinstated in consultation with local authority.

Table B1.1 - Continued: Summary of Land and Property Impacts at all Surface Sites

LOCATION	PURPOSE AND APPROX. DURATION OF MAJOR WORKS	PRESENT USE AND FUTURE PLANS	IMPACT	AFTER USE
Canary Wharf	Work site for construction of Canary Wharf Station (3½-4 years).	Site occupies the Middle West India Dock, Eastwood Wharf and parts of Canary Wharf and Heron Quay.	Temporary loss of open land in development area. No buildings will be demolished.	After-use subject to overall development plans for the area. West India Dock should be reinstated. Eastwood Wharf will be available after works complete.
Blackwall Way	Site for tunnel drive and construction of ventilation and escape shaft (3-4 years).	Site occupies vacant riverside site.	Temporary loss of vacant plot; possible delays to site redevelopment. Permanent loss of small (c. 45m^2) area for shaft.	Site will be available for redevelopment after works complete.
Brunswick	Site for construction of Brunswick Station (3½-4 years).	Site includes currently vacant plot of land previously occupied by Brunswick power station.	Temporary occupation of presently vacant riverside site. Permanent loss confined to station entrances.	Site will be available for redevelopment after works complete.
East India Dock Basin	Site for construction of step plate junction for a possible future branch to Woolwich. Possible site for short tunnel drive to Canning Town (3-4 years).	Site occupies currently vacant plot.	Temporary occupation of presently vacant dockside site. No permanent surface structures.	Site will be available for redevelopment after works complete.

Table B1.1 - Continued: Summary of Land and Property Impacts at all Surface Sites

LOCATION	PURPOSE AND APPROX. DURATION OF MAJOR WORKS	PRESENT USE AND FUTURE PLANS	IMPACT	AFTER USE
The Limmo	Site for construction of a ventilation and escape shaft and cut and cover works associated with the tunnel portal (3-4 years).	Site occupies open ground and railway sidings south of Canning Town Station within development area.	Temporary and small permanent loss of wasteland.	Site will be available for redevelopment after works complete.
Canning Town Station	Site for construction of Canning Town Station (3½-4 years).	Site is presently vacant BR land and land occupied by the existing Canning Town Station and associated tracks, four workshops (three with offices above), the Lighthouse Pentecostal Church, a former public house (now vacant), a depot, a cold storage plant and a service station and garage, and offices.	Permanent loss of workshops, offices, Church, public house, depot, cold storage plant, service station and garage.	Site will be required for operation.
West Ham	Site for construction of West Ham Station (3½-4 years).	Site occupies parts of existing station, depot and truck/ container storage, three shops with dwellings to the rear.	Temporary loss of depot and truck/container storage. Permanent loss of three shops with dwellings to the rear (i.e. three dwellings lost).	Site will be required for operation.

Table B1.1 - Continued: Summary of Land and Property Impacts at all Surface Sites

LOCATION	PURPOSE AND APPROX. DURATION OF MAJOR WORKS	PRESENT USE AND FUTURE PLANS	IMPACT	AFTER USE
Stratford Market	Site for construction of depot (3½-4 years).	The site includes a fruit and vegetable market (much of which is disused) and a goods yard, a public house (the Adam and Eve), warehouse/offices, one of which is used as a skills centre for the disabled, 2 residences (above the public house and a warehouse).	Permanent loss of fruit and vegetable market, goods yard, public house and warehouses/offices, and dwellings.	Site will be required for operation.
Stratford Station	Site for construction of Stratford Station (3½-4 years).	Site occupies BR engineering yard and two warehouses in an area of predominantly British Rail land.	Two warehouses near the junction of Jupp Road and Kennard Road will be demolished.	Site will be required for operation.

closure, but statutory compensation provisions should be sufficient to enable re-establishment of businesses in alternative locations.

B1.2.3 Impacts on Recreational and Cultural Facilities

Three areas of public open space will be permanently affected by the works:

- a small area (c. 45m^2) of Southwark Park will be taken for a ventilation and escape shaft structure;
- a small area (c. 45m^2) of Russia Dock Woodland will be taken for a ventilation and escape shaft structure;
- a small area of (c. 20m^2) of Durands Wharf Park will be taken for an escape shaft.

In addition a church and a public house will be demolished at Canning Town Station.

Eight areas will be temporarily affected by occupation of land:

- c.300m^2 of St James's Park;
- the central grassed area of Parliament Square;
- 1.9ha (65%) of Jubilee Gardens;
- c.2000m^2 of open space at Old Jamaica Road;
- c. 1400m^2 of Southwark Park;
- a concrete play area (c.150m^2) at Ben Smith Way;
- c. 1000m^2 of Russia Dock Woodland;
- Durands Wharf Park.

In all these areas mature trees and other features (e.g. statues and public seating) should be protected and the sites should be reinstated in consultation with local authorities. Construction activity may also cause disturbance to users of the park area in St James's Square and of the south eastern corner of St James's Park.

Public information boards should be placed at all sites, explaining the reasons for the loss/disturbance and the schedule for reinstatement. The location and design of permanent features should be selected to minimise longer term disturbance and intrusion.

1.2.4 Other Landtake

The following are noted:

- public parking facilities (30 spaces) will be temporarily lost in St James's Square and Union Street (80 spaces);
- part (c. 170 spaces) of the Surrey Quays Shopping Plaza car park at Surrey Quays will be permanently lost;
- private parking will be temporarily lost at London Bridge;
- an unofficial sleeping area for the homeless will be temporarily lost on Waterloo Bridge roundabout;
- private parking will be permanently lost at Joan Street/The Cut;
- presently vacant or unused sites will be occupied at: Ewer Street, Major Road/John Roll Way, Pioneer Wharf, Blackwall Way, Brunswick, East India Dock Basin and The Limmo.

B1.3 Impacts on Historic Buildings and Other Features

B1.3.1 Locations of historic or related importance in the vicinity of the proposed development have been identified by reference to statutory and local designations. Listed and locally designated buildings within or adjacent to the Limits of Deviation are listed in Appendix B1 together with a note of any activities which might affect them.

Four areas of potential impact have been considered:

- demolition of designated buildings or features;
- effects of construction activity and permanent surface structures on the setting and amenity of buildings or features;

- the risk of disturbance of archaeological deposits during construction;
- damage to designated buildings as a result of settlement.

The last item is considered in B1.4. The first three are reviewed below.

B1.3.2 Demolition of Listed Buildings

It is not currently anticipated that any Listed or locally designated buildings will be permanently lost as a result of the Extension, although there is some possibility that a Grade II Listed Building (Nos. 1 and 2 Bridge Street) may have to be demolished to accommodate works at Westminster Station. A number of features will, however, need to be protected or temporarily removed, including statues in Parliament Square and possibly the statue of Boadicea on Victoria Embankment. These statues may be temporarily relocated or stored and could be renovated during this period.

The station works at Canada Water will involve the removal of Deal Porters' Lodge, a renovated building on Surrey Quays Road, which has been identified as being of local historical interest. It is recommended that the Lodge be dismantled and reinstated once construction works are complete.

Station works at Canada Water, Canary Wharf and Brunswick Wharf also have the potential to disturb Listed dock walls in these areas. In view of the sensitive structural nature of these walls, all appropriate measures should be taken to maintain their integrity.

B1.3.3 Temporary Disturbance during Construction

The setting of a number of Listed Buildings and features will be affected temporarily during construction. These are:.

o St James's Square and the buildings and street furniture around it.

o The Police Station on the corner of St James's Park; this building will also be permanently affected by the addition of a building to house an escape shaft. The building should be designed in the same style as the existing lodge.

o The buildings and statues in and around Parliament Square and on Victoria Embankment.

o County Hall adjacent to the Jubilee Gardens work site.

o St James's Church (Grade I) near Old Jamaica Road tunnelling site.

Appropriate bodies should be consulted on the design and layout of works to minimise intrusion at all these locations.

The route passes through a number of Conservation Areas (see Table B1.3) and where works are proposed in these areas particular care will be needed.

Close liaison should take place with local authorities in particular to ensure that special conditions applying to these areas are taken into account.

B1.3.4 Impacts on Archaeology

Much of London has a long history of habitation and as such any construction activity is likely to result in the unearthing of archaeological features.

Under the Ancient Monuments and Archaeological Areas Act 1979, as amended by the National Heritage Act 1983, an Archaeological Inspector may apply for a suspension of construction activity, if an area is designated as being of Archaeological Interest whilst investigations are undertaken. However, such action has been avoided in many instances by allowing either prior archaeological excavation of a site of

Table B1.3: Location of Conservation Areas

Conservation Areas	Jubilee Line Construction Activity
St James's (Piccadilly to the Mall)	St James's Square work site Blue Ball Yard underground works and underground tunnelling.
Government Precinct (Storey's Gate to River)	Storey's Gate shaft site (Conservation Area outside work site boundary), Parliament Square work site, Westminster Station site.
South Bank	Jubilee Gardens work site, Waterloo Bridge roundabout work site. Tenison Way work site (Conservation Area outside work site boundaries) underground tunnelling.
Waterloo (just north east of Waterloo Station)	Tenison Way, Waterloo Station and Joan Street work sites (Conservation Area outside work site boundaries) underground tunnelling.
Roupell Street	Joan Street work site (Conservation Area outside work site boundary) underground tunnelling.
Thrale Street (north of viaduct at America Street)	Wardens Grove (Conservation Area outside work site boundary) underground tunnelling.
Borough High Street	Loodoo Bridge Station site (Conservation Area outside LoD) underground tunnelling.
Tooley Street (north of viaduct after Joiner Street)	London Bridge Station site (west). London Bridge Station work site (east) (Conservation Area outside work site boundary). Druid Street work site (Conservation Area outside work site boundary).
Bermondsey Street	Work site (Conservation Area outside work site boundary) underground tunnelling (Conservation Area outside LoD).
Alfred Salter (Wilson Street) (north of Bermondsey Station site)	Ben Smith way work site (Conservation Area outside work site boundary). Major Road/John Roll Way work site (Conservation Area outside work site boundary).
Coldharbour, Isle of Dogs	Canary Wharf (Conservation Area outside work site boundary) underground tunnelling (Conservation Area outside LoD).
Naval Row	Brunswick Station work site (Conservation Area outside work site boundary).
St Johns, High Street (north of Bridge Road)	Stratford Station site (Conservation Area outside work site boundary) underground tunnelling (Conservation Area outside LoD).

* Note: LoD = Limits of Deviation

particular interest or through the mounting of an archaeological "watching brief" during initial surface layer stripping.

A thorough preliminary assessment of the sites involved in the project should therefore be undertaken early in the project programme to enable those sites of particular interest to be identified and, if necessary, an action plan for excavation and/or "watching brief" should be prepared.

Sites of particular archaeological potential so far identified through discussions with local authorities and the Museum of London, within the limits of deviation of the scheme, include the following:

- **Westminster**: area from Storey's Gate to the middle of the Thames, within (and beyond) the limits of deviation, is designated as an Area of Special Archaeological Priority by Westminster Council.

- **North Southwark**: identified as a Roman and Medieval town by the Museum of London.

- **Rotherhithe**: identified as a Saxon and Medieval settlement area by the Museum of London.

- **Stratford**: site of Stratford Langthorne Abbey (1135). The Abbey lies partially within the depot site. The boundary of the Abbey is currently under review by Passmore Edwards Museum.

- **River frontages**: Riverside sites eg. Jubilee Gardens, Durands Wharf, Blackwall Way habitually have a long history of both industrial and residential use.

B1.4 Settlement

Underground excavation may cause some settlement of the overlying ground. This is caused by the removal of spoil and the lowering of the groundwater level. A detailed survey should be carried out to establish the likely extent of settlement above the route.

Experience with other deep level rail lines indicates that settlement above the line should be confined to a "settlement zone" affecting a corridor with a width equivalent to about three times the depth of the tunnels, dependent on ground conditions. The main settlement connected with the Jubilee Line Extension is likely to result from the more extensive excavation at the bored station sites: Westminster, Waterloo, Southwark, London Bridge, and Bermondsey. Particular attention should be given to identifying sensitive properties, including Listed Buildings, so that specific action to prevent damage can be included in the construction contracts. In addition, the following general measures are available to minimise the effects:

- Routeing the tunnel so as to avoid passing directly under very sensitive properties, where practicable;

- The use of modern, purpose-built tunnelling machines and special tunnelling techniques, where possible, to minimise ground settlement.

- Uninterrupted tunnelling, avoidance of overcutting (ie, minimising the tunnel diameter excavated by the cutting machinery), and rapid grouting of each tunnel section to help reduce settlement.

- Special measures, including underpinning, to protect sensitive buildings.

- Continuous monitoring to ensure that immediate remedial action is taken where unacceptable settlement occurs.

- Provision for effective communications to deal with queries and complaints.

APPENDIX B1
LISTED AND LOCALLY DESIGNATED BUILDINGS ALONG THE ROUTE

Statutory Listed Buildings Along the Route

Location	Date/Listing		Use	Jubilee Line Extension Construction Activity
Green Park - Westminster				
2-5 St James's Place		II		underground tunnelling
6 St James's Place		II*		underground tunnelling
No's 7 - 11 St James's Place		II		underground tunnelling
No's 39 - 45 St James's Place		II		underground tunnelling
No's 9 - 18 Blue Ball Yard		II		underground tunnelling shaft works likely to be carried out from within tunnel
No 20 Blue Ball Yard		II		underground tunnelling shaft works likely to be carried out from within tunnel
13 & 14 Park Place		II		underground tunnelling
10 St. James's Street	1832	II*	Offices	underground tunnelling
4 St James's Street		II*		underground tunnelling
1 - 5 Pickering Place		II		underground tunnelling
18 Crown Passage		II		underground tunnelling
8 King Street		II		underground tunnelling

Location	Date/Listing	Use	Jubilee Line Extension Construction Activity
14 - 16 King Street	II		underground tunnelling
22 King Street	1897 II	Office	underground tunnelling
25 King Street	1897 II	Public house (Golden Lion)	underground tunnelling
26 - 28 King Street	II	Almack House	underground tunnelling
29 - 30 King Street	II	Offices	underground tunnelling
31-35 Bury Street	II	Shop, chambers, flats	underground tunnelling
4 St James Square junctions works at Green Park	II*		site works associated with construction of temporary shaft and step plate
5 St James Square	II*		site works associated with construction of temporary shaft and step plate junctions works at Green Park
7 St James Square	II		site works associated with construction of temporary shaft and step plate junctions works at Green Park
Mounting block on kerb in front of No. 7	II		site works associated with construction of temporary shaft and step plate junctions works at Green Park
9 St James Square (including No. 7 Duke of York Street)	II*		site works associated with construction of temporary shaft and step plate junctions works at Green Park
10 St James Square	I		site works associated with construction of temporary shaft and step plate junctions works at Green Park
11 St James Square	II*		site works associated with construction of temporary shaft and step plate junctions works at Green Park

Location	Date/Listing		Use	Jubilee Line Extension Construction Activity
12 St James's Square		II		site works associated with construction of temporary shaft and step plate junctions works at Green Park
13 St James's Square		II*		site works associated with construction of temporary shaft and step plate junctions works at Green Park
14 St James's Square		II	London Library	site works associated with construction of temporary shaft and step plate junctions works at Green Park
15 St James's Square	1865	I		site works associated with construction of temporary shaft and step plate junctions works at Green Park
16 St James's Square	1865	II	East India Sports Club	site works associated with construction of temporary shaft and step plate junctions works at Green Park
Nos. 1A, 1B, 1C King Street		II		site works associated with construction of temporary shaft and step plate junctions works at Green Park
18 St James's Square	1846	II		site works associated with construction of temporary shaft and step plate junctions works at Green Park
20/21 St. James's Square (Distillers House)		I		site works associated with construction of temporary shaft and step plate junctions works at Green Park
25 St James Square		II		site works associated with construction of temporary shaft and step plate junctions works at Green Park
41 lamp Standards: St. James's Square	1910	II		site works associated with construction of temporary shaft and step plate junctions works at Green Park
31A St James Street		II		site works associated with construction of temporary shaft and step plate junctions works at Green Park

Location	Date/Listing		Use	Jubilee Line Extension Construction Activity
32 St James Square		II*	London House	site works associated with construction of temporary shaft and step plate junctions works at Green Park
33 St James Square (including Nos. 31 and 32 Charles II Street)		II*		site works associated with construction of temporary shaft and step plate junctions works at Green Park
St James Square and Gardens		II		site works associated with construction of temporary shaft and step plate junctions works at Green Park
St James Square centre of garden		I	Statue	site works associated with construction of temporary shaft and step plate junctions works at Green Park
St James Square south side of garden		II	Summerhouse	site works associated with construction of temporary shaft and step plate junctions works at Green Park
54 Pall Mall		II	Office	underground tunnelling
71-76 Pall Mall	1836	II*	Oxford and Cambridge Club	underground tunnelling
77-79 Pall Mall	1862	II	Offices	underground tunnelling
80-82 Pall Mall	1668	II*	Offices	underground tunnelling
89-91 Pall Mall	1908	II*	RAC	underground tunnelling
83-85 Pall Mall		II	Extension to RAC	underground tunnelling
Malborough House with enclosing forecourt walls plus service/ stable wing	1907	I		underground tunnelling

Location	Date/Listing		Use	Jubilee Line Extension Construction Activity
3 Carlton Gardens	1828	II*		underground tunnelling
1 and 2 Carlton Gardens	1828	II*		underground tunnelling
Carlton Gardens: 9 lampstandards		II		underground tunnelling
Carlton Gardens: bollards outside No. 4.		II		underground tunnelling
Carlton Gardens: George VI Statue		II		underground tunnelling
Corner of Storey's Gate/ Birdcage Walk	1840	II	Police station	construction of permanent shaft adjacent to police station
Birdcage Walk/Horseguards Road: 9 lampstandards from junction to outside the Citadel	1910	II		construction of permanent shaft adjacent to police station
Government buildings (South block) on Gt. George Street/King Charles Street		II*	Government Buildings	underground tunnelling
9 Gt George Street	1896	II	Institution of Civil Engineers	underground tunnelling
10 Gt George Street		II		underground tunnelling
11 Gt. George Street (Town House)		II	Institute of Chartered Surveyors	underground tunnelling

Location	Date/Listing		Use	Jubilee Line Extension Construction Activity
12 Gt. George Street	1896	II	Royal Institute	underground tunnelling
Westminster - Waterloo				
Little George Street	1906	II*	Middlesex Guildhall	Westminster Station works
Parliament Square: seven statues around Square		II		underground tunnelling and Westminster Station works
Abbey Precinct: 6 lampstands and railings		II		Westminster Station works
Parliament Square: Church of St Margaret		I		underground tunnelling and Westminster Station works
Broad Sanctuary		I	Westminster Abbey & Great Cloisters	underground tunnelling and Westminster Station works
Parliament Street, Nos. 34-42, 45, 46		II	Refurbished offices	underground tunnelling and Westminster Station works
Nos. 43, 44, 47		II*		
St. Margaret's Street/ Bridge Street (Palace Yard Gateway)		II	Gateway	underground tunnelling and Westminster Station works
Houses of Parliament		I		underground tunnelling and Westminster Station works
1-2 Bridge St		II		underground tunnelling and Westminster Station works
10-12 Bridge St		II		underground tunnelling and Westminster Station works
Cannon Row/Derby Gate		II*	Police station	Westminster Station works

Location	Date/Listing	Use	Jubilee Line Extension Construction Activity
Cannon Row: lamp standards	1890 II		underground tunnelling and Westminster Station works
Derby Gate/Victoria Embankment	II*	Norman Shaw building (south)	underground tunnelling and Westminster Station works
Victoria Embankment (river wall, stairs, benches and lamp standards)	II		construction of permanent ventilation outlet
Corner of Embankment/ Westminster Bridge	II	Boadicea Statue	construction of permanent ventilation outlet
Westminster Bridge	II*		underground tunnelling
County Hall - Riverside	II*	To be refurbished	riverside spoil transport operations and construction of temporary working shaft in Jubilee Gardens
Belevedere Road Boundary Wall	II		riverside spoil transport operations and construction of temporary working shaft in Jubilee Gardens
Belevedere Road Embankment Wall	II		riverside spoil transport operations and construction of temporary shaft in Jubilee Gardens
Waterloo - Southwark			
Waterloo Road Royal Waterloo Hospital	II		Waterloo Station works
Waterloo Road St John's Church	II*		Waterloo Station works
Roupell Street Terraced Houses (1-73)	II	Residential	underground tunnelling

Location	Date/Listing		Use	Jubilee Line Extension Construction Activity
Southwark - London Bridge				
74-78 Blackfriars Road		II		Southwark Station works
43 - 44 Dolben Street		II		tunnelling site at Ewer Street
Southwark Street central buildings (Hop Exchange)		II	Offices	underground tunnelling
5 Stoney Street	C18	II		underground tunnelling
Stoney Street/Southwark Street cannon post between 1 and 2 Stoney Street		II		underground tunnelling
Borough High Street:				
32-34 (even)		II		underground tunnelling
38-42 (even)		II		underground tunnelling
50 & 52		II		underground tunnelling
Calvert buildings behind No. 50 Borough High St		II		underground tunnelling
53		II		underground tunnelling
Borough High Street:				
58		II		underground tunnelling
60		II		underground tunnelling
67		II		underground tunnelling
91-95 (odd)		II		underground tunnelling
Borough High Street/Bedale Street Cannon at entrance to Bedale Street		II		underground tunnelling

Location	Date/Listing	Use	Jubilee Line Extension Construction Activity
George Inn Yard	II	Public house	underground tunnelling
King's Head Yard	II	Public house	underground tunnelling
London Bridge - Bermondsey			
St Thomas Street	II*	Guy's Hospital	underground tunnelling
4-16 St Thomas Street (even)	II		underground tunnelling
St Thomas Street, Chapter House	II*		underground tunnelling London Bridge Station works
St Thomas Street Annex No 9	II*		underground tunnelling London Bridge Station works
11 & 13 St Thomas Street	II*		underground tunnelling London Bridge Station works
15 St Thomas Street	II		underground tunnelling London Bridge Station works
St Thomas Street/London Bridge Station	II		underground tunnelling London Bridge Station works
Cathedral Street	I	Cathedral of St. Saviour, Southwark	London Bridge Station works
15-25 Tooley Street (odd)	II		London Bridge Station works
29-33 Tooley Street	II		London Bridge Station works
45-49 Tooley Street	II		London Bridge Station works
51-67 Tooley Street	II		London Bridge Station works

Location	Date/Listing		Use	Jubilee Line Extension Construction Activity
London Bridge Street rear of No. 4		II	Post Office	London Bridge Station works
Abbey Street; railway bridge	1836	II		underground tunnelling
Bermondsey → Canada Water				
Thurland Road: St. James's Church		I		Old Jamaica Road tunnelling works
124-130 Jamaica Road (even)	C18	II		Bermondsey Station works
Canada Water → Canary Wharf				
Renforth Street; pumping station	1836	II		Canada Water works
Canary Wharf → Brunswick Wharf				
West Ferry Road - former west entrance lock to south dock		II		Pioneer Wharf works
West India Dock Road		I	Warehouse and general office North Quay	Canary Wharf Station works
West India Dock Walls, copings and buttresses to export dock		I		underground tunnelling and construction of Canary Wharf Station box and access facilities
Blackwall Basin Walls	1802	I		underground tunnelling

Location	Date/Listing	Use	Jubilee Line Extension Construction Activity
Poplar Dock South Wall	II		
Poplar Dock East Wall	II		underground tunnelling
26 Prestons Road Bridge House	early C19 II		underground tunnelling
Prestons Road: Accumulator tower	1875 II		underground tunnelling
Brunswick - Canning Town			
East India Dock Wall Road, Pumping station	II		Brunswick Station works
East India Dock Wall Road, Boundary wall	II		Brunswick Station works
Naval Row Embankment wall, railings and steps	II		Brunswick Station works
Blackwall Pier and entrance lock to former East India Dock Basin	II		East India Dock Basin works
Orchard Place:			
Trinity Buoy Wharf	II		East India Dock Basin works
Orchard Dry Dock	II		East India Dock Basin works

Location	Date/Listing	Use	Jubilee Line Extension Construction Activity
Canning Town → West Ham			
Orchard Place:			
Jubilee Wharf	II		East India Dock Basin works, Canning Town Station works
West Ham → Stratford Market			
No Listed Buildings identified			
Stratford Market → Stratford			
Nos. 116-130 Abbey Lane	II		Stratford Depot works
Abbey Road Engine House 1897	II*		Stratford Depot works

Locally Listed Buildings Along the Route

Location	Date/Listing	Use	Jubilee Line Extension Construction Activity
Green Park → Westminster			
No locally Listed Buildings identified.			
Westminster → Waterloo			
No locally Listed Buildings identified.			
Waterloo → Southwark			
No locally Listed Buildings identified.			
Southwark → London Bridge			
9 Stoney Street			underground tunnelling
9 Stoney Street Gun shaped post			underground tunnelling
54 Borough High Street			underground tunnelling
56 Borough High Street			underground tunnelling
George Inn Yard		Public house	underground tunnelling
London Bridge → Bermondsey			
No locally Listed Buildings identified.			
Bermondsey → Canada Water			
No locally Listed Buildings identified.			

Locally Listed Buildings Along the Route

Location	Date/Listing	Use	Jubilee Line Extension Construction Activity
Canada Water → Canary Wharf			
Surrey Quays Road: Deal Porters Lodge			
Canary Wharf → Brunswick			
St Lawrence Street: Nos 1-6 (even) 12-14 (even) 7-11 (odd)			underground tunnelling, Blackwall Way works
Blackwall Dock			underground tunnelling, Brunswick Station works
Brunswick → Canning Town No locally listed building identified.			
Canning Town → West Ham No locally listed buildings identified.			
West Ham → Stratford Market			
Burford Road works			Stratford Depot works
Union Street gas depot 329 - 333 High Street			Stratford Depot works
1-23 Bakers Row			Stratford Depot works
Stratford Market → Stratford			
361-371 High Street			Stratford Depot works

B2. NOISE AND VIBRATION

B2.1 Introduction

This section deals with noise and vibration impacts predicted during the construction and operational phases of the extended line.

During construction there will be two potential sources of noise and vibration:

- underground tunnelling affecting property above the activity;
- activity on surface construction sites affecting neighbouring land uses.

These two aspects are considered in Sections B2.2 and B2.3.

Possible disturbance caused by construction traffic is covered in Section B3.

During operation there will be several sources of noise and vibration:

- train movements in tunnels;
- train movements on the surface section of line;
- ventilation shafts;
- station operations;
- depot operations;
- maintenance working;
- transformers and substations.

These are considered in Sections B2.4 to B2.10.

B2.2 Noise and Vibration from Underground Activities during Construction

Measurements carried out by ERL above tunnelling activities on the DLR extension to Bank have indicated that, at the tunnel depths proposed on the Jubilee Line Extension, **vibration** will not be felt at properties above the route. Experience at other sites in similar soils generally tends to confirm this, but at certain locations ground-borne **noise** has been heard in properties above tunnelling operations; this is thought to be caused by unusual soil properties at those locations.

Should such conditions be encountered on the Jubilee Line Extension, impacts will be short-lived, lasting for only a matter of perhaps 2 or 3 days as the tunnelling work passes. Average rates of progress are anticipated to be about 50m per week in the London Clay.

Measurements of vibration and ground-borne noise from spoil train movements within tunnels indicate that these should not cause significant impact during construction of the new line.

B2.3 Construction Site Noise and Vibration

B2.3.1 Predictions of Construction Noise Levels

Until the chosen contractors have fully detailed their methods of working and compiled their own inventories of plant required at each working site, it is only possible at this stage to give indicative figures regarding anticipated noise levels adjacent to above ground construction activities.

Equipment present on construction sites has been estimated for the different phases of working, i.e.:

- site clearance;
- preliminary works;
- main construction.

These estimates have been made from a knowledge of the types of operation that are expected at different work sites together with observations of activities associated with similar projects.

Facade noise levels (L_{eq})[1] at nearest sensitive locations have then been calculated using typical noise emission data for plant given in BS5228 (1984)[2]. Predicted noise levels at those locations are presented in Appendix B2 at the end of this section. At each site details are given of distances to nearest sensitive land uses, approximate duration of construction, and facade noise levels for the main types of activity. For sites where sheet piling may be required peak noise levels from piling are also given.

B2.3.2 Evaluation of Construction Noise Impacts

Predicted noise levels have been compared against criteria for construction site noise. For the daytime these aim to preserve speech intelligibility within buildings and at night aim to prevent sleep disturbance. Table B2.3(a) sets out these proposed standards for acceptable levels of noise from construction activities. These have been derived based on guidance given by the British Standards Institution and the Department of the Environment[3] and reflect standards adopted elsewhere in the construction industry.

In addition, Appendix B2 shows typical background noise levels at each of the sites, as measured during brief surveys undertaken by the consultants. The amount by which noise from construction work exceeds the background (L_{90})[1] level gives a second indication of the potential for general annoyance from site activities. It might be expected that at residential property where noise from construction working exceeds the background level by 10dB(A) or more some annoyance may be experienced; where the value exceeds the L_{90} by 20dB(A) or more such effects would probably result in significant annoyance.

Comparison of predicted construction noise with the evaluation criteria in Table B2.3(a) and with background levels indicates that potential for significant annoyance will occur at some residential properties bordering construction sites, especially in quiet areas away from main road and rail routes. Properties adjacent to some of the sites, generally those close to existing railway lines and primary roads, already experience daytime noise levels in the region of 70-75dB(A)L_{eq}. Noise from construction activities at these locations is likely to be masked by rail and road traffic movements and the daytime impact of construction working will be marginal.

The greatest potential for noise disturbance will occur during the early stages of construction, i.e. during site clearance and preliminary excavation, due to the use of large diesel engined plant, for example, dozers and excavators and the need to employ plant to break up existing hard surfaces; such plant could include pneumatic drills and hydraulic breakers.

Once preliminary excavations have been completed the major construction activities will move below ground level and noise experienced above ground will be mainly due to plant servicing the underground work. This will generally comprise compressors, ventilation equipment and spoil handling plant. For much of the time it should then be possible, using mitigation measures for reducing noise emissions (detailed below), to limit noise to acceptable levels at locations bordering construction sites.

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(1) L_{eq} is a measure of the total sound energy over a period of time. It provides an indicator of the "average" level, as noise varies over the period, and takes account of the number and intensity of intermittent noise events.

(2) British Standards Institution: BS5228, Noise Control on Construction and Open Sites, 1984.

(3) Advisory Leaflet 72 (1976), Noise Control on Building Sites, Department of the Environment.

(1) L_{90} is the dB(A) level exceeded 90% of the time.

Table B2.3(a): Criteria for Evaluating the Significance of Noise During Construction

PERIOD	BUILDING/ LOCATION	CRITERION FOR ASSESSMENT L_{eq} [(1)]	PURPOSE
Day 0700-1900 hrs	Dwellings/Offices (facade)	75 dB(A), 12hr L_{eq}	To maintain speech communication
Evening 1900-2200 hrs	Dwellings (facade)	65 dB(A), 3hr L_{eq}	To maintain speech communication
Night 2200 - 0700 hrs	Dwellings (facade)	55 dB(A), 1hr L_{eq}	To avoid sleep disturbance
Day 0900 - 1600 hrs	Schools (facade)	60 dB(A), 1hr L_{eq}	To maintain speech communication
Anytime	Dwellings	Period L_{90} + 10 dB(A) Period L_{90} + 20 dB(A)	To avoid annoyance To avoid significant annoyance

(1) The above levels are proposed as criteria for the assessment of construction noise at this stage. The setting of working criteria at individual construction sites will be the subject of negotiation with relevant local authorities. For explanation of L_{eq} and L_{90} see footnotes to Section B2.3.1 and B2.3.2.

Regular monitoring of construction noise should be carried out to confirm that acceptable noise levels are achieved.

B2.3.3 Hours of Working

Hours of working will be a subject of negotiation and agreement with relevant local authorities. At certain work sites concerned with the servicing of tunnelling operations and some station sites, the nature of excavations will require 24 hour working for much of the time. It is anticipated that the following work sites will involve 24 hour working once tunnelling commences:

- St. James's Square;
- Parliament Square/Westminster Station;
- Jubilee Gardens;
- Waterloo;
- Joan Street/The Cut;
- Ewer Street;
- London Bridge;
- Old Jamaica Road;
- Major Road/John Roll Way;
- Canada Water;
- Durands Wharf;
- Blackwall Way.

As noted above, sources of noise which will be operating at night are principally those concerned with servicing the tunnelling operation. Night-time noise levels could be sufficient to cause disturbance at nearby dwellings at Joan Street/The Cut, Ewer Street (if used), Old Jamaica Road, Major Road/John Roll Way, Durands Wharf and Blackwall Way.

At other sites work is expected to be predominantly confined to normal daytime construction hours. In summer months these may extend into the evening period when potential for noise disturbance will increase.

There is, however, potential for 24 hour working at all sites depending upon the requirements of the programme at any time.

B2.3.4 Piling

At the following sites the possible need for sheet piling has been identified:

- Joan Street/The Cut;
- London Bridge;
- Major Road/John Roll Way;
- Canada Water;
- Downtown Road;
- Durands Wharf;
- Pioneer Wharf;
- Canary Wharf;
- Blackwall Way;
- Brunswick;
- The Limmo;
- Stratford Station.

B2.3.5 Tracklaying and Depot Construction

Tracklaying will be carried out on the 3.5km surface section between the tunnel portal south of Canning Town station and the terminus at Stratford. Track will also be laid within the planned depot at Stratford, where some 12km of sidings will be provided.

Site measurements taken by the consultants suggest that most operations involving tracklaying result in maximum noise levels below 75 dB(A) at 25m; daytime period L_{eq} levels should be below the 75 dB(A) criterion at 25m. At the depot site no significant impacts are anticipated as the nearest occupied buildings are at least 25m from any point on the depot site. Tracklaying between Canning Town and Stratford may approach within 25m of dwellings lying near the alignment in Pond Road and Bridge Road and offices associated with workshops in Stephenson Street. If daytime L_{eq} levels from tracklaying operations exceed the 75 dB(A) criterion it is not anticipated that such levels will be long-lived as activities will be transitory as work moves along the track alignment. No significant noise impacts are thus predicted.

The depot site will include a number of buildings comprising workshops, administration offices and train sheds. Construction of these facilities may require shallow piled foundations which if bored would be unlikely to result in intrusive daytime noise levels at nearest dwellings.

It is not expected that tracklaying or depot construction will be necessary outside normal daytime site working hours. Consequently, night-time disturbance should not occur.

B2.3.6 Mitigation Measures

A range of mitigation measures are available to reduce noise levels from surface construction activities. These include:

- screening or enclosure of fixed plant such as pumps, compressors, and ventilation fans (site buildings can provide useful screening);
- maximising the separation distance between noisy plant and residential property;
- use of "quiet" piling methods wherever feasible;
- scheduling unavoidably noisy operations (such as piling and initial site clearance) to avoid working which may conflict with the land uses concerned;
- positioning of gates or openings in site screens away from sensitive locations wherever possible;
- use of electrically operated plant in preference to diesel power whenever feasible;
- provision and regular maintenance of effective silencing to motorised plant;
- maximising use of river transport for delivery of materials/removal of spoil where appropriate;
- prohibition of lorry movements at night where sites are close to residential property.

It may also be necessary to consider provision of secondary glazing to bedroom windows facing a work site predicted to produce significant night-time noise impacts. These properties should be identified once the contractor's working methods (incorporating the best practicable means of noise reduction) and plant complements are known.

The specific mitigation measures to be adopted at individual sites should be defined once the detailed scheme design has been finalised, the appointed contractor's working programme and construction methods have been established, and more detailed noise assessment has been carried out.

B2.3.7 Vibration Impacts from Surface Construction Activities

Table B2.3(b) gives various criteria for levels of vibration in buildings of different use. Measurements of vibration levels from typical mobile construction equipment likely to be used at surface work sites indicate that vibration will be imperceptible at distances greater than around 20m from the equipment concerned. Thus, where property is located within 20m of the site boundary, vibration may be perceptible when such equipment is working at the site margins. However, it is unlikely that such vibration will be sufficient to cause annoyance, as the plant will rarely work in any one location for prolonged periods, and the period of disturbance will be correspondingly short.

Where percussive piling may be required, vibration could be perceptible within 100m of the point of impact. Levels of vibration could be sufficient to cause annoyance in dwellings within 60m of the point of impact. There are residential properties adjacent to sites at:

- Joan Street/The Cut;
- London Bridge;
- Major Road/John Roll Way;
- Canada Water;

Table B2.3(b): Criteria for Evaluating Significance of Vibration During Construction and Operation

PERIOD		BUILDING/LOCATION	CRITERION	PURPOSE
Anytime		Any location	0.10 mm/s (rms)[1]	Limit of perception[2] and to protect sensitive equipment
Day	0600 - 2200 hrs	Inside dwellings	16hr rmq 0.20 - 0.40 mm/s	Annoyance threshold
Night	2200 - 0600 hrs	Inside dwellings	8hr rmq 0.14 mm/s[3]	Annoyance threshold
Day	0800 - 1800 hrs	Standard buildings	5 mm/s (peak)[4]	Protection of building structure
Anytime		Listed buildings or potentially vulnerable buildings	3 mm/s (peak)[4]	Protection of building structure

(1) rms denotes 'root mean square' which is a standard method of describing the magnitude of a waveform, e.g. for a sinusoidal waveform rms is the peak divided by 1.414. rmq denotes 'root mean quad' which is a form of averaging used to describe the magnitude of vibration signals over a specified period.

(2) The level of perception varies from person to person; 0.10 mm/s (rms) represents a relatively low level for perception and is equivalent to that suggested in British Standard Institution; BS6472, Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz), 1984 and BS6841, Measurement and Evaluation of Human Exposure to Whole Body Mechanical Vibration and Repeat d Shock, 1987.

(3) As suggest d in BS6472.

(4) As suggest d in German Standard DIN4150 Part III (no equivalent British Standard exists).

- Downtown Road;
- Canary Wharf;
- Stratford Station;

which may be affected, although piling activity is expected to be relatively short lived. No percussive piling is anticipated at night.

Percussive piling also presents a risk of damage to property. Measurements suggest that a 'no risk' level could be exceeded where the point of impact is within 30m of property. This does not imply significant risk of damage; however, it is recommended that an investigation of the structure of any properties within this distance of piling operations is undertaken prior to work commencing, so that if necessary suitable protection to buildings can be incorporated or construction techniques modified.

B2.4 Train Movements in Tunnels

B2.4.1 Generation of Noise and Vibration in Tunnels

The stresses caused by the contact between the train wheel tread and the rail, together with imperfections in both rail and wheel surfaces, result in the generation of forces which pass through the track bed into the tunnel structure and thence into the ground.

These forces are evident as vibration which will be present in both the 'feelable' frequency range (up to 80 Hz) and the audible range (above about 20 Hz). The magnitude of the vibration produced varies according to the system design(1), the magnitude of irregularities in the system (e.g. rail corrugation and joints), the type of track bed formation and the type of rails (continuously welded or jointed track). The vibrations generated may be experienced in properties above the track as 'feelable' vibration or as ground-borne noise.

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(1) The system design includes such variable features as weight of the carriages and design of wheels and rails.

The magnitude of these effects in properties above the route will depend upon the depth of the tunnel and the nature of the intervening geology, since vibration decays with distance due to geometrical spreading and absorption by the media through which it travels.

Table B2.4 presents the criteria used to evaluate noise from train movements in tunnels.

B2.4.2 Noise from Train Movements in Tunnels

Noise predictions have been generated by ERL on the basis of measurements taken above the existing Jubilee and Piccadilly Lines in September 1989.

Track conditions on the Jubilee and Piccadilly Lines are expected to be typical of those that would be found on the new Extension if a standard trackbed formation were used. Calculations have been based on this assumption, but a correction has been applied to allow for use of continuously welded rather than jointed track on the new line. Ground-borne vibration in the audible range is reduced by about 7dB on continuously welded track.

From the noise predictions it can be concluded that noise from train movements in tunnels with a standard trackform will be potentially audible in all properties overlying the route. The extent of audibility will depend on the distance of properties from the tunnel and background noise conditions. In practice train movements will mainly be audible in quiet ground level or basement premises, particularly early in the day or late in the evening when background noise levels are low.

Estimates indicate the following train movements on the extended line:

Table B2.4: Criteria for Evaluating the Significance of Noise during Operation

PERIOD	LOCATION	CRITERION	REASON FOR CRITERION
Trains running in tunnels - anytime	Inside dwellings and similarly sensitive buildings	35 dB(A) (peak)[1] 40 dB(A) (peak)[2]	Desirable level Potential complaint threshold
Trains running at surface - anytime	At dwelling facades	70 dB(A) (L_{eq} 24hr)[3]	Limit of tolerability

(1) This maximum level has been taken from guidelines issued by the American Public Transit Association (1981).

(2) LUL has found that complaint about train passage noise is unlikely below this threshold level. Levels in excess of 40 dB(A) may evoke complaint from some occupiers of residential property.

(3) This level has been suggested as the limit of tolerability to railway noise, e.g. Walker, J.G.; A Criterion for Acceptability of Railway Noise. Proc. Inst. Acoustics, Vol. 10, Part 8 (1988).

Green Park to Canary Wharf:
30 trains/hr each way for 5.5 peak hrs/day
15 trains/hr each way for 13.5 off peak hrs/day
Total: 735 movements/day

Canary Wharf to Stratford:
22 trains/hr each way for 5.5 peak hrs/day
15 trains/hr each way for 13.5 off peak hrs/day
Total: 647 movements/day

Preliminary speed profiles indicate that maximum speeds between stations will vary between 58 kph and 87 kph, with typical speeds lying between 60 and 80 kph for much of the route.

At these speeds, calculations based on the use of standard track form with continuously welded rail indicate that the criterion of 35 dB(A) (adopted from American Public Transit Association Guidelines) would be exceeded within:

- 65m of the tunnel lining at 58 kph train speed;
- 85m of the tunnel lining at 87 kph train speed.

The complaint threshold criterion of 40 dB(A) would be exceeded within:

- 45m of the tunnel lining at 58 kph train speed;
- 65m of the tunnel lining at 87 kph train speed.

Each of the distances quoted represents the slant distance from the lining of the tunnel.

Should a standard trackform be employed it can be concluded that potential for complaint due to train passage would arise at dwellings along the length of the tunnelled route. For instance, taking a typical train speed of 60 kph and the following tunnel depths, the width of the corridor at the surface within which the complaint criterion would be exceeded is:

- 84m at a tunnel depth of 15m;
- 80m at a tunnel depth of 20m;
- 75m at a tunnel depth of 25m.

Taking into account initial estimates of speed profiles and tunnel depths it is estimated that some 500 residential properties along the tunnelled section of the route would fall inside the 40 dB(A) corridor for ground-borne noise if a standard trackform was employed. The majority (about 300) of these properties lie above the tunnels between London Bridge and Canada Water. This number does not include properties such as clubs and hotels where the lowest floor might possibly be used for residential purposes. Potential for complaint is not likely to occur when lowest rooms are employed for non-sensitive uses, e.g. service plant, garages, kitchens, bathrooms, etc.

In order to reduce this potential impact it will be necessary to design a special trackform incorporating resilient features. This will result in less vibration energy being transmitted into the tunnel structure and into the ground. Various forms of resilient trackform have been shown to successfully reduce ground-borne noise levels in various underground schemes worldwide. It is recommended that a programme for the design of such a system be set up. It is recommended that the aim of the programme should be, as far as practicable, to develop a trackform such that no residential property will experience ground-borne noise in excess of 40dB(A).

The preceding discussion has focused on impacts in residential property. A check has also been made for other potentially sensitive buildings in the vicinity of the line.

Based on a standard trackform, the following sensitive locations would experience internal noise levels in excess of 40dB(A) and would be considered to be significantly affected:

Churches: Church of Most Precious Blood (R.C.) (Southwark)
St. James's (Bermondsey)
Rotherhithe Free Evangelical (Southwark)

Schools: St. James's School (Bermondsey)

Hospitals: St. Olaves (Southwark)
Guy's Hospital (North of St. Thomas Street)

The Young Vic Theatre is located about 85m from the intended alignment. It is suggested that a peak noise level of 30 dB(A) should not be exceeded for theatres. This criterion will be met, and the theatre is not expected to be adversely affected.

B2.5.3 Vibration from Train Movements in Tunnel

Prediction of vibration from the tunnels has also been based on measurements taken from the Jubilee and Piccadilly Lines. It is anticipated that vibration from train passage would reach or exceed the level of perception given in Table B2.3(b) (i.e. 0.10 mm/s, rms) within 45m of the tunnel lining at 58 kph and 75m at 87 kph.

In properties with resonant responses (such as houses with suspended timber floors) vibration may be amplified within the building structure and the distances quoted could be doubled.

Along the tunnelled length of the route it is estimated that vibration may be perceptible in about 800 properties.

Annoyance due to vibration (see Table B2.3(b)) is not however anticipated beyond:

- 10m of the tunnel lining at 58 kph;
- 20m of the tunnel lining at 87 kph.

These distances indicate that there will be no annoyance due to vibration along the tunnelled section of the route. However, a risk of adverse comment is possible where vibration amplification occurs within building structures.

B2.5 Train Movements at Surface

B2.5.1 Noise from Surface Movements

Noise levels from movements on the surface section of the line have been evaluated against a criterion of 70dB(A), measured as 24hr L_{eq}. This is generally taken to be equivalent to the 18hr L_{10} criterion of 68dB(A) established for provision of sound insulation for new roads[1][2]. It has also been suggested as a limit of tolerability to railway noise[3].

The consultants have measured trackside noise levels from existing Jubilee Line trains running at surface. Calculations based on preliminary estimates of train movements and speed profiles for the extended line show that the noise levels in Table B2.5 may be expected from trains running at surface.

Unscreened peak noise levels would be about 75dB(A) at 25m from the track at 70kph; levels of this order may then be experienced at dwellings closest to the line. This level is significantly below that currently experienced from movements on the North London Line between Canning Town and Stratford at a similar distance. 24hr L_{eq} levels are only predicted to rise by about 1dB(A) at properties adjacent to the route. Although such an increase may be noticeable, the impact will be marginal and is not considered to be significant.

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(1) British Rail Leaflet; Noise and the Channel Tunnel Rail Link - Some Explanatory Notes, Channel Tunnel Rail Link Group, 1989.

(2) L_{10} is the dB(A) level exceeded 10% of the time.

(3) Walker, J.G.; A Criterion for Acceptability of Railway Noise. Proc. Inst. Acoustics. Vol. 10, Part 8 (1988).

Table B2.5: Predicted Noise Levels near the Surface Line

Location	Approx. Distance to Track (m)	Northbound Speed (kph)	Southbound Speed (kph)	Facade Noise Level (24hr L_{eq} dB(A)) Existing Level	Estimated with Extension
Works:					
Stephenson Rd	15	56	83	64	65
Manor Rd, south	35	68	81	62	63
Manor Rd, north	28	82	62	63	64
Pond Rd	25	50	50	63	64
Bridge Rd	25	65	74	63	64

Speed profiles and train movement numbers have yet to be confirmed. When confirmed figures are available, noise levels should be recalculated, although it is not anticipated that the 70dB(A) criterion will be reached. No mitigation measures are therefore considered necessary at this stage.

B2.5.2 Vibration from Surface Train Movements

Vibration levels have been calculated using an empirical formula derived from measurements adjacent to surface railways in the UK. Peak levels are converted to period averaged levels (rmq's) following BS6472 and BS6841[1].

(1) British Standard Institution; BS6472, Evaluation of Human Exposure to Vibration in Buildings, (1Hz to 80Hz) 1984. BS6841, Measurement and Evaluation of Human Exposure to Whole Body Mechanical Vibration and Repeated Shock, 1987.

Based on guidance given in BS6472 and BS6841 the rmq levels have been calculated for train speeds of 70kph at a location 25m from the track.

Day 0600 - 2200 hrs, rmq = 0.27 mm/s (rms)
Night 2200 - 0600 hrs, rmq = 0.20 mm/s (rms)

The daytime rmq level of 0.27 mm/s lies within the acceptable range suggested in Table B2.3(b). The night-time rmq of 0.20 mm/s may result in adverse comment, although the criterion of acceptability (0.14 mm/s) is only marginally exceeded.

The peak vibration level is expected to be 0.51 mm/s at 25m at a train speed of 70kph. This is well below the 3mm/s level at which damage to property could occur (see Table B2.3(b)).

B2.6 Noise from Ventilation and Draught Relief Shafts

Noise emanating from shafts can result from three sources:

- noise from the passage of the train (intermittent);
- aerodynamic noise, generated by the flow of air as it is forced out of the shaft (intermittent);
- noise from forced draught ventilation fans (ventilation shafts only, continuous during periods of fan operation).

The biggest source of noise from ventilation shafts will be the axial flow fans used to extract air from the tunnels.

Attenuation in the form of in-duct absorptive silencers should be provided where necessary to achieve acceptable noise levels at adjacent buildings or in adjacent open areas. These should be based on the "good" standard of internal noise environment

recommended by Circular 10/73[1] or a level equivalent to the level of marginal significance under BS4142[2].

Noise from draught relief shafts during normal operation will arise only from train movements within the tunnel system, and they are therefore of less significance than ventilation shafts. Escape shafts are fitted with emergency doors which reduce train pass-by noise externally to insignificant levels.

B2.7 **Station Operations**

Noise sources associated with stations include:

- PA announcements;
- footfalls on stairs;
- people noise;
- train idling noise.

Noise from below ground stations is not expected to be perceptible.

Noise from surface station announcements will depend upon the design and layout of the system but will, of necessity, need to rise above background noise levels to be heard on the platforms and might therefore be considered intrusive at adjacent properties. Consideration should be given to design of speaker systems at surface stations to minimise noise at adjacent properties. Maximum use should be made of electronic displays to reduce the requirement for speaker systems. A system which adjusts amplified speech levels on the platforms to suit ambient noise conditions at the time of the announcement should also be investigated.

Noise from human activity at above-ground stations is not expected to cause disturbance to the neighbouring community, except in the case of isolated incidents. Wherever practicable concrete staircases should be used to avoid the noise amplification effects associated with wooden or metal structures.

Noise from trains standing at stations is anticipated to be of the order of 60 dB(A) at 5m. With a stop time of 30 seconds the 24-hour L_{eq} level at 30m (approximate distance to nearest residence) for the total number of movements will be of the order of 45dB(A). No significant impacts will therefore be experienced at the nearest properties on the Canning Town to Stratford section of the line.

Noise from pneumatic door systems may be audible during quieter periods of the day.

B2.8 **Depot Operation**

Sources of noise during the operation of the depot include fixed plant, e.g. compressors and ventilation equipment, workshop activities, including maintenance of trains, train washing and movements of stock to, from and within the depot.

All fixed plant, e.g. compressors, ventilation equipment, should be designed so that noise levels at adjacent dwellings will not exceed the level of "marginal significance" according to BS 4142. Buildings housing the workshop and other potentially noisy activities should be designed to limit noise emissions to a practical minimum.

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(1) Department of the Environment Circular 10/73: Planning and Noise.

(2) British Standards Institution; BS4142, Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas, 1967.

The layout of the depot should be designed to eliminate, where practical, tight radius bends and therefore reduce potential for wheel screech. Trains within the depot will be running at low speeds and it is likely that overall noise emissions from the trains themselves will be dominated by ancillary equipment on the trains, e.g. compressors. Levels from individual trains are likely to be of the order of 50dB(A) at 25m. Noise levels at the nearest properties, which are 50-100m from the sidings, will be about 50dB(A) with three trains operating within the depot.

The use of depot buildings to screen train sources would be beneficial and result in perhaps 5-10dB(A) further attenuation of train noise sources. The incorporation of the above measures within the design and operation of the depot would ensure that no significant impacts arise at properties in the vicinity of the depot.

With a bedroom window partly open internal noise levels will then be about 40dB(A); this level falls midway between what is considered a maximum desirable level and a "good" night-time environment within a bedroom.

B2.9 **Maintenance Working**

In general, the main source of noise from maintenance is grinding of the rail track surfaces, which if carried out on the proposed line will take place before the railway opens, and thereafter every two to three years. This is an unavoidably noisy operation, and after the railway opens it is likely to be carried out at night.

However, the noise will last only a short time in any one location, and the ensuing benefit in reduced wheel/rail noise will be considerable. As is normal practice on the underground, local residents likely to be affected should be notified prior to night-time maintenance operations.

B2.10 **Transformers and Substations**

Transformers and substations are needed to provide the power supply for the system. Magnetostrictive forces inside the transformer core result in noise emissions which can be intrusive, due to their tonal nature. Other noise sources include transformer cooling and motor generator sets.

Details of transformer and substation locations have yet to be finalised; most are expected to be underground. Studies should be carried out when sites have been located and if predicted levels at nearest noise sensitive properties are found to be above criteria for noise acceptability then mitigation measures will need should be taken. These measures might include acoustic screening/enclosure or resiting of the substation.

APPENDIX B2

ESTIMATED CONSTRUCTION SITE NOISE LEVELS

This Appendix presents information on existing and predicted future noise levels in the vicinity of each proposed construction site. Predictions are given for two cases:

- the mean case when equipment is distributed around the site
- the worst case when equipment is concentrated at the boundary nearest to the receptor.

Predictions are also given for four phases of activity:

- 1: Site clearance and preparation
- 2: Preliminary works
- 3: Main construction activity (with lorries)
- 4: Main construction activity (without lorries)

SITE AND SITE USE	NEIGHBOURING LAND USES (present)	DISTANCE FROM SITE PERIMETER (m)	APPROXIMATE CONSTRUCTION PERIOD FOR MAJOR WORKS (years)	APPROXIMATE L_{90} LEVEL AT PRESENT dB(A)		ESTIMATED FACADE NOISE LEVELS (Period L_{eq} dB(A))								SHEET PILING PEAK NOISE LEVEL
				DAY	NIGHT	Mean Case				Worst Case				
						Phase 1	2	3	4	Phase 1	2	3	4	
St James's Square (tunnelling site)	Offices	20	2	62	53	71	69	66	62	76	74	71	68	n/a
St James's Park (escape shaft site)	Public Park	•	2	5•	50	74	66	59	57	83	75	67	66	n/a
	Police Station	•				74	66	59	57	83	75	67	66	n/a
	Offices	20				70	63	56	54	75	68	61	59	n/a
Parliament Square (station work site)	Offices	45	3½-4	67	63	68	64	65	61	71	67	68	64	n/a
	Cathedral	35				69	65	66	62	73	68	69	66	n/a
Westminster (station work site)	Offices	•	3½-4	67	63	74	70	70	67	83	79	78	77	n/a
Jubilee Gardens (tunnelling work site)	Offices	10	3-4	62	5•	73	68	69	66	79	74	74	72	n/a
Waterloo (station work site)		-	3½-4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Tenison Way (station work site)	Church	40	3½-4	57	45	68	65	66	62	72	68	68	65	n/a
	Offices	40				68	65	66	62	72	68	68	65	n/a
	Dwellings	150				53	51	50	47	55	51	51	48	n/a
Joan Street/The Cut (station work site)	Dwellings	10	3½-4	64	45	73	68	69	66	79	74	74	72	69-104
	Offices	30				69	65	66	62	73	68	69	68	63-98

Phase 1 - site clearance and preparation
Phase 2 - preliminary works
Phase 3 - main construction
Phase 4 - main construction (no lorries)

(1) The noise levels shown result from calculations based on equipment noise levels as given in BS 5228 with, where appropriate, corrections for estimated on-time and screening by a site hoarding. The use of further mitigation measures such as acoustic enclosures, screens and additional silencing would result in reduced noise levels. Actual noise levels will then depend upon the degree of noise control employed and the precise layout of plant within sites.

(2) "Mean Case" noise levels represent those anticipated with site plant distributed around the site centre. "Worst Case" noise levels represent those anticipated with plant located towards the perimeter of the site nearest the noise sensitive location.

SITE AND SITE USE	NEIGHBOURING LAND USES (present)	DISTANCE FROM SITE PERIMETER (m)	APPROXIMATE CONSTRUCTION PERIOD FOR MAJOR WORKS (years)	APROXIMATE L_{90} LEVEL AT PRESENT dB(A)		ESTIMATED FACADE NOISE LEVELS (Period L_{eq} dB(A))								SHEET PILING PEAK NOISE LEVEL
						Mean Case				Worst Case				
				DAY	NIGHT	Phase 1	2	3	4	Phase 1	2	3	4	
Union Street (for Ewer Street) site offices	Dwellings Public House Offices	20 15 10	3-4	62	44	Used for site offices only								
Ewer Street (possible tunnelling site)	Public House Offices Workshops	15 15 15	3-4	65	44	72	70	67	63	79	77	73	70	n/a
Wardens Grove (ventilation shaft site)	Works	10	2	63	42	72	65	57	56	79	71	64	62	n/a
London Bridge (station site)	Offices	0	3½-4	60	53	74	70	70	67	83	79	78	77	69-104
Druid Street (ventilation shaft site)	Dwellings	20	2	65	49	71	63	56	54	75	68	61	59	n/a
Old Jamaica Road (tunnelling site)	Dwellings	20	3-4	51	37	71	70	66	62	77	75	71	67	n/a
	Mission	15				72	71	67	63	79	77	73	70	n/a
	School	80				65	64	61	57	68	66	64	60	n/a
	Church	100				64	62	60	55	66	64	62	58	n/a

Phase 1 - site clearance and preparation
Phase 2 - preliminary works
Phase 3 - main construction
Phase 4 - main construction (no lorries)

SITE AND SITE USE	NEIGHBOURING LAND USES (present)	DISTANCE FROM SITE PERIMETER (m)	APPROXIMATE CONSTRUCTION PERIOD FOR MAJOR WORKS (years)	APROXIMATE L_{90} LEVEL AT PRESENT dB(A)		ESTIMATED FACADE NOISE LEVELS (Period L_{eq} dB(A))								SHEET PILING PEAK NOISE LEVEL
						Mean Case				Worst Case				
				DAY	NIGHT	Phase 1	2	3	4	Phase 1	2	3	4	
Ben Smith Way (draught relief shaft site)	Dwellings	10	2	55	50	72	65	57	56	79	71	64	62	n/a
Major Road/ John Roll Way (station site)	Dwellings	15	3½-4	55	50	73	68	69	66	79	74	74	72	71-106
Southwark Park (ventilation shaft site)	Church	10	2	55	53	72	65	57	56	79	71	64	62	n/a
	Undertakers	35				69	62	55	53	74	67	60	58	
	Hospital	55				66	60	52	50	70	63	56	54	
Canada Water (station site)	Dwellings	10	3½-4	53	39	73	68	69	66	79	74	74	72	75-110
Downtown Road (ventilation shaft site)	Health Centre	20	2	48	36	70	63	56	54	75	68	61	59	69-104
	Dwellings	35				69	62	55	53	74	67	60	58	64-99
Durands Wharf (tunnelling site)	Dwellings	10	3-4	53	43	72	71	68	64	79	77	74	70	75-110
Pioneer Wharf (ventilation shaft site)	Dwellings	120	2	67	47	62	56	49	46	64	57	51	48	53-88
	Offices	50				67	60	53	51	70	63	56	54	61-96
Canary Wharf (station site)	Offices	10	3½-4	66	45	73	68	69	66	79	74	74	72	75-110
Blackwall Way (tunnelling site)	Dwellings	10	3-4	54	47	72	71	68	64	79	77	74	70	75-110
Brunswick (station site)	Dwellings	>250	3½-4		n/a	55	52	52	49	59	54	54	52	47-82
	Offices	>250				55	52	52	49	59	54	54	52	47-82

Phase 1 - site clearance and preparation
Phase 2 - preliminary works
Phase 3 - main construction
Phase 4 - main construction (no lorries)

SITE AND SITE USE	NEIGHBOURING LAND USES (present)	DISTANCE FROM SITE PERIMETER (m)	APPROXIMATE CONSTRUCTION PERIOD FOR MAJOR WORKS (years)	APROXIMATE L_{90} LEVEL AT PRESENT dB(A)		ESTIMATED FACADE NOISE LEVELS (Period L_{eq} dB(A))								SHEET PILING PEAK NOISE LEVEL
						Mean Case				Worst Case				
				DAY	NIGHT	Phase 1	2	3	4	Phase 1	2	3	4	
Canning Town (station site)	Dwellings	30	3½-4	58	50	69	65	66	62	73	68	69	66	n/a
West Ham (station site)	Dwellings	25	3½-4	63	44	70	66	67	64	75	70	70	68	n/a
Stratford Market (depot site)	Dwellings	25	3½-4	51	43	70	66	67	64	75	70	70	68	n/a
Stratford Station (station site)	Dwellings	50	3½-4	50	46	67	64	64	61	71	66	66	64	61-96
Newham Way (A13) to Stratford (track laying)	Dwellings	25	3½-4	50-60	43	75 dB(A) during preparation								n/a
						70 dB(A) during track laying								n/a

Phase 1 - site clearance and preparation
Phase 2 - preliminary works
Phase 3 - main construction
Phase 4 - main construction (no lorries)

B3. TRAFFIC AND TRANSPORT IMPACTS

B3.1 Construction Traffic

B3.1.1 Sources and Potential Impacts

The principal materials to be transported to and from the work sites during construction are:

- spoil from tunnelling sites to disposal sites;
- tunnel lining segments;
- track;
- concrete and other construction materials and equipment.

The range of work sites proposed includes a combination of inland and riverside sites. Options for material transport are therefore:

- river transport (shipment of material by barge via the River Thames);
- road transport;
- rail transport.

All options are currently being investigated, and the transport mode to be used for the different sites has yet to be finalised. Particular emphasis however is being placed on maximising the use of barge transport, and this is discussed further in Section B3.1.7. For the purposes of this assessment, it has been assumed that barge transport may used, wherever practicable at riverside sites, and that road transport will be used for inland locations. Rail transport may be used for delivery of track where practical, and possibly for tunnel linings. The assessment has focused on the potential impacts of road traffic from the inland sites on the local and primary road networks, as this is considered to be the main potential source of impact.

Impacts that have been considered in relation to road traffic include nuisance effects (including noise, fumes, visual effects and heavy vehicle intimidation of pedestrians and cyclists), the general annoyance due to HGV ('lorry') effects, and increased congestion for other road users. Temporary closure of roads and footpaths during construction, and some permanent changes, will also affect users.

B3.1.2 Road Vehicle Numbers

Estimates of lorry movements associated with removal of spoil and delivery of construction materials and equipment at the main construction sites (tunnelling and station sites) along the route are given in Table B3.1(a). These figures have been generated using peak rates of spoil extraction, and are therefore worst case estimates.

In addition to these movements, traffic will be generated by workers travelling to and from the sites. Precise figures for the numbers of staff to be employed at each site are not available at this stage, but it is anticipated that there will be less than 100 additional car movements per working day at each of the main work sites. These numbers will not significantly increase baseline traffic flows.

At ventilation and escape shaft sites, movement of spoil and materials, as well as work trips by car, will also occur. However, flows are likely to be of the order of only 5 - 15 lorry movements and 10 - 20 workers' car-based trips per day.

Table B3.1(a): Estimated Lorry Flows at Peak Construction[1]

Site	Estimated Spoil Trips[2] (per day)	Estimated Materials Trips (per day)	Estimated Total HGV Movements
(a) TUNNELLING SITES			
Jubilee Gardens	By Barge	24	48
Ewer Street	80	24	208
Old Jamaica Road	100	24	248
Durands Wharf	By barge	24	48
Blackwall Way	By barge	24	48
The Limmo (portal works)	15	24	78
(b) STATION SITES			
Westminster	60	8	136
Waterloo	55	8	126
Southwark	40	8	96
London Bridge	70	8	156
Bermondsey	15	8	46
Canada Water	15	8	46
Canary Wharf	By Barge	-	-
Brunswick	By Barge	8	16
Canning Town	-	8	16
West Ham	-	8	16
Stratford	-	8	16

(1) Actual numbers and locations will depend on the contractor's chosen working methods.
(2) Assuming use of 20 tonne lorries with 13m^3 capacity.

B3.1.3 Impacts on Local Roads near Construction Sites

Data on existing traffic flows on many of the local roads around each construction site are generally not available from the local highway authority, so that it has not been possible to predict the percentage change in traffic flow that may result from the scheme. However, unless there is indication otherwise, present traffic flows are assumed to be low and the proportional increase in HGV traffic flows resulting from the scheme is assumed to be noticeable.

Local impacts in the immediate vicinity of each of the sites are summarised in Table B3.1(b) From the table, it can be seen that it is likely there would be a noticeable increase in traffic noise and lorry nuisance on some local roads during the peak construction period, in particular those near to the construction sites at St James's Square, Old Jamaica Road, Ewer Street and Canada Water.

Mitigation measures identified to minimise traffic impacts during construction are discussed in Section B3.1.6.

B3.1.4 Impacts on the Primary Road Network

It is not possible to determine exactly which routes lorries will use to gain access to and from construction sites. However, it has been assumed that in Central London congested traffic conditions will mean lorries will travel typically on primary roads. It is also considered likely that most of the spoil generated will be disposed of at licensed landfill sites in Essex or North Kent.

From these assumptions, the following have been identified as the most likely routes for lorries travelling to and from work sites.

- o **From Central London and South of the Thames**, it is envisaged that most lorries would use a route through Southwark and Greenwich, and via the A102(M)/A2 route to Kent (South) or the Blackwall Tunnel (North). Alternatively, lorries from the Central London sites could follow the A2 in the Waterloo area.
- o **From North of the Thames**, lorries would use the A13 (East India Dock Road) to the East and the M25, or thereafter the A102(M) and Blackwall Tunnel to the A2 and Kent.

In general terms, the effects of construction traffic on primary roads are expected to be negligible, although some increases in traffic congestion may occur on primary roads close to those sites where main construction activity is to be concentrated. However, this must be viewed in the context that all primary roads in London currently experience congestion.

B3.1.5 Road Closures

A number of road and footpath closures will be required; most of these will be temporary. A schedule is provided in Appendix B3, with comment on the effect of changes on road users and pedestrians and a note of possible alternative arrangements. The temporary closures will be of a local nature, and are unlikely to cause significant additional traffic congestion or other impacts. Where permanent road closures are proposed (between Canning Town and Stratford), these either reflect changes to land use, such that the road will no longer be required, or alternative arrangements are to be made. Here again, it is unlikely that additional traffic congestion or other impacts will result. It is however recognised that the road closures may be perceived as an inconvenience by local residents and users of facilities in the immediate vicinity of the closures, and the proposed alternative arrangements should be designed in consultation with the local authorities.

B3.1.6 Mitigation Measures for Road Traffic

The effects of lorry traffic on the local roads adjacent to each site can be minimised by lorries being restricted to the shortest appropriate route from the site to the trunk road network, and by avoiding using narrow residential streets wherever possible. Advisory routes taking into account specific local road conditions and vehicle identification measures should be discussed with the

Table B3.1(b): Local Impacts Caused by Construction Traffic

Site	Local Access Roads	Local Land Uses	Comments
(A)	**TUNNELLING SITES**		
Jubilee Gardens	Belvedere Road	Commercial	No significant impacts.
Ewer Street	Ewer Street Dolben Street	Residential Commercial	Existing flows of heavy vehicles are high because of nearby land uses (e.g. Post Office Depot in Union Street). Increases in traffic noise and congestion not likely to be significant. Noticeable increase in pedestrian/cycle conflict with vehicles and lorry nuisance(1).
Old Jamaica Rd	Abbey Street	Residential	Noticeable increases in traffic noise, congestion, pedestrian/cycle conflict with vehicles and lorry nuisance.
Durands Wharf	No local access required	Residential Commercial	See Section B3.1.4
Blackwall Way	Blackwall Way	Residential Commercial	No significant impacts.
The Limmo	Victoria Dock Road/ Dock Road	Residential Commercial	See Section B3.1.4.
(B)	**STATION SITES**		
Westminster	Parliament Square	Commercial	Existing traffic and environmental conditions poor due to heavy flows and congestion. No significant additional impacts.
Waterloo	No local access required	Residential	See Section B3.1.4
Southwark	No local access required	Residential Commercial	See Section B3.1.4

(1) 'Lorry Nuisance' is a standard term used by the UK Department of Transport to describe the effect of lorries on residents, pedestrians and cyclists in an area. It has no legal standing.

Site	Local Access Roads	Local Land Uses	Comments
London Bridge	Joiner Street St Thomas' Street	Commercial Guy's Hospital	Existing flows relatively heavy due to gyratory system in St Thomas' Street. No significant additional impacts.
Bermondsey	No local access required	Residential	See Section B3.1.4
Canada Water	Surrey Quays Road	Residential	Noticeable increase in traffic noise, pedestrian/cycle conflict with vehicles and lorry nuisance(1).
Canary Wharf	No local access	Commercial	Site served by barge.
Brunswick	Blackwall Way	Residential Under redevelopment	Site intended to be serviced predominantly by barge.
Canning Town	No local access	Commercial Residential	See Section B3.1.4
West Ham	No local access	Commercial Residential	See Section B3.1.4
Stratford	No local access	Commercial Residential	See Section B3.1.4
(C)	OTHER SITES		
Ventilation Shafts	Various	Various locations	Flows generated by construction of ventilation and escape shafts will be negligible. No significant additional impacts.
St James's Square	St James's Street	Commercial Residential	Noticeable increase in traffic noise, pedestrian/cycle conflict with vehicles and lorry nuisance likely.
Stratford Market (depot site)	Abbey Road	Commercial Residential	Flows generated by construction works will be negligible. No significant additional impacts.

(1) 'Lorry Nuisance' is a standard term used by the UK Department of Transport to describe the effect of lorries on residents, pedestrians and cyclists in an area. It has no legal standing.

individual local authorities, and contractors should be required to adhere to such measures at all times.

Account should be taken of local authority guidance on construction and good construction practices regarding traffic should be included within the contractual documents to reduce the potential for nuisance to local residents.

Measures to reduce traffic disturbance include scheduling deliveries of materials and plant and departure of spoil loads such that night-time lorry movements and overnight lorry parking is avoided. In this respect, it should be noted that a ban on night-time lorry movements on selected routes is operated by certain local authorities in the London area.

B3.1.7 **River Transport**

Spoil disposal by barge may be possible at Jubilee Gardens, Durands Wharf, Canary Wharf, Blackwall Way and Brunswick. The spoil could be carried to other riverside development sites or to waste disposal sites on the Thames estuary.

The present tunnelling programme indicates that the use of the proposed riverside sites would allow up to about 45% of the spoil requiring disposal from the Extension to be removed directly from its site of origin by barge. This has several advantages, in environmental and other terms, over other modes of transport:

- disturbance, pollution and congestion caused by large numbers of road vehicles are avoided;
- barge transport causes relatively little noise, dust or air quality impact, except during loading and unloading;
- the large capacity of barges reduces the need for stockpiling;
- removal of spoil can be carried out continuously (24 hrs/day; 7 days/week).

The major disadvantage of barge disposal is that it removes the flexibility offered by road transport to vary destinations for small quantities. This could, however be overcome by allowing for removal of special loads by truck.

The riverside jetties required for barge transport should be designed and operated in consultation with the Port of London Authority so as to ensure that adverse impacts on existing river traffic are minimised.

B3.2 <u>Traffic Impacts during Operation</u>

B3.2.1 Road traffic associated with the operation of the Extension will comprise:

- passengers travelling to and from the new stations and interchanges by road;
- employees' cars and motorcycles;
- maintenance vehicles.

Traffic generated due to requirements for maintenance work associated with shafts and stations will be very limited, typically involving 1 vehicle visit to each site per month. This is not considered to be significant.

B3.2.2 **Passengers travelling by car/motorcycle**

The proposed line runs through Central London, and most of the new stations are proposed at existing public transport nodes. The additional road traffic which will be generated as a result of operation of the extended line is expected to be negligible in relation to the existing flows around these. In most cases, passengers using the new line will interchange from other LUL lines, BR lines or buses, and this could be reinforced by not providing additional car parking facilities on the Extension, although there will be some additional car-borne passengers who will use the line, which could lead to extra pressures on car parking in streets near stations.

However, it is also likely that the new line will result in transfer of some trips from road to rail, and on balance, it is expected that the proposal will result in a net decrease in road traffic overall.

B3.2.3 Passengers Travelling by Bus

Although detailed data on the transport modal split for passengers arriving at the stations are not available at this stage, it is likely that a significant proportion will make feeder trips to the stations by bus. All the proposed station sites lie on or near existing bus routes. It may be possible to amend these and to add extra services at peak times to accommodate increased demand. New bus interchange facilities are proposed at Canada Water and Canning Town Stations.

The demand for such services at individual stations is not expected to result in significant increases in traffic flows around the stations, or changes in traffic noise, air quality or other environmental conditions.

B3.2.4 Trips by Employees

Extra traffic will also be generated by operational and maintenance staff travelling to and from stations and the depot.

Numbers travelling by road will be small and impacts are therefore expected to be negligible.

APPENDIX B3

ROAD AND FOOTPATH CLOSURES

This Appendix presents information on temporary and permanent changes in roads and footpaths resulting from the proposals. The effects of these changes on traffic and access are noted.

Temporary and Permanent Closures of Roads and Pedestrian Access

ROAD/STREET	DESCRIPTION OF CLOSURE/NARROWING	EFFECTS OF CHANGE
St James's Square	East footpath and east half of carriageway on west side of St James's Square closed during construction.	St. James's Square is a one-way and hence congestion problems are not expected. Pedestrians may use footpath on opposite side of street. No significant effect.
Birdcage Walk	North footpath closed during construction.	South footpath remains open plus alternative pedestrian route via St James's Park. No significant effect.
Broad Sanctuary	North footpath providing access to Parliament Square closed during construction.	All other footpaths in Parliament Square remain open. No significant effect.
Great George Street/ Parliament Street/ Bridge Street/St. Margaret Street Junction	Station entrances will be constructed at all four corners.	Some additional delay to pedestrians possible at peak times. No significant effect.
Bridge Street (Parliament Street/St. Margaret Street to Victoria Embankment)	North footpath narrowed during construction.	No significant effect.
Bridge Street (Parliament Street/St. Margaret Street to Victoria Embankment)	South footpath narrowed to provide access to subway.	North footpath remains open. No significant effect.
Parliament Street	East and west footpaths narrowed during construction.	No significant effect.

Temporary and Permanent Closures of Roads and Pedestrian Access (contd)

ROAD/STREET	DESCRIPTION OF CLOSURE/NARROWING	EFFECT OF CHANGE
Parliament Square	Partial carriageway closures over approx. 6 month period to construct umbrella. Closure of Parliament Square for 3 days to install umbrella.	Traffic disruption should be minimised by confining closures to off-peak periods. Closure of Parliament Square planned for bank holiday period to minimise disruption.
St Margaret Street	East footpath narrowed during construction.	No significant effect.
	West footpath narrowed during construction.	No significant effect.
Cannon Row	East footpath narrowed for access to working site.	West footpath remains open or alternative pedestrian route using Whitehall. No significant effect.
Albert Embankment footpath, adjacent to Jubilee Garden	Temporary closure during construction.	Well used pedestrian route; an alternative route should be provided from the river to Belvedere Road.
Victoria Embankment (Bridge Street to Derby Gate)	East footpath and one lane of southbound carriageway closed during construction.	West footpath remains open. No significant effect. Additional traffic congestion likely at peak times as no simple detour available.
Jubilee Gardens	Footpaths within Jubilee Gardens closed during construction.	East footpath remains open. No significant effect.
Belvedere Road	West footpath narrowed during construction.	Alternative pedestrian route via Mepham Street. No significant effect.

Temporary and Permanent Closures of Roads and Pedestrian Access (contd)

ROAD/STREET	DESCRIPTION OF CLOSURE/NARROWING	EFFECT OF CHANGE
Tenison Way	South footpath closed during construction.	Alternative pedestrian route via Mepham Street. No significant effect.
Whichcote Street	North end and east half under railway arches closed during construction.	Alternative pedestrian route via Mepham Street. No significant effect.
Buckley Street	Street closed during construction.	Alternative pedestrian route via Mepham Street. No significant effect.
Mepham Street	Southern half of street narrowed during construction.	North footpath remains open. No significant effect.
Taxi rank in front of Waterloo Station	Narrowed during construction of draught relief shaft.	Some additional congestion likely at peak times. No significant effect.
BR Waterloo Concourse	Narrowed during construction of ticket hall.	Some additional congestion at peak times. No significant effect.
Waterloo roundabout, pedestrian subway routes	Possible temporary closures to certain routes, dependent on worksite requirements.	Potential for significant effects on pedestrian access and journey times; closures should be agreed with local authorities.
Joan Street, un-named access road off Dolben Street	Closed during construction.	Some localised diversion of traffic necessary via Union Street and Suffolk Street. No significant effect.

Temporary and Permanent Closures of Roads and Pedestrian Access (contd)

ROAD/STREET	DESCRIPTION OF CLOSURE/NARROWING	EFFECT OF CHANGE
Duke Street Hill	North footpath in front of Colechurch House closed during construction to allow for widening of Duke Street.	Alternative pedestrian routes via Station access off London Bridge or London Bridge Street. No significant effect.
	South footpath and westbound carriageway closed during construction.	West bound traffic will divert. No significant effect.
Railway Approach	North and south footpath closed during construction.	Alternative pedestrian routes via London Bridge Street. No signifcant effect.
Un-named footway between Railway Approach and London Bridge Street	Closed during construction.	Alternative pedestrian routes via London Bridge Street. No significant effect.
London Bridge Street	North footpath closed during construction.	South footpath remains open. No significant effect.
Druid Street (east of Tower Bridge Road)	One lane (southern) of carriageway closed during construction.	Alternative traffic routes via Tooley Street and Fair Street. No signifiant effect.
Kimmins Gardens	Footpath through Gardens closed during construction.	Other footpaths via Sun Passage and remaining open space remain open. No significant effect.
Ben Smith Way	Parking for Broomfield Court temporarily relocated.	No significant effect.
Culling Road	Northern footpath closed during construction.	South footpath remains open. No signifcant effect.
Surrey Quays Road	Temporary diversion for road access to station entrance.	Alternative traffic route via Redriff Road. Delays to traffic likely.

Temporary and Permanent Closures of Roads and Pedestrian Access (contd)

ROAD/STREET	DESCRIPTION OF CLOSURE/NARROWING	EFFECT OF CHANGE
Deal Porters Way	Possible temporary remodelling of the junction with Surrey Quays Road.	Alternative traffic route via Redriff Road.
Canada Water	Temporary closure of a section of local heritage walk (north west edge of Canada Water and along Albion Channel).	Alternative pedestrian route via Albatross Way, Needleman Street, Surrey Quays Road. No significant effect.
Downtown Road	New temporary access to be constructed off Downtown Road to ventilation shaft work site.	No significant effect.
Rotherhithe Street	New temporary access to be constructed off Rotherhithe Street to ventilation shaft work site.	No significant effect.
Durands Wharf	Temporary severance of riverside access within work site.	Alternative pedestrian routes via Rotherhithe Street. No significant effect.
Westferry Road	New temporary access to be constructed off West Ferry Road to ventilation shaft work site.	No significant effect.
Blackwall Way	New temporary access to be constructed off Blackwall Way to work site.	West footpath remains open. No significant effect.
Dock Road	New permanent access to be constructed off Dock Road.	No significant effect.
Victoria Dock Road	Part closed and part narrowed during construction.	No significant effect.
Victoria Dock Road, north of Woodstock Street	Permanent closure for construction of bus access to Canning Town Station.	Victoria Dock Road is a cul-de-sac at this point, only providing access to premises which will be lost to the bus interchange. No significant effects.

Temporary and Permanent Closures of Roads and Pedestrian Access (contd)

ROAD/STREET	DESCRIPTION OF CLOSURE/NARROWING	EFFECT OF CHANGE
Silvertown Way	Removal of west footway during construction.	East footway to remain. No significant effect. Subways at Silvertown Way and Barking Road Closure during construction.Moderate severance effect for pedestrians.
Durban Road	Permanently closed at junction with Manor Road. New connection to be made with Memorial Avenue at West Ham Station.	No significant effect.
Manor Road	Temporary narrowing from Memorial Avenue northwards over existing railway bridge.	Traffic flows relatively low for type of road. No significant effect.
Abbey Road	Possible temporary narrowing for bridge works.	If necessary, alternative routes available via Bridge Road and West Ham Lane. Possible delays to local traffic may result.
Burford Road	Permanent closure at south end.	Access no longer required as existing industrial units are to be incorporated in depot site. No significant effect.
Channelsea Road	Permanent closure at south west end.	New access to depot site to be created. No significant effect.
Jupp Road	Permanent closure at north end.	Existing adjacent uses to be relocated. No significant effect.
Jupp Road Footbridge	Replacement of bridge.	Construction phasing should allow replacement bridge to be opened before existing ones removed. No significant effect.
Stratford Station	Temporary relocation of footbridge associated with station works.	No significant effect.

B4. SPOIL DISPOSAL AND SOIL CONTAMINATION

B4.1 Introduction

This section discusses the generation and disposal of spoil arising during construction of the Jubilee Line Extension. It also considers the question of potential risks to the environment and to the Extension if contaminated soils are encountered during the construction.

- **Spoil Disposal.** It is estimated that approximately 1.8 million m^3 of material will be excavated in the construction of the Jubilee Line Extension. Some 56,000m^3 will be reused as backfill at underground station sites, leaving approximately 1.75 million m^3 for disposal. The material falls into three principal types:
  - some (up to approximately 40%) is ideally suited for use in civil engineering groundworks and has a positive economic value;
  - some may be usable as construction fill or cover for waste disposal sites, but its value will depend on the market at the time of excavation, and a proportion may have to be disposed of at a net cost.
  - some is not suitable for use and may be so contaminated as to require special disposal.
- **Soil Contamination.** The railway passes through an area which has been the subject of intensive and changing use throughout London's history. Several of the surface sites which will be excavated have been occupied by industrial and other activities which may have left behind soils contaminated with potentially toxic and noxious materials in the near surface layers. These two issues are discussed further below.

B4.2 Spoil Disposal

B4.2.1 Spoil Quantities and Types

The estimated quantities and characteristics of spoil generated by the scheme are summarised in Table B4.2. Sites at which spoil may be removed from the underground workings are identified but final selection will rest with the contractor.

B4.2.2 Options for Use or Disposal

There are several potential end uses for the spoil generated by the scheme:

- London Clay from the western part of the tunnel could be used as a cover material in the groundworks on construction sites in the London area or at landfill facilities. These could include riverside locations such as the Greenwich Peninsula development, or the Mucking Wharf landfill facility.
- A significant proportion of the inert sands and clays (including clean superficial deposits) may be taken up by contractors, for use as general cover material and subsoil for site creation and landscaping. The amount used in this way will depend on the market at the time.
- The remaining "clean" material may be used as cover material for landfill sites or be disposed of by landfill.

An as yet unknown quantity of contaminated material will also be generated, largely from dock and river dredged silts and potentially contaminated work sites. This will require disposal at licensed waste disposal sites.

Table B4.2: Spoil Quantities and Type

Working Site	Spoil Type and Volume	
	London Clay m^3	Other[1] m^3
St James's Square (temporary shaft to construct step plate junctions)	29,000	
Storeys Gate, St James's Park (escape shaft)	3,400	400
Parliament Square/Westminster Station (station site)	35,800	52,800
Jubilee Gardens (tunnelling site)	145,400	
Tenison Way (part of Waterloo Station work site)	28,200	
Waterloo Station (station site)	14,500	5,750
Joan Street/The Cut (Southwark Station work site)	16,500	3,800
Ewer Street (tunnelling site)	256,400	33,400
Wardens Grove (ventilation and escape shaft)	1,200	400
London Bridge (Joiner St) (station work site)	27,400	11,200
Druid Street (ventilation and escape shaft)	1,250	400
Old Jamaica Road (tunnelling site)	50,000	159,000
Ben Smith Way (draught relief shaft for Bermondsey station)		2,600
Major Road (Bermondsey Station - work site)		18,000
Southwark Park (ventilation and escape shaft)		1,350

(1) Mainly inert sands and gravels.

Table B4.2 - Continued: Spoil Quantities and Type

Working Site	Spoil Type and Volume	
	London Clay m^3	Other[1] m^3
Canada Water Station (station site)		160,000 (of which 14,000m^3 will be backfilled on site)
Downtown Road (ventilation and escape shaft)		6,000
Durands Wharf (tunnelling site and escape shaft)		158,000
Pioneer Wharf (ventilation and escape shaft)		4,500
Canary Wharf Station (station site)		235,000
Blackwall Way (ventilation and escape shaft and tunnelling site)	75,500	81,500
Brunswick Station (station site)		160,000 (of which 28,000m^3 will be backfilled on site)
East India Dock Basin (construction of step plate junctions and short tunnel drive to Canning Town)	24,000 (of which 6000m^3 will be backfilled on site)	
The Limmo (ventilation and escape shaft and tunnel portal works)	7,500 (of which 8000m^3 will be backfilleld on site)	28,000
Canning Town Station		No significant spoil generation
West Ham Station (redevelopment of station)		No significant spoil generation
Stratford Market (construction of depot facilities)		No significant spoil generation
Stratford Station (boring of over-run tunnels)		10,000

(1) Mainly inert sands and gravels.

B4.2.3 Impacts of Disposal

The bulk of the spoil generated will be inert material which can be used or disposed of without adverse effects on the environment at the point where it is deposited. Some material may be used to achieve environmental benefits by reclaiming disused workings or contaminated sites, although the potential for this will depend on the arrangements made by the contractors.

The main concerns associated with spoil will be disposal of contaminated spoil, dust generation during handling within construction sites and impacts on transport. The last two issues are dealt with in B3 and B5.

It is not possible at this stage to quantify the amounts of contaminated spoil, or the nature of contamination, and possible impacts cannot therefore be assessed. Measures to control the impacts of contaminated spoil are reviewed below.

B4.2.4 Mitigation Measures

The use of river transport from a number of sites will make a significant contribution to minimising the environmental impacts of construction. Several options, aimed at maximising the volume of spoil to be removed by barge, are currently being examined.

Where use of spoil is not possible, it will need to be disposed of to licensed disposal sites, in accordance with the provisions of the Control of Pollution Act 1974. A consignment note system will be required for spoil constituting 'special waste'. The following general mitigation measures should also be considered to minimise potential impacts associated with spoil disposal.

- o Provision for separating contaminated materials where they arise prior to transport.
- o Dewatering of bentonite slurry spoil mixtures to maximise usability of spoil.
- o Supervision of excavation, loading and despatch of spoil by suitably qualified personnel to ensure that contaminated soils are identified and the correct health and safety procedures and handling and disposal arrangements are observed.

B4.3 Soil Contamination

B4.3.1 Introduction

During the course of the assessment we have identified those sites involved in construction of the railway which in the past have supported activities liable to result in soil contamination. We have considered the relative likelihood of their being contaminated, and reviewed the measures available where necessary to avoid or minimise potential health and safety or disposal related impacts which may arise if such material is encountered.

B4.3.2 Sources and Types of Contamination

Contamination rarely affects soil beyond about 5m in depth. The main source of potentially contaminated soil will therefore be the material encountered during surface works and shallow excavations at construction sites along the route. This material may have been contaminated over the years by:

- direct contamination from the storage and use of raw materials, such as metal ores, additives, coal/coke, etc;
- spillage and leakage of solids (during handling) and of liquids (from pipes, drums, tanks, etc.);
- waste disposal; since this has only recently been regulated, waste materials, particularly in the large, open areas of dockland, were frequently left on site either as surface

deposits or buried. In addition, sites which became vacant were frequently used by neighbouring industries as waste dump sites;

- wharf construction; materials used for wharf construction were often locally-derived industrial wastes;

- filled areas; again, low lying areas or redundant dock areas were frequently infilled with locally available waste material;

- migration of pollutants from adjacent contaminated sites.

B4.3.3 Potential Impacts

The significance of contamination depends on the intended after-use of the site. Stricter standards would normally apply to "soft" end uses such as houses and gardens and allotments, than to "hard" uses such as flats or industrial developments.

In this project the projected after-uses are generally 'hard'. In developing proposals at individual sites consideration will need to be given to:

- protection of the workforce from exposure to harmful or hazardous substances;

- chemical attack on buildings and materials;

- risks of fire and explosion from buried materials;

- risks of contamination of water resulting from disturbance of contaminated deposits.

B4.3.4 Identification of Potentially Contaminated Sites

Thirteen sites have been identified as having potential for soil contamination. These are described in Table B4.3. It should be emphasised that the site history information only indicates that there is **potential** for contamination on the above sites; it does not prove its presence or indicate the degree of contamination. At these sites some form of remedial measures or particular site practices may be necessary prior to or during the construction period.

The presence and degree of contamination should be confirmed using Department of the Environment ICRCL Trigger Values[1] through further investigation, including chemical analyses of soil and water samples, as the sites become available to the Extension.

B4.3.5 Mitigation of Potential Impacts

As noted above, the presence and the degree of contamination at the sites proposed for the Extension have yet to be established. Where subsequently found to be necessary, mitigation and remedial measures will need to be defined on a site-by-site basis, but certain general principles can be established.

In drawing up these principles, three factors can be considered.

- o In general the sites are relatively small. The volumes of contaminated materials are therefore likely to be relatively small and may be restricted to local hot spots.

- o Many of the sites will only be temporarily occupied. Lengthy and costly measures such as in-situ or off-site treatment would be difficult to justify.

- o Most of the surface will later be hard-covered, isolating contaminants from people and materials on the surface.

The following general principles are proposed with regard to the generation of site-specific control measures:

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(1) Interdepartmental Committee for the Redevelopment of Contaminated Land; Guidance on the Assessment and Redevelopment of Contaminated Land, ICRCL 59/83, 2nd Ed.

Table B4.3: Potentially Contaminated Sites

Site	Use	Past Uses	Risk of Contamination[1]	Possible Contaminants
Jubilee Gardens	Tunnelling	Iron foundry, lime and cement wharf, builders yards, stone and timber wharf.	M - H	Toxic metals, oils, greases, solvents, river silts, methane gas.
Ewer Street	Tunnelling	Starch works, iron bedstead manufacture, stables, engineering works, iron foundry.	M - H	Metals, oils, greases, ink wastes, domestic and industrial wastes.
London Bridge Station	Station site.	Station.	M	Oils, coal residues.
Old Jamaica Road	Tunnelling.	Tannery and dyeing works, drill hall, school, housing.	H	Dyestuffs and lacquers, tars, oils, livestock disease organisms such as anthrax.
Canada Water	Station site.	Docklands.	H	Metals, inorganic and organic contaminants, wastes, river silts, coal and coke residues, methane gas.
Durands Wharf	Tunnelling and escape shaft site.	Wharfs, timber preserving works.	H	Coal tar, oil based products, solvent based pesticides, oils, greases, wastes, methane gas.

(1) M = Moderate, H = High Risk of Contamination

Table B4.3 - Continued: Potentially Contaminated Sites

Site	Use	Past Uses	Risk of Contamination[1]	Possible Contaminants
Pioneer Wharf	Ventilation and escape shaft site.	Docklands.	H	Coal and coke residues, oils, greases, wastes, methane gas.
Canary Wharf	Station site.	Dock.	H	Dock and river silts, organic contaminants, metals, methane gas.
Blackwall Way	Tunnelling and ventilation and escape shaft site.	Dock and wharfs, next to Thames Iron Works.	H	Oils, greases, wastes, methane gas.
Brunswick	Station site.	Railway land, dock, goods depot, coal fired power station.	H	Coal dust and coal ash, mineral oils, asbestos, PCB's, methane gas.
The Limmo	Tunnelling works and ventilation shaft site.	Wharf.	M	Metals, organic contaminants, wastes.
Stratford Market	Depot site.	Railway goods and coal depot, vegetable market. Next to bleaching and chemical works.	M - H	Metals, organic contaminants, oils, solvents, asbestos, coal and coke residues.
Stratford Station	Station site.	Railway land.	M	Oils, solvents.

(1) M = Moderate, H = High Risk of Contamination

- o Risks to the health and safety of both workers and the public during site works involving contaminated material to be minimised by strict adherence to a series of site practice controls. Worker information sheets, displayed in canteens, site offices, etc., should cover subjects such as hygiene, eating on site, precautions when working in trenches, the need for protective clothing, etc.

- o Isolation of contaminants by capping or covering the sites with temporary or permanent hard-standing, following the removal for off-site disposal of "hot spots" where necessary.

- o Disposal of contaminated material (including river and dock silts) excavated in the course of the site works, to off-site licensed landfill sites such as those available in Essex or Bedfordshire.

- o Disposal of this contaminated material to be carried out with the agreement of the relevant local authority's Environmental Health Department and the London Waste Regulatory Authority.

- o A consignment note system to be used for both contaminated and inert loads removed off-site, to demonstrate that such material is disposed of responsibly, delivered to the authorised location, and unloaded in accordance with the instructions of the site manager.

- o Where considerable quantities of inert material are to be excavated and removed off-site along with a relatively small volume of contaminated material, for example during shaft sinking, it may be possible to mix the two materials together, so diluting the contaminant concentrations to the extent that all of the material may be disposed of to a domestic landfill. This should be carried out only with local authority consent.

- o Where aggressive contaminants (e.g. sulphates in the case of concrete, or tars, oxides and oils in the case of plastics and rubber) are encountered, consideration should be given to the use of protective measures, such as sulphate resistant cement for the hardstanding and any necessary foundations.

- o Pipes and cables passing through contaminated material should be laid within appropriately lined trenches and backfilled with clean material.

The presence and degree of contamination at the sites identified as potentially contaminated needs to be confirmed before site specific mitigation measures can be identified. However, the most appropriate means of dealing with contaminated soil encountered during the construction of the Extension, (some of which must be removed to allow tunnelling/excavation to be carried out) is considered to be a combination of 'standard' techniques; off-site disposal, on-site mixing to reduce contamination, and the use of cover layers where appropriate to reduce exposure to contaminants.

B4.3.6 Potential Gas Hazards

Landfill or natural gas may be present within certain of the sites to be used in the construction of the Jubilee Line Extension. This gas is produced as a result of the decomposition of organic matter, either within natural sediments, such as dock and riverside silts or peat beds, or within the materials used for the infilling of docks and wharf walls.

The sites concerned are:

- Jubilee Gardens;
- Canada Water;
- Durands Wharf;
- Pioneer Wharf;
- Canary Wharf;
- Blackwall Way;
- Brunswick.

It will be necessary to monitor for gas at these locations prior to and during the construction periods. If necessary, appropriate gas control measures can then be incorporated within the detail ed design of the project, and special work site practices adopted to ensure worker safety.

B5. ATMOSPHERIC IMPACTS

B5.1 Introduction

This section of the report reviews the impacts of emissions to air arising during construction (B5.2) and operation (B5.3) of the Extension.

B5.2 Construction Dust

Dust will be generated from the following sources during the construction phase.

- o General on-site surface works, eg: site preparation and clearance, demolition of buildings, breaking up existing ground surface, earth moving operations.
- o Spoil removal from tunnelling, station works, and ventilation/escape/access shaft works, on-site storage of spoil and spoil transport. Loading of lorries, trains or river barges is a source of dust emissions; the scale of emissions will depend on the methods employed.
- o Transport, on-site storage and use of construction materials.

Dust in the vicinity of the construction sites should be minimised by a range of standard control measures which need to be incorporated within the construction contract documents. Measures to prevent dust could include:

- use of enclosed stockpiles and water sprays to dampen stored material, where necessary.
- hard surfacing of areas subject to regular movements of vehicles;
- design controls for construction equipment and construction vehicles to minimise dust release (eg. hoods, or where conveyors are used, minimum drop heights);
- wheel washing facilities for vehicles leaving the major sites and sheeting of loads;
- regular spraying of construction site and loading/off-loading areas for construction materials/spoil;
- on-site speed restrictions for construction traffic if appropriate.

Due consideration should be paid to the policies of local authorities, such as Considerate Contractor Schemes, when drawing up site specific dust control measures.

We have identified certain construction sites where sensitive neighbouring land uses are in very close proximity to the site boundary. These are identified in Part A and we have recommended particular attention to dust control at these locations.

In the case of spoil removal and handling, it is not anticipated that there will be any substantial dust emissions (except for the potential for dust pick-up on vehicle wheels leaving the site), because of the moist nature of the London Clay and the sand/gravel slurry extracted. Where spoil stockpiling is required over periods such that drying out and hence dust production may occur (such as at Canada Water, where excavated spoil will be retained on-site for subsequent backfilling), appropriate dust suppression measures should be taken.

B5.3 Operational Air Quality Impacts

B5.3.1 The following sources of atmospheric emissions will arise during operation of the railway.

- o In-tunnel emissions of ozone and dust from train/track contact and equipment wear.
- o Emissions from ventilation shafts and the tunnel portal of pollutants produced in the tunnel.

The likely impacts and significance of these pollutant sources are discussed below.

B5.3.2 In-Tunnel Emissions from Train/Track Contact

The potential air pollutants arising from operation of the proposed electric train system are ozone and dust. Ozone is produced from arcing (ionising of air) between the power rail and train. The main sources of dust are from wear on brake blocks and wheels during train braking, and from wear on the rims and flanges of wheels and on the heads of the rails caused by contact between the moving wheels and the track.

Ozone monitoring in the London Underground during the 1940's found ozone levels to be so low as not to warrant further work. Ozone levels in the tunnels are frequently less than in the external environment due to the role of photooxidants and sunlight in ozone formation in the open air.

Dust monitoring by LRT in the London Underground (1982) found dust levels within tunnels to be of potential concern for workers in areas where trains are subjected to heavy braking and where trains have to negotiate sharp curves. This source of emissions is being steadily reduced as traditional tread-braked stock is replaced by new rolling stock with rheostatic brakes. Most, if not all, stock operating on the Extension will be of the latter type.

B5.3.3 Emissions from Ventilation Shafts

Experience of London Underground ventilation shafts indicates that there is no cause for concern with this atmospheric emission source. High levels of dilution of in-tunnel air are achieved within short distances of ventilation shafts and LUL are not aware of complaints from people living in the vicinity of existing shafts.

B6. VISUAL IMPACTS

B6.1 Introduction

This section reviews the impacts on the visual environment arising during construction of the Extension and during its subsequent operation.

B6.2 Visual Intrusion during the Construction Period

A number of sites that will be temporarily occupied during construction are visually sensitive due to their proximity to local residents and other occupiers and sites of historic/tourist importance. At these sites, the presence of construction plant and materials, and night-time lighting (including security lighting) may cause impact on neighbouring land uses. Sites with a potentially high degree of visibility are those adjoining the Thames at Jubilee Gardens, Durands Wharf, Blackwall Way and Brunswick. Due consideration should be given to the recent Department of the Environment Strategic Planning Guidance for London, concerning the preservation of views of the River Thames in the design of the riverside construction sites. The Jubilee Gardens site will be of particular concern because of its location on Kings Reach, a stretch of the river considered to be of high amenity value. It will also be visible to users of Westminster Bridge and the Embankment. Impacts at this site, however, must be considered against the background of other developments that will be taking place in the area.

Sites within historic/tourist areas which may be considered particularly sensitive to visual intrusion include:

- St James's Square;
- Storey's Gate;
- Parliament Square and Westminster Station;
- the Embankment.

Other main sites within the urban fabric which will be visible to local residents and passers-by include:

- Tenison Way;
- Southwark Station;
- Ewer Street;
- Old Jamaica Road;
- Southwark Park;
- Bermondsey Station;
- Canada Water.

General measures that should be adopted to mitigate the visual impacts of construction sites include:

- retention of existing trees and other features;
- erection of suitably decorated screen hoarding;
- control of night-time lighting;
- full restoration of sites where appropriate.

Specific measures appropriate to each site should be considered at the detailed design stage.

B6.3 Visual Impacts of Permanent Structures

B6.3.1 The visual impacts associated with the operational phase of the line will not be signficant, given that three quarters of the Extension route passes underground. Sources of potential visual impact associated with the operational phase are the following:

- above ground structures for ventilation and escape shafts;
- access points associated with the underground stations;
- surface stations at Canning Town, West Ham and Stratford;
- the depot facilities at Stratford Market;
- train movements on the surface section of the line between Canning Town and Stratford within the existing railway corridor.

B6.3.2 Ventilation and Escape Shafts

The exact locations of ventilation and escape shafts have not yet been determined, nor have the details of their size, shape and architectural design. It has therefore not been possible to make specific predictions of their visual impacts. All practicable steps should be taken in the design and location of shafts to minimise visual intrusion.

In many cases shafts can either be designed to be obscured within an existing building or structure, or can form a visually attractive feature and thus add to the surrounding environment. Potential visual impacts will be avoided in many cases by locating the shafts under the existing viaducts along the route. In all cases shafts should be designed in consultation with the local authorities and relevant bodies.

Particularly sensitive sites, where location and design of shafts will be very important, include the following:

- **St James's Park**: corner of Storey's Gate and Birdcage Walk. Here it is suggested that the shaft building form an extension or copy of the existing Listed police station.

- **Victoria Embankment**: a ventilation outlet is proposed in this area. This should be designed in consultation with the local authorities.

Where shaft structures are located in parks, visual intrusion should be minimised by locating the shafts as close as possible to the boundaries and by ensuring that their architectural design is appropriate to that context.

B6.3.3 Access Points for Underground Stations

At Westminster, Waterloo and London Bridge, the Jubilee Line Extension facilities will be incorporated within the existing stations. At Waterloo and London Bridge it is not anticipated that there will be any new potential sources of visual impact other than visually minor modifications to the existing structures.

At Westminster, modifications are planned to the existing station, with new stair access to a ticket hall under Parliament Square. The Jubilee Line works are to be incorporated within the redevelopment over the existing station, and once the works are complete there could be an overall improvement in the appearance of the station and its environs.

New stations are proposed at Southwark and Bermondsey. Both sites are within built-up areas of shops, offices and housing, and significant visual impacts are not anticipated.

New stations are also to be built within the development schemes at Canada Water, Canary Wharf and Brunswick Wharf. It is anticipated that they will be incorporated within the overall design of these developments, and so contribute to their visual amenity.

B6.3.4 Surface Stations at Canning Town, West Ham, and Stratford

The new station at Canning Town will form part of a new station arrangement incorporating the existing BR station and the proposed DLR station. At West Ham and Stratford Stations, the Jubilee Line works will comprise extensions and modifications to existing British Rail facilities. The works at these three stations are not expected to result in adverse visual impacts, given the already established uses of the areas concerned. The visual appearance of the existing stations could be improved with sensitive design and layout.

B6.3.5 Stratford Market Depot

The depot site currently comprises an extensive area of railway sidings with associated large sheds and warehouses. The proposed depot facilities are similar in form and general scale to the present use of the site, and significant visual impacts are thus not anticipated. The depot will need to be lit for security and operational reasons but the use of low level, directional lighting would minimise off-site intrusion. The perimeter of the depot should also be landscaped to provide visual screening.

B6.3.6 Train Movements on the Overground Track Sections

The additional track and associated equipment required by the Jubilee Line Extension within the existing North London Line railway corridor will not cause significant additional visual impact since the visual character of the corridor is already established.

The increased frequency of trains passing along the route may give rise to some visual impacts on properties overlooking the route. However, as noted above, the visual character of the corridor, including the passing of trains back and forth is already well established, and therefore any additional impact is not expected to be significant.

B7. URBAN ECOLOGY

B7.1 Introduction

Ecological impacts which could arise as a result of the Extension include:

- the total or partial loss of habitats, at both permanent and temporary construction sites, due to land preparation, construction operations and the storage of spoil and bulk construction materials;
- the loss of some species as a result of habitat loss;
- the loss of areas that might otherwise be developed for ecological amenity purpose in the urban context (though they may have no ecological value at present, nor any likely future value outside the urban context);
- damage or disturbance to nearby habitats by dust and noise;
- downstream impacts due to changes in surface water flows and groundwater levels and flows.

A survey of the proposed route indicates that no natural or semi-natural wildlife habitats will be directly affected by the proposed development. Ecological impacts might however arise in connection with the following types of 'man-made' habitat:

- wasteland sites, mostly former dockside and railway lands, supporting ruderal(1) plant communities, in some cases developing towards more established communities, eg. rough grassland, secondary woodland;
- artificially created wildlife habitats;
- formal green space of various kinds with limited wildlife interest, mainly for ornithology.

B7.2 Sites of Ecological Interest

The Jubilee Line Extension will involve occupation of land, either temporarily or permanently, in nine sites which have been identified as being of some ecological interest. These sites are:

- St James's Park;
- Ewer Street;
- Canada Water;
- Russia Dock Woodland (Downtown Road);
- Durands Wharf Riverside Park;
- The Limmo;
- The railway corridor between Canning Town and Stratford;
- Stratford Market;
- Stratford Station.

The impact of construction works on the Thames itself must also be considered. Work sites close to the Thames will not impinge directly on mud used by birds for feeding, and the indirect effects (e.g. noise disturbance) will only impinge on areas that are very small indeed compared to the total habitat of this kind available in the locality.

No known wader or wildfowl roosts of importance have been recorded in the immediate vicinity of the proposed Extension, and significant impacts on birds associated with the River Thames are therefore not expected.

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(1) A plant occurring in waste land areas close to buildings. Often used more loosely to describe plants that characteristically occur on ground disturbed by human activities connected with construction or industry, or adjectivally to describe sites that support such plants.

Several other areas of formal green space are also affected, but they have little claim to nature conservation interest and are not considered further here, e.g. Parliament Square, Jubilee Gardens, Old Jamaica Road and Southwark Park.

The nine individual sites identified as being of some ecological interest are discussed below.

B7.3 **Assessment of Sites**

(i) St James's Park

This is a formal park in central London. The lake is of considerable interest for its large and diverse populations of water birds (mainly duck species). In view of its intense use by the public it obviously has exceptionally high amenity value in connection with its bird interest. The site is designated as a site of Metropolitan Importance for Nature Conservation (MINC) (a non-statutory designation issued by the London Ecology Unit and accepted by most local authorities for planning purposes).

An escape shaft will occupy a small area (about 20m^2) in the corner of the park about 75m from the lake. In view of the prevailing high levels of noise and disturbance in this area it is unlikely that bird populations will be affected by the construction activities. The initial surface works should, however, be scheduled so as to avoid the wildfowl breeding season (generally from March to May), when the birds are more susceptible to disturbance.

(ii) Ewer Street

This is an open site supporting only a small area of ruderal vegetation which is unexceptional in character. Its loss to a work site will not constitute a significant impact.

(iii) Canada Water

This site centres upon the former dock basin which has relatively good water quality (freshwater). It is under development by the Wildlife in Docklands Project as a site for wildfowl, and has potentially high amenity value in connection with its bird interest.

The works associated with the construction of Canada Water station may require the temporary loss of up to 1,400m^2 of shoreline habitat along the eastern margin of Canada Dock, recently created as part of a Wildlife in Docklands Project. This loss, representing up to 45% of the shoreline habitat, is considered significant in terms of ecological amenity. As little of this area as practicable should be used, and it should be fully reinstated once works are completed.

(iv) Russia Dock Woodland (adjacent to Downtown Road)

This is a new park on former dockland (the filled in site of Russia Dock). It incorporates purposely created wildlife habitat principally in the form of woodland plantings and ponds. Together with Stave Hill Nature Park (run by the Trust for Urban Ecology, and not affected by the proposed scheme) it forms part of a large area of created wildlife habitat.

The work site for a ventilation and escape shaft adjacent to Downtown Road would take a small area (about 1500m^2) of newly planted woodland. In view of the relative ease of restoration and the large areas of adjacent plantings that would survive, this is not considered a significant impact. The area not permanently required for the ventilation and escape shaft (c. 1450m^2), should be fully restored upon completion of works; and the opportunity taken to include native climax tree species (e.g. beech, oak) in the planting mix to enhance the nature conservation interest of the woodland.

(v) Durands Wharf Riverside Park in Rotherhithe Street

This is a new park with extensive ornamental shrub plantings of limited value to wildlife. The park is intended to be used as a work site for tunnelling operations, and for an escape shaft, involving the permanent loss of approximately 20m^2 of park. There may be temporary loss of nesting and foraging habitat for

small numbers of common birds. This would not constitute a significant impact. The site should, however, be fully restored when works are complete, and consideration given to incorporating native species in the shrubb plantings.

(vi) The Limmo

The Limmo site within the Thames Wharf and Limmo Peninsula is a site of Metropolitan Importance for Nature Conservation (MINC).

At present the MINC site has limited amenity value for nature conservation. There is reputed to be a riverside walk, but there is little sign of any official encouragement for this. There are many discouragements to family use. The paths are extensively used by bikers; fly tipping, rubbish tipping and burning are frequent; and away from vehicle routes the uneven terrain is dangerous to walk across.

The designated site does however have high potential for nature conservation use. It contains ruderal areas supporting a wide variety of plant species including many that are characteristic of London wasteland sites. It also contains a number of plant species that are uncommon in Inner London. The site is also important for birds and invertebrates; species include red-legged partridge, pheasants and stonechat which are not common in London, and are likely to depend on the large area of undisturbed rough habitat. The diversity of the invertebrate fauna is enhanced by coastal species associated with the estuarine Thames.

The following ecological impacts may result from the construction of a ventilation and escape shaft and access road, and cut and cover tunnel works on the Limmo:

- temporary reduction in the overall size of the MINC site by about 10%; work site areas could feasibly be restored to wildlife habitat after the completion of works;
- isolation of the Limmo Peninsula during the construction period; a limited wildlife corridor would survive in the form of Bow Creek itself;
- disturbance to bird populations on the central area of the site from construction activities on land close by, especially vehicle movements, construction workers on foot, and dust.

The consequences of these primary impacts for open-ground bird populations are hard to predict. Suitable habitat for open-ground birds will survive, and the southern part of the site will be relatively free from disturbance; however the size of the existing MINC site is its exceptional feature, and these factors may not entirely offset the effects of reducing the area of habitat available.

The most valuable parts of the site - the Limmo Peninsula, the former railway sidings area and the Southern Dock Road area would be unaffected by landtake for the Jubilee Line Extension. We understand that these areas would however be affected by works in connection with the Docklands Light Railway Extension and the Lower Lea Crossing. These schemes would isolate the areas affected by the Extension before the extension works begin.

In order to minimise impacts on the MINC site it is recommended that the railway sidings area which lies just outside the area of proposed landtake should not be encroached upon, except in connection with the shaft that falls within it. Landtake in this area for the access road to the shaft should be minimised. In addition consideration should be given to leaving a narrow riverside strip of wild space along Bow Creek to minimise the isolation of the Limmo Peninsula.

(vii) The Railway Corridor between Canning Town and Stratford

This railway corridor will be used for the surface section of the Jubilee Line Extension. The trackside communities (grassy ruderal vegetation) that occur along the North London Line between Canning Town and Stratford are common beside working

railways in London. Such communities are under little general threat (as opposed to those of disused railway lands which are), and even quite extensive losses would not in themselves constitute a significant impact. The loss of grassland and scrub on the disused sidings in the area of West Ham Station is too small in extent to be considered significant, even though the habitat is of modest ecological interest.

The verges of the North London Line form the eastern boundary of a wildlife corridor occupying the lower part of the Lea Valley. This corridor provides habitat for flora and fauna, extending their range into the metropolitan area of East London and connecting with larger areas of wildlife importance such as Hackney Marshes and the Limmo Peninsula. The loss of habitat along the verges of the North London line from Canning Town to Stratford, together with disused railway sidings and wasteland at the Limmo site, West Ham and Stratford Market would to some extent detract from the overall value of the Lower Lea Valley wildlife corridor. However, the corridor would certainly not be severed, and the verges of the North London Line itself would not be permanently lost to the corridor.

(viii) Stratford Market

In the area of Stratford Market there are disused railway sidings and small parcels of wasteland which will be lost as a result of depot construction.

The nutrient-poor and free-draining characteristics of railway ballast give rise to stressed conditions that naturally favour the development of distinctive and species-rich plant communities on disused railway lands, especially sidings. In London such sites are under pressure from development, and the loss of disused railway sidings at Stratford Market and the Limmo site (and also on a smaller scale close to West Ham station) would contribute, albeit in a relatively small way, to an overall trend that gives some cause for concern.

At present the Stratford Market site supports a diverse ruderal flora including species characteristic of London wastelands, but also some locally uncommon species, notably Lepidium latifolium (Dittander) and Trifolium arvense (Haresfoot Clover). The site has no amenity value, there being no public right of entry; the potential for amenity use is low because it is only accessible from a road serving an area of scrap yards and haulage businesses. The site appears to have been relatively recently abandoned.

(ix) Stratford Station

The Channelsea River runs through the railway lands at Stratford. Its slow-flowing freshwater supports tall marsh plants some of which are not common in Inner London, e.g. Acorus calamus (Sweet Flag), Oenanthe crocata (Hemlock Water Dropwort). North of the station the wide banks are covered with brambles and scrub and are likely to support common birds. South of the station it is culverted and therefore of less ecological interest. Marsh plants and scrub habitat for birds associated with the Channelsea River would be lost to the Jubilee Line Extension from culverting works to the north of the station. Owing to the small extent of the area involved this would be significant in a local context only.

Waste areas within working railway lands north of the London to Chelmsford main line are noted in London Ecology Unit records as supporting ruderal vegetation of an unexceptional character. More recent surveys by ERL suggest that the vegetation is very typical of working railway wastelands. The loss of the vegetation would not constitute a significant impact.

B7.4 Summary of Findings

The proposed development will affect mainly wasteland sites which support various types of ruderal vegetation. These are not without nature conservation interest in the urban context, though on purely scientific criteria they would not rank highly in comparison with natural or semi-natural habitats, eg. old woodlands, flower-rich grasslands. Their interest lies in their typical urban character, the presence of distinctively recognisable

and constant plant communities rich in established non-native species, and their potential for nature conservation amenity use.

They are at present fairly common in Inner London, though many have been lost and the current stock is under heavy pressure from proposed developments. They develop quickly when land is abandoned, and to this extent they are easily replaceable.

One Site of Metropolitan Importance for Nature Conservation (MINC, a London Ecology Unit designation accepted by most local authorities for planning purposes) will be temporarily affected, that is the Thames Wharf and Limmo Peninsula site at the mouth of Bow Creek. Less than 10% of the MINC site will be temporarily affected by the Limmo work site but other developments will also take substantial parts of the site. The area affected by the Jubilee Line Extension is probably the least valuable part of the site, supporting only ruderal communities associated with highly disturbed conditions which are generally common. The affected area lies at the northern extremity of the MINC site, and its loss would not have a fragmenting effect on the surviving parts of the site.

The works associated with the construction of Canada Water station may require the temporary loss of a margin of up to 1,400m² of shoreline habitat along the eastern margin of Canada Dock, recently created as part of a Wildlife in Docklands Project. This loss, representing up to 45% of the shoreline habitat, is considered significant in terms of ecological amenity. As little of this area as practicable should be used, and it should be fully reinstated once works are completed.

The general loss of wild space on the eastern margin of the Lower Lea Valley wildlife corridor caused by works alongside the North London Line give cause for some concern. However, only part of the loss is permanent, and will not be sufficient to impair seriously the functioning of the area as a corridor for wildlife.

The filled in area of Russia Dock, adjacent to Downtown Road, has been planted as woodland with ponds to create a wildlife habitat. A small part (c. 45m^2) of this would be lost for a ventilation and escape shaft; but any young trees removed can be readily replaced, perhaps with a wider range of tree species than were used in the original planting. The temporary loss of the park at Durands Wharf is expected to have little effect on wildlife.

B7.5 **General Mitigation Measures**

Where appropriate, site specific mitigation measures are described in Part A. A number of general principles also apply throughout the route.

- Wherever wildlife habitat remains alongside working areas, fencing should be provided before the commencement of works to prevent tipping, vehicle movements, and encroachment of personnel on foot into areas that are not essentially required.

- Good standards of dust control should be applied at all construction sites (damping down of dust sources, wheel washing of vehicles leaving sites, plastic sheeting of buildings during especially dusty operations) to protect wildlife habitats adjacent to work sites.

- Where work sites are near to freshwater (St James's Park, Canada Water, Russia Dock Woodland, Stratford), and at riverside sites, precautions should be taken to prevent the entry of pollutants into water bodies (see B8).

- All sites should be properly reinstated where appropriate (e.g. parkland areas).

Consideration should also be given to ensuring the survival of less common plant species found on sites by transplanting to similar conditions close to those they occupy at present. At Stratford Market Lepidium latifolium (Dittander) is spreading and it would be easy to find young plants suitable for transplanting. At the Limmo it should be confirmed that any less common species found are also present on unaffected parts of the site.

B7.6 **Potential Impact on Trees**

The proposals may require the felling of one tree on Parliament Square during the construction of the Extension. This is covered by a Tree Preservation Order. Other mature trees are also located within or in the vicinity of work sites at St. James's Park, Parliament Square, Jubilee Gardens, Old Jamaica Road, Southwark Park and Russia Dock Woodland. Effects on these trees should be minimised by the adoption of appropriate mitigation measures. These should include the following:

- selective removal of lower limbs by a tree surgeon to reduce mechanical damage by construction plant;

- the use of matting around the root zone to prevent excess soil compaction; and

- the use of chestnut paling around the trunk to reduce mechanical damage.

B8. IMPACTS ON THE AQUATIC ENVIRONMENT

B8.1 Introduction

Impacts of construction and operation of the proposed Extension on the quantity and quality of groundwater and surface water resources have been examined. Five potential issues have been considered:

- reduction in availability of groundwater used for abstraction of supplies, caused by seepage into the tunnel; drawdown of water levels can also affect waterlogged archaeological deposits and surface habitats;
- reduction in the quality of groundwater used for abstraction, caused by leakage of contaminants out of the tunnel, or by mixing of aquifers;
- disposal of tunnel seepage and construction site drainage;
- culverting of streams;
- spillage from riverside spoil transfer operations;
- effects of dock works on water quality.

B8.2 Impacts on Groundwater Levels

Seepage through the walls of the tunnel during construction will cause drawdown of the water table in the surrounding area. Estimates suggest that where the tunnel runs through saturated strata, drawdown could extend to, at most, tens of metres from the tunnel. Data from Thames Region of the National Rivers Authority (NRA-Thames) indicate that there is no licensed groundwater abstraction from parts of aquifers that could be affected. No surface features that could be adversely affected by groundwater drawdown have been identified.

In those sections of the line which are in saturated strata (mainly the Reading and Woolwich Beds and Thanet Beds of the eastern section of the line) construction and ground treatment techniques will need to be selected which minimise groundwater ingress. Options include:

- **Caisson construction**: where groundwater inflows are expected or where the ground material may present instability problems (for example, the surface sands and gravels), shafts can be constructed using caisson methods.
- **Ground treatment**: to minimise water ingress to tunnels and shafts, the ground can be grouted (using either bentonite cement or chemical grouts) or frozen.
- **Deep well dewatering**: where the shafts penetrate saturated strata, dewatering within the shaft may require deep wells, although local sumps may be adequate.
- **Compressed air tunnelling**: through saturated strata of the Woolwich and Reading Beds, the running tunnels may be driven with semi-mechanical shields with compressed air. This method involves working under a pressure slightly in excess of the hydrostatic pressures in the host strata, thereby exerting an outward pressure from the excavations and minimising groundwater ingress.
- **Earth pressure balance tunnelling**: an alternative to using compressed air for tunnelling through saturated strata of the Woolwich and Reading Beds could be to use an Earth Pressure Balance Tunnel Boring Machine (EPBTBM). This variation on the conventional TBM is specially suited to tunnelling through saturated ground. Grouting is carried out both ahead and behind the EPBTBM to minimise groundwater inflow.

Full geotechnical investigations should be carried out during the next stage of design, at which time detailed decisions on tunnelling methods will need to be taken.

The completed tunnels will be lined with concrete segments cemented into the surrounding ground. The permeability of the lining materials is relatively low and groundwater inflows in the long term will be small.

B8.3 **Groundwater Contamination**

Tunnelling can lead to contamination of groundwater:

- by leakage of materials used during tunnelling into adjacent aquifers; these materials include cement mortar, bentonite, chemical grouts, oils and lubricants;
- by mixing of groundwater from one aquifer with that from another as a result of vertical shaft or tunnel construction; if the first aquifer contains saline or contaminated groundwater the second may be adversely affected;
- by infiltration of contaminated surface drainage.

As noted above no abstractions from groundwater have been identified in the immediate vicinity of the line. The low levels of contamination that could arise from these sources are therefore unlikely to affect any sources of drinking water or other supplies. It is, however, recommended that areas of potential soil and groundwater contamination in the vicinity of shaft sites are investigated prior to shaft sinking, to determine any special requirements for control of aquifer mixing and disposal of seepage.

Good standards of housekeeping during tunnelling and on surface construction sites, including use of bunds and drip trays for material stores (e.g. fuel tanks), would minimise risks of contamination from these sources.

B8.4 **Disposal of Tunnel Seepage and Site Drainage**

Tunnel seepage and site drainage will be collected and discharged to sewers or directly to surface watercourses. These effluents may be contaminated by:

- suspended solids from soils, grouting and lining materials,
- oils and lubricants from machinery and stores;
- trace pollutants released from disturbance of contaminated soils;
- contaminants dissolved from the tunnel lining (carbonates, sulphates, etc.

All discharges must be approved by NRA-Thames Region and should be subject to consent conditions established to protect the receiving water or sewage treatment plant. Measures must be taken as necessary to ensure these conditions are met. These are likely to include provision of settling lagoons and oil interceptors for construction site drainage and oil interceptors at station and depot sites. During operation, attention must be given to ensuring that receiving waters offer sufficient dilution for herbicides and de-icants used on the above ground section of the route. If consent conditions are met no significant adverse effect on receiving waters is expected.

B8.5 **Stream Culverting**

Modifications will be necessary to the Channelsea River culvert at Stratford Station. These works have the potential to affect downstream flow and water quality and result in loss of aquatic habitat and wildlife, although the aquatic life present is not expected to be particularly sensitive, as a result of previous culverting.

However, agreement will be required with NRA-Thames Region on appropriate design and maintenance of the works, to ensure that downstream flows and flooding conditions are not adversely affected.

B8.6 Riverside Spoil Transfer Operations

Creation of floating pontoons and spoil transfer operations associated with river barging of spoil at Jubilee Gardens, Durands Wharf, Canary Wharf, Blackwall Way and Brunswick have the potential to affect the water quality of the Thames.

During construction of the pontoons a short term increase in suspended solids and turbidity may result from bankside works. This will cause a slight lowering of water quality whilst work is in progress, but the suspended particles will quickly settle and the water quality will return to its previous quality once construction work is completed.

During normal operations, removal of spoil by barge should not affect river water quality. There is however a risk of accidental spoil spillage and leakage of oil from the barges. The release of large quantities of either material could result in a significant lowering of water quality and damage to fish life. Particular care will therefore be necessary to ensure efficient work practices in order to minimise this risk.

B8.7 Dock Works

Construction of Canary Wharf is anticipated to involve creation of a temporary artificial island between Canary Wharf and Heron Quays. Construction of the island would involve sheet piling to create a water-tight box; draining of water from the box; removal of dock sediments; lining of sheet piles with bentonite and cement; infilling with sand and gravel.

The station would be built by digging down from this work site through the bottom of the dock. On completion the island would be removed, leaving the station at the base of the dock.

Construction of Canary Wharf Station may have the following potential impacts on water quality:

- o disturbance of dock sediment from piling activities, resulting in changes in water quality;
- o lowering of water quality in the dock as a result of contamination, e.g. from bentonite.

During piling at Canary Wharf, river sediment will be disturbed resulting in: increased water column turbidity; decreased oxygen concentration; release of heavy metals and polycyclic aromatic hydrocarbons (PAH) into the water column.

The intense piling activity already taking place does not seem to have had an adverse effect on the biota although there have been short-term reductions in algal crops and elevated turbidities. Levels of oxygen in the water columns have approached those adverse to fish survival but no fish kills have been reported. We do not, therefore, expect the station piling would have other than short-term effects on water quality.

It was understood that large quantities of bentonite are unlikely to enter the dock water. Bentonite is a relatively inert material. In high concentrations it can sequester plant nutrients and heavy metals, and in very large amounts it will clog fish gills. The most likely effect of low concentrations will be to reduce light penetration into the water. This will be visually obvious and will reduce algal growth.

It would be prudent to disturb bottom sediments in West India Dock as little as possible. Timing construction operations so that only small quantities of sediment at a time are allowed to mix with the open water would allow settlement of metals and reoxygenation. A requirement that contractors use silt curtains during construction work in West India Dock would help to

minimise sediment resuspension. To protect fish during the pumping operation, it is recommended that a pumping system be considered which removes the fish with the water without harming the fish. Alternatively, fish could be removed first, after temporary stunning by electro-fishing. It is recommended that the slurry formed during pumping at the bottom of the piled area is either allowed to settle in a holding area before discharge, or is removed with the sediment for disposal elsewhere.

ANNEX I

LIST OF ERL CONSULTEES

Westminster City Council*

London Borough of Lambeth*

London Borough of Southwark*

London Borough of Tower Hamlets*

- Isle of Dogs Neighbourhood Team
- Planning Team

London Borough of Greenwich*

London Borough of Newham*

London Docklands Development Corporation

- Isle of Dogs Area*
- Surrey Quays Area*

North Southwark Community Development Group*

Cathedral Area Residents Association*

Southwark Environmental Trust*

London Wildlife Trust(1)

Docklands Consultative Committee(2)

Docklands Forum*

Association of Island Communities(1)

Surrey Bank Residents Association(1)

Westminster Society(1)

Museum of London*

Passmore Edwards Museum(1)

Theatres Trust(1)

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* Consultations

(1) Letters only - sent by ERL

(2) Phone call only

ANNEX 2

ENVIRONMENTAL ASSESSMENT BIBLIOGRAPHY

Environmental Assessment Bibliography

Listed below are references to the main environmental assessment documents relevant as background material to this Statement.

The Town and Country Planning (Assessment of Environmental Effects) Regulations 1988. Draft Statutory Instruments No. 1199; in force July 1988.

Council Directive of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment (85/337/EEC) OJEC L175; 5.7.85.

Joint Circular from the Department of the Environment and Welsh Office on Environmental Assessment, Circular No. 15/88, 23/88.

Environmental Assessment under EC Directive 85/337, Departmental Standard HD 18/88, Department of Transport, July 1989.

Report of the Joint Committee on Private Bill Procedure (HC625 of Session 1987-88) (§80).

Environmental Assessment: A Guide to the Procedures; Guidebook prepared by the Department of Environment and Welsh Office, HMSO 1989.

East London Rail Study Summary Report; prepared by Halcrow Fox and Associates for the Department of Transport, 1989.

ANNEX 3

THE PROJECT TEAM

PROJECT TEAM

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Jubilee Line Extension Project Office
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London
SW1H 9HP

JUBILEE LINE EXTENSION ENVIRONMENT STATEMENT 03/90

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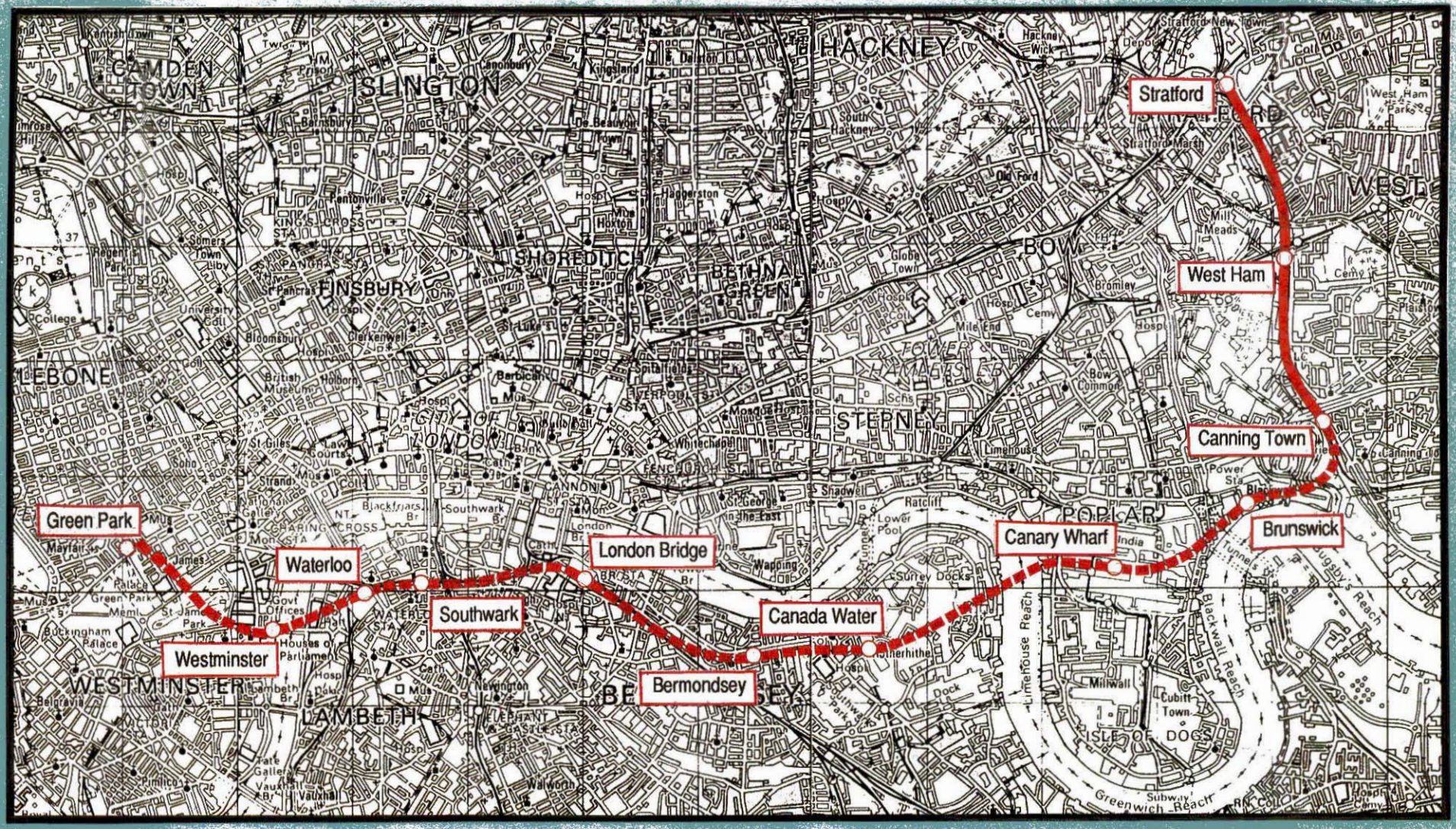


Jubilee Line Extension Route

Stations

Line Underground

Line at Surface

- **Waterloo** The Jubilee Line platforms at Waterloo would be constructed beneath the present British Rail main line station. This would provide an interchange with British Rail's Network Southeast services, the proposed Channel Tunnel Terminal, the Northern and Bakerloo Lines, and the Waterloo and City Line.

- **Southwark** A new London Underground station is proposed here, to be sited near the junction of Blackfriars Road and The Cut. The station would serve the local area and provide an interchange with buses.

- **London Bridge** The proposed Jubilee Line platforms would be built beneath the present British Rail station, allowing passengers to connect to main line trains as well as to the Northern Line. The proposal links with plans to improve the capacity of the Northern Line and to provide a new station entrance on Borough High Street.

- **Bermondsey** A new London Underground station is proposed at the junction of Keeton's Road and Jamaica Road, to serve the local residential areas and provide an interchange with bus services on Jamaica Road.

- **Canada Water** This proposed new London Underground station would be sited at the north end of the Surrey Quays development. An interchange is proposed with a new station on the East London Line. Bus interchange facilities are also proposed as part of the station complex.

- **CanaryWharf** A new London Underground station is proposed within the Canary Wharf development currently under construction. It would be built directly beneath the old West India Docks, and would enable interchange with the Canary Wharf station of the Docklands Light Railway. The station is intended to service the large commercial and residential development at Canary Wharf and Heron Quay, as well as other new developments on the Isle of Dogs.

- **Brunswick** This new London Underground station would be built at the site of the old Brunswick Power Station on the north bank of the Thames, to serve new developments proposed for the area.

- **Canning Town** This proposed new London Underground station would form part of a new station arrangement at Canning Town adjacent to the A13. The arrangement will incorporate the existing British Rail station and the proposed Docklands Light Railway station.

- **Pioneer Wharf** (25) The proposed site is on a strip of land between the River Thames and West Ferry Road, presently occupied by a concrete batching plant.

- **The Limmo** (30) The site would occupy an area of disused railway sidings and open ground south of Canning Town Station. The Limmo site would be used for portal construction and associated cut and cover works, in addition to the construction of a shaft.

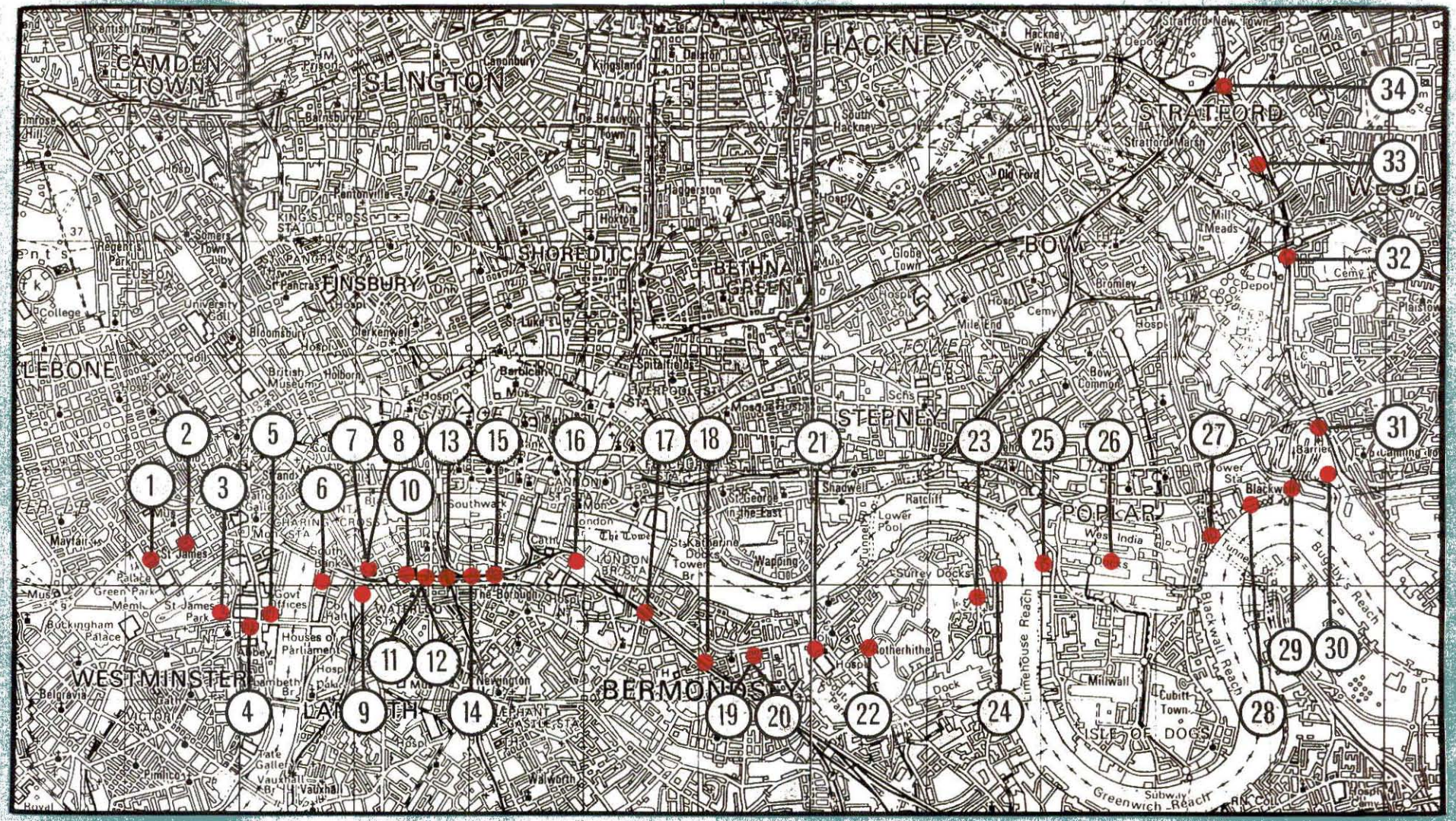
Surface activity at these various sites would include site preparation, the removal of spoil, the delivery, storage, and collection of construction materials (particularly concrete and cast-iron tunnel lining sections), and site management. The length of time for which each site is needed would depend on final work phasing, construction methods, and the rate of progress at that site. In general, however, it is envisaged that major works at station sites will take about 3½ to 4 years, tunnel sites about 3 to 4 years, and shaft-only sites up to 2 years. While 24-hour working would be necessary at many of the work sites during the peak construction period, activity would be focused on underground works during night-time operations in residential areas, in order to minimise disturbance at surface level.

All the construction sites have the potential to cause disturbance. The following sections describe the general measures that can be adopted to minimise disturbance, and the specific measures that may be needed at particular sites.

The main effects of the railway construction are likely to be felt by people who live or work close to the various construction sites, and to a lesser extent by visitors to those areas. The two most evident effects would be from noise and dust.

Noise would be caused by the breaking up and preparation of ground, by piling operations, by the operation of stationary equipment (such as compressors and diesel-powered vehicles), and by lorries delivering supplies and removing spoil. Dust would result from general site operations, the storage and use of construction materials, and again from lorries moving to and from the construction sites.

A key requirement to minimise these effects should be the inclusion of a formal set of conditions in the contracts for the construction of the railway. These conditions should define the acceptable noise standards at the nearest building facade, as well as 'good housekeeping' measures that must be applied to minimise noise, dust, and visual intrusion. Effective monitoring would also be needed to ensure that these contractual conditions were consistently met.



Construction Sites

1. Blue Ball Yard
2. St James's Square
3. Storey's Gate
4. Parliament Square
5. Westminster Station
6. Jubilee Gardens
7. Tenison Way
8. Waterloo Bridge Roundabout
9. Waterloo Station
10. Joan Street
11. Joan Street/The Cut
12. Scoresby Street
13. Union Street
14. Ewer Street
15. Wardens Grove
16. London Bridge Station
17. Druid Street
18. Old Jamaica Road
19. Ben Smith Way
20. Major Road/John Roll Way
21. Southwark Park
22. Canada Water
23. Downtown Road
24. Durands Wharf
25. Pioneer Wharf
26. Canary Wharf
27. Blackwall Way (Charrington Site)
28. Brunswick
29. East India Dock Basin
30. The Limmo
31. Canning Town Station
32. West Ham Station
33. Stratford Market
34. Stratford Station

A2. THE EXTENSION AND ITS POTENTIAL ENVIRONMENTAL EFFECTS

A2.1 Introduction

This section provides a summary description of the proposed scheme and identifies the potential environmental changes that could arise as a result of the Extension. These are then examined in more detail in subsequent sections.

In describing the proposed scheme and its effects a distinction has been made between:

- o The components of the overall scheme (A2.2)
- o The construction phase (A2.3)
- o The operation of the railway (A2.4).

A2.2 The Proposed Scheme

A2.2.1 The Overall Scheme

The proposed scheme will provide a new railway link between Green Park, Docklands and Stratford, via Waterloo and London Bridge. The scheme is conceived as an extension of the Jubilee Line, using similar trains, and running underground for most of its length, being at surface level only between Canning Town and Stratford. Eleven stations are proposed to service the line, generally located to maximise interchange with existing rail facilities. The proposed scheme will require underground tunnelling and construction of surface structures such as stations and ventilation shafts. The proposed line is shown in Figure A2.2(a).

A2.2.2 Rationale for Scheme

The present London Underground system is experiencing rapid and sustained growth in demand. On 23 January 1989 the Secretary of State for Transport announced to Parliament the establishment of an East London Railway Study to examine the best options for improving rail access from central London to Docklands and Thamesmead. The key conclusion of this study was that the preferred option was an extension to the Jubilee Line from Green Park via Waterloo, London Bridge and Canary Wharf to Stratford, as is now proposed.

The main criterion used to select the route and station locations, within the overall constraint of minimum disruption to existing surface conditions, was to link Docklands to the Central Area and to maximise passenger use. This was seen as central to the long-term viability of the scheme. Wherever possible, therefore, station locations, and thus the route itself, were positioned to maximise interchange with existing rail facilities. Green Park, Westminster, Waterloo, London Bridge, Canada Water, Canary Wharf, Canning Town, West Ham and Stratford stations all provide interchange with existing British Rail and London Underground systems.

The main components of the proposed 15.3km Extension are described below.

A2.2.3 Rail System

The proposed railway is planned as an Extension to the existing Jubilee Line, using similar trains. The line will comprise two 12km (approximately) single-tracked tunnels at an average depth of 25m, and approximately 3.5km of surface line. This surface line will run as twin tracks parallel and immediately to the west of the existing North London Line tracks. The railway will include 8 underground stations and 3 surface (at grade) stations.

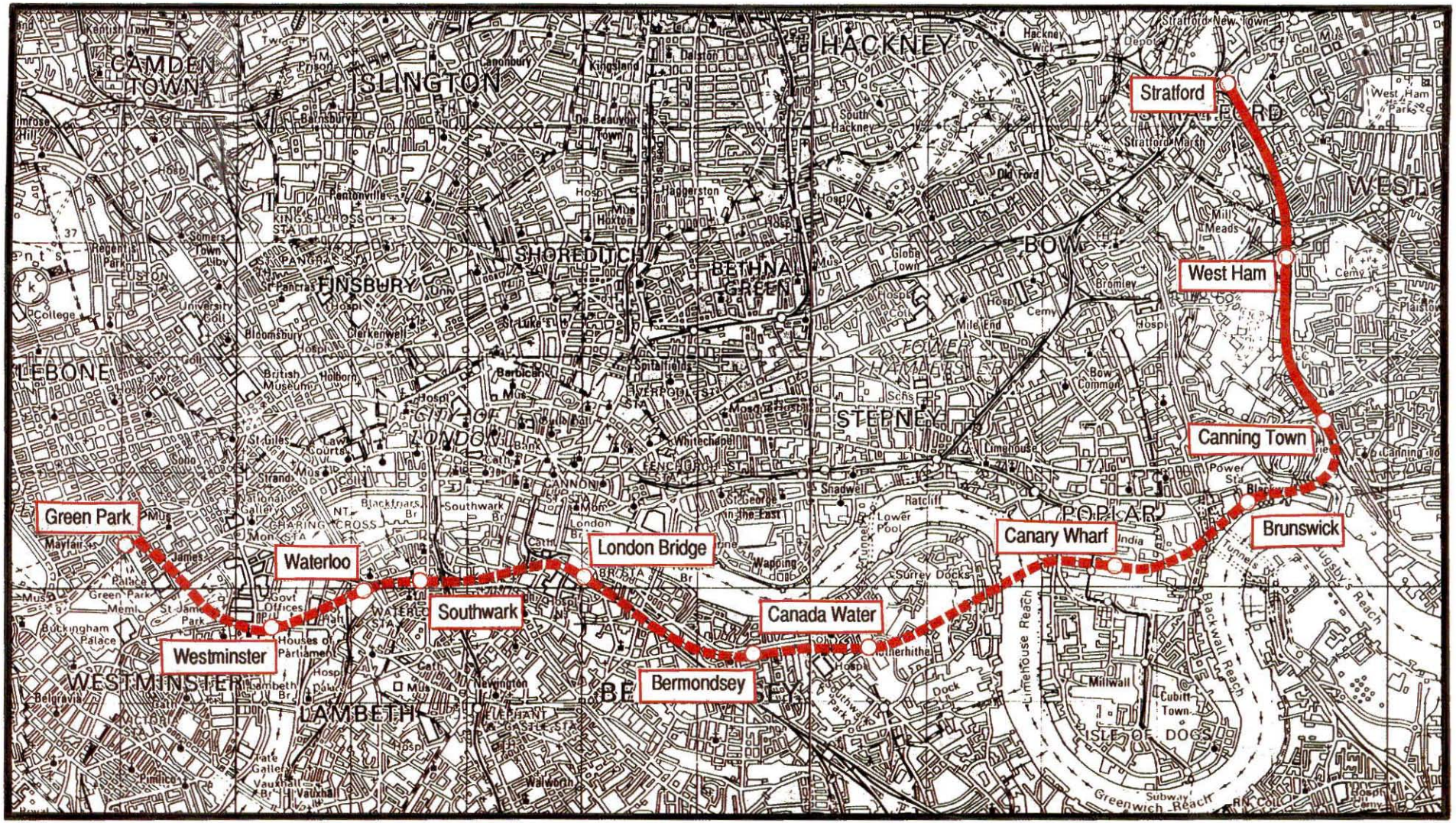


Figure A 2.2 (a) **Jubilee Line Extension Route**

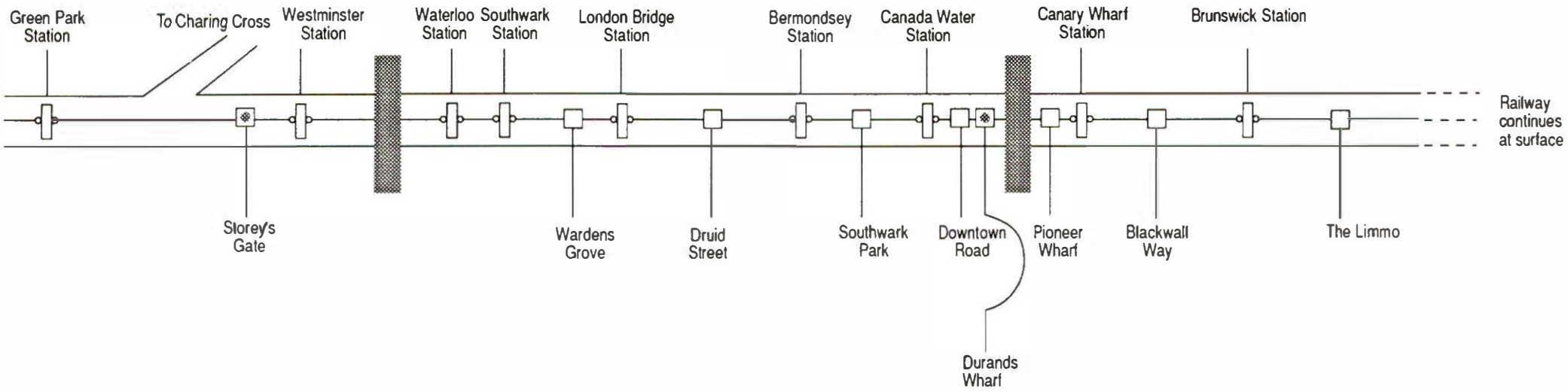


Figure A 2.2 (b)
Schematic Plan of Ventilation and Escape, and Draught Relief Shaft Locations.

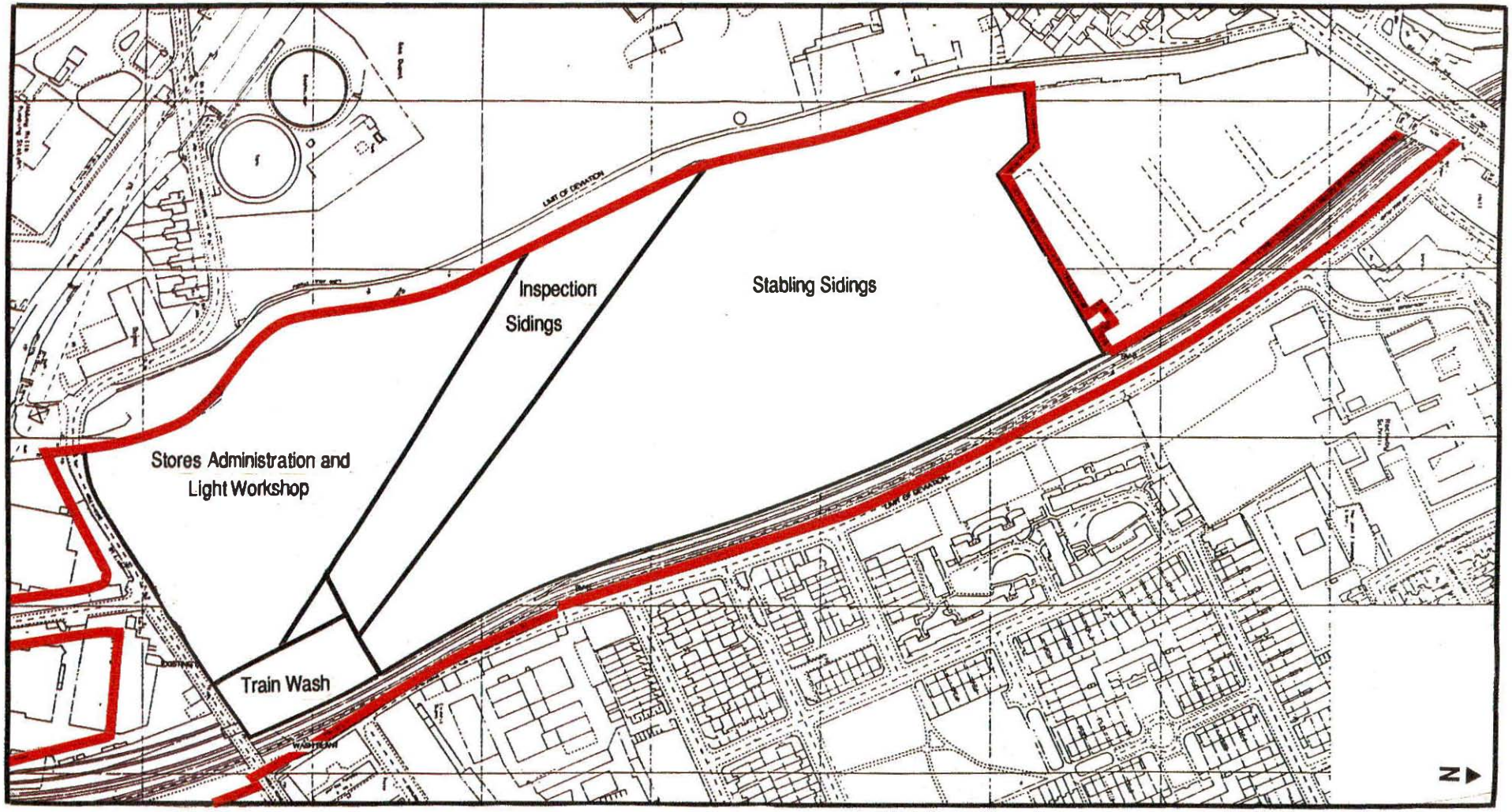


Figure A 2.2 (c) **Schematic Plan of Stratford Market Depot**

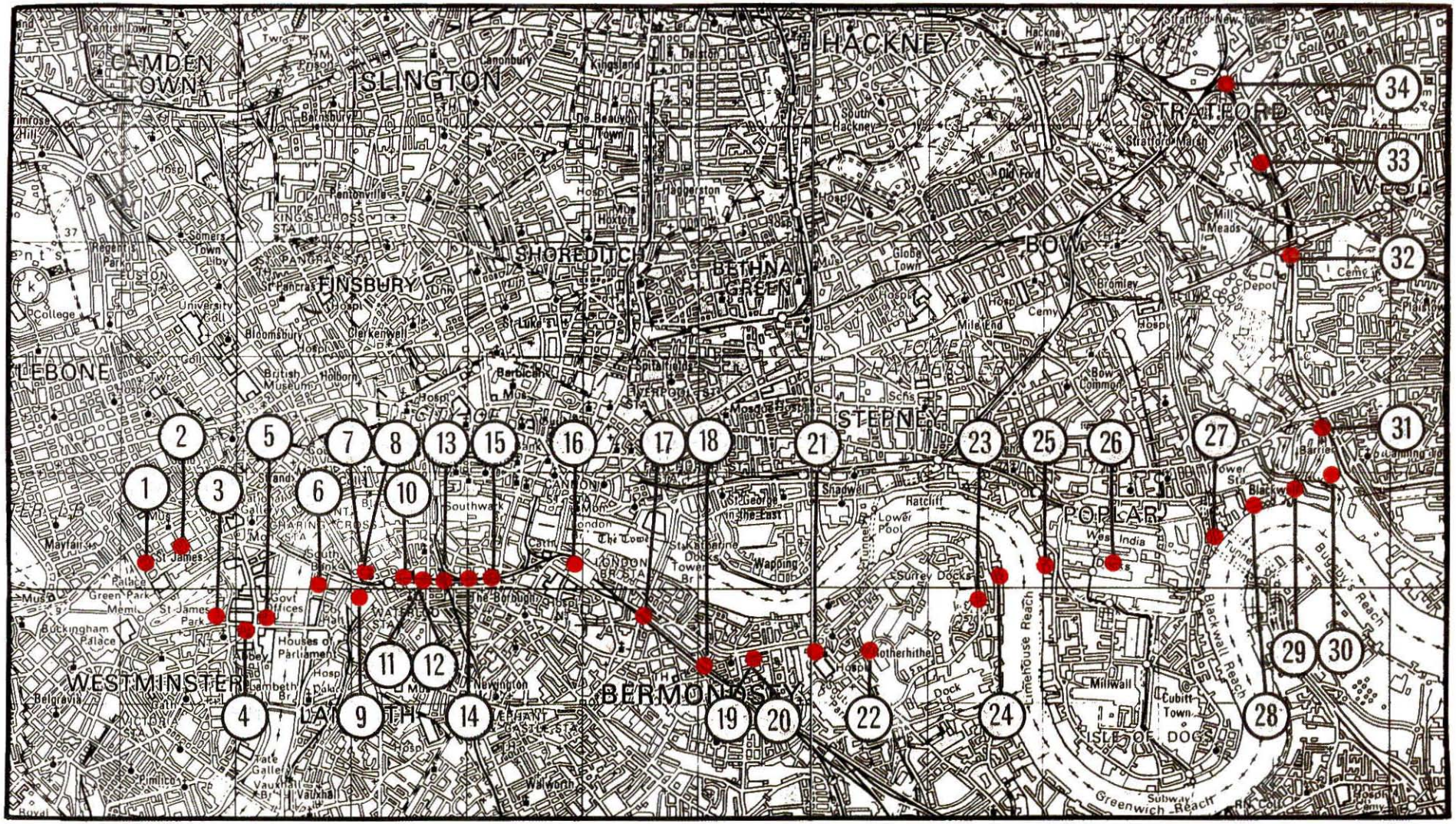


Figure A 2.3 (a) **Construction Sites**

1. Blue Ball Yard
2. St James's Square
3. Storey's Gate
4. Parliament Square
5. Westminster Station
6. Jubilee Gardens
7. Tenison Way
8. Waterloo Bridge Roundabout
9. Waterloo Station
10. Joan Street
11. Joan Street/The Cut
12. Scoresby Street
13. Union Street
14. Ewer Street
15. Wardens Grove
16. London Bridge Station
17. Druid Street
18. Old Jamaica Road
19. Ben Smith Way
20. Major Road/John Roll Way
21. Southwark Park
22. Canada Water
23. Downtown Road
24. Durands Wharf
25. Pioneer Wharf
26. Canary Wharf
27. Blackwall Way (Charrington Site)
28. Brunswick
29. East India Dock Basin
30. The Limmo
31. Canning Town Station
32. West Ham Station
33. Stratford Market
34. Stratford Station

Table A2.3(a)
Construction Activities along Railway Route

Construction Site Location	Existing Use	Construction Activities	Surrounding Land Use
Blue Ball Yard (1)	Existing ventilation shaft housing within courtyard.	Possible modification to existing ventilation shaft; to be carried out from within tunnel.	Garaging, restaurant, hotel, offices.
St James's Square (2)	Roadside car parking spaces.	Construction of step plate junctions relating to Green Park Station.	Park, clubs, hotels, offices, Government offices.
Storey's Gate (3)	Parkland/grounds of police station.	Escape shaft construction.	Police station, Government offices, parkland.
Parliament Square (4)	Open space, pedestrian walkways.	Site for construction of expanded Westminster Station. Construction works will include temporary decking of the road junction at the northeast corner of the square.	Government buildings, church, Abbey, Guildhall, commercial premises, public walkways, important tourist area.
Westminster Station (5)	Offices, commercial premises, station, public riverside walkway.	Site for construction of expanded Westminster Station.	Government buildings, church, Abbey Guildhall, commercial premises, river, public walkways, important tourist area.
Victoria Embankment (5)	Riverside walkway.	Site for ventilation and escape shaft.	Government buildings, river, public walkway, important tourist area.
Jubilee Gardens (6)	Riverside gardens, vehicle access, car parking, paved areas providing pedestrian access. Potential future use uncertain.	Tunnelling site; spoil removal operations including construction of river jetty and loading of spoil onto barges; tunnel lining and track delivery and off loading.	County Hall presently offices, but proposed for possible hotel conversion in early 1990's. Riverside walkway, car park, Shell centre and other commercial premises.
Tenison Way (7)	15 shops housed in largely single storey buildings, (a number of the shops are unused), commercial premises under viaduct.	Site for constructing Waterloo Station; access to work area below existing station; construction material storage and preparation; limited tunnelling.	Major road interchange, and British Rail viaduct, St John's Church.
Waterloo Bridge Roundabout (8)	Pedestrian routeway under roundabout providing access to Waterloo station Unofficial sleeping area for homeless.	As for Tenison Way	Major road interchange, precincts of Waterloo Station, St John's Church.
Waterloo Station (9)	Railway station.	Station modification works.	Railway station.

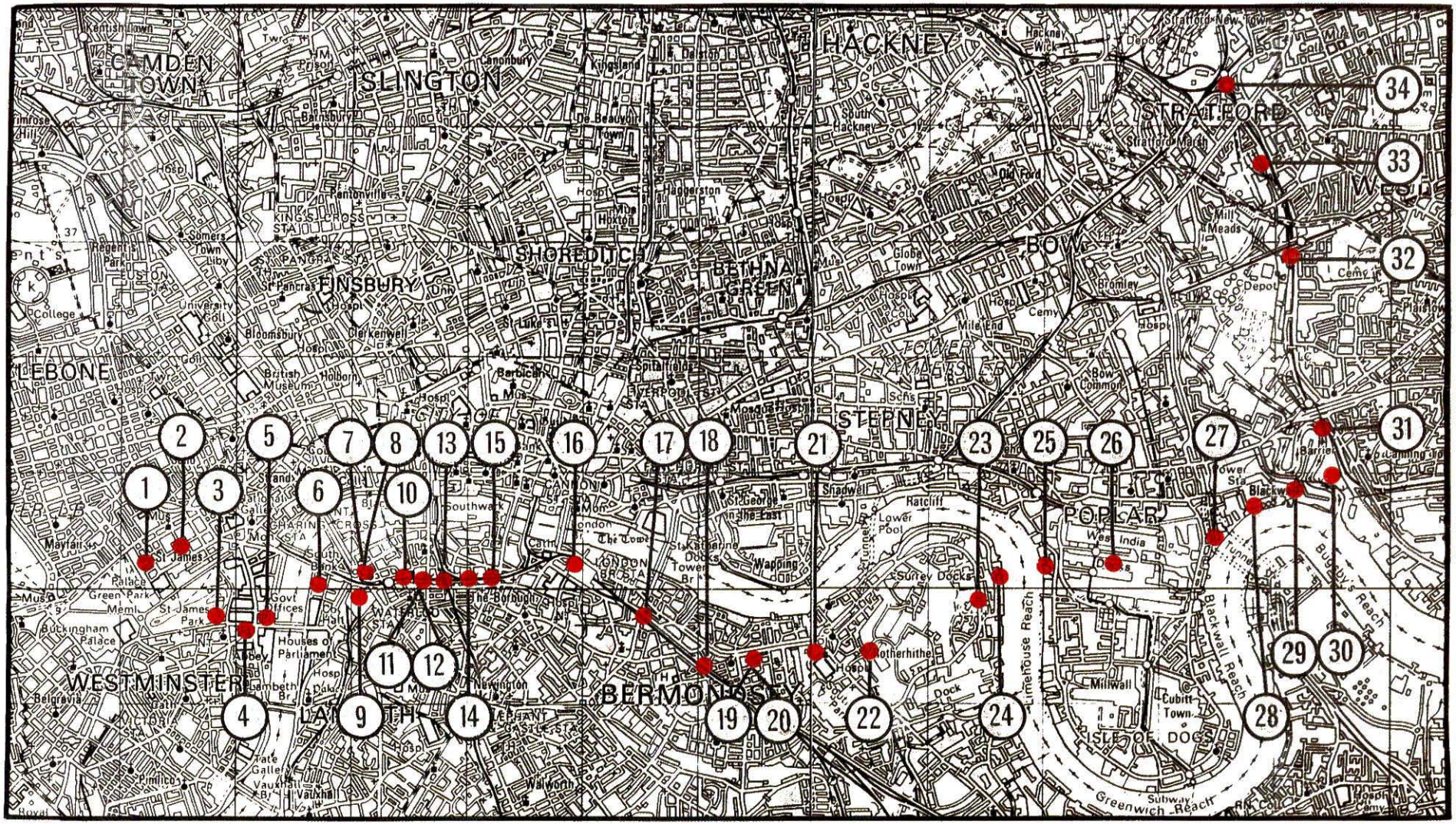


Figure A 2.3 (a) **Construction Sites**

1. Blue Ball Yard
2. St James's Square
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27. Blackwall Way (Charrington Site)
28. Brunswick
29. East India Dock Basin
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31. Canning Town Station
32. West Ham Station
33. Stratford Market
34. Stratford Station

Eastwood Wharf Preston's Rd. Nth Greenwich → Nth Greenwich option

A3. SUMMARY OF IMPACTS ALONG THE ROUTE

A3.1 Introduction

A3.1.1 In this part of the report we present information on the present situation and the predicted impacts of the Extension along the route. The line of the Extension has been divided into six sections, shown on Figure A3.1(a).

In the following pages we present, for each section of the route, the principal detail of the proposals, including a plan and long section, and a description of the present and projected environment for the proposals. We then summarise predicted impacts at each of the surface sites, and impacts occurring along the line of the route, and describe specific mitigating measures proposed within the section.

For each of the surface work sites impacts have been considered under the following general headings:

- land and property;
- noise and vibration;
- dust and visual impacts;
- access and traffic aspects;
- cultural resources.

More detailed information on the way in which impacts have been assessed are presented in the individual specialist studies in Part B. (e.g. Noise Criteria; pages 173, 176 and 178).

When construction activity noise levels are quoted in the route sections, these are in terms of L_{eq} values, based on the estimated on-times of items of construction plant, and where possible, source data derived from BS5228 (1984). Background noise levels, where quoted, are equivalent to L_{90}. More detailed definitions of these terms are provided in Section B2.3, p.172.

The frontispiece map for each Route Section illustrates the Limits of Deviation[1], marked in blue, and the approximate centre line of the route and its associated work sites, marked in red.

A3.1.2 **General Proposals for Mitigation Along the Route**

In addition to the location - specific mitigating measures identified in the following pages, a number of general measures are identified throughout the length of the route. These are summarised in Table A3.1 on pages 29-32.

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(1) Limits of Deviation is the term used to denote the extent of land, defined on the Parliamentary Plans, over which powers of acquisition of sub-soil rights are being sought by LUL in the deposited Bill. For the exact Limits of Deviation of the route the reader should refer to the Parliamentary Plans and Station Studies Book, available from the Jubilee Line Extension Project Office, 8-12 Old Queen Street, London SW1H 9HP.

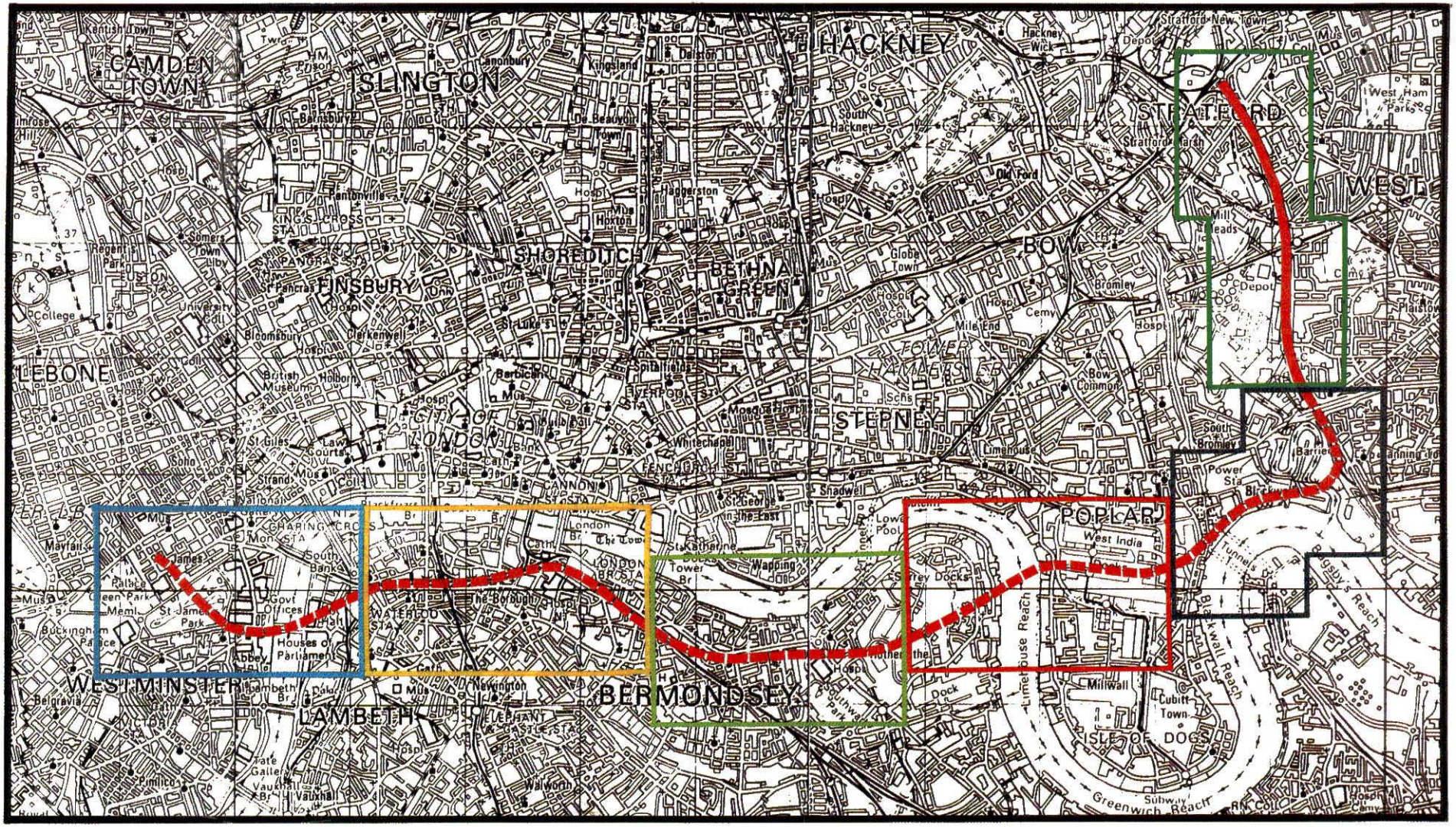
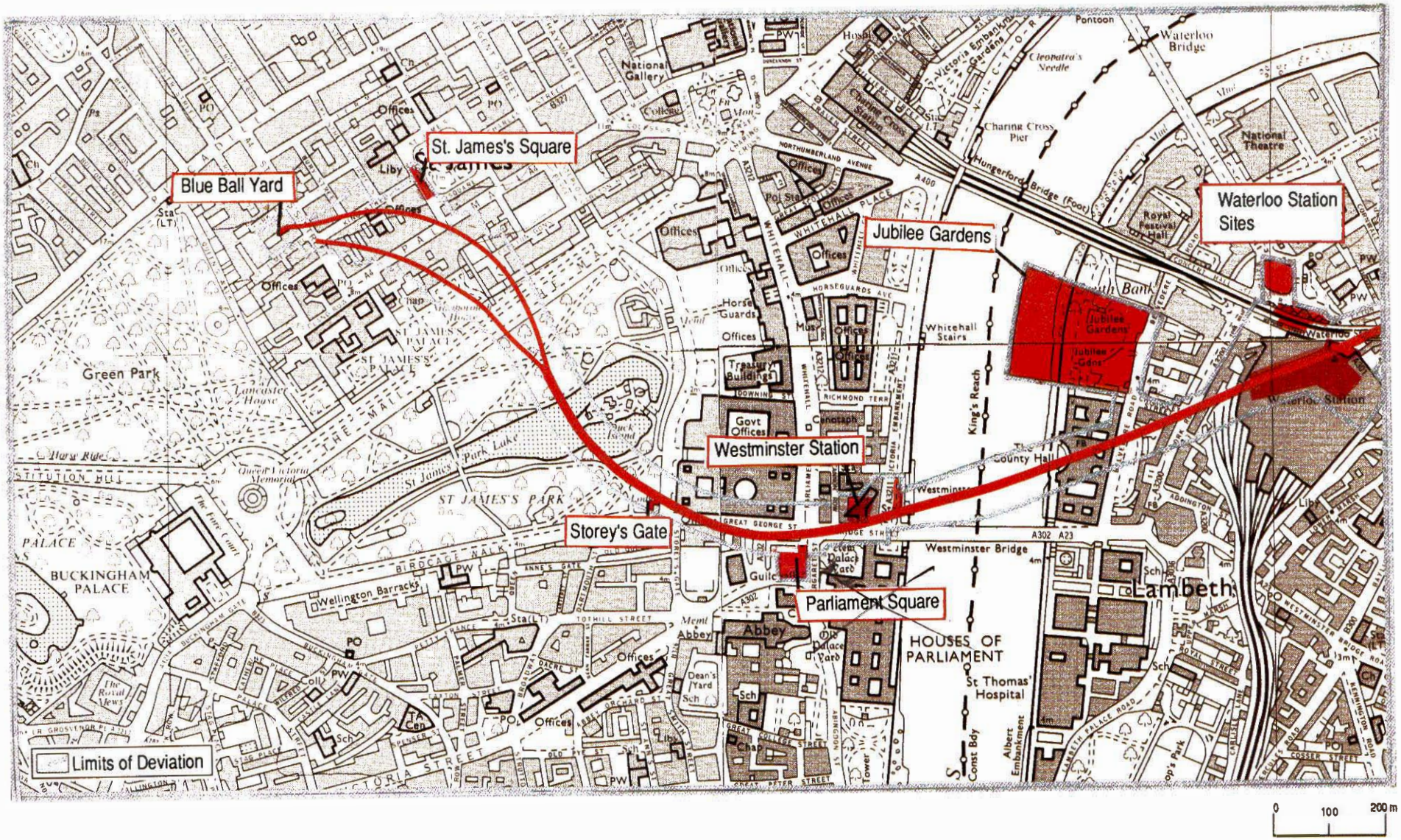
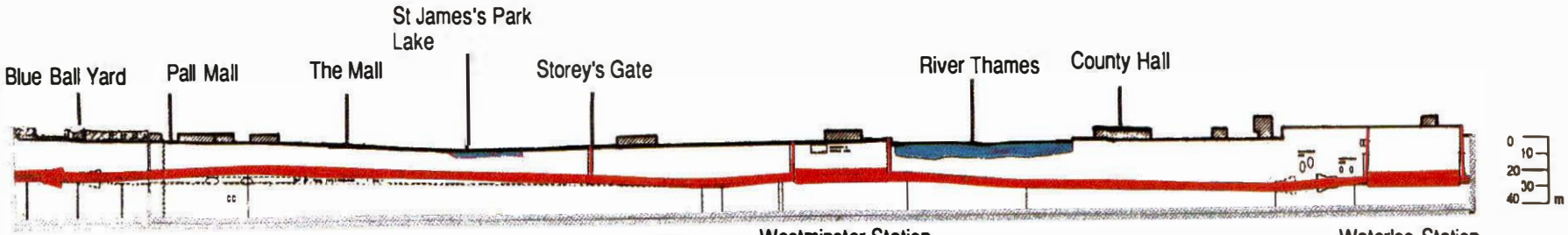


Figure A3.1(a) **Route Sections Key**


Blue Ball Yard
St. James's Square
Jubilee Gardens
Waterloo Station Sites
Westminster Station
Storey's Gate
Parliament Square
Limits of Deviation
Green Park
BUCKINGHAM PALACE
ST JAMES'S PARK
HOUSES OF PARLIAMENT
Lambeth
Waterloo Bridge
Westminster Bridge
Whitehall Stairs
King's Reach
County Hall
National Gallery
National Theatre
Charing Cross Pier
Cleopatra's Needle
Wellington Barracks
Horse Guards
Treasury Buildings
Govt Offices
St Thomas' Hospital
Albert Embankment
0 100 200 m


St James's Park Lake
Blue Ball Yard
Pall Mall
The Mall
Storey's Gate
River Thames
County Hall
Westminster Station
Waterloo Station
0 10 20 30 40 m

A3.2 Route Section 1: Green Park to Waterloo

A3.2.1 The Proposals

This section of the route runs from a junction with the existing Jubilee Line, approximately 150m to the south east of Green Park Station, to Waterloo Station, via Westminster. It crosses below the River Thames immediately to the north of Westminster Bridge, and passes under County Hall before entering the precincts of Waterloo Station.

As the route plan profile indicates, the line typically runs at depths between 20 and 25m below ground level along this section of the route. Figure A3.2(a) illustrates the tunnel depths and positions in the Westminster area.

Surface structures required on this section comprise station works at Westminster, (including optional access stairways on Parliament Square, Great George Street, and Parliament Street) station works at Waterloo, an escape shaft, to be constructed immediately adjacent to the police station at Storey's Gate at the south east corner of St James's Park, and a ventilation facility to be provided for Westminster Station on the Victoria Embankment immediately to the east of the station.

A3.2.2 Context

Of the 2.5km of this section, approximately half is routed beneath parkland (St James's Park), the river and roadways.

The route passes beneath three potentially sensitive areas of above ground land use: St James's and Westminster/ Parliament Square, which contain many Listed Buildings, including London clubs and institutions and famous landmarks, and County Hall, which is to be redeveloped. Current plans for County Hall are for a hotel, conference centre and residential accommodation.

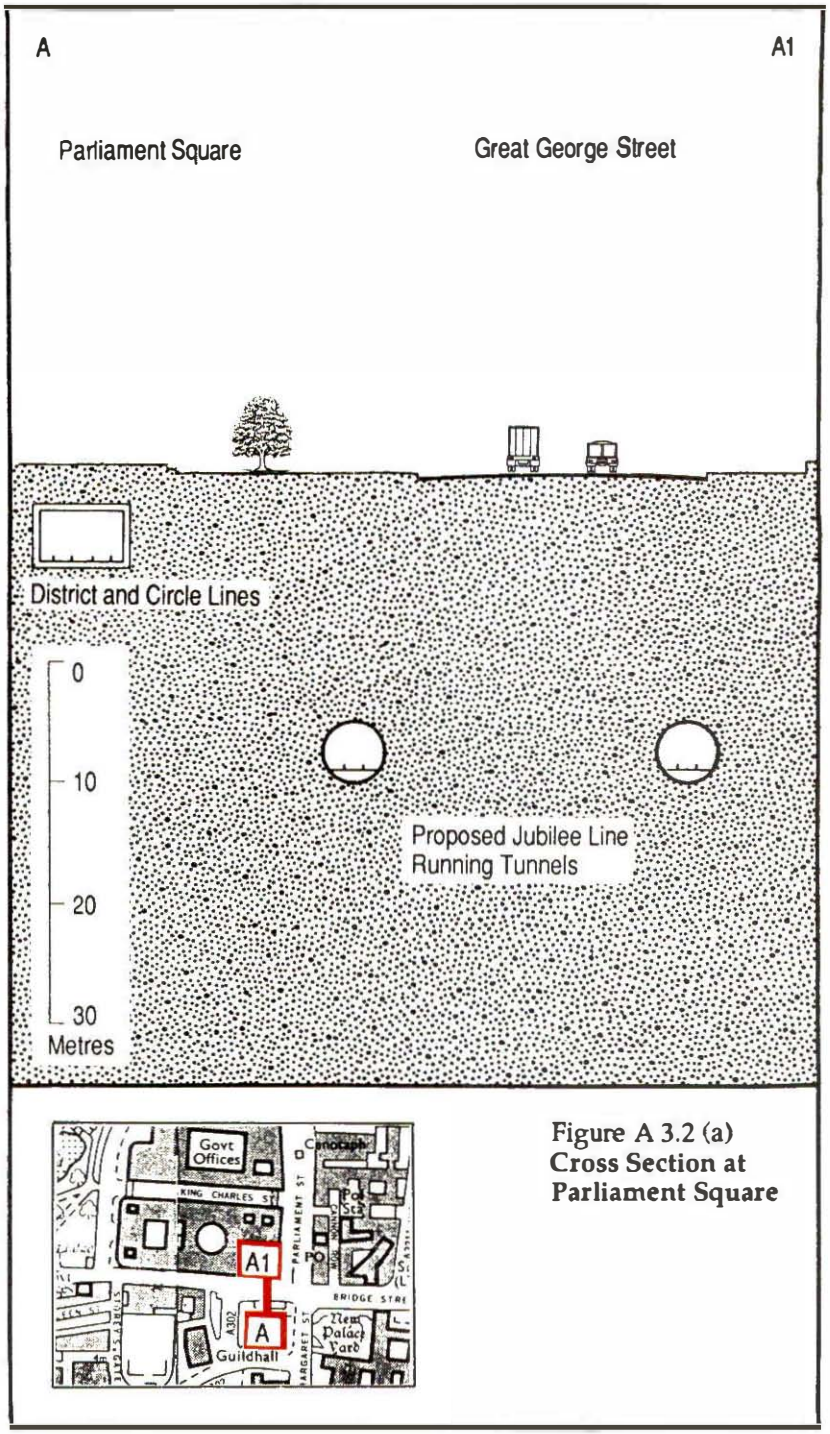


Figure A 3.2 (a)
Cross Section at Parliament Square

A3.2.3 Main Sites

There are three main work sites on this route section.

- **Parliament Square and Westminster Station.** Parliament Square is the area of open space flanked by the Houses of Parliament, St Margaret's Church, Westminster Abbey, Middlesex Guildhall and Government offices (see Figure A3.2(b) and accompanying photograph). The Jubilee Line work site will occupy the central area (c. 0.5ha) of Parliament Square. Construction works will also take place within the existing station itself. Major works at these sites will last approximately 3-4 years. An area of about 800m^2 will also be required on the Victoria Embankment for a period of up to 2 years for the construction of a ventilation facility. A raised 'umbrella deck' will be installed at the crossing of Parliament Street, Great George Street and Bridge Street.

  Although the square itself is of little historic interest, the buildings associated with it attract many millions of visitors each year. The Westminster sites are located within an area designated by the Greater London Development Plan as an Area of Special Character and is of metropolitan importance. The major policy aims for this area are special care for its existing character, tradition and views, removal of extraneous traffic and improvement of pedestrian conditions. Traffic in the square is regularly congested.

  The Westminster sites are also within a Conservation Area and the whole area from Storey's Gate to the Thames is a special archaeological priority area.

  The sites will be used for the construction of the Jubilee Line platforms, connecting passages and a new ticket hall for Westminster Station. These works will be incorporated with the overall redevelopment of the station area being undertaken by the Property Services Agency.

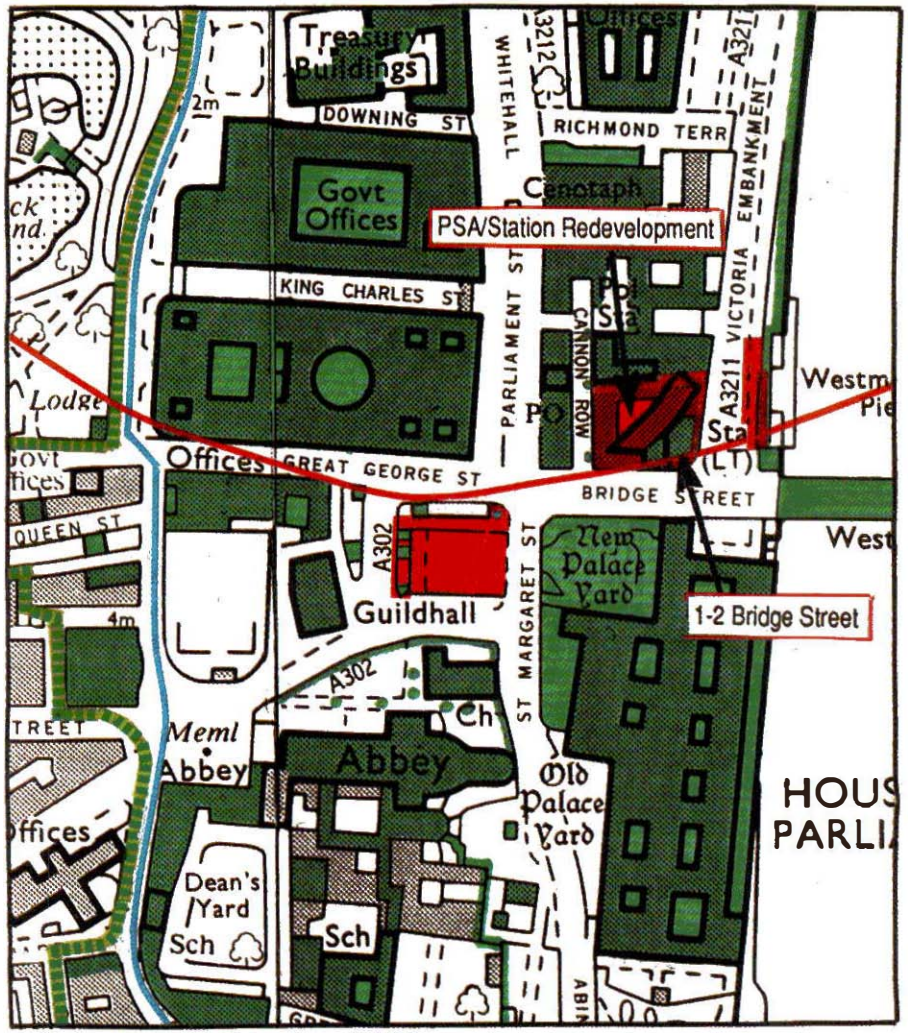
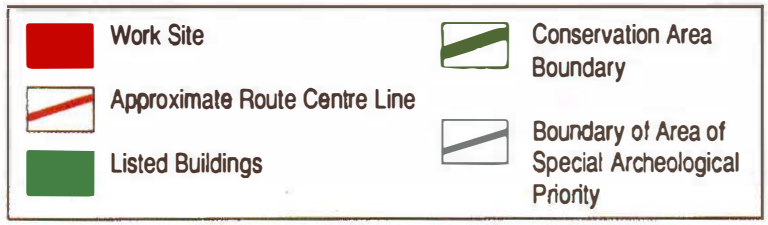


Figure A 3.2 (b) **Parliament Square and Westminster Station Work Sites**



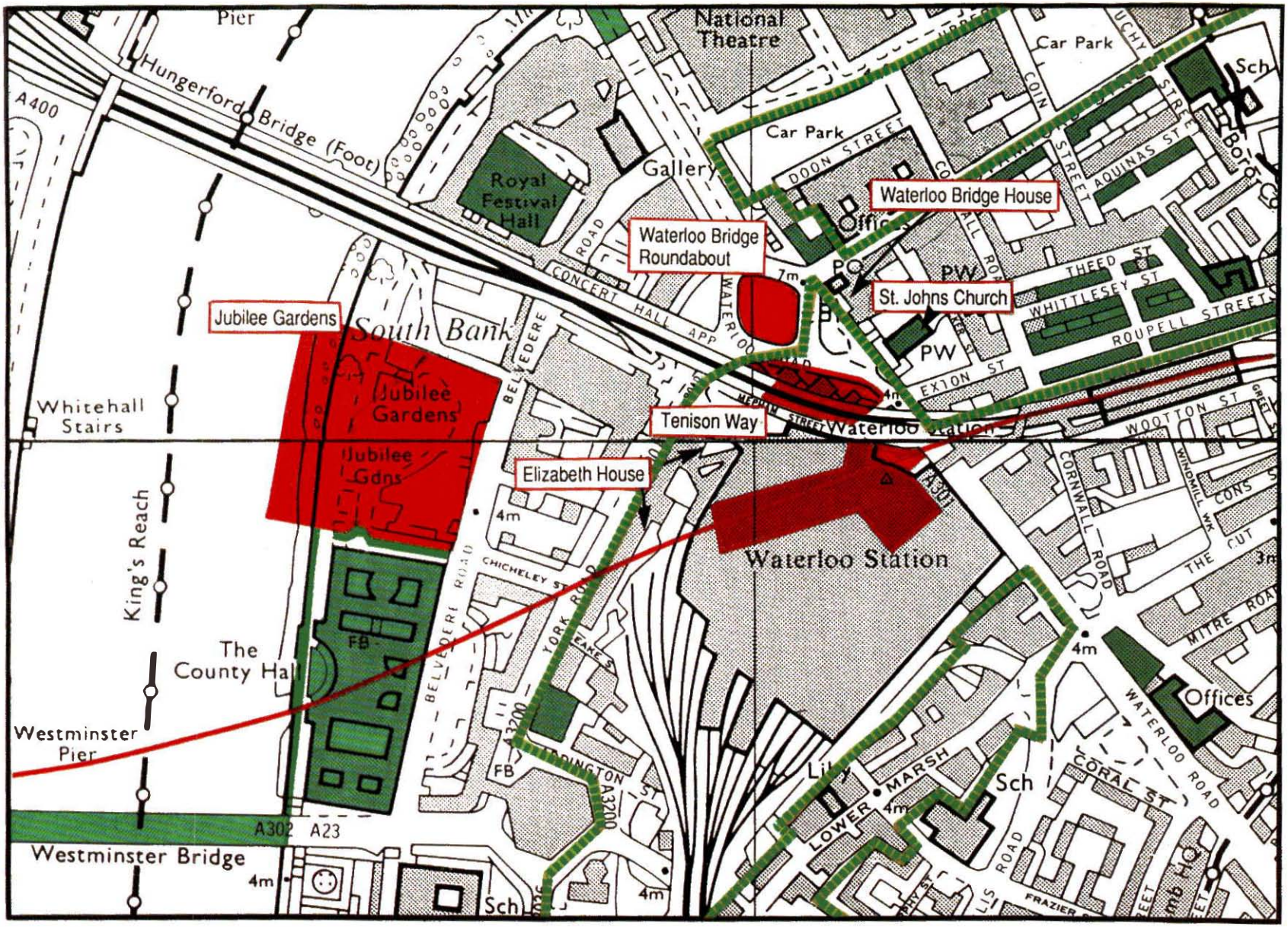


Figure A 3.2 (c) **Jubilee Gardens and Waterloo Work Sites**

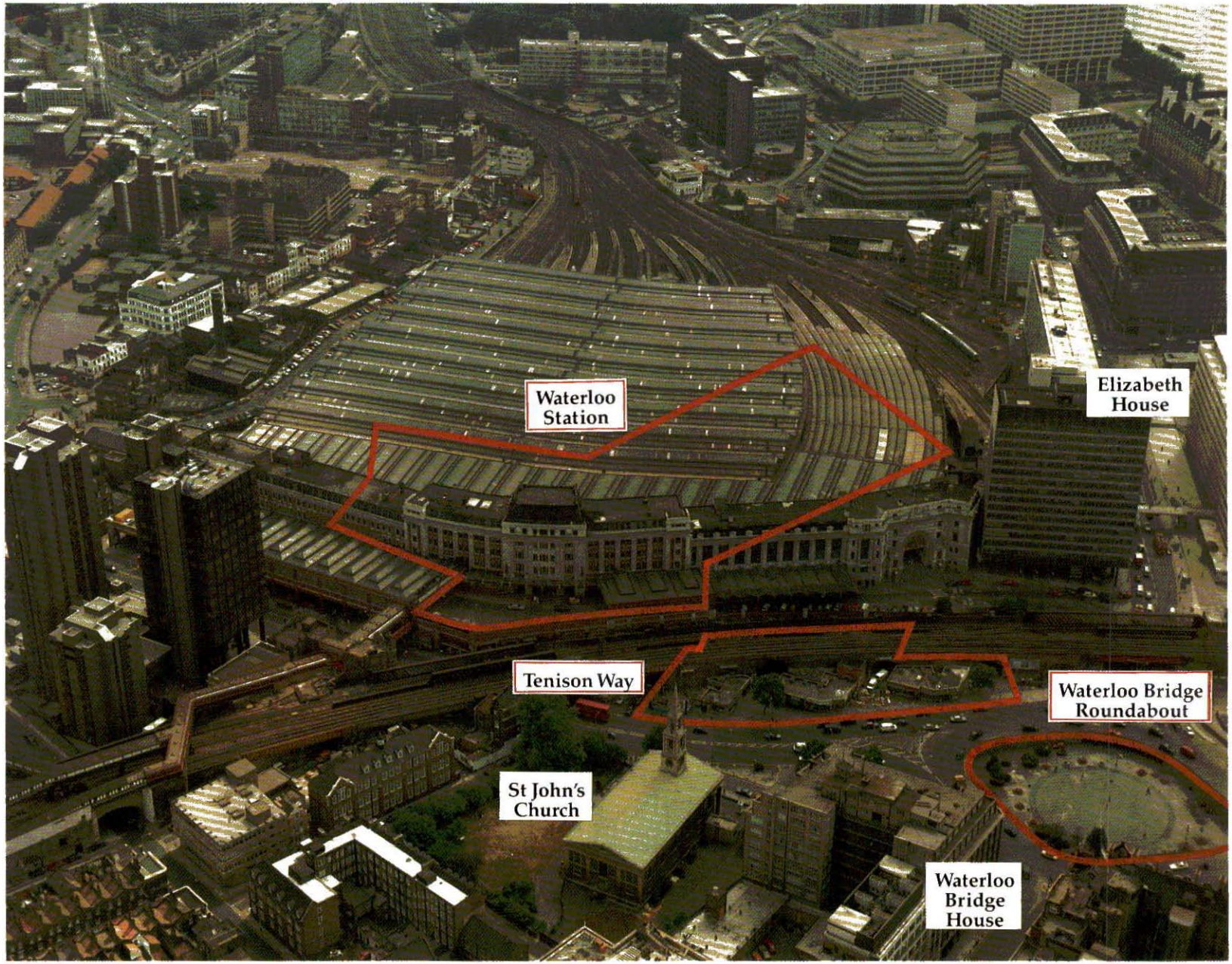
Work Site

Approximate Route Centre Line

Listed Buildings

Conservation Area Boundary

0 100 200 300 metres



The worksites at Waterloo Station

Terminal under the Channel Tunnel Act, 1987. British Rail and P & O also propose to provide 1.2 million square feet of office accommodation over and adjacent to the station.

A3.2.4 Other Sites

- **Blue Ball Yard**. Modification work to the existing Jubilee Line ventilation shaft in Blue Ball Yard off St James's Street will be necessary. This work is expected to be carried out from the existing below ground facilities and hence a surface work site will not be necessary.

- **St James's Square**. An area of roadway on the west side of St James's Square, currently used to provide 30 public car parking spaces (from a total of 125 within the square), will be required for major works for a period of up to 2 years, to enable connecting junctions to be constructed between the existing Jubilee Line tunnels and those of the Extension (see Figure A3.2(d)). St James's Square is Grade II Listed, located within a Conservation Area and contains a considerable number of similarly Listed private clubs, offices and hotels. Properties immediately opposite the site (c. 15-20m distance) include the Junior Carlton Club, Army and Navy Club, East India Sports Club and offices.

  At the completion of the works the area should be restored to its previous use, or as required by the local authorities; no permanent surface structures will remain at the site.

- **Storey's Gate**. This site is a Grade II Listed Building, located to the rear of Storey's Gate Lodge Police Station, at the south east edge of St James's Park on the corner of Birdcage Walk and Horse Guards (see Figure A3.2(e)). Government offices are located to the south and east. Approximately 300m^2 of parkland and 200m^2 of the Police Station precinct will be required for the construction of an escape shaft, the major works for which are expected to take about 2 years. At the completion of works, the parkland and remaining station precinct should be restored to its former condition; the surface structure of the escape shaft will

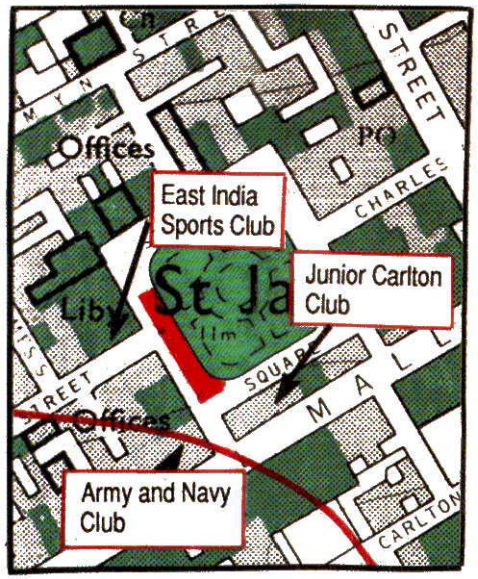
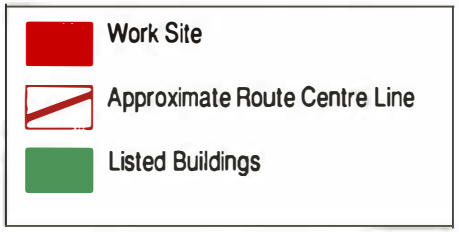


Figure A 3.2 (d) **St. James's Square Work Site**



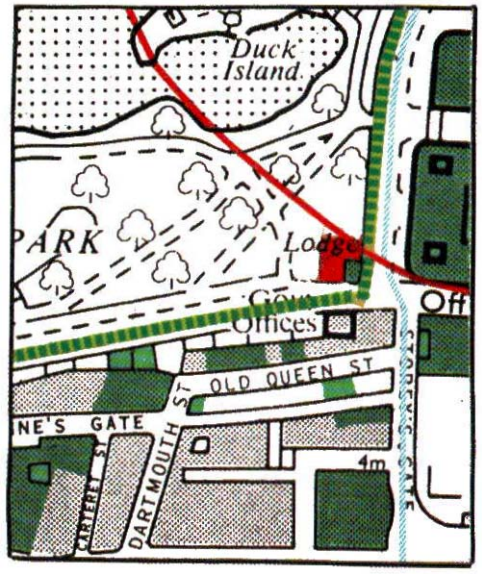
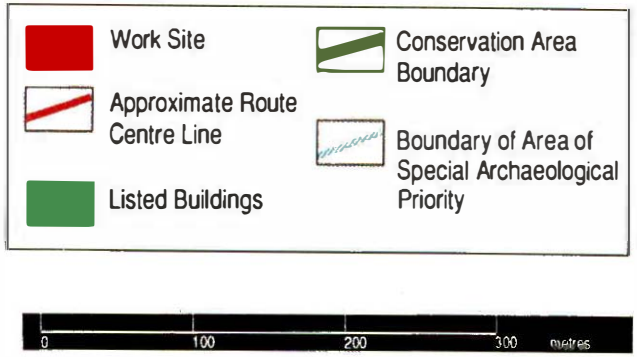


Figure A 3.2 (e) **Storey's Gate Work Site**



occupy approximately 15-20m^2 of the police station precinct, and should be designed to appear as an 'extension' to the Lodge.

A3.2.5 Impacts of Surface Works

The Table at the end of Section A3.2 summarises information on the impacts resulting from occupation of, and construction works on, surface sites in this section.

A3.2.6 Impacts of Tunnelling

Two issues have been considered in relation to tunnelling:

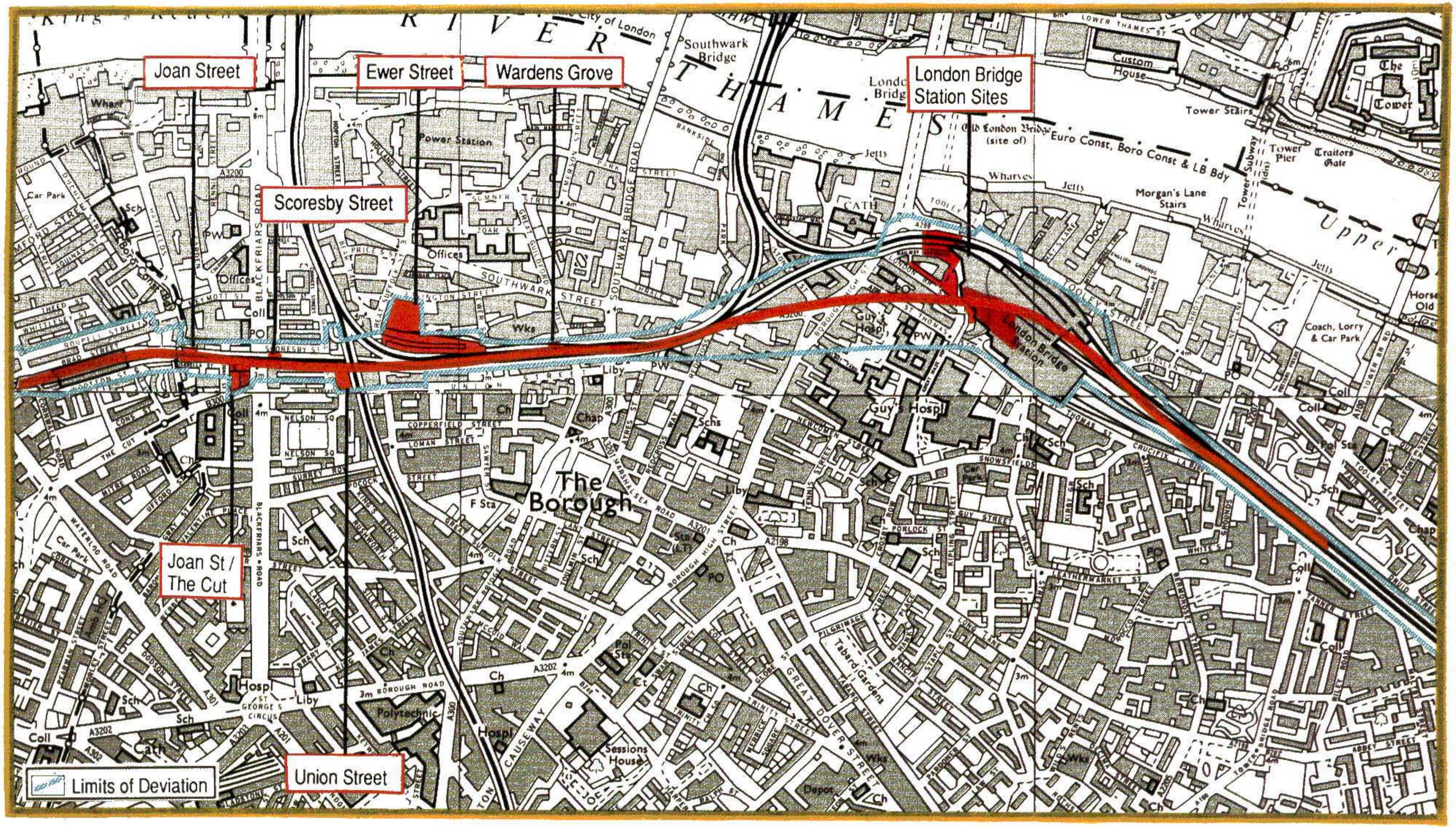
- **Noise and Vibration**

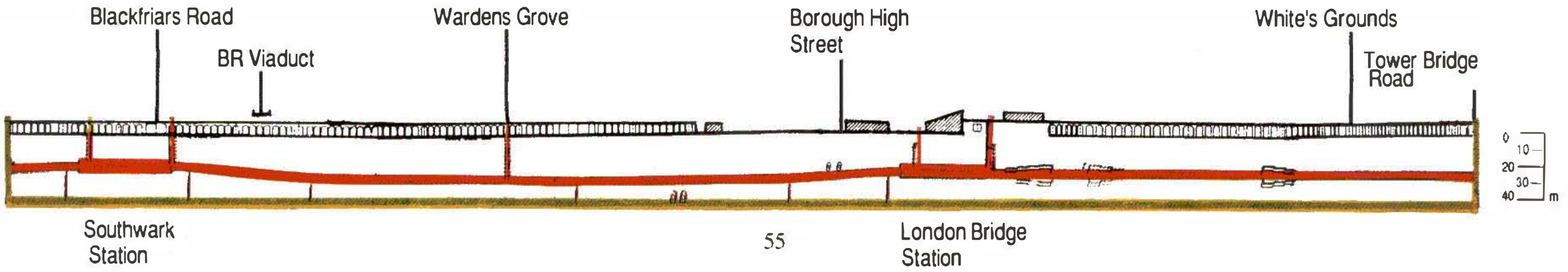
  The assessment indicates that noise and vibration from tunnelling operations will not normally be perceptible in properties above the tunnel in this section. There is, however, a possibility of exceptional soil properties being encountered along the route, which could lead to some noise and/or vibration affecting sensitive buildings. The likelihood of this cannot be assessed at this stage, but geotechnical investigations should be carried out over the course of detailed design, which will provide further information.

- **Settlement**

  An assessment has identified that buildings and other structures along this route section may be subject to some settlement. Buildings in St James's and Westminster are considered to be potentially sensitive and therefore not listed individually.

  Use of appropriate tunnelling techniques and good working practise will minimise the degree of settlement. Where necessary protective measures - such as ground stabilisiation and underpinning techniques should be used. All sensitive structures will be monitored on a regular basis to detect any departure from predicted behaviour and enable corrective action to be implemented at the earliest opportunity.


Joan Street
Ewer Street
Wardens Grove
London Bridge Station Sites
Scoresby Street
Joan St / The Cut
Union Street
Limits of Deviation
The Borough
RIVER THAMES
Southwark Bridge
Power Station
Guy's Hospl
London Bridge Station
Custom House
The Tower
Tower Pier
0 100 200 m


Blackfriars Road
BR Viaduct
Wardens Grove
Borough High Street
White's Grounds
Tower Bridge Road
Southwark Station
London Bridge Station
0
10
20
30
40 m

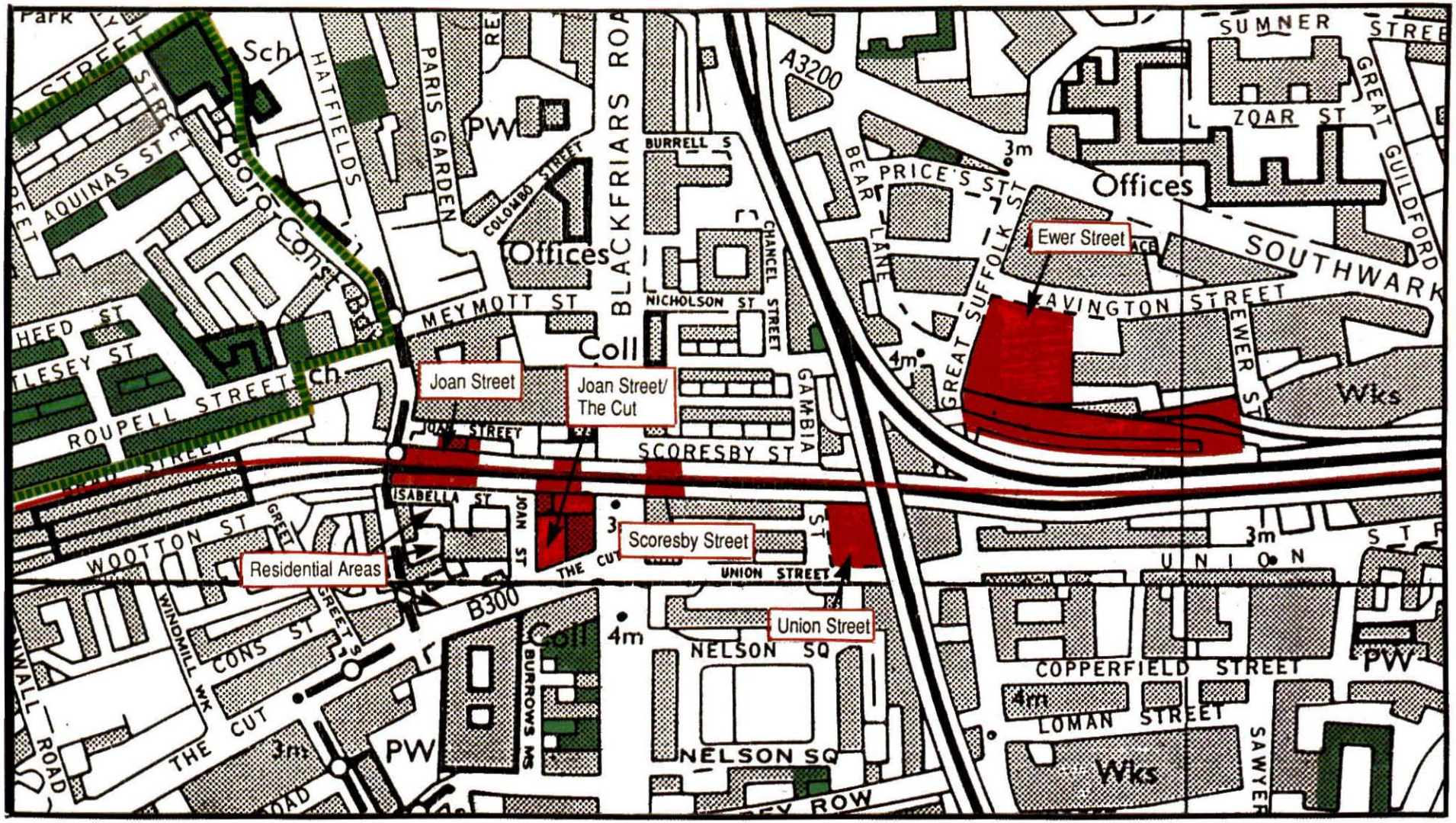
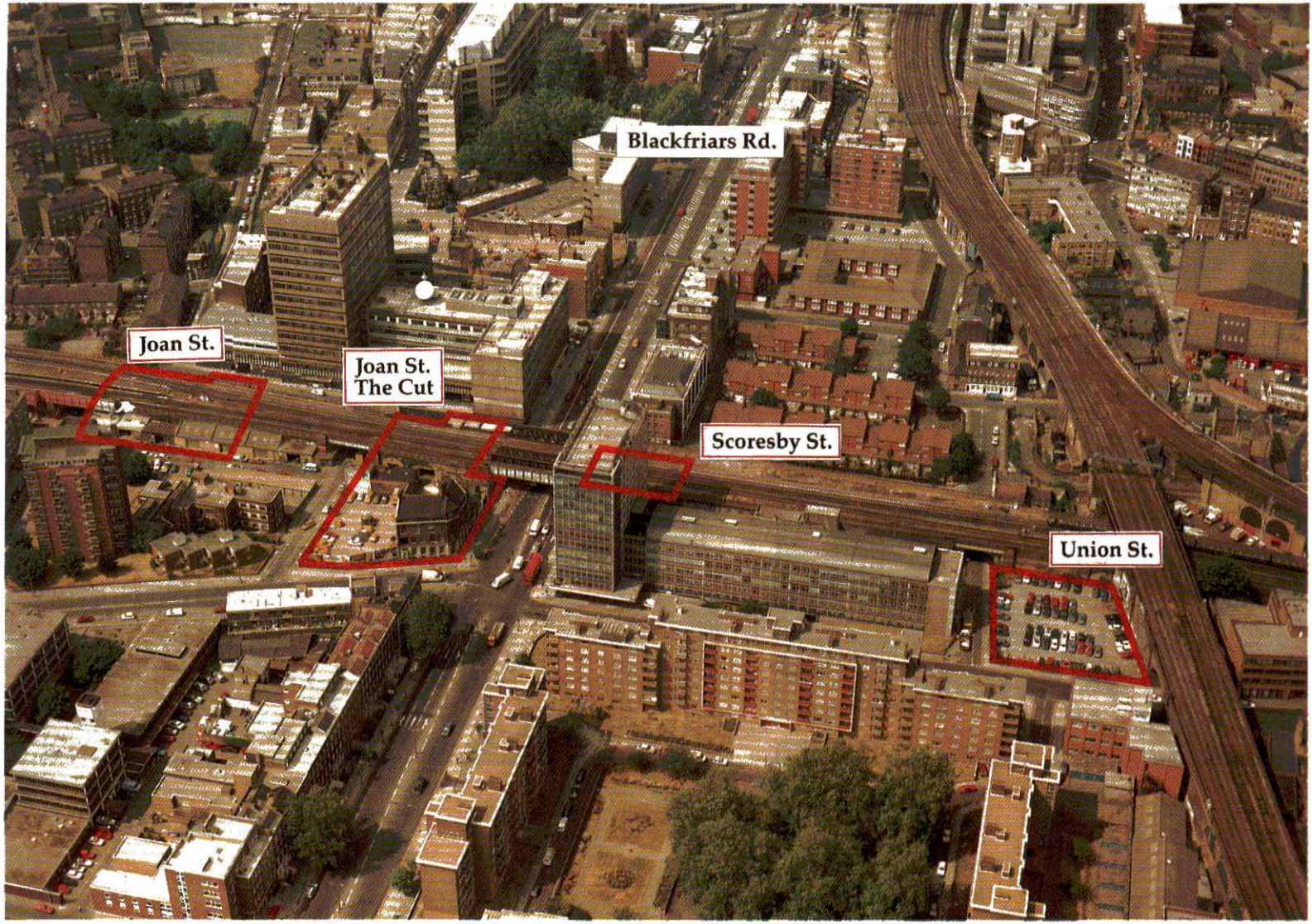


Figure A 3.3 (c) **Southwark Station and Ewer Street Work Sites**



The worksites at Southwark Station

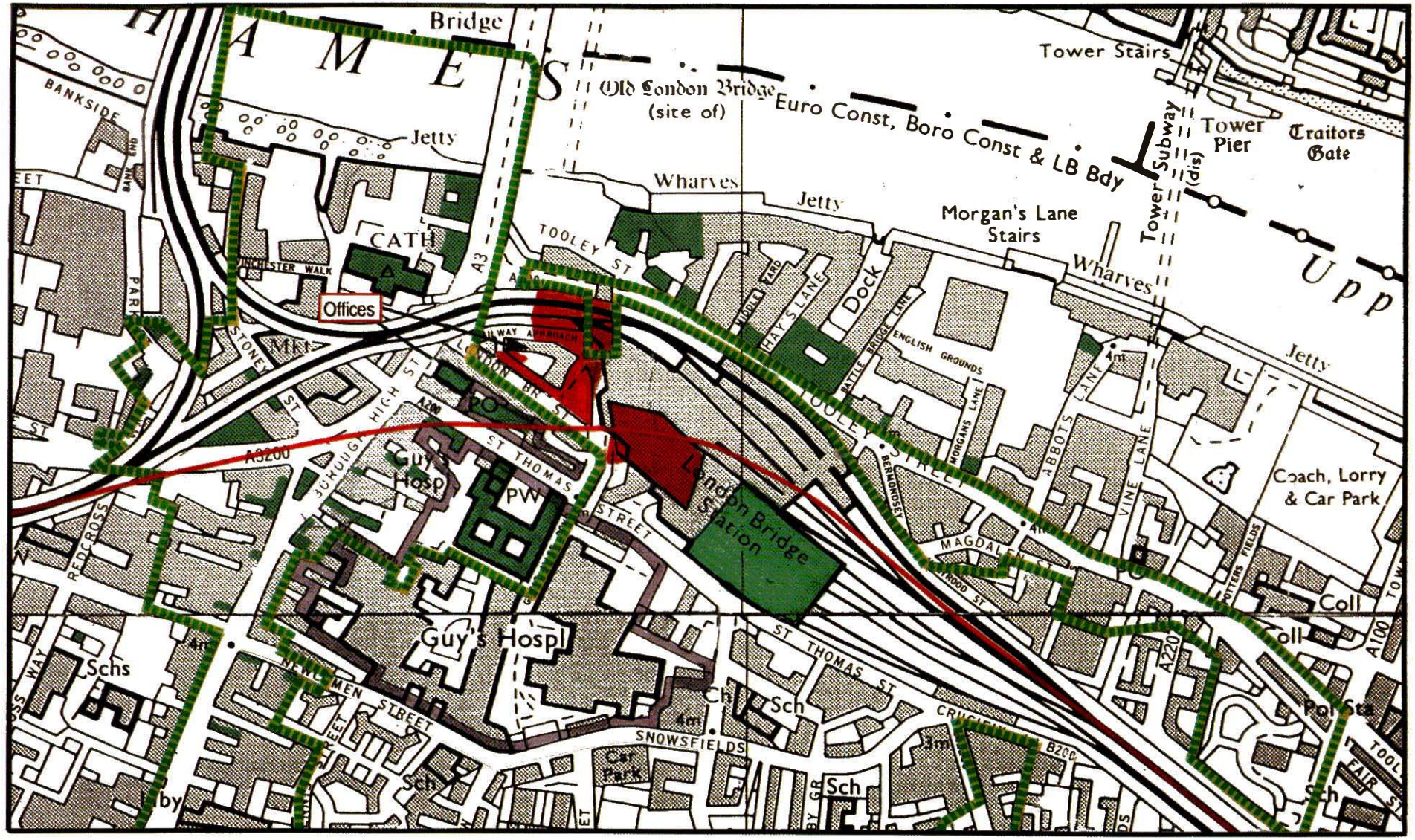


Figure A 3.3 (d) **London Bridge Station Work Site**

Work Site

Approximate Route Centre Line

Listed Buildings

Conservation Area Boundary

Guys Hospital

0 50 100 150 200 250 300 metres

about 3-4 years and will be available after tunnelling works are complete.

Immediate surrounding land uses include British Library offices across Gambia Street (c.10m), residences in Rowland Hill House (c.20m) and nearby offices in Union Street (c.15m).

o **Wardens Grove**

Two railway arches at Wardens Grove will be used to construct an interstation combined ventilation and escape shaft (see Figure A3.3(e)), the major works for which are expected to take up to 2 years. The arches are presently being used as a vehicle repair shop. Only one will be needed permanently to house the shaft.

The site will be accessed to the north of the viaduct via Great Guildford Street. Surrounding land use is predominantly light industrial. Thrale Street Conservation Area is to the north east of the site.

A.3.3.5 Impacts of surface works

The Table at the end of this section summarises information on impacts resulting from occupation of, and construction works in, surface sites in this section.

A3.3.6 Impacts of Tunnelling

Two issues have been considered in relation to tunnelling:

o **Noise and Vibration**

The assessment indicates that noise and vibration from tunnelling operations will not normally be perceptible in properties above the tunnel in this section. There is, however, a possibility of exceptional soil properties being encountered along the route, which could lead to some noise and/or vibration affecting sensitive buildings.

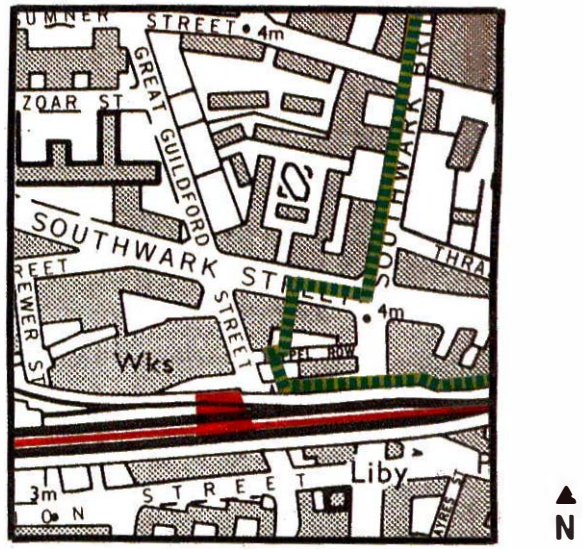
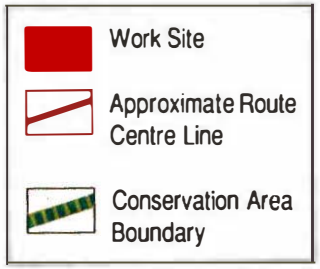
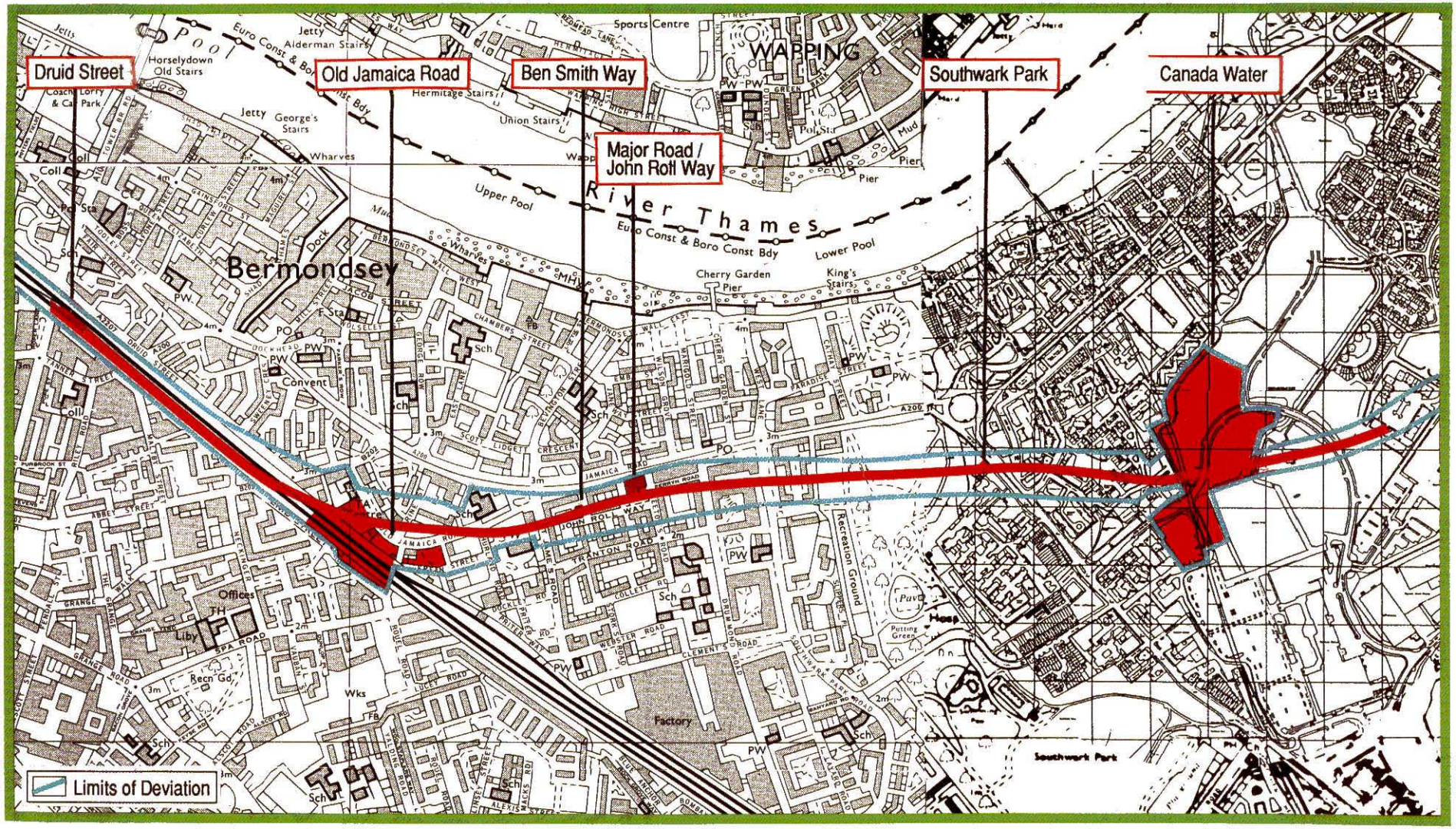
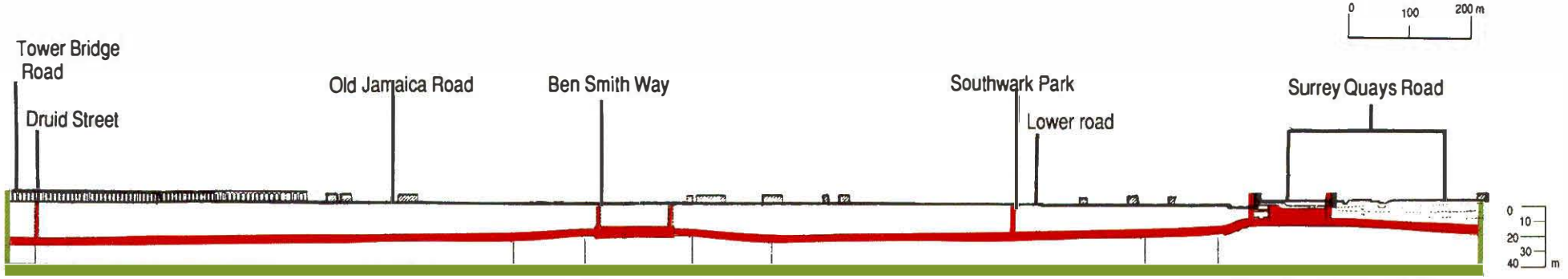


Figure A 3.3 (e) **Wardens Grove Work Site**




Druid Street
Old Jamaica Road
Ben Smith Way
Major Road / John Roll Way
Southwark Park
Canada Water
WAPPING
River Thames
Upper Pool
Lower Pool
Bermondsey
Limits of Deviation


0
100
200 m
Tower Bridge Road
Druid Street
Old Jamaica Road
Ben Smith Way
Southwark Park
Lower road
Surrey Quays Road
0
10
20
30
40
m
Bermondsey Station
Canada Water Station

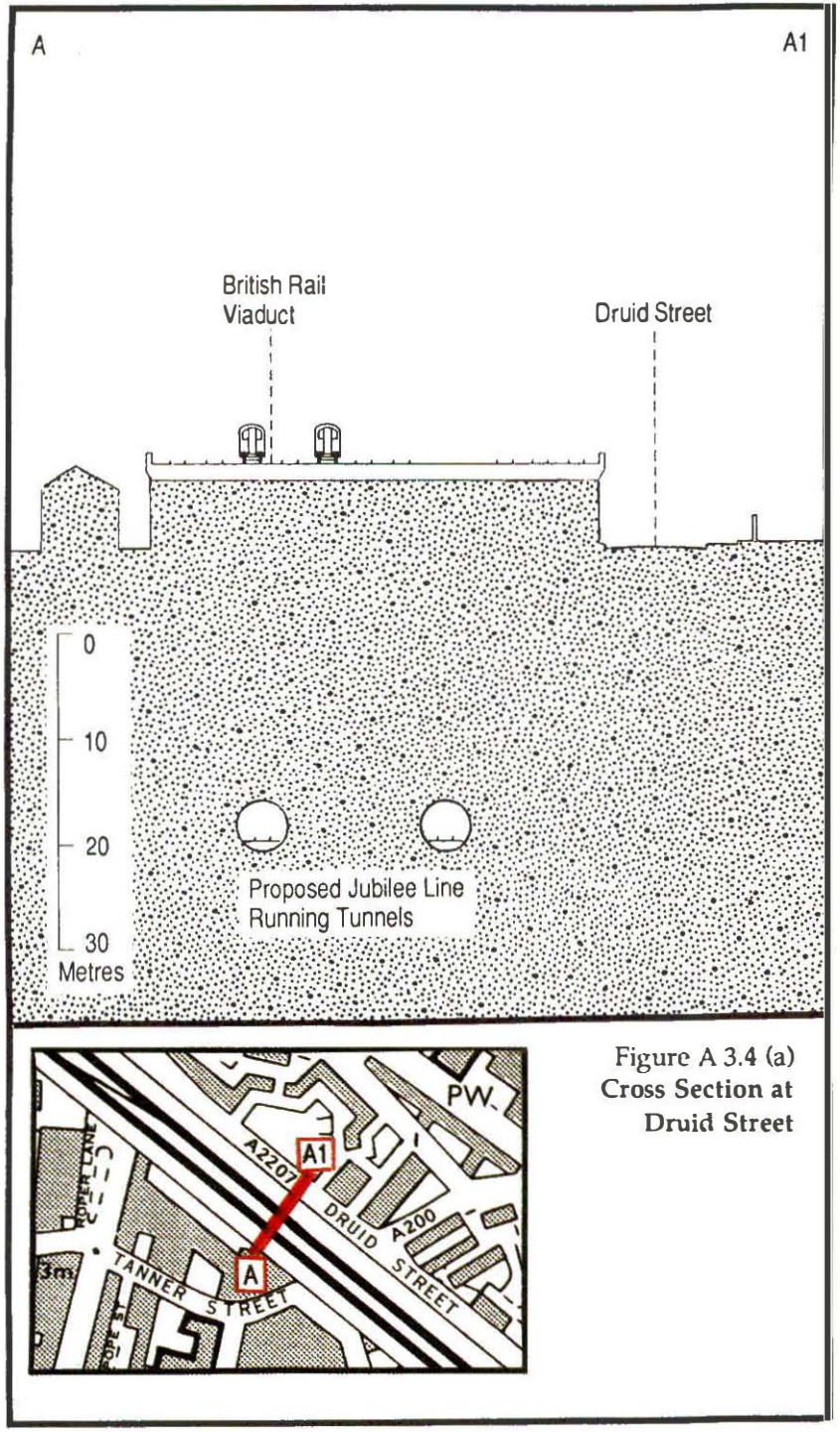


Figure A 3.4 (a)
Cross Section at Druid Street

A3.4 Route Section 3: London Bridge to Canada Water

A3.4.1 The Proposals

This section of the route runs from east of London Bridge Station to Canada Water Station in the old Surrey Docks, via a new Bermondsey Station situated on Jamaica Road.

As the route plan profile indicates, the line typically runs at a depth of about 25m to the west of Bermondsey Station, and at 20m between Bermondsey Station and Canada Water Station, rising to about 12m immediately before Canada Water Station. Figures A3.4(a) and (b) illustrate the tunnel depths and positions in the Druid St and Bermondsey Station areas.

Surface structures required on this section comprise an interstation ventilation and escape shaft within the railway viaduct arches at Druid Street, entrances, emergency escape facilities and a ticket hall at Bermondsey Station, entrances and emergency escape facilities at Canada Water, and a combined ventilation and escape shaft at the north east corner of Southwark Park.

In addition to the work sites for the surface structures, this route section includes a tunnelling site at Old Jamaica Road. The site will be used for the installation of the tunnel boring machines, the removal of spoil from the tunnelling excavations, and the supply of tunnel lining sections.

A3.4.2 Context

Just over one third of this section of the line is routed under existing railway viaducts (carrying BR mainline tracks), or parkland (Southwark Park).

Other land uses along this section of the route are predominantly residential, with much of the area around Canada Water undergoing extensive redevelopment, mainly for retail purposes to the south, (the recently opened Surrey Quays shopping centre), and proposed retail business, housing and leisure uses (the Surrey

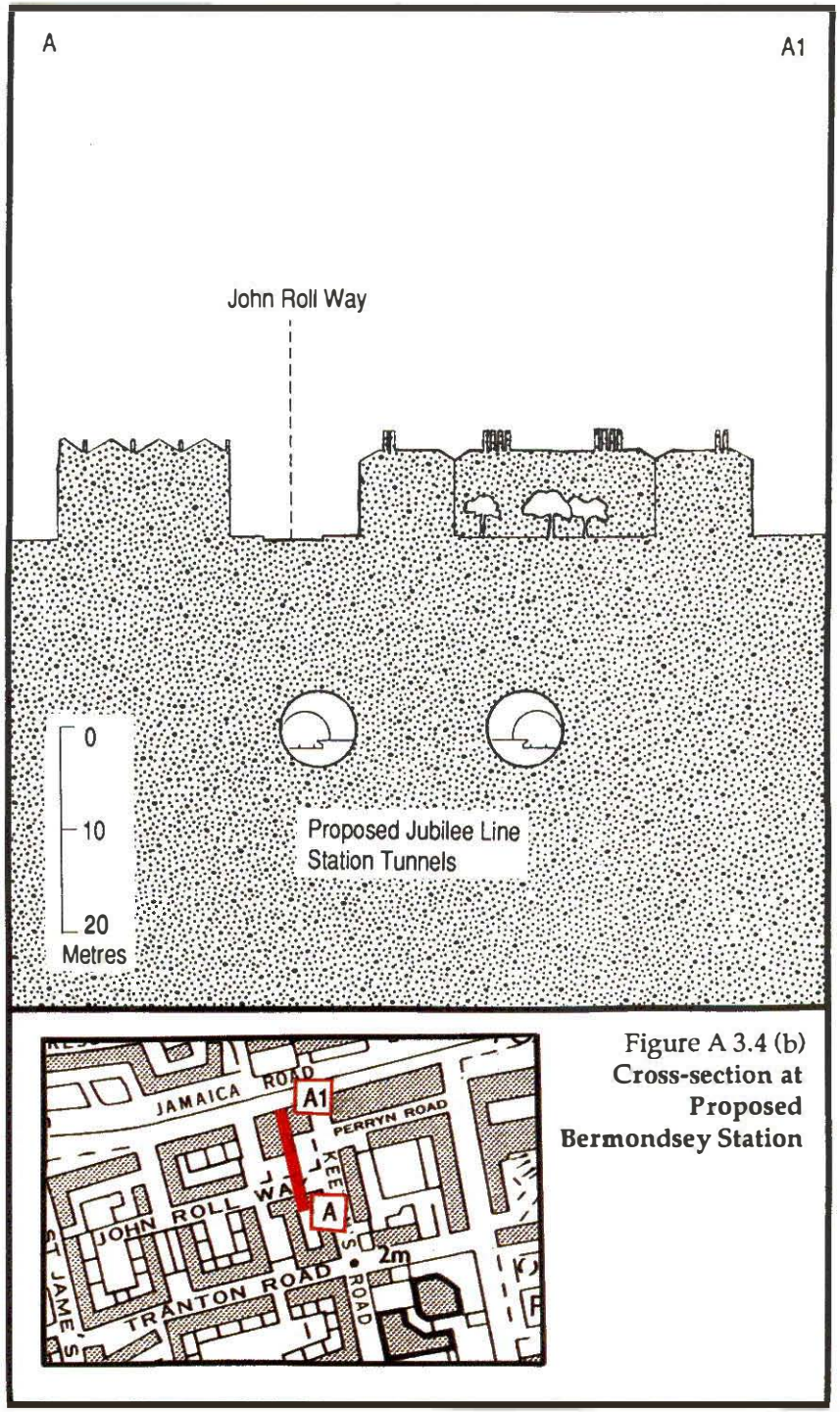


Figure A 3.4 (b) **Cross-section at Proposed Bermondsey Station**

Quays Commercial Centre, Phase II), immediately adjoining and to the north and east of Canada Water.

A3.4.3 Main Sites

There are 3 main work sites on this route section:

- **Old Jamaica Road**

The site is located to the south of Old Jamaica Road, and currently comprises depots and vehicle yards, warehouse/ storage arches under the BR viaduct, approximately 100m^2 of the gardens of 2 vacant houses (44-46 Old Jamaica Road) and Grace Kimmins Gardens, an area of open space (2000m^2). The site is divided by Rouel Road, which will remain open during the construction period. Land uses around the site are generally mixed residential and commercial, with St James' Primary School (75m to the north east) and St James's Church (Grade I Listed) (100m to the east) nearby (see Figure A3.4(c) and accompanying photograph).

The site will be required for about 3-4 years for major works, and will be used as the starting point for the tunnel drives to London Bridge in the west, and to Canada Water in the east. The spoil arising from these operations is expected to be removed from the site by road transport. At the completion of the works, the open space should be restored to its original condition or to an alternative layout, to be agreed with the Local Authority. The area of depot and vehicle yards will be available for reoccupation or development.

Previous uses of the site, including a tannery and depot, suggest that the soil may be contaminated with solvents, dyes, animal disease organisms and oils. If testing of the soil confirms the presence of significant contamination, appropriate measures will be required to protect site workers and local residents and to ensure that any contaminated material removed from the site is properly disposed of.

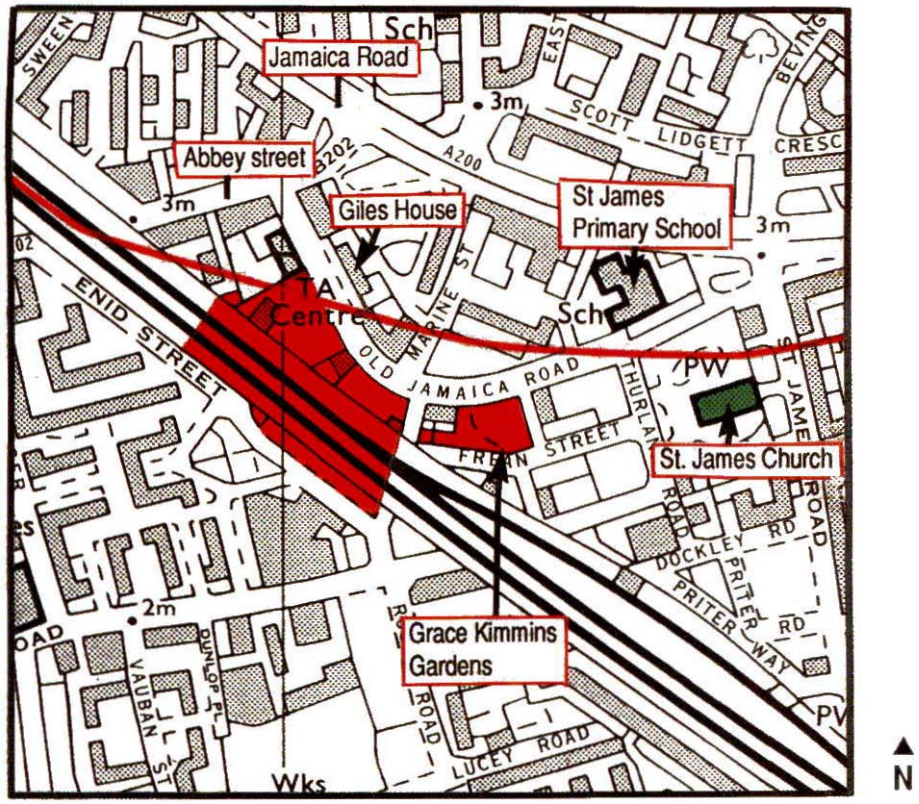
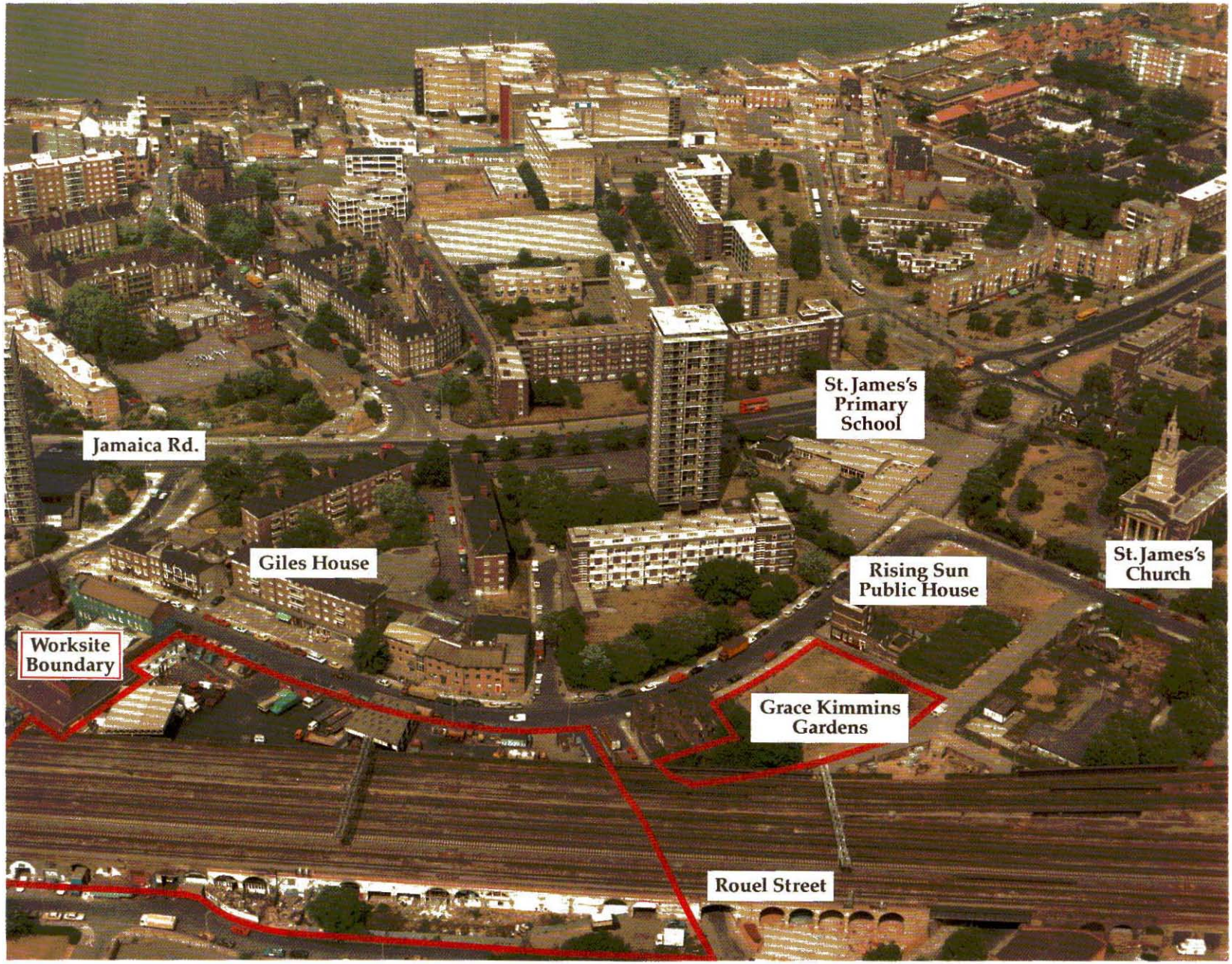


Figure A 3.4 (c) **Old Jamaica Road Work Site**



The worksite at Old Jamaica Road

o **Major Road/John Roll Way**

The site for the construction of Bermondsey Station comprises a block of seven derelict shops and their yards/gardens bounded by Jamaica Road, Keeton's Road, John Roll Way and Major Road. The site fronts onto the heavily trafficked A300 Jamaica Road, in a predominantly residential area. An estate providing sheltered housing lies immediately to the south of the site, approximately 15m from the site boundary at its nearest point. Four Grade II Listed Buildings, numbers 124-130 (even) Jamaica Road, lie approximately 50m to the west of the site and the Wilson Street Conservation Area lies to the north of the site, on the northern side of the Jamaica Road dual carriageway (see Figure A3.4(d) and the accompanying photograph).

The site will be required for approximately 3½-4 years for the major works involved in the construction of the station, including a ground level ticket hall, escalators and a disabled persons lift to platform level.

o **Canada Water**

The site for the construction of Canada Water Station lies within the London Docklands Development Corporation development area, at the junction of Deal Porter's Way and Surrey Quays Road (see Figure A3.4(e) and the accompanying photograph). It borders the western and northern sides of Canada Water and includes approximately 170 car parking spaces used by visitors to the Surrey Quays Shopping Plaza (from a total of approximately 1050 spaces).

The area is currently undergoing major redevelopment; the newly opened Surrey Quays Shopping Plaza lies to the south, and the site is included within the proposed Surrey Quays Commercial Centre (Phase II) which extends to the north and east.

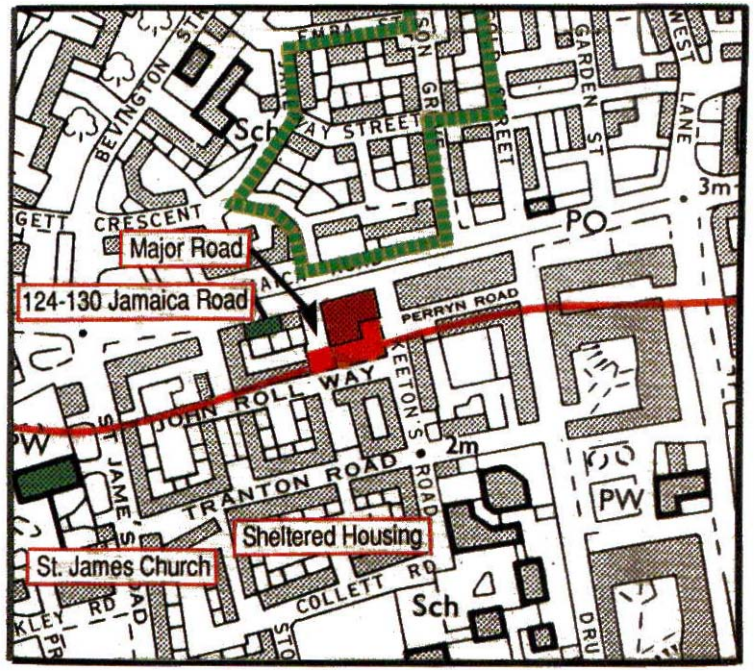


Figure A 3.4 (d) **Major Road/John Roll Way Work Site**

The worksites at Major Road/John Roll Way and Ben Smith Way

The area to the west of the site is generally residential, including Columbia Point and Regina Point, two high rise tower blocks, approximately 10m from the site boundary at its nearest point.

A locally Listed Building, Deal Porters Lodge, is situated within the work site boundary; this will need to be dismantled and removed and then reinstated following construction of the station.

An area of up to approximately 1400m^2 (45%) of 'shoreline' along the western edge of the dock, recently created by the Wildlife in Docklands Project as a wildfowl refuge, will be temporarily lost to the construction works. The area to be occupied (primarily for road diversions) should be minimised and fully reinstated at the completion of the construction works.

The site will be used for the construction of a joint Jubilee and East London Line Station, and the provision of bus interchange facilities. Major works at the site will take 3½-4 years. Post-construction, the site will be available for incorporation within the overall development of the area. Permanent surface structures will be station entrances, draught relief shafts for the Jubilee Line, reconstructed ventilation shafts for the East London Line, and bus interchange facilities.

The area of car parking will be permanently taken to provide bus interchange facilities.

The site is located within an area of former dockyard and infilled docks (Canada Dock, Albion Yard and Albion Dock), and it is possible that contamination by oils, and the general fill (often waste materials) used to infill the former dock may be encountered during the site works.

If significantly contaminated material is found, appropriate measures will be required to protect site workers and the

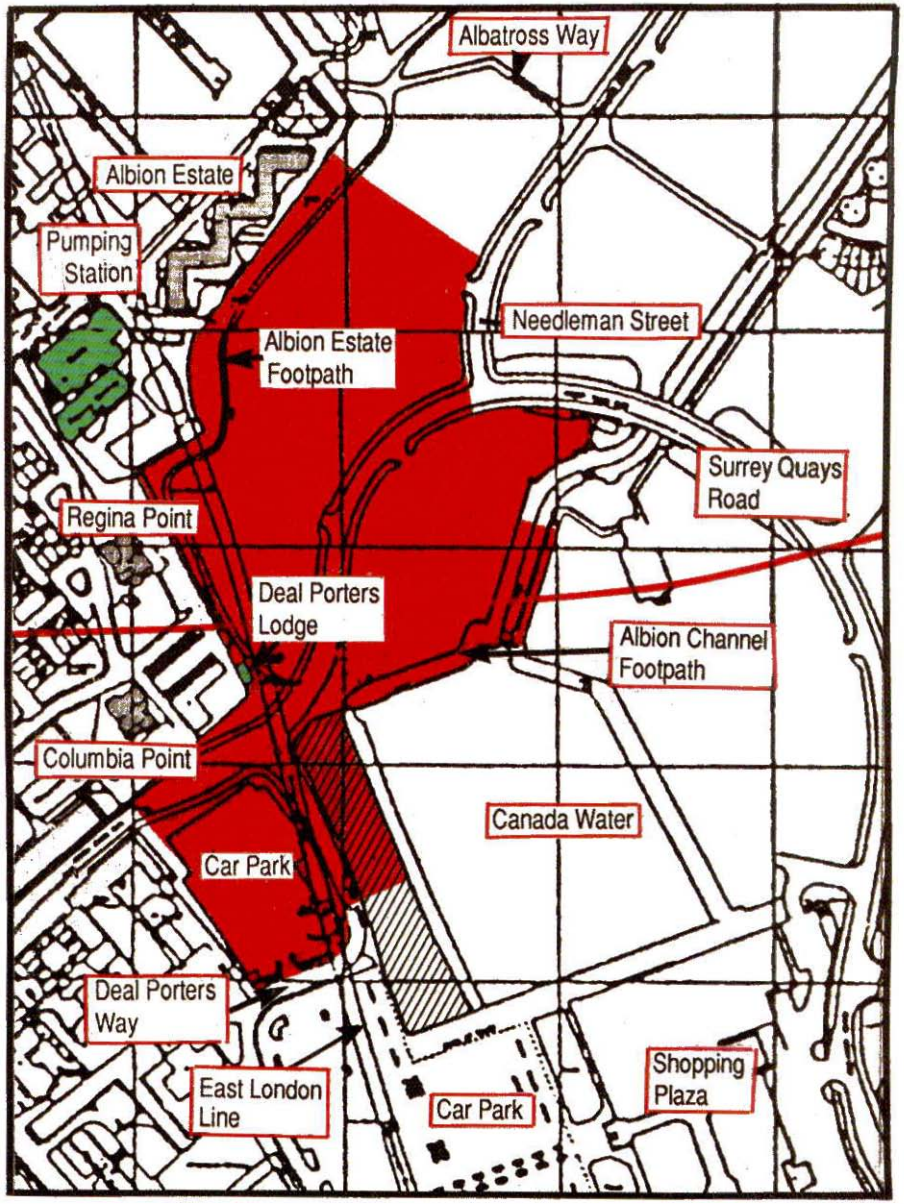
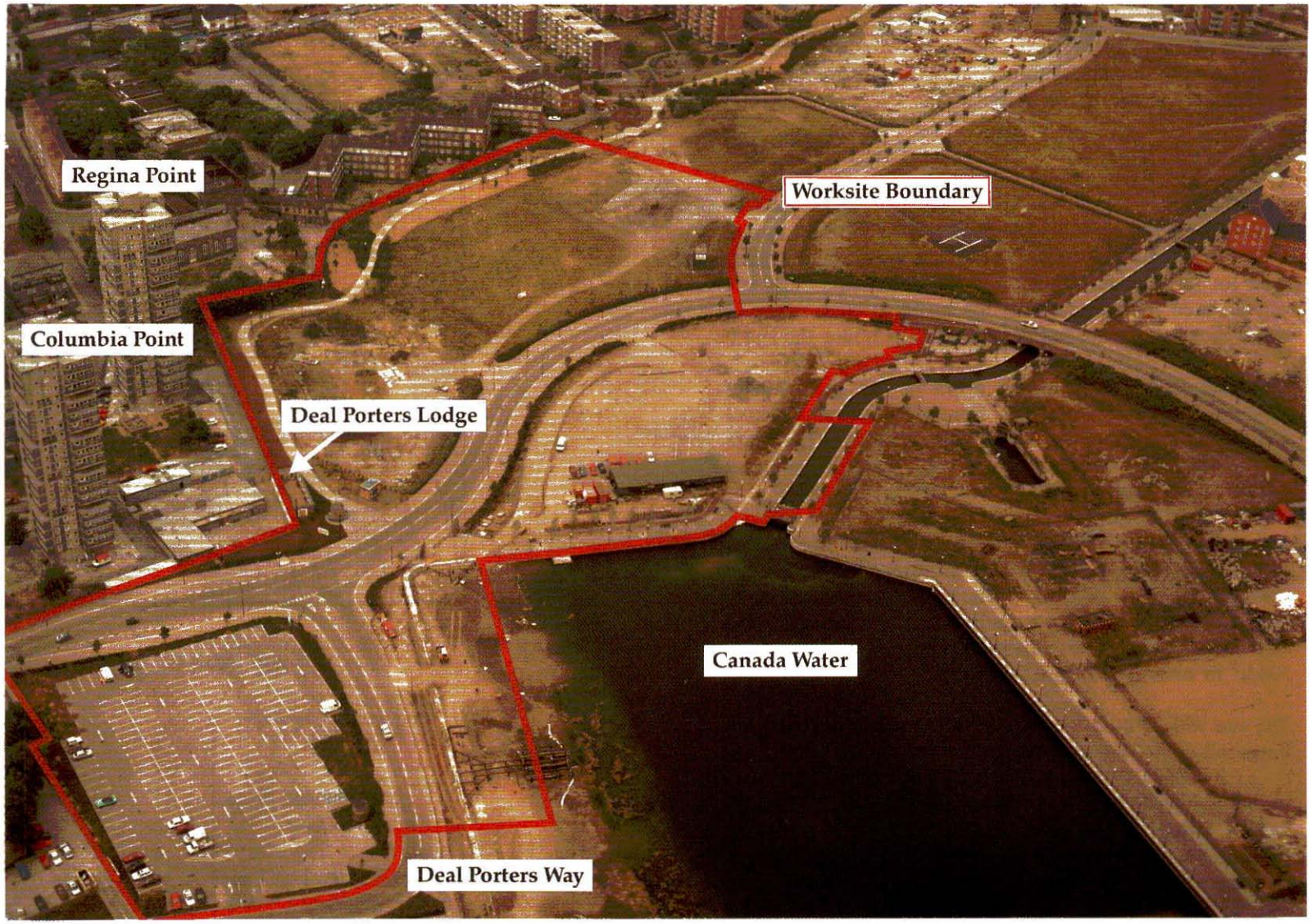


Figure A 3.4 (e) **Canada Water Work Site**



The worksite at Canada Water

public. and to ensure that any contaminated material removed from the site is properly disposed of. Regular monitoring for the presence of gas, often associated with infilled dock areas, should also be carried out and appropriate venting measures should be incorporated within the scheme design, if necessary.

A3.4.4 Other Sites

- **Druid Street.** Two railway arches will be needed to construct an interstation combined ventilation and escape shaft (see Figure A.3.4(f)). The arches are presently being used for storage, scaffolding and motor repairs. The site will be used for major works for up to 2 years. One of the arches will be needed permanently to house the shaft.

  The area immediately to the north of the site includes residential flats at about 20m from the viaduct, a school and boys club. There is a light industrial area to the south of the site. The eastern boundary of the Tooley Street Conservation Area lies to the west of the site.

- **Ben Smith Way.** The site is located on Ben Smith Way, off Jamaica Road, to the rear of Broomfield Court, a low rise development of flats. The area is predominantly residential. The site is currently a concrete-surfaced play area and 7 garages with hard standing of approximately 500m^2 in total (see Figure A3.4(g)).

  The site will be used to construct a draught relief shaft for Bermondsey Station and will be used for major works for up to 2 years. During this period, the garages will need to be removed, and the shaft surface structure will be located in part (c.45m^2) of the area originally occupied by the garages. Following construction the play area should be reinstated to an equivalent or improved condition to be agreed in consultation with the local authorities, and consideration given to reinstating the garages on the area presently occupied by hard-standing.

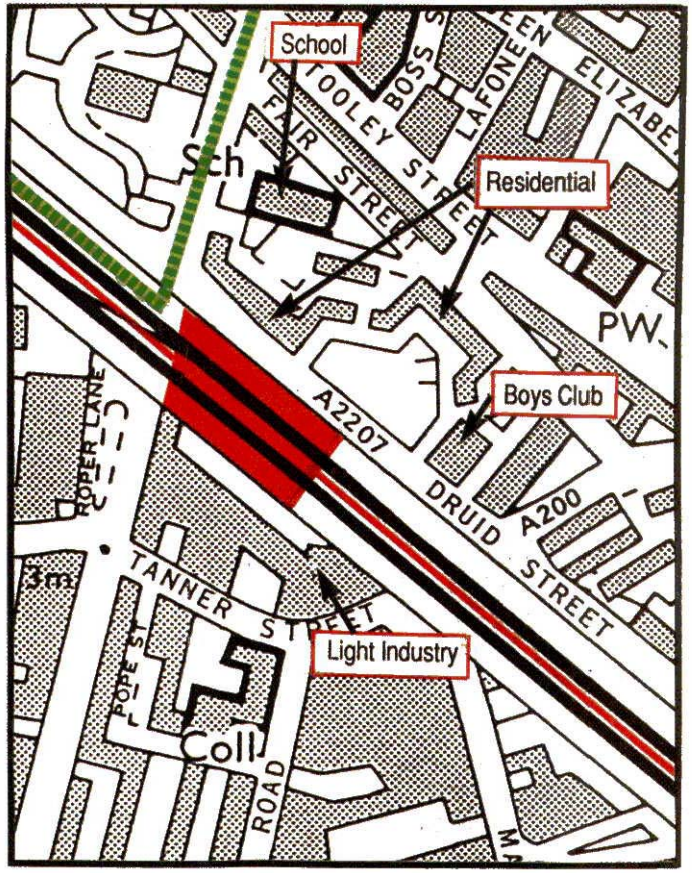


Figure A 3.4 (f) **Druid Street Work Site**

- **Southwark Park.** An area of approximately 1400m^2 at the northeast corner of Southwark Park, at the junction of the Lower Road dual carriageway and Culling Road, will be required for up to 2 years for the construction of an interstation ventilation and emergency escape shaft. Rotherhithe Free Church is located opposite the site, approximately 10m from the site boundary. A funeral directors, only accessible from Culling Road, is situated to the rear of the Church, 35m from the site boundary. Further to the southeast, approximately 55m from the site, is St Olave's Hospital, currently undergoing refurbishment/ extension work. At the completion of construction work the area should be reinstated, with the exception of approximately 45m^2 occupied by the shaft, which should be designed to suit its parkland location (see Figure A3.4(h)).

A3.4.5 Impacts of Surface Works

The Table at the end of this section summarises information on the impacts resulting from occupation of, and construction work at surface sites in this section of the route.

A3.4.6 Impacts of Tunnelling

Two issues have been considered in relation to tunnelling:

- **Noise and Vibration**

  The assessment indicates that noise and vibration from tunnelling operations will not normally be perceptible in properties above the tunnel in this section. There is, however, a possibility of exceptional soil properties being encountered along the route, which could lead to some noise and/or vibration affecting sensitive buildings. The likelihood of this cannot be assessed at this stage, but geotechnical investigations should be carried out over the course of detailed design, which will provide further information.

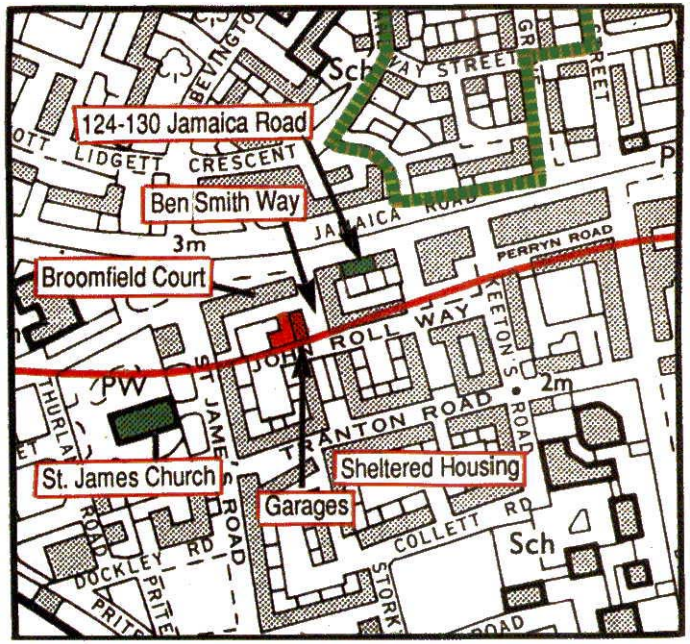
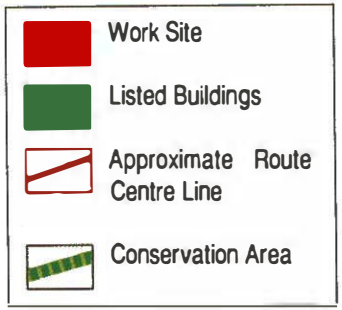


Figure A 3.4 (g) **Ben Smith Way Work Site**



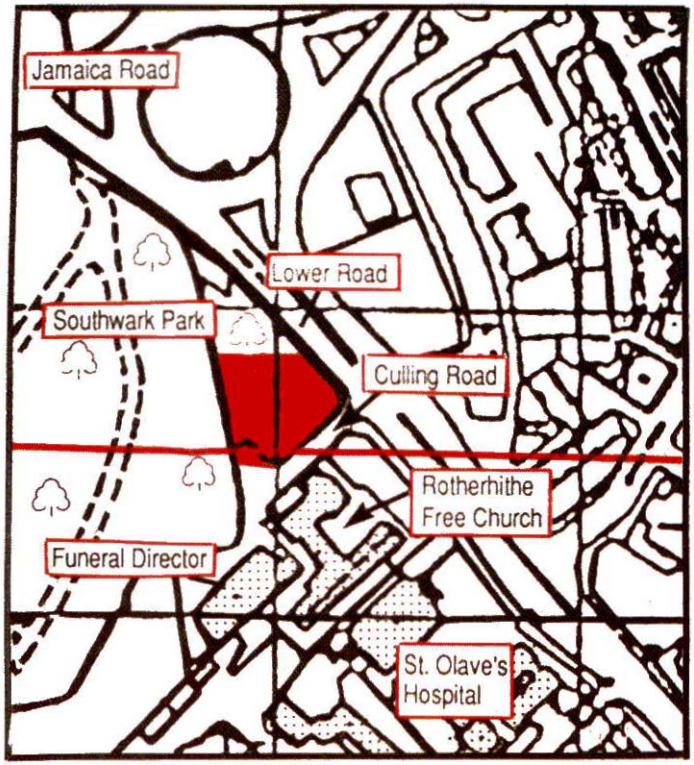


Figure A 3.4 (h) **Southwark Park Work Site**

o **Settlement**

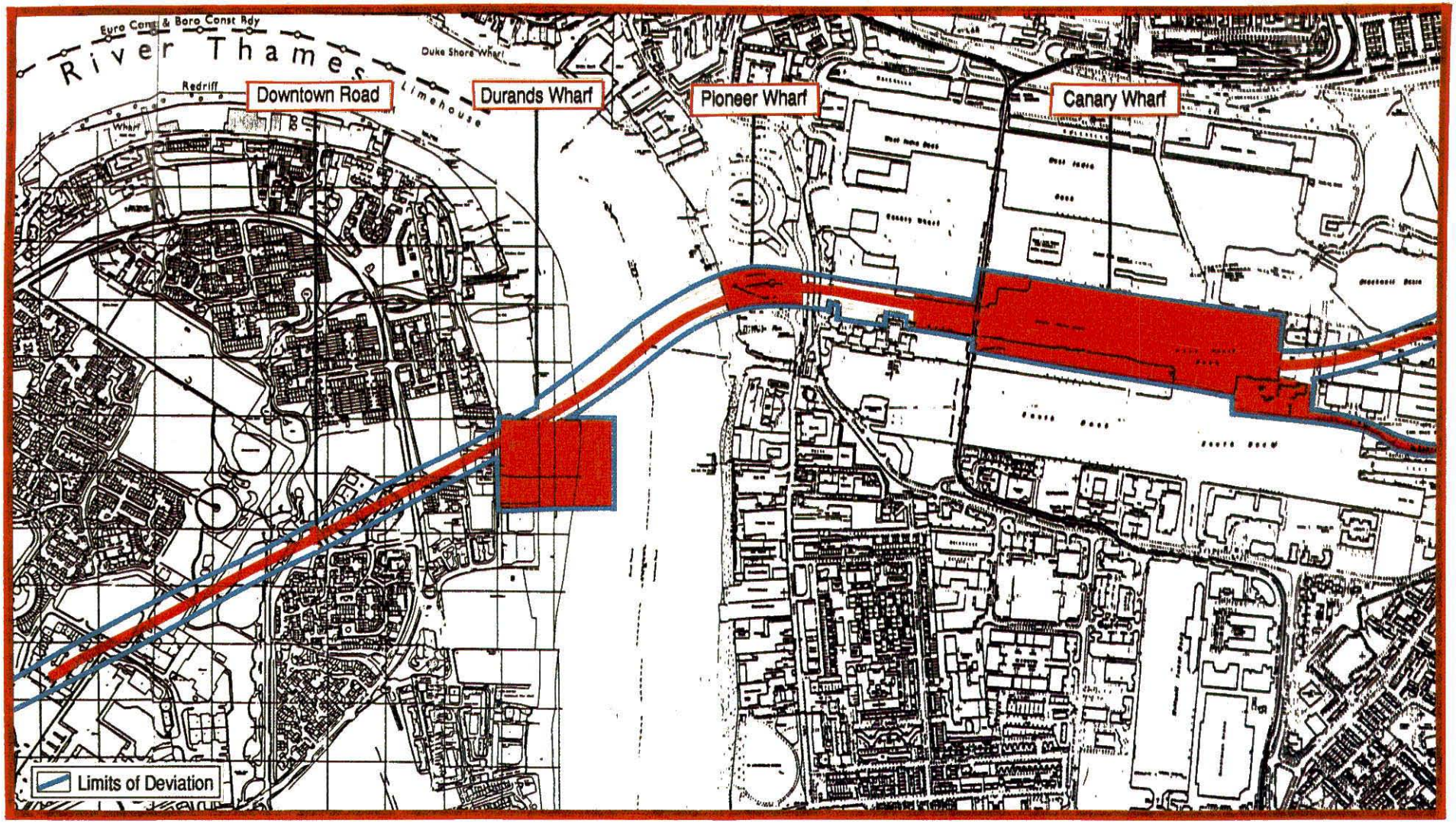
An assessment has identified buildings and other structures which may be subject to some settlement as follows:

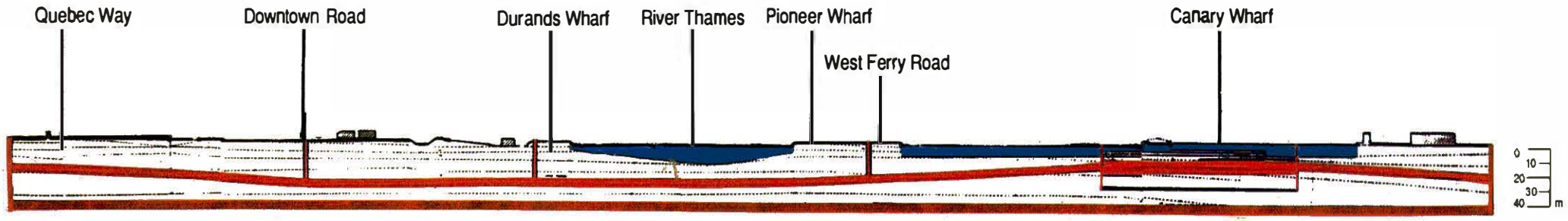
- the BR Viaduct, arches and adjacent structures along the route to Abbey Street;
- Carlton House;
- residential premises between Jamaica Road and Tranton Road from St James's Road to Southwark Park;
- residential property from Lower Road to Canada Water Station.

Construction of Canada Water Station may also have a small effect on the Columbia Point and Regina Point tower blocks. These structures should be monitored on a regular basis during construction.

Construction of Canada Water Station may effect the existing East London Line tunnel and the dock walls surrounding Canada Water. Adequate protective measures should be included in the detail design and method of working to ensure the stability of these structures is preserved.

Services in this area may also be subject to disturbance and settlement from the station and tunnel construction. Critical and sensitive services should be diverted before construction starts. Elsewhere regular monitoring should be adequate to detect excessive settlement and enable protective works to be carried out before damage occurs.


River Thames
Euro Cont & Boro Const Rdy
Duke Shore Wharf
Redriff
Limehouse
Downtown Road
Durands Wharf
Pioneer Wharf
Canary Wharf
Limits of Deviation
0
100
200 m


Quebec Way
Downtown Road
Durands Wharf
River Thames
Pioneer Wharf
West Ferry Road
Canary Wharf
0
10
20
30
40
m
Canary Wharf
Station

A3.5 Route Section 4: Canada Water to Canary Wharf

A3.5.1 The Proposals

This section of the route runs from the Surrey Docks Peninsula, just east of the proposed new Canada Water Station to the Isle of Dogs where a new station is proposed at Canary Wharf. The route crosses under the River Thames at Durands Wharf and passes under Pioneer Wharf and on under West India Docks, between Canary Wharf and Heron Quay. As the route plan profile indicates, the line typically runs at depths of 20 to 30m.

Surface structures required on this section include pedestrian access points associated with the new underground station at Canary Wharf; the majority of permanent works needed for this station, including station draft relief shafts and passenger access facilities, will be incorporated within the overall Canary Wharf development. Permanent shafts will be constructed at Downtown Road and Durands Wharf on the Surrey Docks Peninsula and at Pioneer Wharf on the western side of the Isle of Dogs.

A3.5.2 Context

This section of the route is in the London Docklands Development Corporation (LDDC) area, and both the Surrey Docks Peninsula and the Isle of Dogs, through which the route passes, are undergoing extensive redevelopment. On the Surrey Docks Peninsula the existing land use is a mixture of low density new residential, light industrial and parkland uses. The development of the area will aim to retain this mixed character, with an emphasis on open space and leisure facilities. Potentially sensitive land uses on this section of the route include the residential and parkland areas near the work sites.

The mid section of the Isle of Dogs through which the route passes is undergoing major redevelopment at present and large scale office and commercial premises are under construction. The station will be integrated within this development.

A3.5.3 Main Sites

There are two main work sites on this route section.

- **Durands Wharf.** Durands Wharf is a small (approx. 1ha) public riverside park off Rotherhithe Street, on the eastern side of the Surrey Docks Peninsula. Its location is shown in Figure A3.5(a) and the accompanying photograph. This site will be a tunnelling site for the Extension. Use will be made of its river access and spoil will be transported away from the site by barge.

  The site will also be used to construct a permanent escape shaft which will be used as an access shaft during construction. Major works at the site will take about 3-4 years. The site is bounded to the north by new residential riverside apartments which are at present being occupied. To the west, across Rotherhithe Street, is a school which has recently been closed; the future use of this site is at present uncertain. To the south of the site is a light industrial property. The dominant land use in the surrounding area is residential. There are however a number of vacant sites (including the school site and a large cleared area to the south) awaiting development.

  On completion of the works, the site should be reinstated to parkland in consultation with Southwark Borough Council.

  Previous uses of the site as a wharf may mean that the soil is contaminated with oils, lubricants and cargo spillages. If testing of the soil confirms the presence of significant contamination, appropriate measures will be required to protect site workers and the public, and to ensure that any contaminated material removed from the site is properly disposed of.

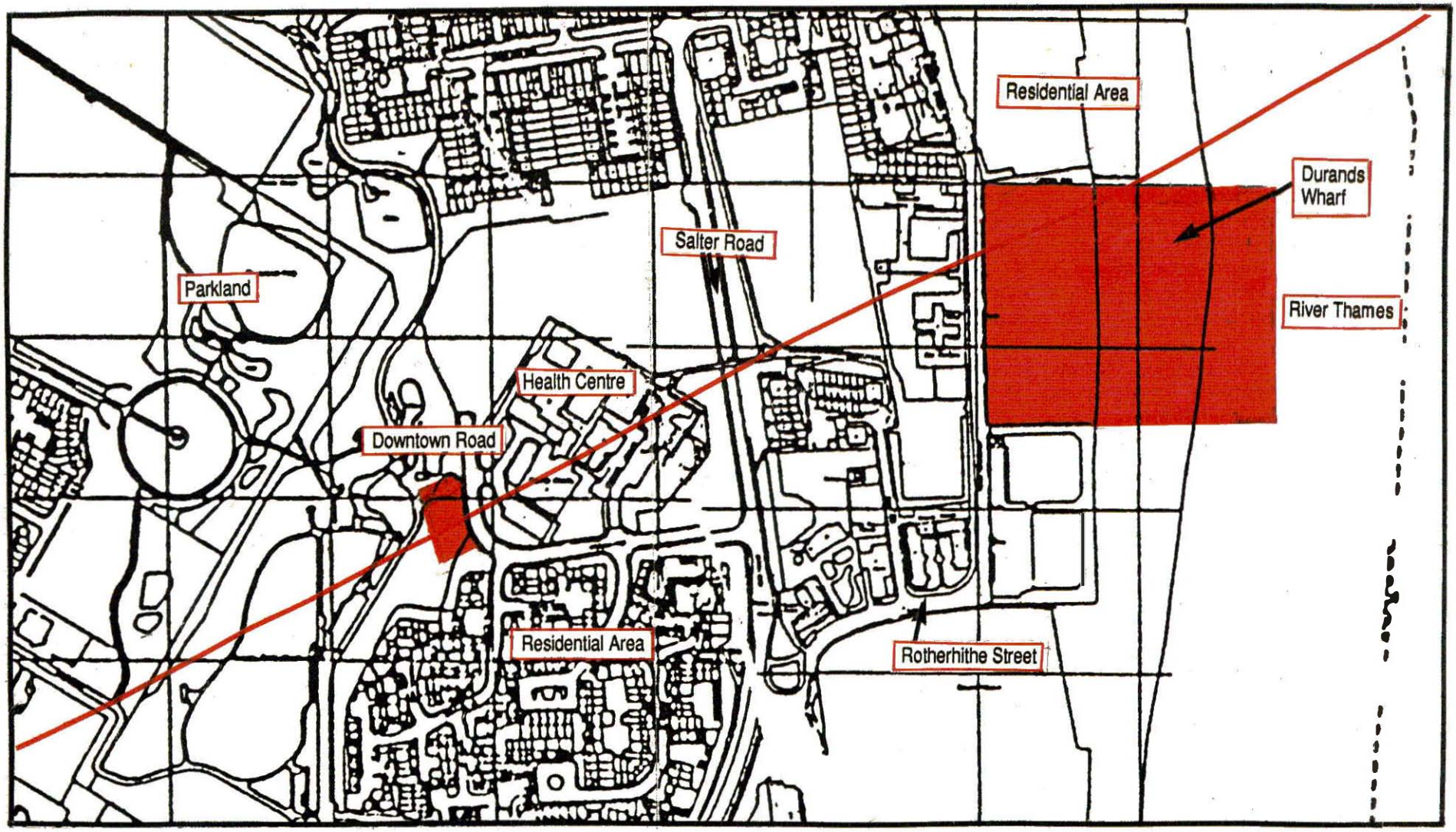


Figure A 3.5 (a) **Downtown Road and Durands Wharf Work Sites**

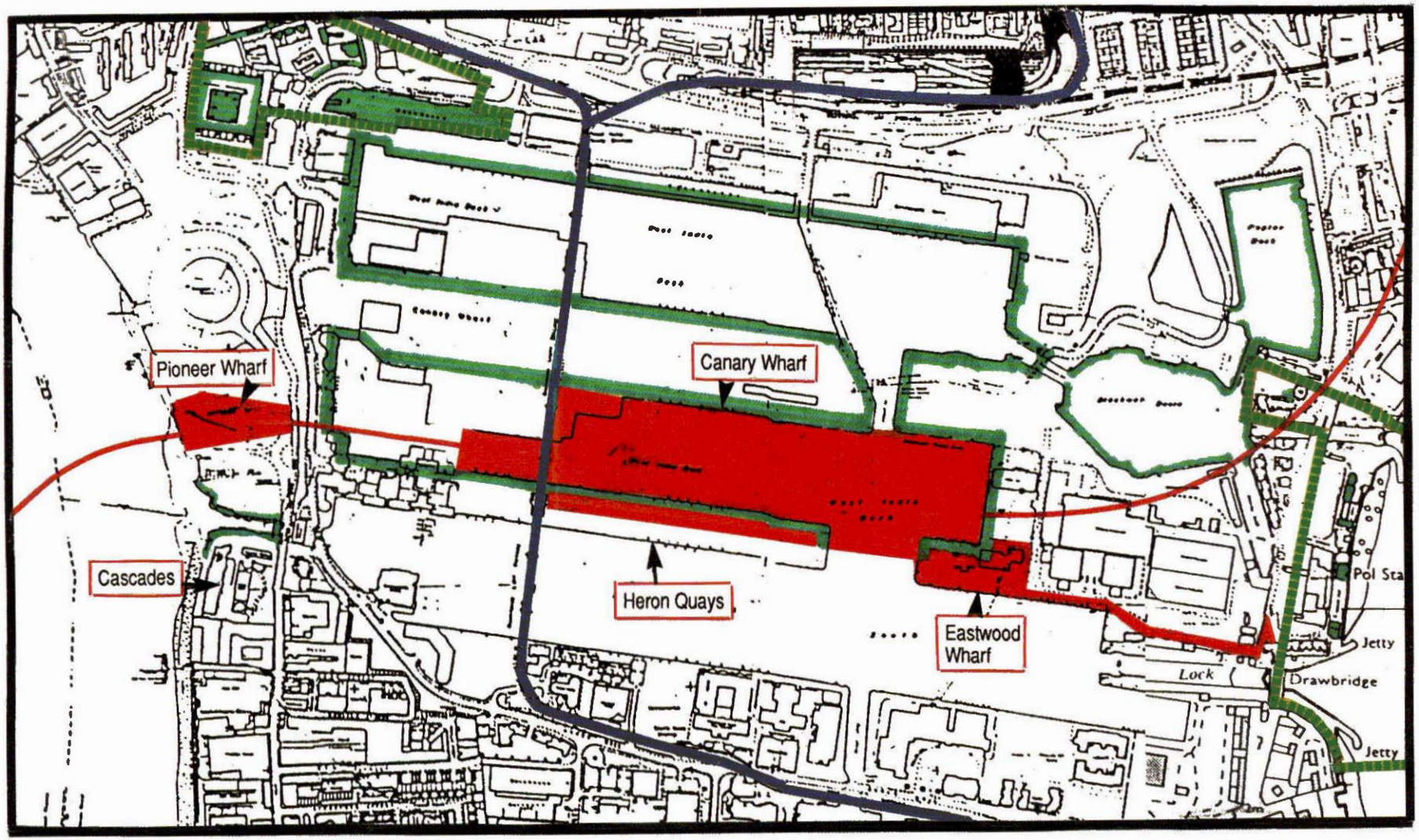
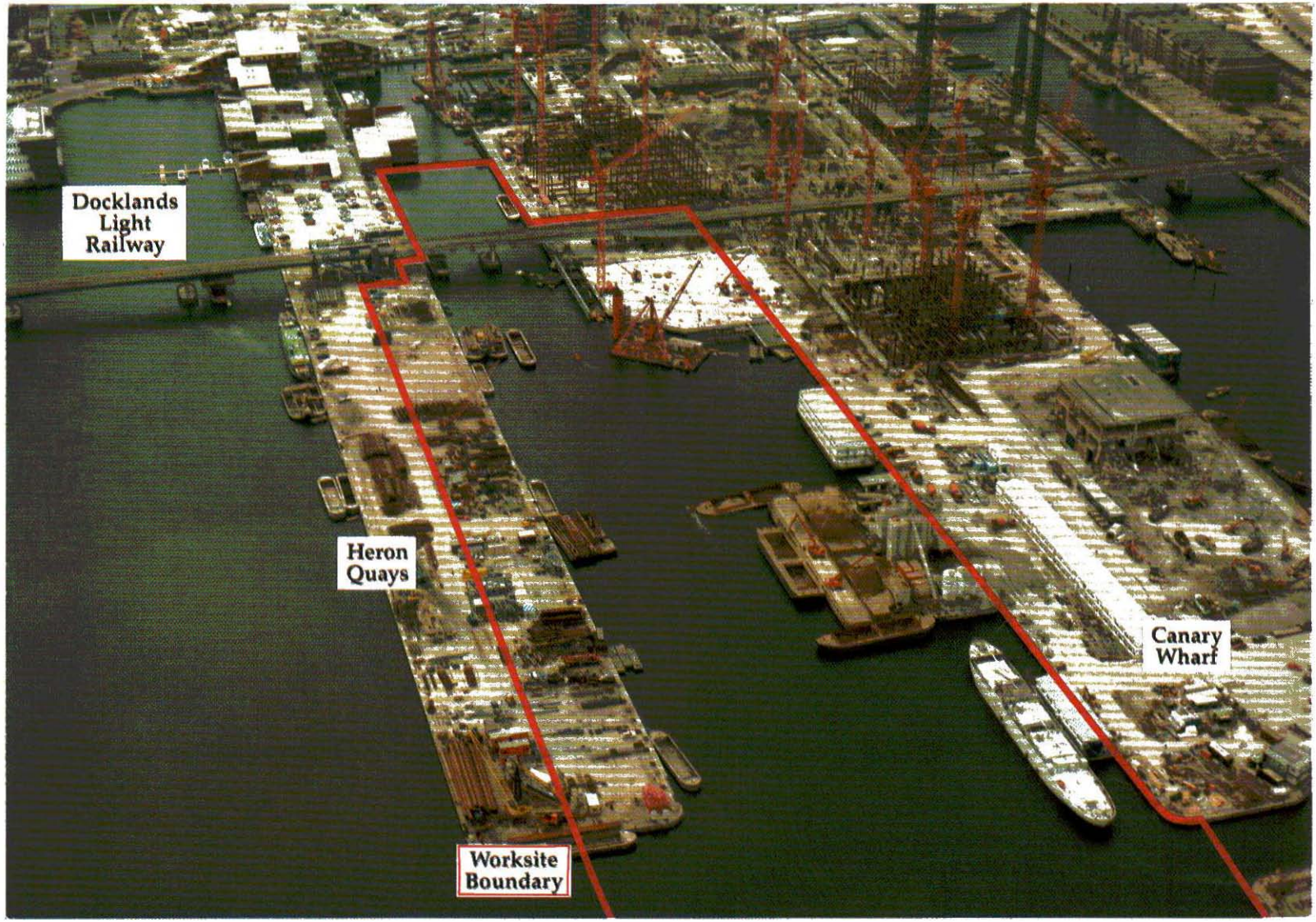
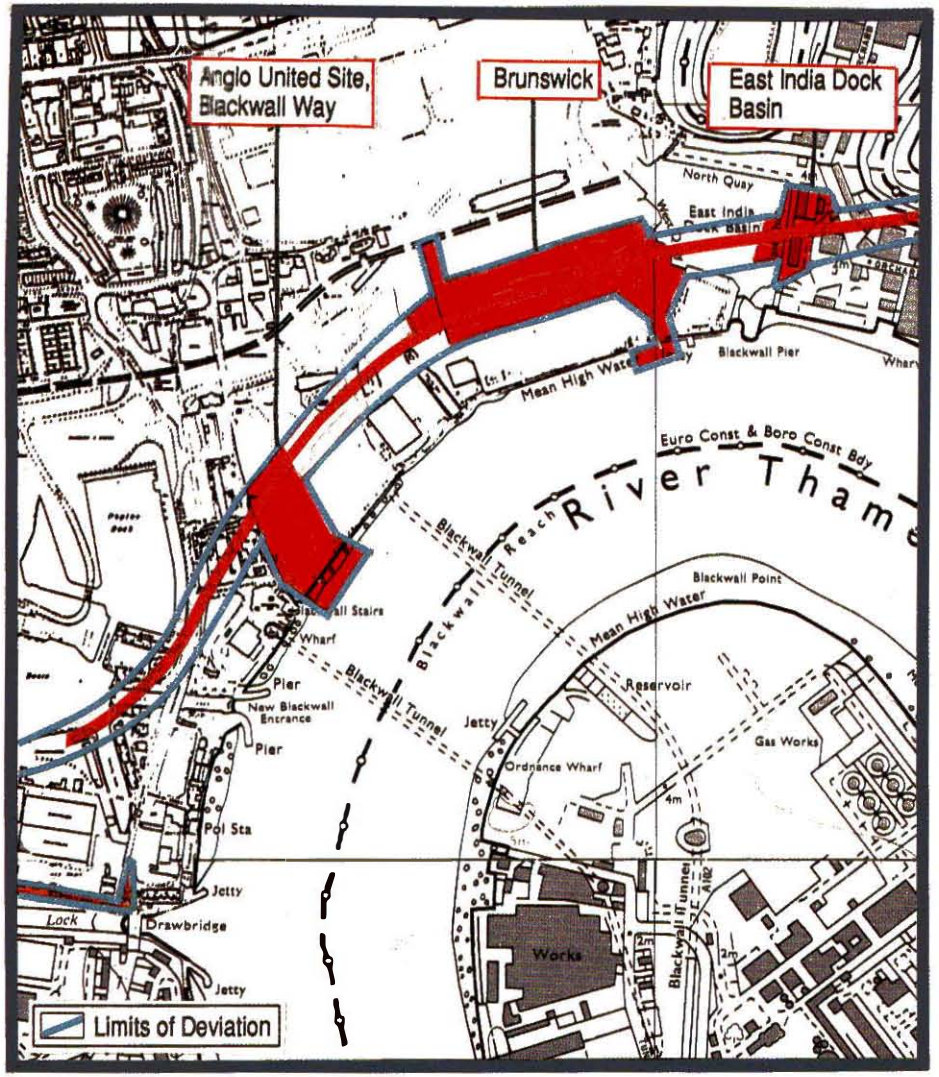
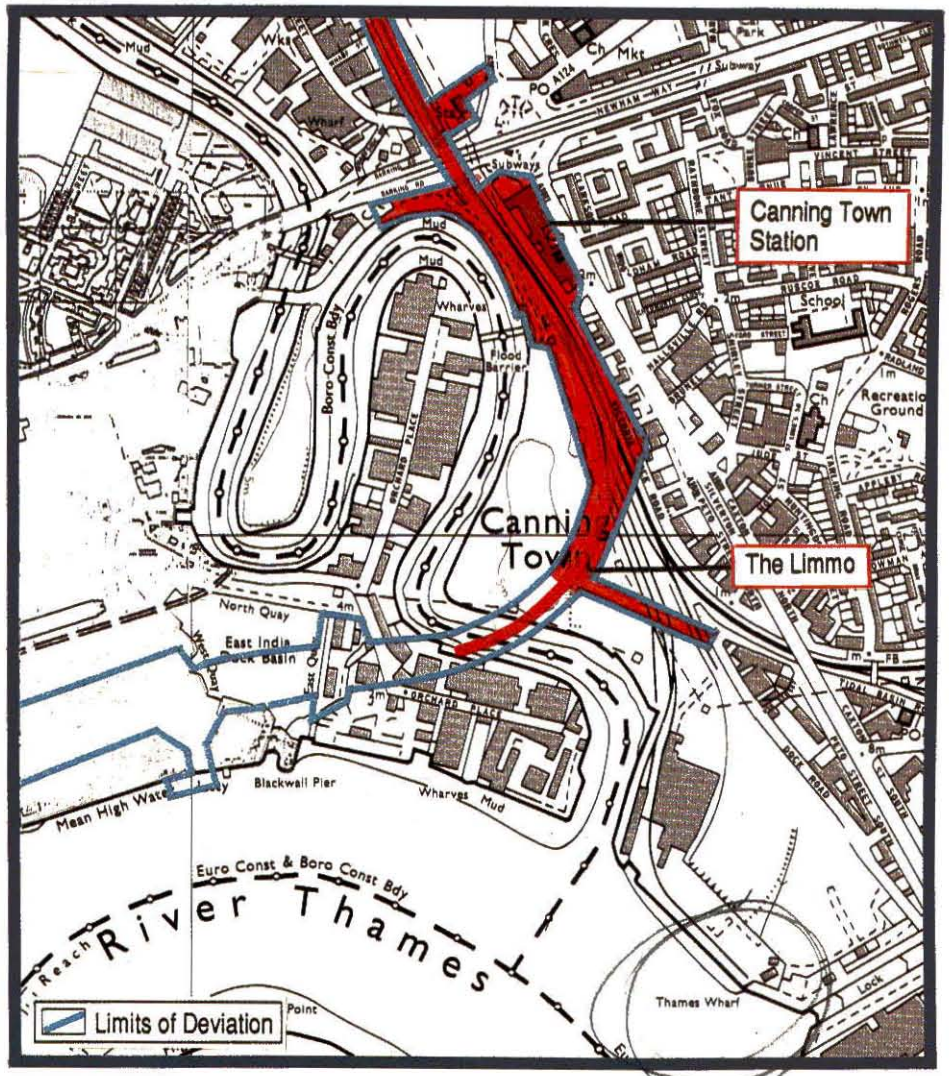


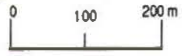
Figure A 3.5 (b) **Canary Wharf Station Work Site**

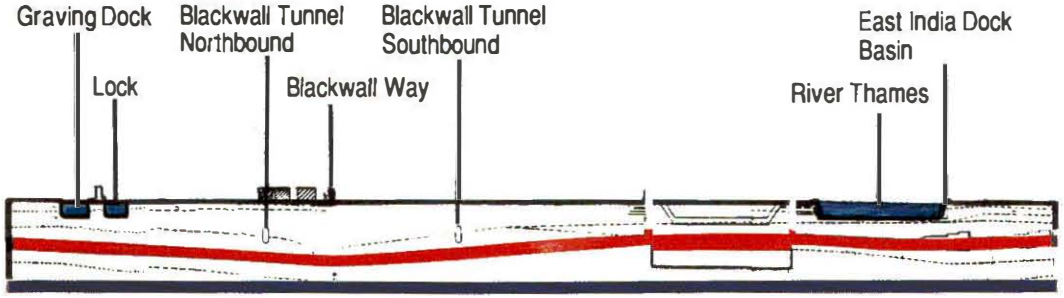


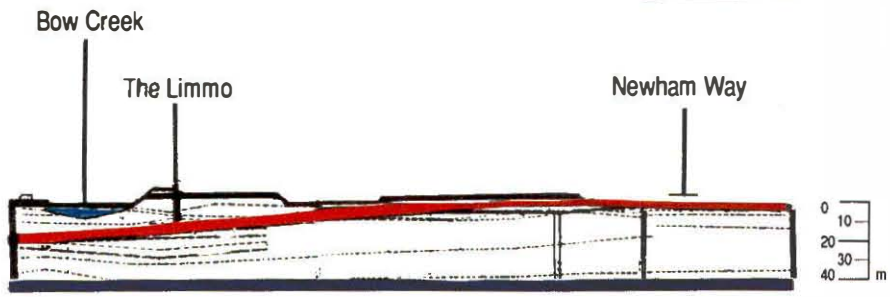
The worksite at Canary Wharf


Anglo United Site, Blackwall Way
Brunswick
East India Dock Basin
North Quay
East India Dock Basin
Blackwall Pier
Mean High Water
Euro Const & Boro Const Bdy
River Thame
Blackwall Reach
Blackwall Tunnel
Blackwall Point
Mean High Water
Reservoir
Gas Works
Ordnance Wharf
Jetty
Pier
New Blackwall Entrance
Pier
Pol Sta
Jetty
Lock
Drawbridge
Jetty
Works
Blackwall Tunnel
Limits of Deviation


Canning Town Station
The Limmo
Mud
Wharves
Flood Barrier
Boro Const Bdy
School
Recreation Ground
North Quay
East India Dock Basin
Blackwall Pier
Mean High Water
Euro Const & Boro Const Bdy
River Thames
Reach
Thames Wharf
Limits of Deviation


0
100
200 m


Graving Dock
Lock
Blackwall Tunnel Northbound
Blackwall Way
Blackwall Tunnel Southbound
East India Dock Basin
River Thames
Brunswick Station


Bow Creek
The Limmo
Newham Way
0
10
20
30
40
m

A3.6 Route Section 5: Canary Wharf to Canning Town

A3.6.1 The Proposals

This section of the route runs north east from Canary Wharf, via a new station at Brunswick Wharf, to East India Dock Basin where it swings north, crossing under the River Lea, to Canning Town.

As the route profile indicates, the line runs at depths of approximately 30m below ground level at Blackwall Way to 20m at Brunswick. The depth at which the Extension runs decreases after passing under the River Lea, in its approach to Canning Town Station. Figure A3.6(a) illustrates the tunnel depths and positions in the Blackwall area.

Surface structures required on this section comprise station works at Brunswick and Canning Town, the tunnel portal to the south of Canning Town Station, a ventilation and escape shaft at Blackwall Way, and a ventilation and escape shaft at the Limmo site, adjacent to the Lower Lea River crossing site. Canning Town Station will connect with the North London Line and the DLR.

A3.6.2 Context

Over half of this route section runs beneath the docklands area of Blackwall where most of the land is either vacant or undergoing redevelopment. There are, however, a number of statutory and locally Listed structures associated with the docks, including some of the dock walls themselves.

The northern section, through Canning Town, also has extensive areas of vacant land, mostly on the western side of the line. Land use on the eastern side is mixed, with commercial, industrial and large residential areas.

A3.6.3 Main Sites

There are four main work sites on this route section:

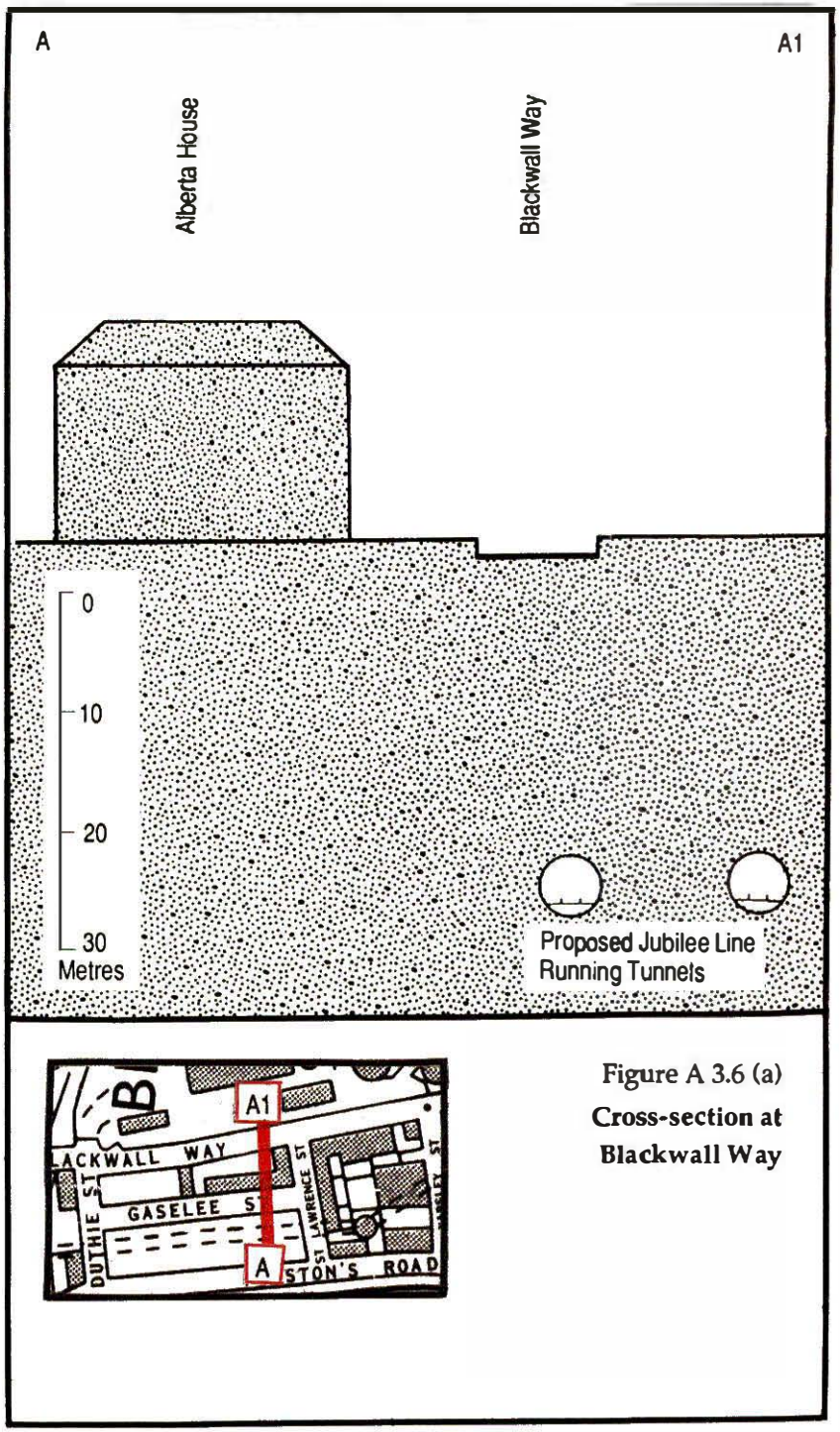


Figure A 3.6 (a)
Cross-section at Blackwall Way

Blackwall Way

The work site at Blackwall Way is located on the western edge of the vacant plot presently owned by Anglo United. To the immediate north and east the land is currently vacant. The Reuters office development lies about 90m to the east, within the locally Listed, infilled area of Blackwall Dock.

St Lawrence Cottages on St Lawrence Street, near Blackwall Way, are also locally Listed Buildings. The dry dock at Blackwall Way within the Blackwall Dock is statutorily Listed. A ventilation shaft to the Blackwall Tunnel is adjacent to the northern tip of the site. Residential properties, shops and commercial uses lie adjacent to the western edge of the site, across Blackwall Way. Most of the land to the north of the site is used for commercial purposes. The site fronts onto the river (see Figure A3.6(b)).

There are number of proposals for residential, commercial and retail developments around the site, which is within the London Docklands Development Corporation area.

The work site will be used for 3-4 years to service tunnelling on the eastern section of the route and spoil will be removed by barge. The site will also be used to construct an interstation combined ventilation and escape shaft.

Past activities on this site mean that contaminated soils requiring special treatment may be present.

Brunswick

Brunswick Station site is located on a currently vacant plot of land between East India Dock basin and Blackwall Yard and previously occupied by Brunswick power station. The Reuters building to the west of the site, in Blackwall Yard is nearing completion. Brunswick Wharf is within the London Docklands Development Corporation area. The site incorporates water access via the wharf, to the southeast of the site (see Figure A3.6(b)).

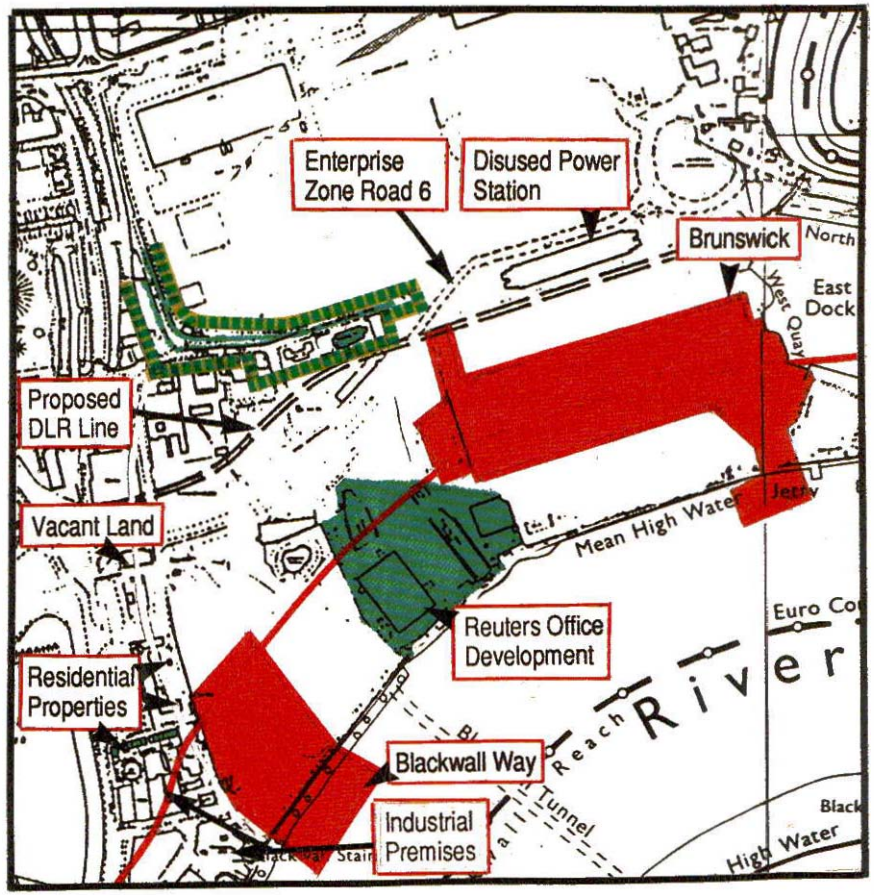


Figure A 3.6 (b) **Blackwall Way and Brunswick Station Work Sites**

There are a number of proposals for new developments in the area, including new roads and a Docklands Light Railway station. A broad range of land use proposals for the Brunswick Wharf area range from residential to commercial and retail.

A Conservation Area lies to the northwest of the site, within which are Listed Buildings, including East India Dock Wall Road boundary wall and pumping station, and Naval Row embankment wall railings and steps. Other Listed Buildings in the vicinity include Blackwall Dock and Blackwall Dry Dock. A development under construction lies north of the Conservation Area.

The Brunswick site will be used for the construction of the station. The major works for the station will take 3½-4 years. The wharf frontage will be used as an access point to remove spoil and deliver bulk materials to the site by river. Brunswick Station will provide an interchange with the proposed DLR station and bus interchange via stairs and escalators. A connection with the Riverbus pier is also envisaged.

On completion of the works, permanent surface works will be limited to the entrances to the station and draught relief shafts at either end of the station, leaving the area free for further development.

Past uses of the area suggest that the site is likely to contain contaminated soils, which may require special treatment.

East India Dock Basin

The East India Dock Basin work site is located on the eastern side of East India Dock Basin, in a currently vacant plot. It is bordered by industrial properties to the east, and there are also industrial properties further north of the site (see Figure A3.6(c)).

Listed Buildings in the vicinity of the site include Blackwall Pier and entrance lock to the former East India Dock Basin, Trinity Buoy Wharf, Jubilee Wharf and Orchard Dry Dock, all Grade II Listed.

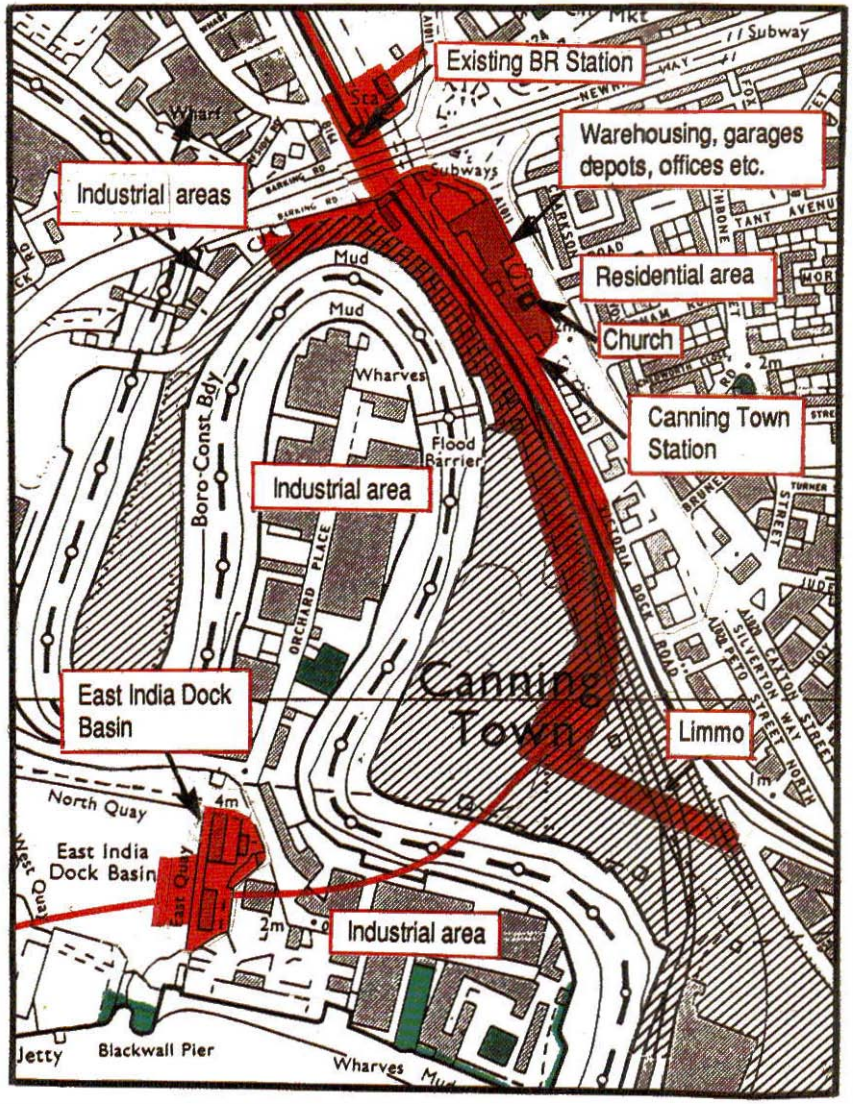
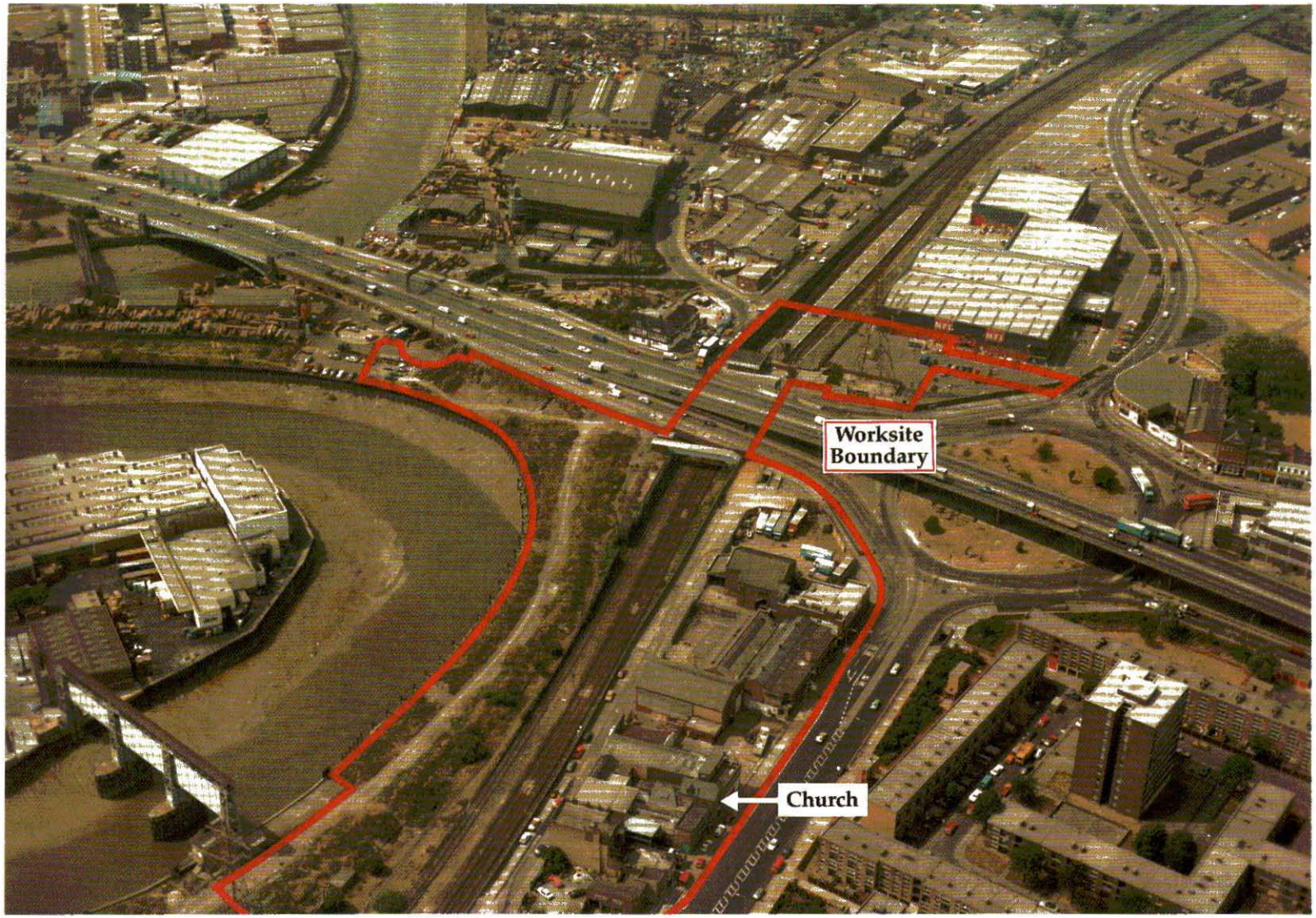
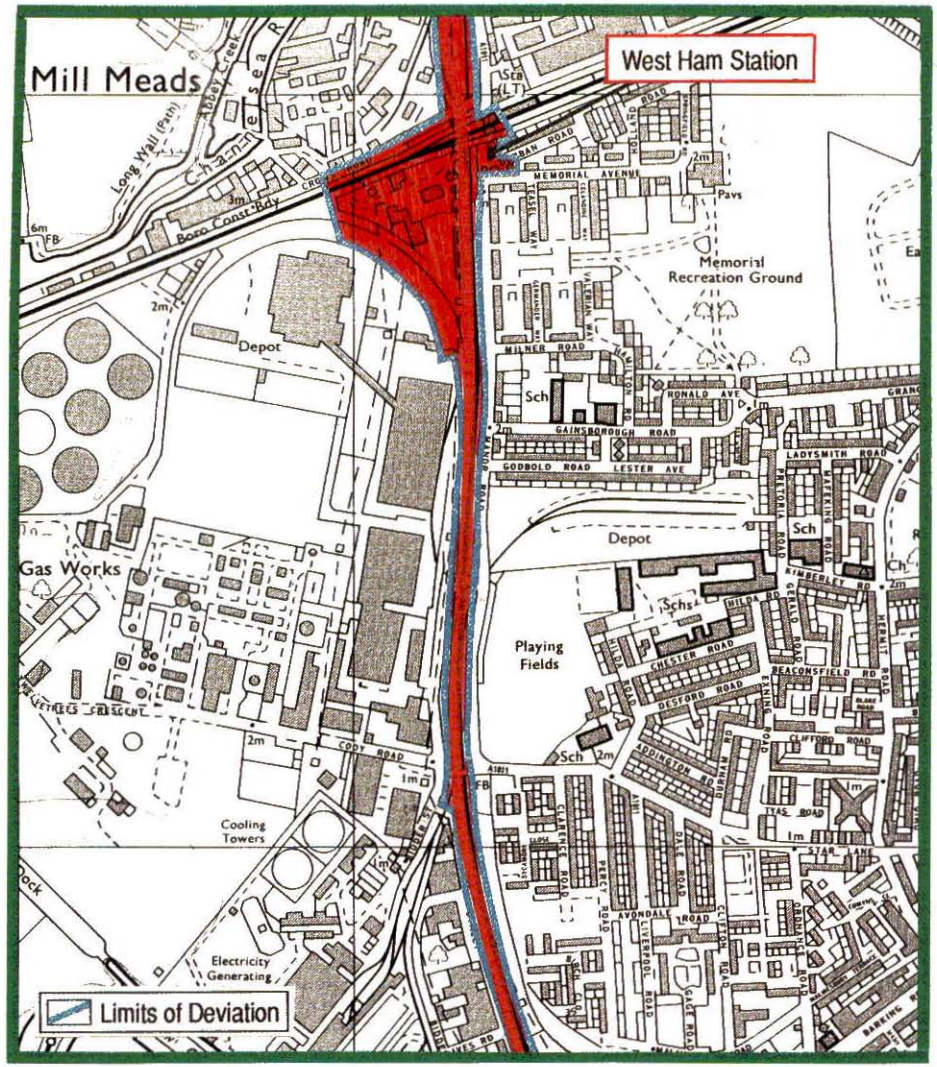
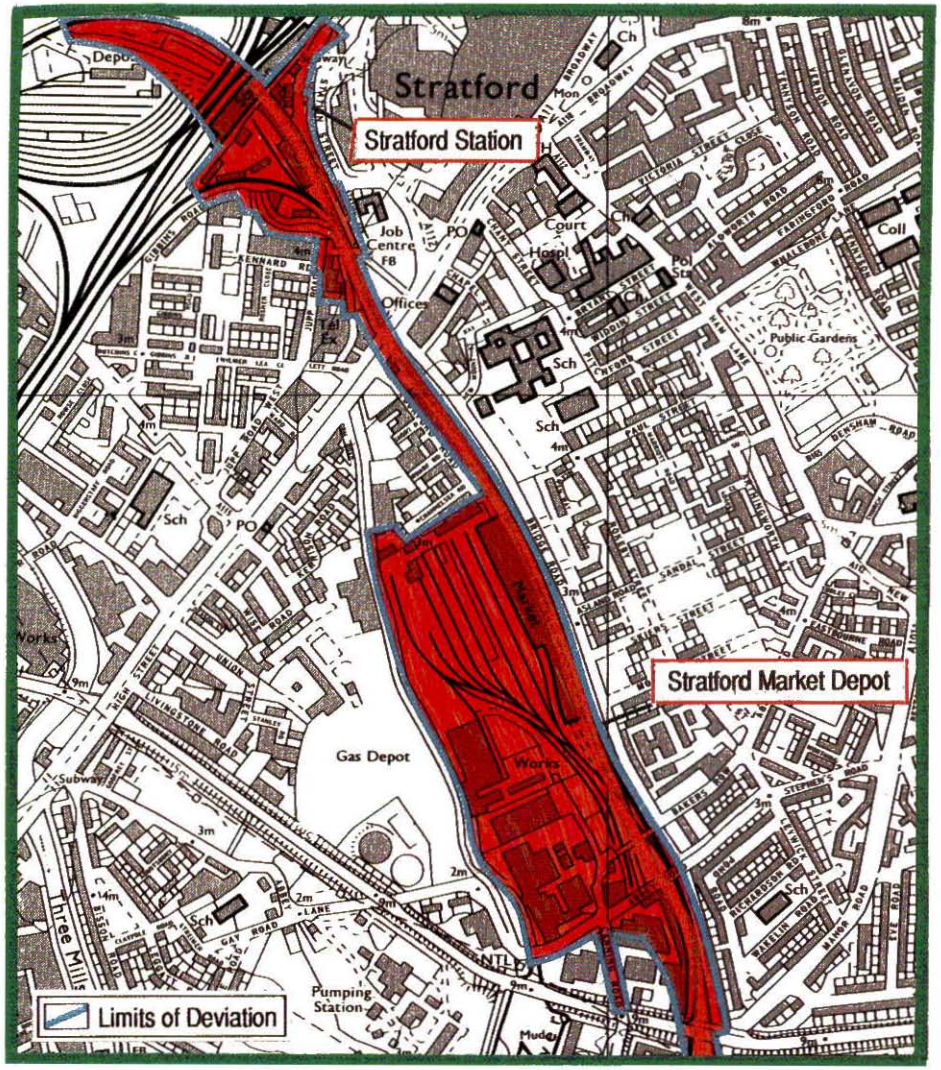


Figure A 3.6 (c) **East India Dock Basin and Canning Town Station Work Sites**

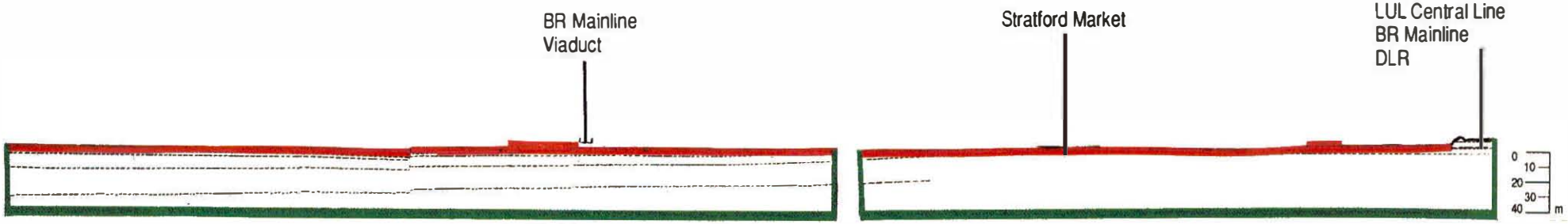


The worksite at Canning Town Station


Mill Meads
West Ham Station
Memorial Recreation Ground
Depot
Gas Works
Playing Fields
Cooling Towers
Electricity Generating
Limits of Deviation


Stratford
Stratford Station
Stratford Market Depot
Gas Depot
Pumping Station
Limits of Deviation

0 100 200 m


BR Mainline Viaduct
Stratford Market
LUL Central Line
BR Mainline
DLR
West Ham Station
Stratford Station
0 10 20 30 40 m

A3.7 Route Section 6: Canning Town to Stratford

A3.7.1 The Proposals

This section of the route runs north of Canning Town Station, on the western side of the North London Line tracks to Stratford Station, via West Ham. The line will run at surface along this section of the route.

In addition to track and track equipment, surface structures will comprise station works at West Ham and Stratford, and the construction of a depot at Stratford Market. The depot at Stratford Market will provide facilities for the overnight stabling of about 40 trains, for the day to day maintenance and washing of trains and for emergency repair work. The depot will also have staff facilities.

A3.7.2 Context

This route section runs on the surface within the existing railway corridor of the North London Line. Along the western side of the route the land use is mainly industrial and commercial. On the eastern side of the route, the land use is residential.

A3.7.3 Main Sites

There are three main work sites on this route section:

- **West Ham Station** is an existing station serving the District, Metropolitan (peak hours only) and North London lines. The surrounding land area is predominantly industrial and commercial to the north east, north west and south west of the station. The area to the south east of the station is mainly residential, some of which is currently being upgraded. There is a Post Office sorting office immediately to the south of the site and a chemical works to the north (see Figure A3.7(a) and accompanying photograph).

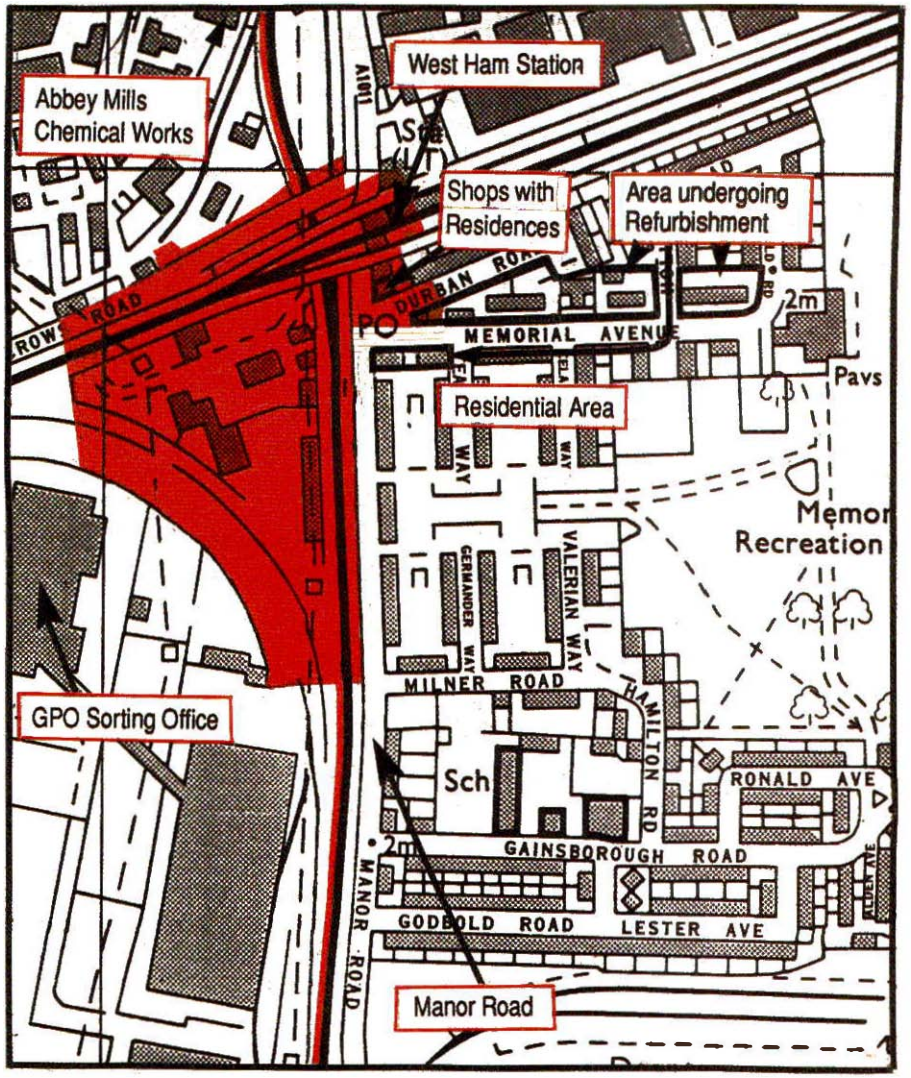


Figure A 3.7 (a) **West Ham Station Work Site**

The Jubilee Line work site will occupy the site of the existing BR station (approximately 5½ha) and an adjoining truck depot alongside Manor Road, for 3½-4 years.

Modifications to the existing station include reconstruction of the existing footbridge over Manor Road, together with the construction of a new ticket hall and station entrance.

The station entrance will be in approximately the same location, but will form part of a proposed new development to the south of the existing entrance. The new Jubilee Line platform will be situated on the west side of the existing tracks.

A new bridge will be constructed under the District and BR lines for the Jubilee Line Extension tracks.

The main policy aims for this area are to retain existing, and to attract new employment to the area, in conjunction with environmental improvements. The creation of appropriate housing and recreational opportunities are also seen as important.

o **Stratford Market.** The Stratford Market depot site (see Figure A3.7(b)), is located in a former fruit and vegetable market and goods yard. The existing market is run down, and the main market businesses have relocated elsewhere. The site is however occupied by a number of offices and warehouses.

To the north east and east of the site is a large residential area. Small scale commercial developments lie to the south west and also to the northern end of the site (along Burford Road).

The previous use of the site as a railway goods yard may have led to soil contamination which could require special treatment.

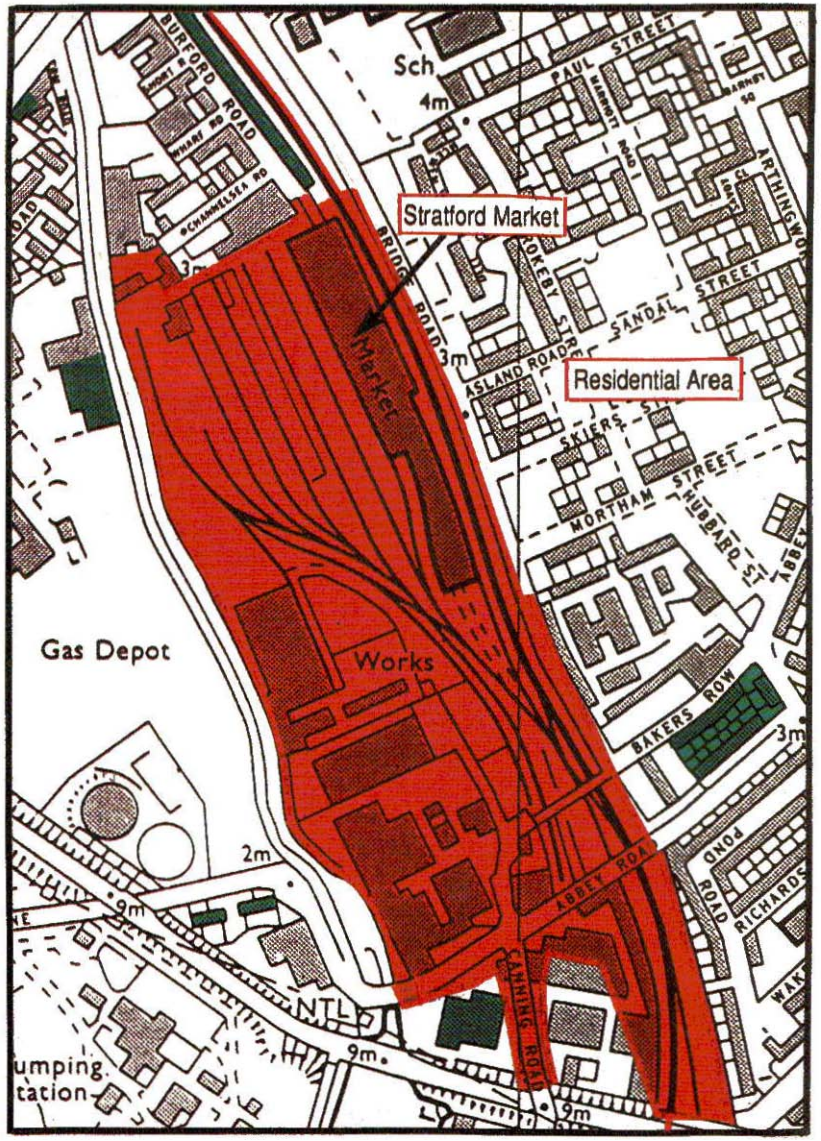


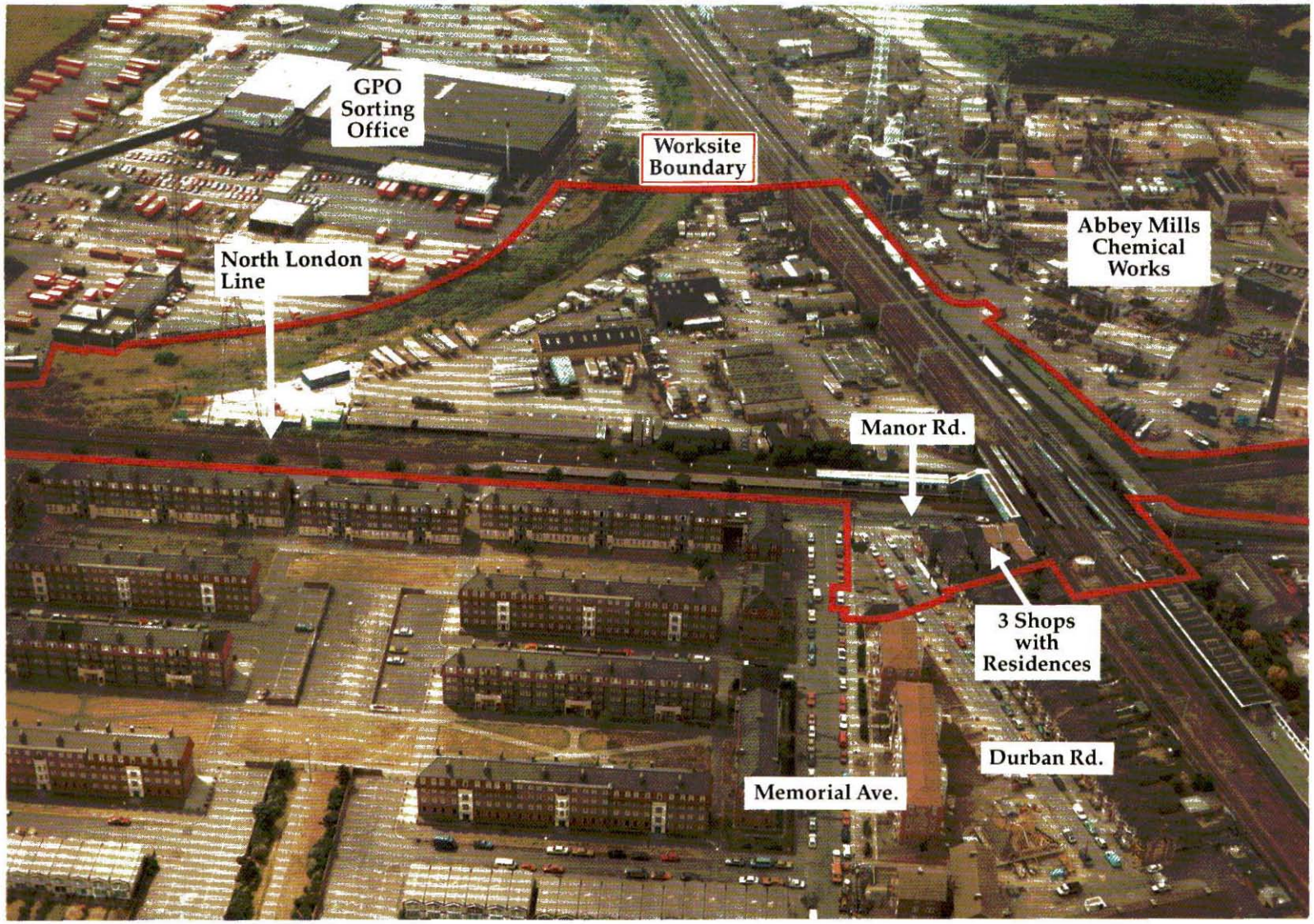
Figure A 3.7 (b) **Stratford Market Work Site**

Work Site

Approximate Route Centre Line

Listed Buildings

0 100 200 300 metres



The worksite at West Ham Station

o **Stratford Station.** Stratford Station is an existing station serving the Central Line, the North London Line, and BR main line services. It is also the northern terminus for the Docklands Light Railway. The proposed Jubilee Line station at Stratford will form part of the existing BR complex. The work site for the Jubilee Line station is situated in an existing BR engineering yard.

Much of the site is vacant, with warehousing at its southern end. The Channelsea River lies to the west of the site, and beyond, to the south west are commercial and residential properties; a youth centre lies adjacent to the south western edge of the site, across Gibbins Road. To the east there is a bus station and multi-storey car park between the site and Stratford shopping centre, on Station Street. A Conservation Area (St. John's) lies to the south east of the site (see Figure A3.7(c) and accompanying photograph).

The land to the immediate north of the construction site is mainly BR land, with areas of vacant land. South east of the site, the land use is very mixed, with offices, commercial property, car parking, and areas of vacant and open space.

The site will occupy approximately 3ha for about 3½-4 years and will be used for the construction of joint Jubilee Line Extension/BR stations. Extension of the existing passenger subway system is proposed, with a possible link to the BR main line station; a realignment of the existing footbridge to the south of the station is also proposed. The station and track works will require the realignment and culverting of the Channelsea River, and the driving of overrun tunnels beneath the BR/LUL high level lines will be necessary immediately to the north of Stratford Station.

Planning permission has already been granted for a new station concourse to be developed by British Rail within the Jubilee Line Extension site boundary.

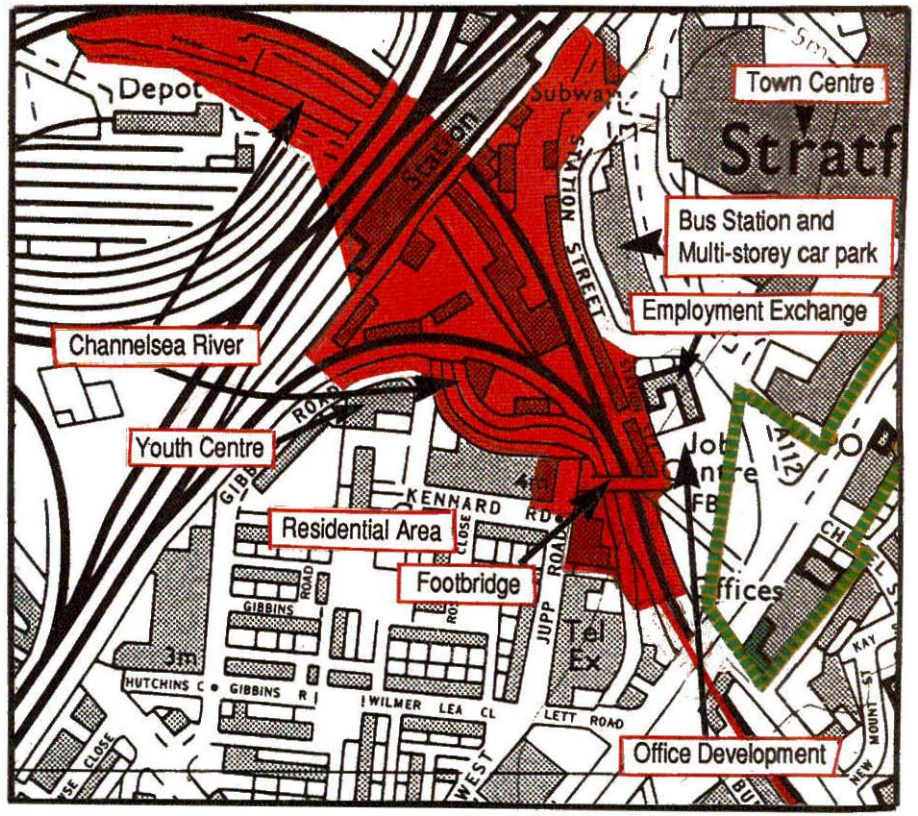


Figure A 3.7 (c) **Stratford Station Work Site**