



PROJECT PROFILE

UK

**Jubilee Line
Extension (JLE)**

omega centre

Centre for Mega Projects in Transport and Development

A global Centre of Excellence in Future Urban Transport
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This report was compiled by the OMEGA Centre, University College London.

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A INTRODUCTION

Type of Project

The Jubilee Line Extension (JLE) has been described as “a political project from the outset” (Wolmar, 2002: 78), from the deposition of the first Parliamentary Bills in 1989 to the last frantic push to get the line opened in time for the non-negotiable deadline imposed by the Millennium Dome and associated celebrations (Mitchell, 2003: iv). The Jubilee Line extension was one of London's biggest engineering projects to date and cost over 3.5 billion, making it one of the most expensive projects in the world at over 4 million per metre of its 16km length.

Table 1: Key Project Characteristics

Project Name:	London Underground Jubilee Line Extension
Description of Mode Type:	Underground Railway
Technical Specification:	
<i>Maximum line speed:</i> 80 km/hr (50mph)	<i>Gauge:</i> 1435mm
Electrification:	
<i>Voltage:</i> 630V	<i>Current:</i> dc fourth rail pick-up
Rolling stock	
<i>Number of vehicles:</i> 59 six-car trains (354 vehicles)	<i>Capacity:</i> 1000+ seated and standing
Maximum speed:	100 km/h (62 mph)
34 lifts and 118 escalators provide step-free access to all platforms	
First use in London of sliding platform-edge doors	
New tunnels built with diameter of 4.35m (existing tunnels are 3.85m diameter)	
Step-free access at every station	
Client: London Underground Limited (LUL)	

Source: <http://www.urbantransport-technology.com/projects/jubilee/specs.html>

Principal Transport Nodes

The JLE runs from Green Park to Westminster, Waterloo and on eastward to a new terminus at Stratford. The transport nodes include:

6 completely new stations:

- Southwark
- Bermondsey
- Canada Water
- Canary Wharf
- North Greenwich
- Canning Town.

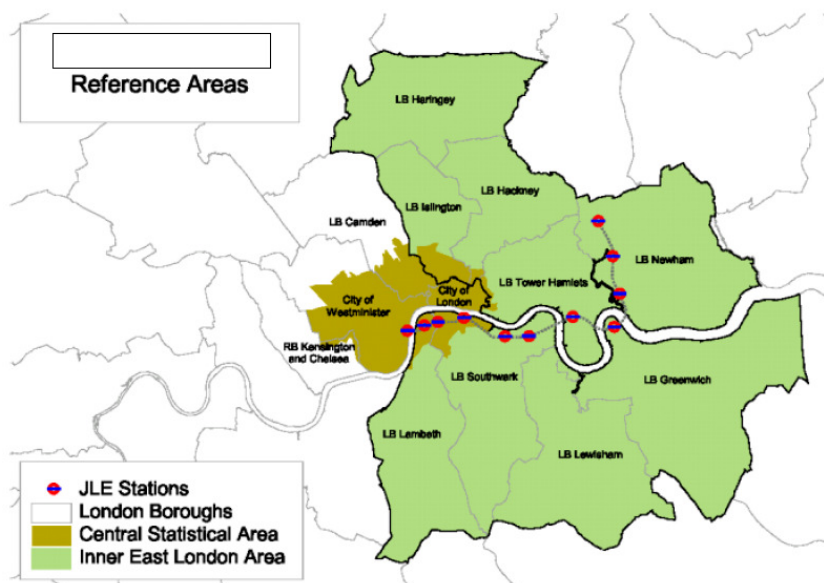
5 existing stations enlarged or rebuilt:

- Westminster (new ticket hall and two additional deep-level platform)
- Waterloo (two additional deep-level platforms)
- London Bridge (two additional deep-level platforms)
- West Ham (two additional surface platforms)
- Stratford (new station building and plaza as well as three additional surface platforms)

These 11 nodes are located in 6 London boroughs as shown by Figure 1 below. Westminster station is in LB Westminster; Waterloo station is in LB Lambeth; Southwark, London Bridge, Bermondsey and Canada Water stations are all in LB Southwark; Canary Wharf station is in LB Tower Hamlets; North Greenwich station is in LB Greenwich, and Canning Town, West Ham and Stratford stations are in LB Newham. Stratford also houses the new line control centre at Neasden and the new train depot at Stratford Market.

Source: www.wdf.org/gspc/virtual2001/ppt/MetaisPaper.ppt

Figure 1: Map showing route of JLE and the London boroughs through which it passes

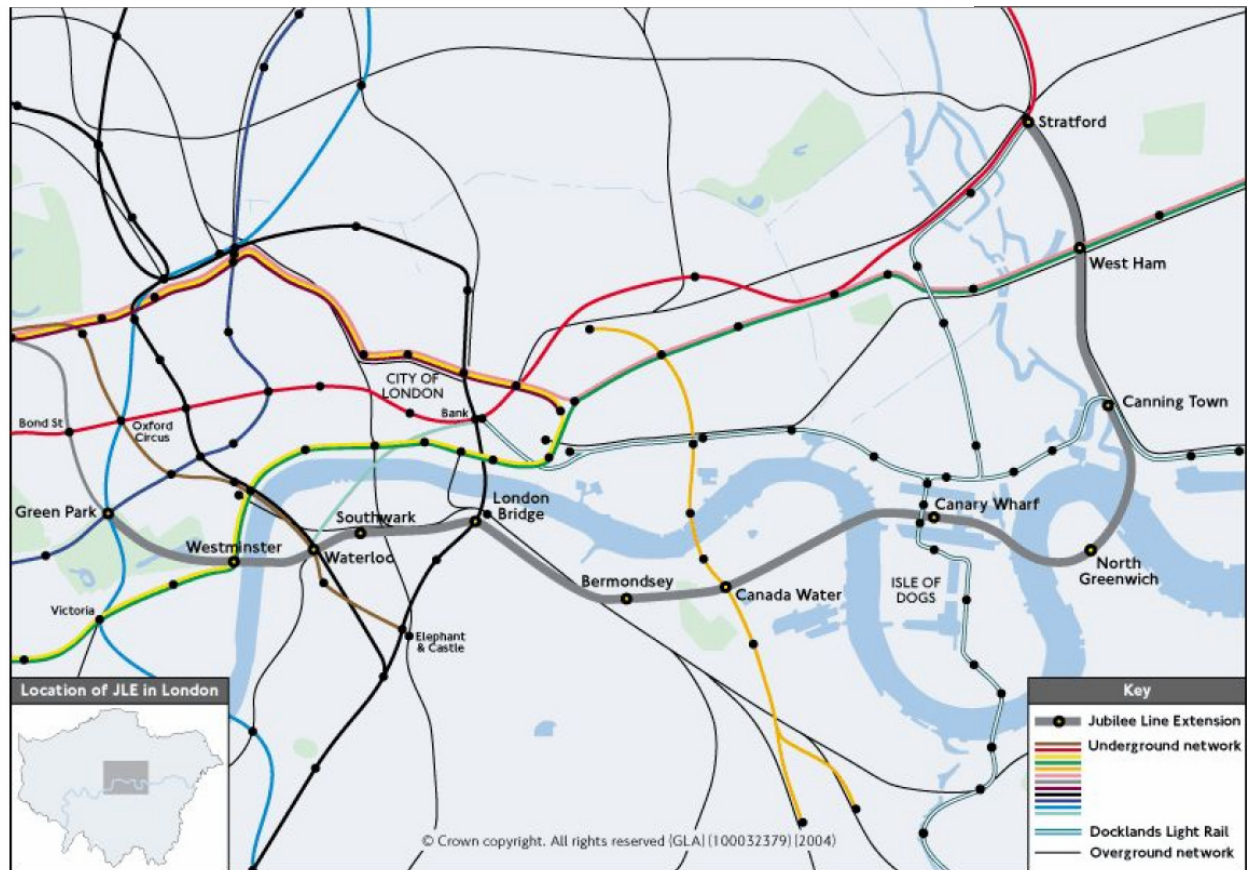


Source: University of Westminster WP46, Appendix

Location

The Jubilee Line extension joins Central and East London, running through the Docklands Regeneration Area. The line crosses the Thames river four times as shown in Figure 2 below.

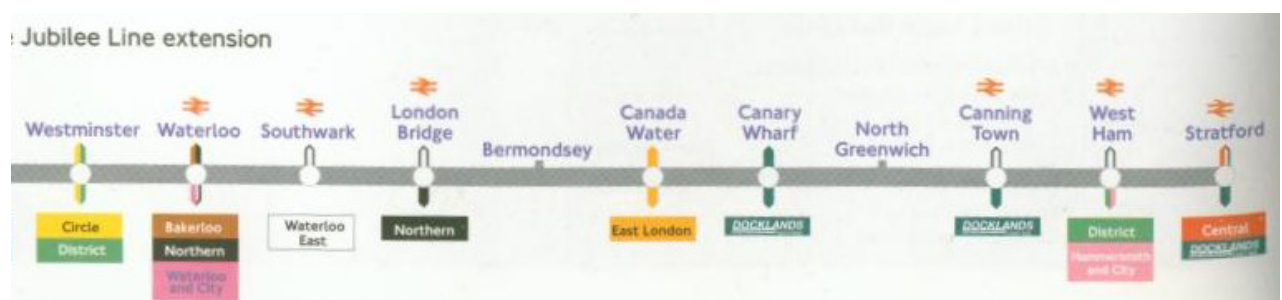
Figure 2: JLE in relation to other major rail transport links in central London



Source: Westminster University WP48

There are railway interchanges at 10 of the 11 Jubilee Line Extension stations. The extension interchanges with 7 other London tube lines, the docklands light railway, and 6 National Rail stations as shown in Figure 3 & Figure 4 below.

Figure 3: Interchanges on the JLE



Source: Willis, 1997: 42

Figure 4: Route of JLE superimposed on aerial photo of central London



Source: www.wdf.org/gspc/virtual2001/ppt/MetaisPaper.ppt

Major Associated Developments

There are five major developments associated with the Jubilee Line Extension. These are :

- Portcullis House – parliamentary offices
- Southwark: Tate Modern, Great London Authority Headquarters.
- The Canary Wharf development (Canary Wharf) – business/financial centre
- The Greenwich Millennium Dome– arts/entertainment/exhibition complex
- Stratford Development

Current Status

The JLE was fully completed in December 1999 and has been operating since then.

B BACKGROUND TO PROJECT

Principal Project Objectives

The following is an extract from "Benefits of the Jubilee Line Extension: A Summary"¹, produced in July 1995 by the Jubilee line extension project Public Relations Department.

"The Jubilee line extension will:

- Provide two extra strategic river crossings to the area; east to Canning Town & Stratford and west to the Isle of Dogs, Inner South London and the West End, firmly anchoring the area to the rest of Docklands.
- Act as a catalyst to regenerate this inner city contaminated site through encouraging and supporting the proposed housing and office scheme.
- Relieve road traffic on river crossings, particularly the Blackwall Tunnel.
- Give access to Underground services for a wider area of south London via a major bus network from North Greenwich bus station to areas such as Charlton and Eltham bringing the benefits of Docklands developments within easy reach of wide areas south of the river.
- Link the large SE London population ([London Borough of] Greenwich population is 220,000, [London Borough of] Lewisham 230,000 and [London Borough of] Bexley 220,000) with the growing employment north of the river.
- Provide a 500 space new park and ride facility with scope to expand to 1,000 spaces if justified. This facility could help ease pressure for car access into the Isle of Dogs.

According to the London Regional Transport's annual Report for 1989/90², the key transport planning objectives for the new railway included:

- Enhancing the performance of London's transport system as a whole by inter-connections with other lines and bus services.
- Increasing the number of underground stations south of the river Thames and east of Waterloo.
- Providing a direct link from the West End, and Waterloo and London Bridge main line stations to Docklands.
- Improving connections from Waterloo and London Bridge to the West End.
- Relieving rail congestion on the Waterloo & City line, the DLR and Northern line and at Bank, London Bridge, Waterloo and Embankment stations.
- Relieving road congestion, particularly in the east-west corridor south of the Thames and in east London.
- Improving accessibility over a wide sector of east and south London where the river had long been a barrier to ease of movement.
- Completing and making fuller use of the Jubilee Line so as to use its capacity in a balanced and efficient way.

Transport for London's stated objectives were to:

- Support development and enhance regeneration along the route, particularly:
 - To create of new jobs at Canary Wharf easily accessible from mainline termini at Waterloo and London Bridge

¹ Source: <http://www.greenwich2000.com/millennium/events/jle.htm>

² Source: Mitchell, 2003: p10, p12

- To link the Docklands and North Greenwich areas into the London Underground network
- To improve access between other LUL and commuter lines from Stratford to Docklands
- Congestion relief on Central and District lines and Docklands Light Railway
- Increase accessibility to jobs and services from East and South-east London
- To enhance transport for tourism and leisure
- Improve safety standards
- Increase step-free access to London Underground system

There are also reports of the JLE being chosen by London Underground to showcase new technology by pioneering 'a new generation of computer controlled signalling systems which, when commissioned, could revolutionise the Tube network, boosting capacity by up to 50%.' (NCE, 1999).

Key Enabling Mechanisms³

The proposal to extend the Jubilee Line to Docklands was officially recommended by the East London Rail Study in 1989. Consequently the first London Underground Bill was deposited through Parliamentary process in November 1989.

Since the 1800s, railway companies have obtained parliamentary powers through private bills such as the London Underground (Jubilee) 1989 Bill. The purpose of obtaining powers is to be able to construct the works, compulsorily acquire land and property, obtain planning permission and to gain ancillary authorisation for road closures, general street works and the like. The case for the new railway is considered by special committees in the House of Commons and House of Lords. Part of the process includes third parties affected by the scheme having the right to raise their concerns and have them addressed, a practice known as petitioning.

The essential process for the JLE was comprised of a number of elements as follows:

- Deposition of the bill.
- A period allowed for petitioners to review the proposals and put forward their objections.
- First reading of the bill in the House of Commons- a formality.
- Second reading of the Bill and debate in the House of Commons.
- Presentation of the Proposals to the Commons Committee and the hearing of petitions.
- Decision of the Commons Committee followed by the third reading and debate in the House of Commons.
- First reading of the Bill in the House of Lords.
- Second reading and debate in the House of Lords.
- Presentation of the Proposals to the House of Lords Committee and the Hearing of petitions.
- Decision of the Lords' Committee followed by the third reading and debate in the Lords.
- Royal Assent.

London Underground Limited acquired permission to construct the JLE through the deposition of four bills overall with parliament seeking powers for the proposed works. The

³ Source: Willis, 1997 and Mitchell, 2003:pp51-53

first bill was deposited following the agreement of the Department of Transport (DoT) in November 1989. In addition, there were two additional provisions for using the River Thames, dealing with listed buildings and the withdrawal of the Charing Cross Park service from the existing Jubilee Line. The Bills and Additional provisions resulted in three Acts and the London Underground Act 1992 was the primary one.

The four Bills were:

- The London Underground Bill (1989), deposited in November 1989, was based on the alignment passing through Brunswick between Canary Wharf and Canning Town.
- The London Underground No.2 Bill (1990) coped with many minor changes and the requirements of improved station designs, in particular at London Bridge.
(The first two bills were united into one bill during the process through Parliament.)
- The London Underground (Jubilee) Bill (1991) and the London Underground (Green Park) Bill (1991) were deposited to contain additional works in Westminster, Lambeth and Southwark owing to design changes and for works to relieve congestion and allow for safety improvements at Green Park station. However, the works at Green Park station included the construction of a second ticket hall, which was dismissed by Parliament because of the vociferous objections from third parties.

Two additional Provisions, namely the North Greenwich Additional Provision (1990) and the Green Park Additional Provision (1993) were raised in accordance with the necessary changes. The North Greenwich Additional Provision (1990) was lodged in 1990 in order to change the alignment from the original route via Brunswick to the North Greenwich alignment. Due to strident opposition from petitioners about the London Underground (Green Park) Bill (1991), The Green Park Additional Provision (1993) was brought to amend the powers in the Bill to offer an emergency escape shaft and a passenger interchange subway linking the Jubilee and Piccadilly lines at low level including providing access for the impaired between the two. They were deposited to amend and to be incorporated into the London Underground Bill (1989) and the London Underground (Green Park) Bill (1991) separately.

The three Acts were:

1. London Underground Act 1992 (16 March 1992)– deposited in 1989
2. London Underground (Jubilee Act) 1993- deposited in 1990
3. London Underground (Green Park) Act 1994

The key enabling mechanisms are summarised in Table 2 below.

Table 2: Key enabling mechanisms timeline

Time	Year	Event
Spring	1989	A joint team (Olympia & York, London Transport, London Underground Limited) was set up to manage the further design and bill preparation. (willis,1997:43)
November	1989	London Underground (Jubilee) Bill 1989 deposited before Parliament
February	1990	Project Team established by LUL.
November	1990	Additional provision – second bill deposited proposing changes to 1989 Bill.
Feb-April, December	1991	Parliamentary Committees consider and approve the bill.
16 March	1992	London Underground Act 1992 receives Royal Assent
29 October	1993	Private sector funding secured, Sec of State for Transport writes to LT Chairman approving go-ahead for the project.

Main Organisations Involved

Central Government Bodies/ Departments

- UK Parliament
- Department of Transport (DoT)
- Department of the Environment (DoE)
- London Regional Transport (LRT) – also called London Transport (LT)⁴

Local Government

- London borough of Westminster
- London borough of Southwark
- London borough of Lambeth
- London borough of Greenwich
- London borough of Tower Hamlets
- London borough of Newham

London Underground limited (LUL)

London Underground Limited (LUL) was the main player through the whole life-cycle of the JLE project.

The details of the financial framework and control of LUL are detailed below⁵:

- LUL, a limited liability company incorporated under the Companies Acts on 29 March 1985, began trading on 1 April 1985 and it is a wholly-owned subsidiary of LRT and, as such, its directors are appointed by LRT. Its Chairman is also Chairman and Chief Executive of LRT.
- LUL prepares its accounts in accordance with the Companies Acts. No other statutory financial limitations or obligations apply to it as such but it is also indirectly subject to the financial obligations imposed on LRT by section 15 of the LRT Act and in addition, under section 16 of the LRT Act, the Secretary of State for Transport may determine the financial objectives of LRT and hence, indirectly, of LUL.
- LRT's financial obligations under section 15 are to:
(a) ensure that, so far as practicable, its revenues, including Government grant, when combined with that of any subsidiaries, should be not less than sufficient to meet their combined charges properly chargeable to revenue account, taking one accounting year with another; and

⁴ London Regional Transport is in charge of the provision of public transport services for Greater London.

⁵ Source:http://www.competition-commission.org.uk/rep_pub/reports/1991/fulltext/305c4.pdf[accessed 1 July 2008]

(b) charge to revenue account, and ensure that its subsidiaries charge to revenue account, all costs, including depreciation, which should be so charged.

Olympia and York

Olympia and York Properties Corp (O&Y) was a Canadian commercial real estate company that focused on ownership, management and development of prestige office buildings. Olympia and York were the developers in charge of the multi billion pound office development at Canary Wharf and one of the principle proponents for a underground link between central London and the London Docklands. In 1993 Olympia and York reached an agreement with LUL to provide £398 million in private funding total towards the JLE but O&Y were victims of the 1989 real estate crash which resulted in their contribution to the project being significantly reduced

“Of the many developers who fell victim to the real estate depression beginning in 1989, none was bigger or more highly respected than Canada's Reichmann brothers, owners of Olympia & York Developments Ltd. (O&Y). Until the market took a turn for the worse in 1989, the Reichmanns enjoyed a career of unbroken and brilliant success, gaining a reputation as financial magicians while assembling the world's largest collection of office buildings and a stock portfolio that included several of Canada's leading corporations. Like most deal makers, however, Paul Reichmann and his brothers were gamblers who kept their interest in the game by continually raising the ante, a strategy that culminated in O&Y's Canary Wharf development in London, the largest office complex ever conceived. Then the real estate market plummeted in 1989. Unable to maintain debt payments, O&Y was forced into Chapter 11 bankruptcy in Canada and the United Kingdom, and its holdings were parceled out among ninety-one lenders who had come to believe the Reichmanns infallible. The final reorganization of assets has not yet been settled, but even if the Reichmanns retain a good chunk of equity their reputation will never be fully repaired.” (Funding Universe, 2009)

The ‘Safety and Security Co-ordinating Committee’

This body was charged with ensuring that the highest standards of safety and security were upheld during the planning, design and construction of the JLE, and consisted of:

- The London Underground Chief Engineers Group
- The Jubilee Line Operating Unit
- The London Fire and Civil Defense Department (LFCDA)

The LFCDA was created in April 1986 following the demise of the Greater London Council (GLC) and incorporated the London Fire Brigade. This Body was responsible for “ensuring that new works and rolling stock complied with relevant fire safety legislation and that fire safety requirements were properly observed during construction” (Mitchell, 2003: 92).

- The representative of HMRI (Her Majesty's Railroad Inspectorate)

The authority for approval of new or altered works was delegated to the Health & Safety Executive (HSE) HMRI has been part of the Health and Safety Executive since 1994 when new safety legislation was introduced. The role of HMRI is to “secure the proper control of risks to the health and safety of employees, passengers and others who might be affected by the operation of Britain's railways” (Mitchell, 2003: 92).

- The London Underground Business Unit.
- The Secretary of State's Agent (Arup Project Management Ltd).

Because of the complexity and specialised nature of the JLE project, the Secretary of State's Agent was to be "an independent expert adviser to participate alongside UK Department of the Environment, Transport and the Regions (DETR) Officials in the DETR's own control and monitoring regime and to provide independent advice on matters for which the Secretary of State retains responsibility as set out in the control and monitoring document or about which he should be informed" (Arup, 2000: v). Arup Project Management was commissioned by DETR following a bid process in early 1992. However, due to the delay of construction works, the formal appointment was postponed until November 1993, with the due date of the full-time commission falling on the 30 November 1999.

Arup's review into the project management of the JLE was damning. In terms of the pre-construction stage, Arup asserted that London Underground Limited failed to apply the proper degree of firm and effective guidance to JLE. According to the Arup's End-of-Commission Report "a client who does not have the experience, resources and capability to direct his project manager on a large, complex multi-disciplinary development needs to appoint a senior Board member to be responsible for the project. The board member should be supported and advised by a group whose members will be experienced in programme, progress and cost disciplines and have the authority of the Board to monitor, probe and challenge the project manager on detail and implementation" (Arup, 2000:15).

In terms of the Delivery Phase, according to the End-of-Commission Report by the Secretary of State's Agent, "London Underground Limited lacked the forceful, strong and effective management needed for the coordination of the JLEP, CEG, and JELL in the delivery of the Railway and in the observance of new H&SE / HMRI legislation". (Arup, 2000: 21) It was argued that "a strategy and management structure for delivery of the Railway should be established from the outset and these arrangements reviewed periodically to accommodate changing circumstances. The client should consider appointing a "Railway Delivery Supremo" with the power and authority to coordinate and manage the efforts of all bodies of the client. He should be responsible to the client for the successful delivery of the Railway and in obtaining the approval from the statutory authorities to operate a public service. For this purpose, he needs to be the single high-level point of contact with the regulatory authorities."(ibid) Figure 5 and Figure 7 below denotes how the delivery of the railway appeared to work which was examined by Arup, while Figure 6 and Figure 8 demonstrates Arup view of suggested reporting/ communications lines at late construction and delivery stages.

The organizational chart illustrates the structure of the London Underground project. At the top is the Secretary of State (DETR), who has a direct reporting line to London Transport and a communication line to the Agent's Project Manager. HM Treasury is also at the top level. Below the Secretary of State are HMRI and LFCDA. London Transport reports to the Secretary of State and oversees London Underground Ltd. London Underground Ltd has four main branches: JELL (Line operator), CEG ("Ownership" of line infrastructure), Client Team, and LUL Director of Engineering. The LUL Director of Engineering oversees the JLEP (Design, construction, etc., of project). The Agent's Project Manager is also connected to the JLEP. At the bottom, there are four boxes detailing the responsibilities of each main branch: JELL (train/ provide staff, trail operate, prepare safety case*), CEG (set design standards, accept asset, certify to HMRI asset is complete & compliant*), Client Team (define scope of works, notify JLEP of Client required change), and JLEP (infrastructure provider, design, procure, build, equip, commission, provide compliance*, documentation to CEG). A legend indicates that solid lines represent reporting and dashed lines represent communication. A note states that * = new legislation requirement regulations of HMRI.

```

graph TD
    HM_Treasury[HM Treasury]
    Sec_State[Secretary of State  
DETR]
    Sec_Agent[Sec. of State's Agent  
Arup]
    HMRI[HMRI]
    LFCDA[LFCDA]
    London_Transport[London Transport]
    London_Underground_Ltd[London Underground Ltd]
    JELL[JELL  
Line operator]
    CEG[CEG  
"Ownership" of line  
infrastructure]
    Client_Team[Client Team]
    LUL_Director[LUL Director of Engineering]
    JLEP[JLEP  
Design, construction, etc.,  
of project]
    Agent_PM[Agent's  
Project Manager]

    Sec_State --- HM_Treasury
    Sec_State --- London_Transport
    Sec_State -.-> Agent_PM
    Sec_State -.-> HMRI
    Sec_State -.-> LFCDA
    London_Transport --- London_Underground_Ltd
    London_Underground_Ltd --- JELL
    London_Underground_Ltd --- CEG
    London_Underground_Ltd --- Client_Team
    London_Underground_Ltd --- LUL_Director
    LUL_Director --- JLEP
    JLEP -.-> Agent_PM
  
```

• train/ provide staff
 • trail operate
 • prepare safety case* for HMRI

• set design standards
 • accept asset
 • certify to HMRI asset is complete & compliant *

• define scope of works
 • notify JLEP of Client required change

infrastructure provider
 • design
 • procure
 • build
 • equip
 • commission
 • provide compliance *
 documentation to CEG

* = new legislation requirement regulations of HMRI
 — reporting
 - - - communication

The organizational chart illustrates the structure of the Jubilee Line Extension project. At the top level, the **Secretary of State DETR** is the central authority, with **HM Treasury** and the **Sec. of State's Agent Arup** as external stakeholders. Reporting lines (solid lines) flow from the Secretary of State DETR to **HMRI**, **LFCDA**, and **London Transport**. **London Transport** reports to **London Underground Ltd**, which in turn reports to the **Jubilee & East London Line**, **Chief Engineers Group**, **Client Team**, and the **Jubilee Line Extension Project**. The **Jubilee Line Extension Project** is further detailed with a **LUL Board Member for JLE** and the **JLE Management Group**. Communication lines (dashed lines) connect **HMRI** and **LFCDA** to the Secretary of State DETR, and the **Client Team** to the **Jubilee Line Extension Project**. The **Agent's Project Manager** is shown as a key contact for the project, with a dashed line connecting to the **Jubilee Line Extension Project**.

```
graph TD
    HM_Treasury[HM Treasury] --- Secretary[Secretary of State DETR]
    Sec_Agent[Sec. of State's Agent Arup] --- Secretary
    Secretary -.-> HMRI[HMRI]
    Secretary -.-> LFCDA[LFCDA]
    Secretary --> London_Transport[London Transport]
    London_Transport --> London_Underground_Ltd[London Underground Ltd]
    London_Underground_Ltd --> Jubilee_East_Line[Jubilee & East London Line]
    London_Underground_Ltd --> Chief_Engineers_Group[Chief Engineers Group]
    London_Underground_Ltd --> Client_Team[Client Team]
    London_Underground_Ltd --> Jubilee_Line_Extension_Project[Jubilee Line Extension Project]
    Jubilee_Line_Extension_Project --- LUL_Board[LUL Board Member for JLE]
    Jubilee_Line_Extension_Project --- JLE_Management_Group[JLE Management Group]
    Client_Team -.-> Jubilee_Line_Extension_Project
    Jubilee_Line_Extension_Project -.-> Agent_Project_Manager[Agent's Project Manager]
```

Figure 7: Arup's view of how the delivery of the JLE appeared to work at project delivery

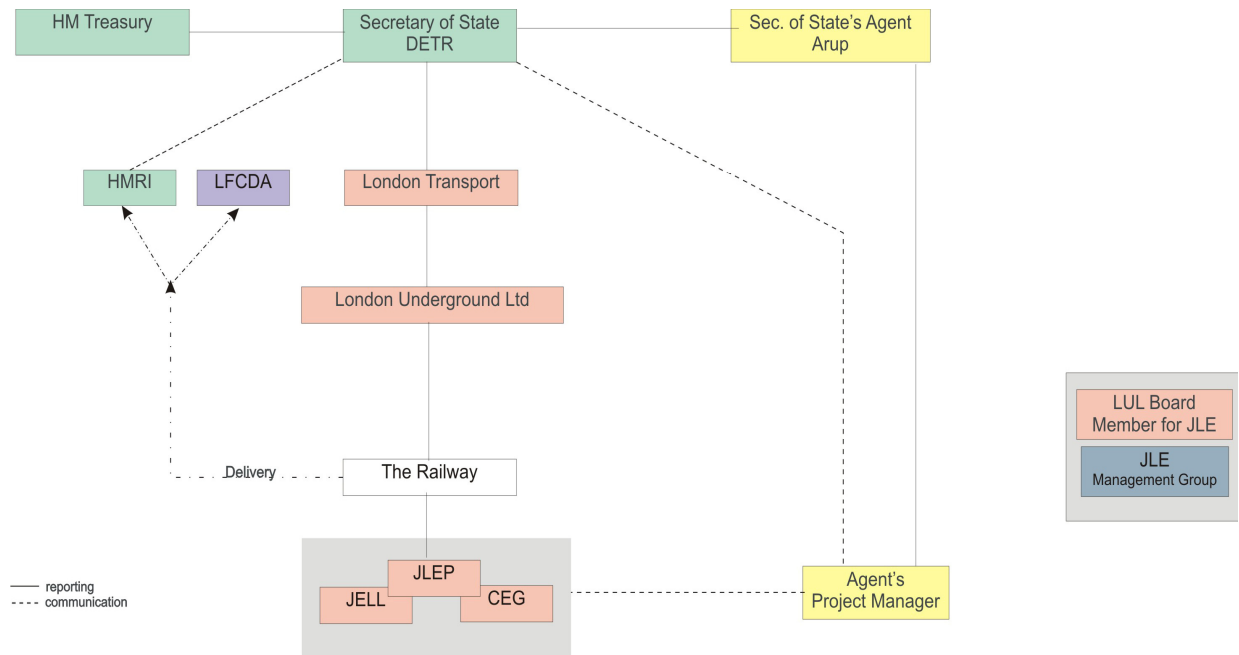
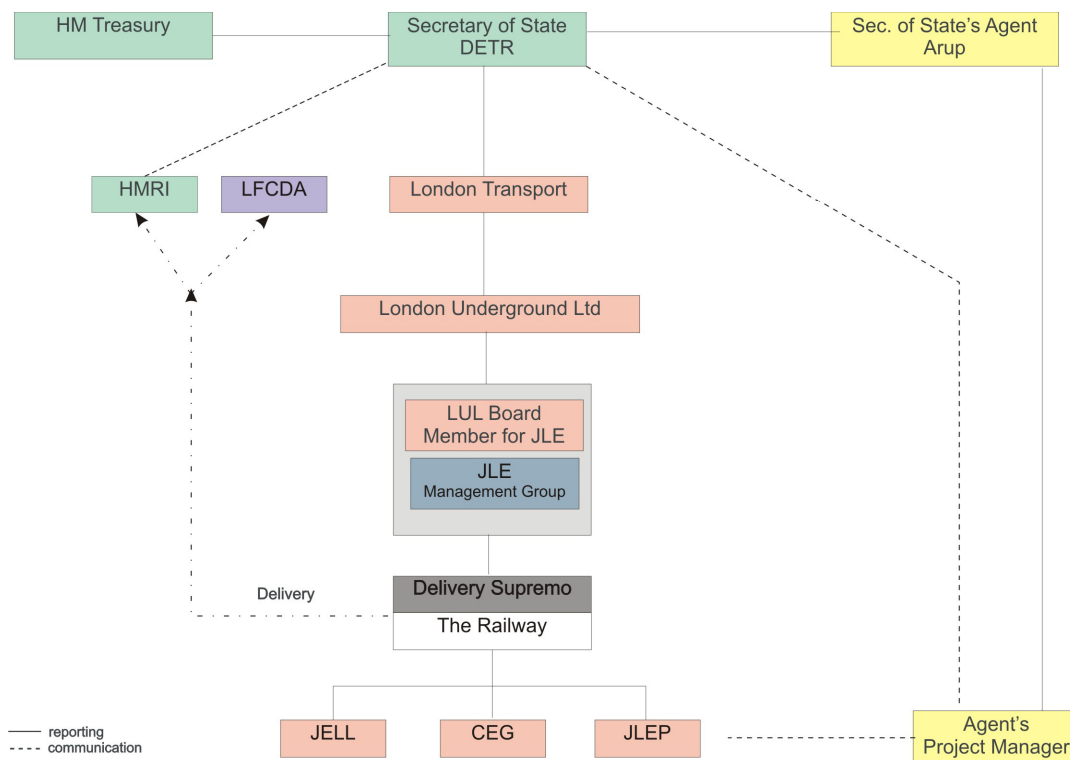


Figure 8: Arup's view of how the delivery of the JLE should be implemented at late construction/delivery stage



Contractors

The main civil engineering contractors employed on JLE comprised those high profile firms that are often present on many of the large infrastructure projects in the UK, Europe or elsewhere. The contract strategy developed for JLE led to more than 30 major contracts as outlined in Table 3 below and numerous minor contracts.

“The original Project Director, Russel Black, had strong views from day one on the best packaging of the contracts, which meant that a clear contracting strategy was laid down from the start” (Mitchell 2003, P 293)

Table 3: Contracts awarded during design and construction of JLE

Project management : Bechtel Corporation (from September 1998)
Contract 101 Tarmac Construction Ltd
Contract 102 Balfour Beatty-Amec Joint venture
Contract 103 Aoki: Soletanche Joint Venture
Contract 104 Costain Taylor Woodrow joint venture
Contract 105 Aoki: Soletanche Joint Venture
Contract 106 Wimpey Construction Ltd (Later novated to Tarmac)
Contract 107 McAlpine-Wayss& Freytag-Bachy joint venture
Contract 108 Tarmac-Bachy joint venture
Contract 110 McAlpine-Wayss& Freytag-Bachy joint venture
Contract 111 John Mowlem Construction plc
Contract 112 John Laing Construction Ltd
Contract 113 Tarmac Montcocol TP joint venture
Contract 114 John Laing Construction Ltd
Contract 115 Christiani-O'Rourke Joint venture
Contract 117 Trafalgar House construction
Contract 118 Tarmac construction Ltd
Contract 201 Alstom Transport Ltd
Contract 202 Westinghouse Signals Ltd
Contract 203 GEC ALSTHOM transmission and distribution projects Ltd
Contract 204 GPT
Contract 205 JWP(UK) Ltd and Drake & Scull Engineering Ltd Joint venture
Contract 206 JWP(UK) Ltd and Drake & Scull Engineering Ltd Joint venture
Contract 207 O&K escalators Ltd
Contract 208 Westinghouse Cubic Ltd
Contract 210 Westinghouse Brakes Ltd
Contract 211 SCHOMA Schottler Maschinenfabrik GmbH
Contract 212 GEC Alstom Engineering Systems Ltd
Contract 213 Alcatel Canada Inc.
Contract 214 Bombardier prorail Ltd
Contract 215 GEC Alstom Signalling Ltd
Contract 296 Wimpey Construction Ltd (later novated to Tarmac)

Source: Mitchell, 2003: 301, 302, 305)

Planning and Environmental Regime

The JLE Planning Regime

London Underground Act 1992

London Underground (Jubilee Act) 1993

London Underground (Green Park) Act 1994

The Environmental Statement

The JLE was one of the first mega-projects to carry out an environmental assessment. According to the recommendation of the Joint Select Committee's Report on Private Bill Procedure (Para. 80), environmental assessments should be required for private bills (Mitchell, 2003:350). The Environmental Statement (ES) of the JLE was commissioned to Environmental Resources Limited by London Underground Limited (LUL) and published in March 1990. The main aims of this document were twofold (ibid: 57):

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

Both impacts during construction and of its operation after completion were considered in this Environmental Statement. Special issues examined were noise, dust, vibration, effects on groundwater, disposal of tunnel seepage and site drainage, loss of property, temporary loss of amenity, impacts from the transport of spoil and materials, disposal of contaminated spoil, noise and vibration from operations, visual impacts of the completed scheme and cultural and ecological impacts.(ibid: 57-58)

In November 1991, the *Project Update* (an updated environmental review of the project) was released to cover the substantial changes associated with the North Greenwich alignment, the London Bridge Station works and so on. This supplementary review concerned ten wider spectrum of environmental issues tackled in the JLE. (ibid: 350)

- Land and property.
- Settlement
- Architectural heritage
- Archaeology
- Noise and vibration
- Traffic and transport
- Ground contamination
- Air quality
- Urban ecology
- Aquatic environment

This is in stark contrast to the Canary Wharf development, one of the principle stations planned on the JLE, where building started in 1988 and where 'no environmental studies were done – all of that was wiped out with the establishment of the LDDC and the sidelining of local authorities – there was no warning before the cranes and bulldozers moved in and the air was filled with dust and dirt and all sorts of pollutants (Stewart, 1993: p150)

Project Environmental Policy & the Environmental Management System (EMS)

The Project Environmental Policy and the Environmental Management System (EMS) were adopted to minimise environmental effects. In order to achieve the goal, a small unit within the project team was dedicated to environmental matters. Table 4 details the sites which were deemed to be at risk of environmental contamination.

The key principles of the environmental policy, according to Mitchell (2003: 351) were to:

- Meet legislative requirements
- Cause minimum disturbance to the community
- Effectively manage environmental issues during all phases of the design, construction and operation of the extension.

Table 4: Sites deemed to be at risk of environmental contamination

Worksite	Information Extracted from Environmental Statements*
Jubilee Gardens	Moderate to high risk of contamination from a variety of contaminants
London Bridge	Moderate risk of contamination from oils and coal residues
Old Jamaica Road	High risk of contamination from a variety of contaminants
Canada Water	High risk of contamination from a variety of contaminants
Durands Wharf	High risk of contamination from a variety of contaminants
Thames Wharf	Contamination of top 2.5 m of ground with range of chemicals
The Limmo	Medium risk of contamination from metals, organics and waste
Stratford Market Depot	Medium to high risk of contamination from a variety of contaminants
Stratford Station	Medium risk of contamination from oils and solvents

* only those sites for which contaminants were predicted have been included.

Source: University of Westminster WP36: 33

The EMS, based on British Standard 7750, offered a comprehensive management structure to confirm the environmental threats were addressed properly. However, Scott Wilson, who carried out the Environmental Impact Baseline Study on behalf of the University of Westminster, admitted that the list of sites deemed to be at risk of environmental contamination was itself “of limited use as it is purely a prediction of what could have been expected to be encountered during construction” (University of Westminster, WP36: 33).

Ideally, as Scott Wilson argue, a large-scale environmental impact assessment involving the collation of project and contractor data would be necessary to gain a full picture of environmental contamination caused by the JLE.

Archaeological Impact Assessment

The JLE Project Team commissioned an Archaeological Impact Assessment from the Museum of London and the Passmore Edwards Museum. These two organizations, together with English Heritage, provide an archaeological service for the Greater London area. Sites identified as having high archaeological potential were St James's Square, Storey's Gate, Parliament Square, Westminster Station, Jubilee Gardens, Ewer Street, London Bridge, Druid Street, Stratford Market and Stratford Station. (Mitchell, 2003: 58)

Public Consultation

Although Stephen Jolly, a key member of the JLE Project's public relations team has argued that "it is vital that the people feel they really own the scheme by having had a say in its preparation and detail" (quoted in Mitchell, 2003: 56), in reality it is doubtful whether the consultation process was anything more than a source of persistent annoyance to the JLE Project Team. During the parliamentary process, the 1989 Bill received 96 petitions, a total which has variously been described as "not...significant" (Mitchell, 2003: 57) and "representing a major workload for the developers" (Willis, 1997: 86). A further 60 petitions were raised following the deposition of the North Greenwich Additional Provision and the 1990 Bill (ibid). Most of these petitions concerned environmental issues, especially those associated with noise and disturbance resulting from construction works. The most vociferous protests came from local groups at Waterloo and Canada Water stations. In spite of extensive consultation and negotiations, 24 petitioners reported their cases to the House of Commons' Committee (ibid: 57).

These petitioners were heard in front of a four-member House of Commons Committee over a 22 day period during March and April 1991, with the result that a number of minor changes to the original Bill were made. When the Bill passed to the Lords, a further 87 petitions of objection were received, concerning the planned withdrawal of services to Charing Cross, compensation issues, and the temporary loss of open space at Jubilee Gardens. A Lords Committee of five Peers sat over ten days in December 1991 and gave their assent to the Bill, again with minimal changes. (Willis, 1997: 86-87). The system of Parliamentary scrutiny has since been replaced by that of the Planning Inquiry by the Transport and Works Act 1992.

Complaints Procedures

Organisations and individuals materially affected by a railway bill can register their opposition by lodging a petition against the bill. The 1989 bill attracted 96 petitions representing a major workload for the promoters. A further 60 petitions were lodged as a result of the Additional Provision and the 1990 bill (Willis, 1997:86).

Ecological Mitigation⁶

The Jubilee Line Extension involved occupation of land, either temporarily or permanently, in nine sites which were identified as of ecological importance:

⁶ Source: University of Westminster WP36: 40-44

These sites were:

- *St James's Park* – JLE escape shaft to surface 75m from park lake which provides a home to a diverse bird population
- *Ewer Street* – small area of ruderal vegetation, “unexceptional in character”
- *Canada Water* – temporary loss of up to 1,400 m² (45%) of shoreline habitat along eastern fringe of Canada Dock
- *Russia Dock Woodland* (Downtown Road) – ventilation and escape shaft to require the removal of 1,500m² of newly planted woodland, considered “not a significant impact”.
- *Durands Wharf Riverside Park* – permanent loss of approx 20m² of parkland, “not a significant impact”.
- *The Limmo* – temporary reduction of 10% of this site of Metropolitan Importance for Nature Conservation (MINC).
- *The railway corridor between Canning Town and Stratford* – loss of habitat along the verges of the North London line
- *Stratford Market* – loss of small parcels of wasteland.
- *Stratford Station* – loss of marsh plants and scrub habitat for birds, “significant in a local context only”.

The impact of construction works on the Thames itself also had to be considered. It was concluded that work sites close to the Thames would not impinge directly on mud used by birds for feeding, and the indirect effects (e.g. noise disturbance) would only impinge on areas that were very small compared to the total habitat of this kind available in the locality. No known wader or wildfowl roosts of importance were recorded in the immediate vicinity of the proposed Extension, and significant impacts on birds associated with the River Thames were therefore not expected. Several other areas of formal green space are also affected, but they have little claim to nature conservation interest and were not considered further by Scott Wilson, e.g. Parliament Square, Jubilee Gardens, Old Jamaica Road and Southwark Park. Over 200 trees were either preserved or removed during construction phase and subsequently replanted” (Mitchell, 2003:352).

Landscape mitigation

A survey identified around 100 buildings of special architectural and historical interest affected by the proposed extension. Project effects on neighbouring buildings were to be minimised through:

- Choice of alignment.
- Use of special tunnelling techniques.
- Uninterrupted tunnelling, avoidance of overcutting and rapid grouting.
- Special measures e.g. underpinning to protect sensitive buildings.
- Continuous monitoring.

Regeneration

The JLE presented a unique opportunity to measure the effects of a major public transport project in London on the wider economy (Westminster University, WP58: 1). The project was projected to employ around 5,000 people at the peak of construction activity, generating over 15,000 person-years of direct labour. Allowing for the effects on the rest of the economy the peak direct impact on employment was estimated at over 14,000 jobs, with almost 50,000 person-years of employment to be created (Willis, 1997:80).

The wider effects of the JLE were originally estimated at 91,000 jobs in areas of the Isle of Dogs, Leamouth and Poplar (Willis, 1997:82), but were subsequently revised upwards to 150,000 jobs once the full extent of the plans to redevelop Canary Wharf became known (Willis, 1997:82).

Employment

In addition to the benefits directly related to the transport infrastructure users, the JLE was expected to deliver additional benefits through regeneration and the creation of additional jobs. Employment in the JLE catchment areas increased from 365,000 in 1998 to 426,000 in 2000 - an increase of 17% (compared with an 8% increase in Greater London as a whole). Due to employment growth in the JLE catchment areas outperforming the London trend, an additional 32,000 jobs were created between 1998 and 2000. Most of these jobs were of a "high value, high productivity" type (Westminster University, WP31: ii).

The JLE has helped to integrate labour markets and provide wider access to jobs, as an additional one million people are now within 60 minutes commuting distance of the average JLE station. In particular, North Greenwich, Canada Water and Bermondsey have benefited with at least two million extra people now within 60 minutes commuting distance of each station."

Unemployment

Despite the JLE's success in creating jobs, the scheme has not significantly reduced unemployment in the catchment areas studied. However, it may take considerably more time before the full effect of the JLE materialises, with residents entering the labour market in the future either, having the appropriate skills to take advantage of the financial and business services jobs attracted to the corridor or by using the JLE to reach employment centres elsewhere in London.

Office Space Created

“The creation of the new business district at Canary Wharf is of a type and at a density that would not have occurred without the JLE. The JLE operating at its current capacity will approximately support 12m sq. ft. of commercial development on the Isle of Dogs.⁷”

“The development of Canary Wharf has provided international firms, in particular those in the financial sector, with a supply of high quality office space, which can be built relatively quickly and offered at a lower rent than an alternative location in the City. As a result, Canary Wharf has acted as a ‘safety value’ for demand pressures in the City, without which London might have found it harder to sustain its predominant financial position in Europe against other European rivals.”

“A number of other prestigious developments are also in the pipeline, principally at London Bridge, Canada Water & North Greenwich, consisting of 4.3m sq. ft of offices & 12,000 residential units, which would not have been of the planned scale and form without the JLE. In addition the JLE was influential in securing the redevelopment of Stratford, which will comprise of 4.2m sq. ft of offices and 4,500 residential units.”

Housing provision

“Residential development has increased at a faster rate in the JLE corridor than in the rest of the Inner East London reference area since the JLE was approved. In 1991 and 1992 the number of dwellings constructed (by year application received) in the corridor was on average 17% of the total number built in the Inner East London reference area, while between 1993 and 2000 this figure doubled to 34%.”

“The characteristics of households moving into the JLE corridor to newly constructed residential development are significantly different to those existing residents who remained in the area after the construction of the JLE. The average income of households moving into new developments was nearly three times (£45,067) that of incumbent households (£16,182).”

⁷ TfL’s calculations are based on the available capacity provided by the JLE at Canary Wharf station and the ratio of 1 employee per 23 sq m. The Uni of Westminster report at least 12 m sq ft of commercial development is due to the JLE at Canary Wharf..

Means of appraisal and evaluation

The key appraisal document for the second line to the docklands was the 1989 East London Rail Study, which was commissioned by the Department of Transport, and undertaken by Halcrow Fox and Associates (HFA) (Hansard, 26th July 1989 vol 157 c729w). The principle evaluation document was the Environmental Indicator Report 2002. Table 5 outlines the key appraisal and evaluations undertaken for the JLE.

Table 5: Ex-ante / Ex-post studies of the JLE

	Before Construction	During construction	After Construction
Baseline Studies	<ul style="list-style-type: none">East London Rail Study 1989	<ul style="list-style-type: none">Employer Pilot Survey(1998)Household Pilot Study(1998)Development Activity Study Scoping Report(1999)Property Market Scoping Report (1999)Development Activity Baseline Study Property Market Baseline Study	
Monitoring environmental variables			<ul style="list-style-type: none">Post Project Evaluation- Environmental Indicator Report - December 2002
Risk Analyses	<ul style="list-style-type: none">Quantified risk assessment (QRA)modelling		

Ex-ante studies

Cost benefit appraisal - East London Rail Study 1989

The cost benefit analysis⁸ (Table 6) which lay behind the ELRS report was calculated using the present (1989) value of costs and benefits for the Jubilee line extension from Green Park via (inter alia) Waterloo, Canary Wharf and Greenwich Point to Stratford.

Table 6: Cost benefit appraisal - East London Rail Study 1989

1988–89 prices discounted to 1989 £ million	
Capital costs	(690)
Operating cost	(90)
Additional revenue	290
Funding gap	(490)
Passenger benefits	730
Road user benefits	200
Net benefit	440
Benefit: cost ratio	1.56:1

⁸ Source: http://hansard.millbanksystems.com/written_answers/1990/jun/18/east-london-rail-study [accessed 21st June 2008]
Section citation: HC Deb 18 June 1990 vol 174 cc444-5W.

NPV of Jubilee line extension

According to Hansard, the official report, Steve Norris defined the NPV of the JLE as follows:

“In net present value terms, at mid-1991 discounted to 1991, the road and rail decongestion benefits of the Jubilee line extension would be around £230 million and £275 million respectively.”

“London Transport has recently estimated that it would cost around £300 million or £330 million to extend the Jubilee line to Woolwich Arsenal taking a route north of the Royal Victoria dock, or £370 million taking a route south of the Royal Victoria dock. Extending beyond Woolwich Arsenal to Thamesmead would cost an estimated £160 million more. All estimates are in mid-1990 prices“.

“The results, in present value terms, of a recent cost benefit analysis of the proposed Jubilee line extension from Green Park to Stratford, taking into account the quantifiable benefits conventionally used in the appraisal of rail transport schemes, are given in the table.”

“No recent cost-benefit analysis has been carried out in respect of possible further extensions of the Jubilee line to Woolwich and Thamesmead. At the time of the east London rail study, published July 1989, however, it was clear that the costs of such extensions would far exceed the benefits.”

Quantified Risk Assessment (QRA) modelling

Quantified Risk Assessment (QRA) modelling was launched in the design development process and was used to assess the cost: safety benefit ratios of potential design options and to derive the ALARP(As Low As Reasonably Practicable) solution.(Mitchell, 2003:97) The contents of the assessment was illustrated in Mitchell’s book as follows: (ibid)

- The production of fault and event trees based on the evolving designs and the likely operational and maintenance philosophy.
- Use of predictive consequence events such as major fires and flooding, supported by testing where necessary. An example of testing to prove or disprove the analysis was the potential for fire propagation within the train saloon even with fire safety code compliant materials. Fire testing of seating units was undertaken at Hainault Depot using various amounts of combustible materials and accelerants.

The advantage of QRA model was described as “The top event of QRA model provided input to the safety engineering activities by providing specific reliability and availability targets for the E&M system designs. The fault and event trees enabled the significant risk contributions to be identified and therefore those systems where improved safety performance would result in the greatest reduction in levels of risks” (ibid, p98)

Ex-post studies

JLE - Post Project Appraisal - Environmental Indicator Report - December 2002⁹
Forecast cost benefit ratio of the JLE

The JLE project was initially approved with a benefit cost ratio of 0.95 with an expectation that there would be substantial, though unquantified, benefits from the regeneration of the South Bank and the creation of new jobs in Canary Wharf. Using current DfT guided methods of transport appraisal, it is now estimated that the JLE delivers a benefit cost ratio of 1.75, even after accounting for the cost over-runs experienced on the project.

Land Acquisition

The lands affected by the scheme and details of ownership are provided in the London underground (Jubilee) Bill 1989 and the book of reference.

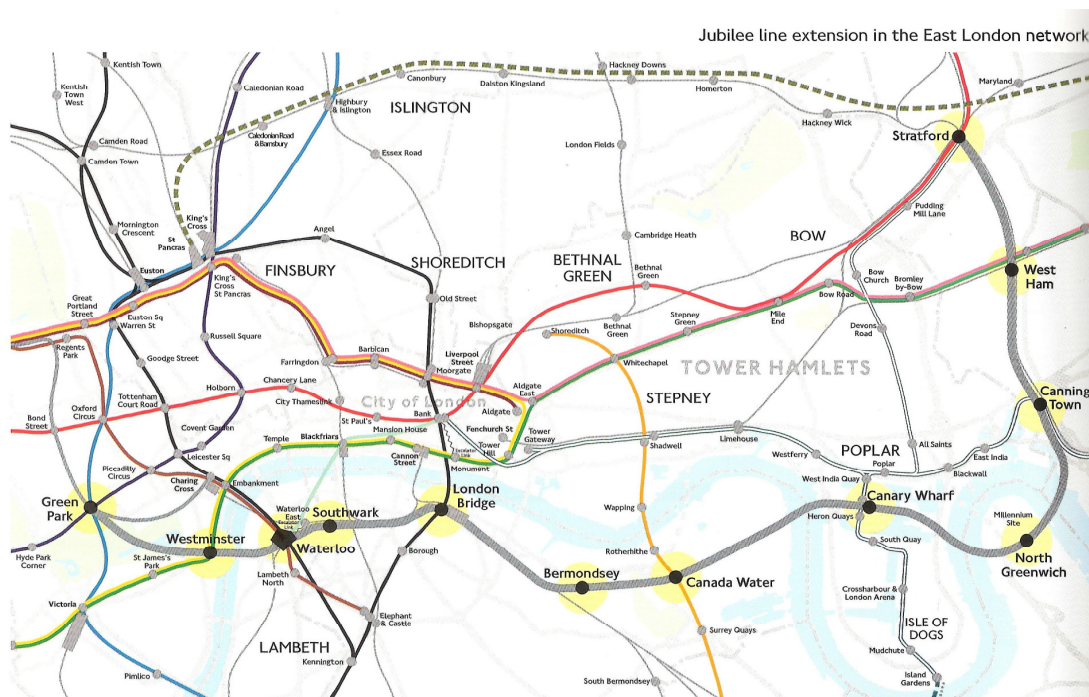
⁹ Source: [http://home.wmin.ac.uk/transport/jle/wp/WP49_Environment_Study_\(Wave_2\).pdf](http://home.wmin.ac.uk/transport/jle/wp/WP49_Environment_Study_(Wave_2).pdf)

C Principal project characteristics

Description of Route

The JLE is the first major addition to London underground network since 1979. The final route of Jubilee line extension is comprised of four new river Thames crossings, six completely new stations and five existing stations from west to east, namely Green park station, Westminster station, Waterloo station, Southwark station, London Bridge station, Bermondsey station, Canada Water station, Canary Wharf station, North Greenwich station, Canning Town station, West Ham station and Stratford station (**Error! Reference source not found.**).

Figure 9: The JLE Route Map



Source: Willis,1997: 48

- Existing alignment between Green Park and Charing Cross is closed and regular services cease (although the infrastructure remains operational).
- New tunnels built below St James' Park and Great George Street to the rebuilt Westminster station on the north east corner of Parliament Square, below the Portcullis House office building.
- The route then follows underneath the Thames to Waterloo, with platforms below the north-eastern corner of Waterloo mainline station; below The Cut to the new Southwark station on the corner of Blackfriars Road; below Union Street and Southwark Street, passing beneath the mainline railway to London Bridge, where the platforms are below the western side of the mainline station.
- The route continues eastwards, with tunnels running to the south of Tooley Street and Jamaica Road to the new Bermondsey station on the corner of Keeton's Road; then to the new Canada Water station on Surrey Quays Road; under the Rotherhithe peninsula and the Thames to the Isle of Dogs, where the new Canary Wharf station is between Canary Wharf and Heron Quays DLR stations, parallel to Grime Street.

- The route crosses the Thames again to the Greenwich peninsula to serve the new North Greenwich station on Millenium Way; then curves sharply to the north and crosses the river again before resurfacing at Canning Town, where the platforms are adjacent to the North London Line platforms and directly below the DLR platforms; then runs alongside the North London Line on the western side of Manor Road to West Ham, where interchange with the existing District Line and new mainline platforms on the eastern side of Manor Road is via a footbridge.
- The extension is completed by a stretch running north-west parallel to Pond Road and Bridge Road to the newly rebuilt Stratford station, passing the new Jubilee Line depot to the west of the tracks.

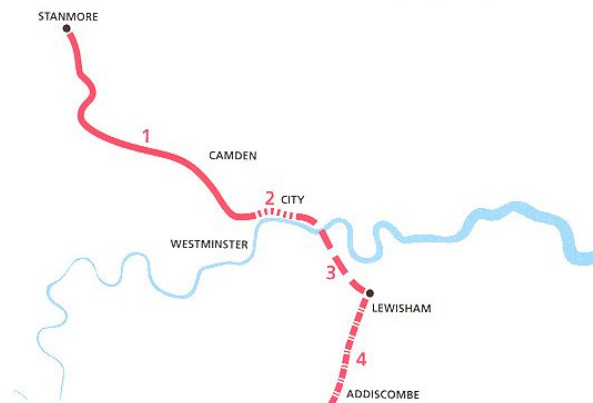
The evolution of the route

1960s Fleet Line Proposal

By the late 1960s the need for improved connections for Docklands was beginning to be recognised. London Transport were actively proceeding with planning work (Figure 10), and Parliament were pressing for a solution “Would the Minister agree that it is becoming increasingly urgent to increase the commuter capacity in South-East London” (Hansard, 1968, vol 766 cc1087-8).

Figure 10: The Fleet Line Proposal

1. Baker St. to Charing Cross. 2. Charing Cross to Fenchurch St.
3. Fenchurch Street to Lewisham. 4. Lewisham to Addiscombe.



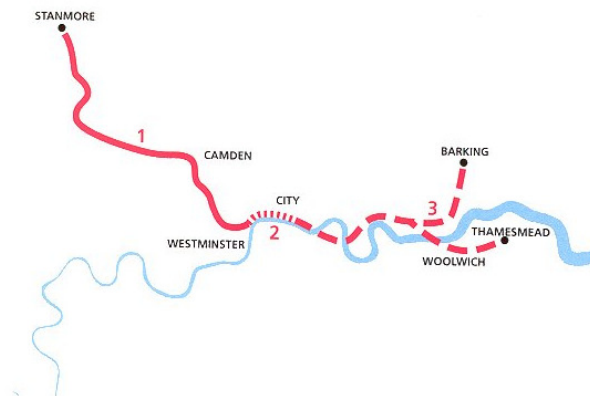
Source: <http://www.lddc-history.org.uk/transport/3tran1.jpg>

1973 Travers Morgan Docklands Study: Jubilee Fleet Line

"The 1973 Docklands Study, undertaken by Travers Morgan for the Department of the Environment and the GLC, looked at possible rail connections in the light of the development considered likely. This study came to the conclusion that the needs of Docklands could be met with the construction of a lower cost 'Minitram' system from Fenchurch Street, linking in with the proposed second stage extension of the Jubilee Line (Figure 11) This, the first precursor of the DLR, would link areas north and south of the river and could ultimately have been extended to Barking and Thamesmead, with three new river crossings.

Figure 11: The Travers Morgan Docklands Study - Jubilee Fleet Line

1. Stanmore to Aldwych (constructed). 2. Aldwych to Fenchurch Street Minitram. 3. Fenchurch Street to Barking and Thamesmead.



Source: <http://www.lddc-history.org.uk/transport/3tran1.jpg>

1974/1976 London Rail Study/ London Docklands

"The idea of a full scale underground connection was not abandoned and the 1974 London Rail Study undertaken by the DoE, GLC, BR and LT promoted the River Line, an extension of the Jubilee Line from Fenchurch Street to Thamesmead. This was considered to have advantages over a less conventional system such as 'Minitram' because of the use of proven technology, and the integration with the rest of the Underground network. It also avoided problems associated with the acquisition of surface rights of way."

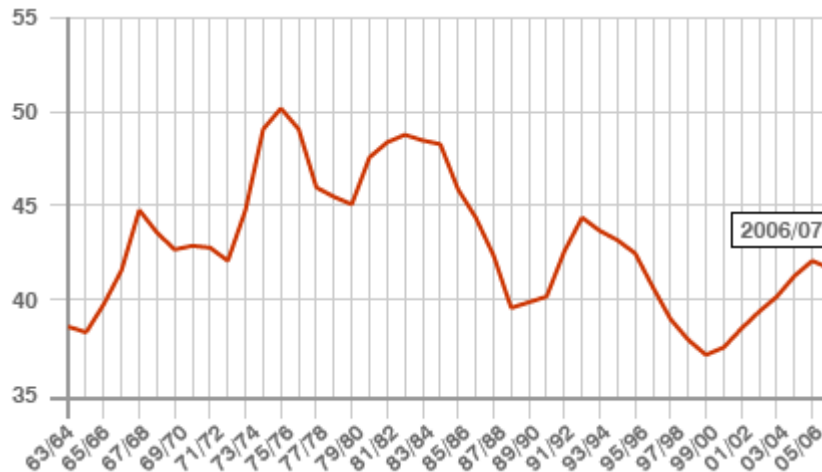
"The proposed line would include five new river crossings and would link Surrey Docks, the Isle of Dogs, the Blackwall Peninsula, the Royal Docks, Woolwich and Thamesmead. The route is shown on Figure 13. The Study gave a higher priority to an extension of the Jubilee Line eastwards to Thamesmead rather than south to Lewisham and on to Hayes and Addiscombe."

"The idea was taken up by the Docklands Joint Committee, and after a period of consultation and review, especially as to whether the new link should be a Tube, tram or bus, the Underground scheme was endorsed in the 1976 London Docklands Strategic Plan. The proposals included two options east of Custom House in the Royals: one taking a northerly route through Beckton and then direct to Thamesmead and the other taking a southerly line through Silvertown and Woolwich Arsenal before reaching Thamesmead. (Figure 13)"

"By the late 1970s the Government was under increasing pressure to cut spending. (Figure 12) In 1979 the Government asked the GLC to develop ideas for a lower cost alternative, and in 1980 after further review the 1976 proposals were abandoned. The search was on for

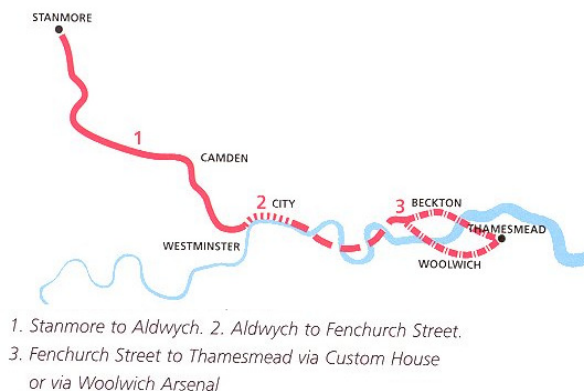
a cheaper option which would still allow the regeneration of the Docklands area. The proposals for the DLR grew out of this study, which eventually led to the approval of the initial railway in 1982.”

Figure 12: Long Term Government Spending – Total Spending as percentage of GDP



Source: HM Treasury

Figure 13: The London Rail Study/London Docklands Strategic Plan



Source: <http://www.lddc-history.org.uk/transport/3tran1.jpg>

1985 GLC: Jubilee Extension Proposal

“Strategic thinking about mass transit links for East London continued. In Public Transport-the Next Ten Years published in 1985, the GLC investigated a proposal to extend the Jubilee Line along the southern side of the Thames, largely using the rail corridor from Surrey Docks to Abbey Wood. This is shown on Figure 14. This did not in the end form part of the study’s recommendations, which did, however, include the extension of the DLR from Custom House to Woolwich and Thamesmead. During 1985, however, the proposals for Canary Wharf were also taking shape.”

As these unfolded it became increasingly clear that with the scale and type of activity now proposed for Docklands the capacity of the DLR would need to be increased, and that a better link from Docklands to the City was also required. As part of the package to lure Olympia and York to Canary Wharf, which included tax incentives and planning freedom, the Government promised various transport improvements in return for a cash contribution of

£64M, the DLR extension to Bank with its capacity quadrupled involving increasing the rolling stock, lengthening the platforms to accommodate double car trains, and strengthening the structure of the viaducts) being the major component.

The private contribution was agreed by O&Y, the result was that the DLR City extension was approved in 1987 and opened in 1991 six months late, However there were severe reliability issues which affected the fourfold expansion of the capacity of the railway, which was acheieved some three years late (Shabas, 2002).

Figure 14: GLC Jubilee Line Extension Proposal



1985, GLC: Jubilee Line Extension Proposal

1. Stanmore to Aldwych (built). 2. Aldwych to London Bridge.

3. London Bridge to Abbey Wood and Thamesmead.

Source: <http://www.lddc-history.org.uk/transport/3tran1.jpg>

1988 Olympia & York: Bakerloo Line extension

“By 1988 the construction of Canary Wharf was giving a fresh impetus to development proposals elsewhere in the area and a further high capacity link to central London was needed. In particular a direct link to the main line BR terminals of Waterloo and London Bridge was considered important to give rapid access to travellers from the south, south east and south west.”

“The first response to this was a proposal in early 1988 to extend the Bakerloo Line from Waterloo to Canary Wharf via either London Bridge or Bricklayers Arms. This could then be extended with two branches; one to Stratford and possibly Tottenham Hale and the second via East India/Brunswick to the Royals. This is set out in Figure 15.”

Figure 15: Olympia and York Bakerloo Line Extension

1. Waterloo to Isle of Dogs via London Bridge.
2. Waterloo to Isle of Dogs via Bricklayers Arms.
3. Isle of Dogs to Stratford and Tottenham Hale.
4. Isle of Dogs to Beckton.



Source: <http://www.lddc-history.org.uk/transport/3tran1.jpg>

1988 Olympia & York: Docklands Second Rail Line (Waterloo and Greenwich Railway)

“Political difficulties were anticipated because of the diversion of the Line away from its present South London terminus at Elephant and Castle, and proposals were then developed later in the year by Canary Wharf developers Olympia & York for a stand-alone railway from Waterloo to Canary Wharf and Westcombe Park where the depot would be located. This would be capable of extension and was regarded by the promoters as a possible core for a future high speed east-west regional metro (Figure 16), thus fitting the proposal into a sensible overall development strategy, although the line's main purpose was to carry commuters from the main line terminals at Waterloo and London Bridge in docklands. The line was seen as critical by O&Y in attracting potential workers for the Canary Wharf Development, and unlocked the potential of the Greenwich peninsula including a 80ha site owned by British Gas”

LTs reaction to the proposal was not positive, as it was seen as conflicting directly with its own ambitions, to build Cross Rail. The Waterloo and Greenwich railway was seen as a threat because it would compete for the same parliamentary time and political support as Cross Rail. It also fulfilled some of the same objectives by diverted traffic away from central London. This may have been a tactical error on the part of O&Y (Schabas 2002).

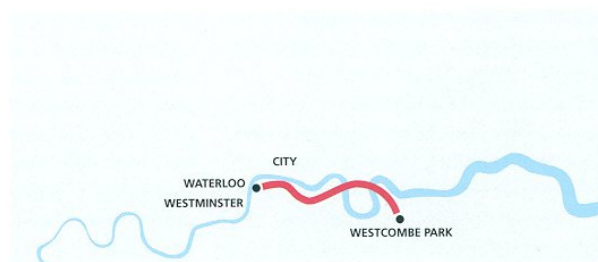
During the summer of 1988 O&Y put together a Parliamentary Bill for the line, and paid five contractor consortia to prepare turnkey bids. The bids for the railway came in at £450m. Allowing one year to gain the parliamentary powers and four years for construction O&Y estimated the project would be completed in early 1993. To speed the project along O&Y offered significant funding contributions to London Transport at this time to help pay for this line, and critically as share in the risks, including any overruns and operating losses. The government's share would have been relatively small with an option to take over the line at a later day at no cost. (Schabas, 2002)

LT advised the government to reject the offer, arguing on the basis of some very quick modelling work (Central London Rail Study) that the public benefit did not even justify the modest public investment suggested by O&Y. Government officials declined the O&Y offer, as Schabas states “they were captive to the experts at LT”.

“ the risks of taking a decision ‘on instinct’ against the advice of a statutory body are just too high for civil servants who are subject to audit committees and such” Ministers were not pleased the offer had been turned down and insisted the East London Railway Study was prepared by someone other than LT

Figure 16: Olympia and York: Docklands Second Rail Line

*1988, Olympia & York: Docklands Second Rail Line
Waterloo to Westcombe Park*

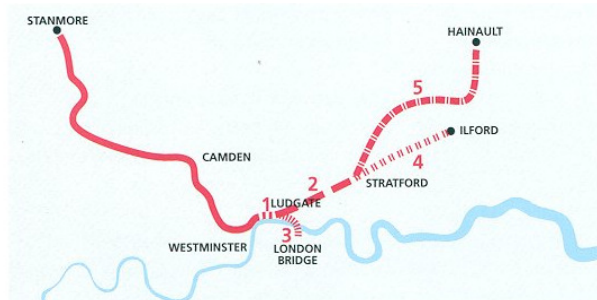


Source: <http://www.lddc-history.org.uk/transport/3tran1.jpg>

1988 Central London Rail Study: Jubilee Line Extension

At the same time as these proposals were being developed to improve access to Docklands, a separate exercise, the Central London Rail Study (CLRS), undertaken by the Department of Transport, British Rail Network South East, London Regional Transport, and London Underground, was looking at the problems caused by the rapid growth of employment and rail traffic into Central London. This increased traffic had resulted in congestion and overcrowding on many of the routes into London, particularly from the east. The CLRS concluded that a further study should be undertaken into the extending the Jubilee Line via Ludgate either to London Bridge or to Stratford and then Ilford or Hainault (Figure 17) as an alternative to the stand alone Waterloo and Greenwich Railway being proposed by O&Y. The study also resurrected the East-West Cross Rail Scheme, dating from the 1940s. LT were at last able to predict a positive benefit/cost ratio for Cross Rail and government approval seemed achievable (Mitchell, 2003)

Figure 17: Central London Rail Study: Jubilee Line Extension



1. Aldwych to Ludgate. 2. Ludgate to Stratford.
3. Ludgate to London Bridge. 4. Stratford to Ilford.
5. Stratford to Hainault.

Source: <http://www.lddc-history.org.uk/transport/3tran1.jpg>

1990 East London Rail Study: Jubilee Line Extension

As a solution to the problems of Central London, the O&Y proposal had low benefits and did not compare well with alternatives such as CrossRail; but it was recognised that an extension of the Jubilee line through Docklands via different route options could be an attractive alternative to the proposed Waterloo and Greenwich Railway. These were then examined in a further study, the East London Rail Study (ELRS) commissioned by the DoT, following a statement by the then Secretary of State for Transport, Paul Channon, in January 1989, in which he announced initiatives to improve transport to Docklands. The report concluded the preferred option (Figure 18), a £900million plus (1988 prices) extension of the Jubilee Lin from Green Park via Waterloo, London Bridge and Canary Wharf to Stratford. The proposed new JLE would also support development in the docklands. The governments advisors considered that property values along the route would increase by more than £1 billion.

Figure 18: The East London Rail Study: Jubilee Line Extension

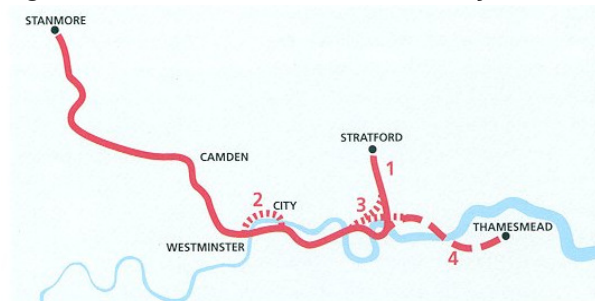


Figure 21: 1990, East London Rail Study: Jubilee Line Extension

- 1 Green Park to Stratford – now under construction
- 2 Aldwych to London Bridge via City
- 3 Canary Wharf to Canning Town via Leamouth
- 4 North Greenwich to Thamesmead

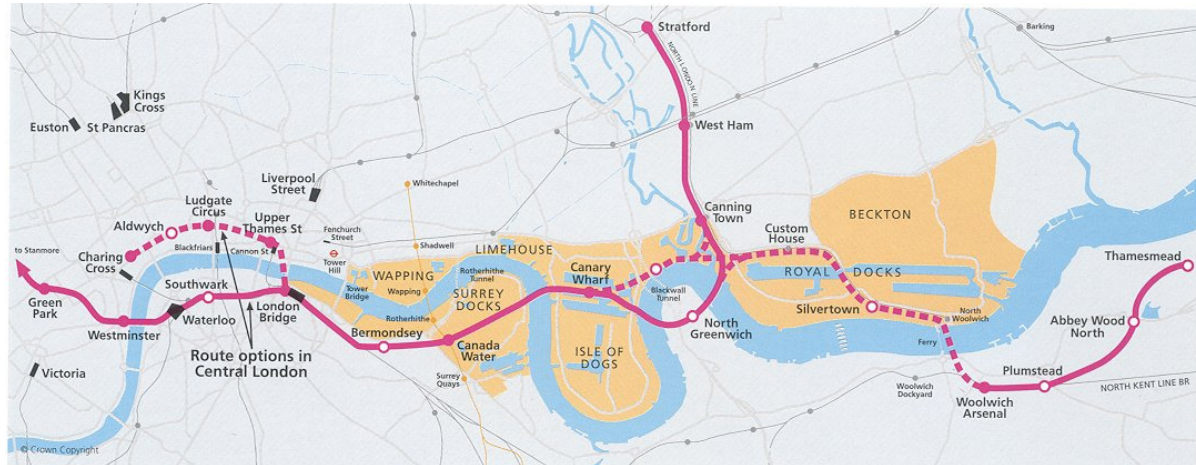
Source: <http://www.lddc-history.org.uk/transport/tranmon3.html#Abeyance>

1990 Route changed via North Greenwich point

Following further work and negotiations with property developers and landowners, the east London rail study which was announced in July last year, identified two possible alignments for the Jubilee line extension between Canary Wharf and Canning Town either via Greenwich point, or via the Brunswick foreshore (See Figure 19) . Based on the pressure of a November deadline for London Regional Transport (LRT) to deposit a Bill, for the extension, the Bill was lodged in line with the consideration of the shorter and cheaper alignment via Brunswick. However, further discussions have been held with property developers and landowners whose interests would be affected by both alignments to ascertain whether they would be prepared to meet the additional costs of providing a station and changing the route, as necessary. Each of the interested groups has offered to contribute on this basis but the financial case for proceeding with the Greenwich alignment is more robust and offers a number of additional benefits. It is essential to secure the regeneration of the industrial wasteland in the Greenwich peninsula and above all, by providing two further river crossings it will open up new areas in south London to the Underground network.

Source: UK Parliamentary Publications and records: House of Commons Hansard Debates for 22 Feb 1990: Column 855 & 856, London Underground.

Figure 19: Jubilee Line Route Extension Options 1990



Source: <http://www.lddc-history.org.uk/transport/3tran4.jpg>

Figure 20: History of the Jubilee Line Extension

1940s 1949: Concept developed for new Tube Line to south-east London.

1950s No significant progress.
Project revived.

1960s 1969: Powers granted for section to Charing Cross

1970s 1973: Travers Morgan Docklands report proposed that line should terminate at Fenchurch Street because of low demand and any extension should be constructed as "Minitram"
1974: London Rail Study gave priority to construction of Tube Line to Thamesmead.
1976: After consultation LDSP proposed extension of Tube Line to Thamesmead.
1979: Parliamentary Powers obtained for route as far as Woolwich. Government asked GLC to consider low cost options because of spending constraints.

1980s 1980: Original Jubilee Line proposals for Thamesmead extension abandoned.
1985: GLC proposed extension to Thamesmead south of the river.
1988: Proposals for Bakerloo Line extension and Second Rail Line to Docklands.
1989: East London Rail Study recommended Jubilee Line Extension to Stratford, Jubilee Bill submitted.

1990s 1992: Royal Assent for Jubilee Bill.
1993: October, Construction started.
Safeguarding included for extension to Royal Docks.
1998: September, Target completion.

Source: <http://www.lddc-history.org.uk/transport/3tran5.jpg>

Main Termini and Intermediate Stations

Westminster Station

Introduction

Prior to the advent of the JLE, Westminster station was a joint node of the District and Circle lines. However, a high capacity and modernized station was needed because the existing facility and capacity couldn't satisfy growing demand. The original Westminster station was one of the oldest nodes of the Metropolitan District Railway, having opened on Christmas Eve, 1868, and remained virtually unchanged until the advent of the JLE, save for a 1920s facelift and some platform lengthening works in 1962 (Mitchell, 2003: 153). However, as patronage of the London Underground increased dramatically in the 1980s (see Figure 21) the simple two-platform, single ticket-hall station became unfit for purpose and so the JLE was seized upon as an opportunity to redevelop the Westminster interchange (ibid.).

Figure 21: Cumulative Passenger Journeys – Light Rail, London Underground and National Rail



Source:

http://www.dft.gov.uk/about/strategy/whitepapers/previous/fot/coll_chapter4transformingourrail/dft_about_031273-2.gif

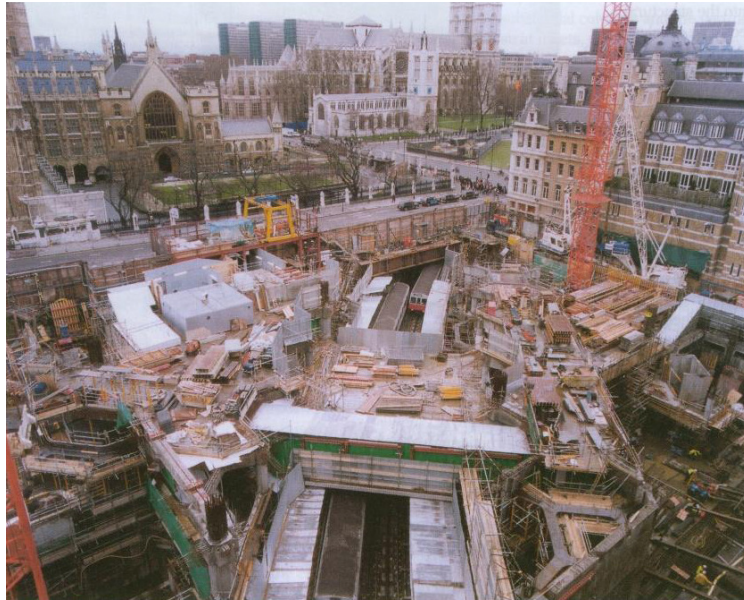
The construction of Westminster Station on the JLE necessitated the hollowing-out of what was, at 39m, the deepest underground box excavation (Figure 22) in London at that time (Hankin, 2000: 20). On the one hand, this provided the architect with a more satisfactory and spacious design for greater ease of passenger movement, but presented three key technical challenges to the civil engineer and contractor (Bailey et al, 2000: 37):

1. the need to adapt the existing District & Circle (D&C) Line station
2. the construction of the New Parliamentary Building (Portcullis House)

3. the need to minimize ground settlement and horizontal movement of buildings of historic national importance, in particular the clock tower of St Stephen's ('Big Ben')

The existing D&C Line was open to the air and cut the main worksite diagonally in two (see Figure 22 below):

Figure 22: Aerial view of Westminster site looking south east



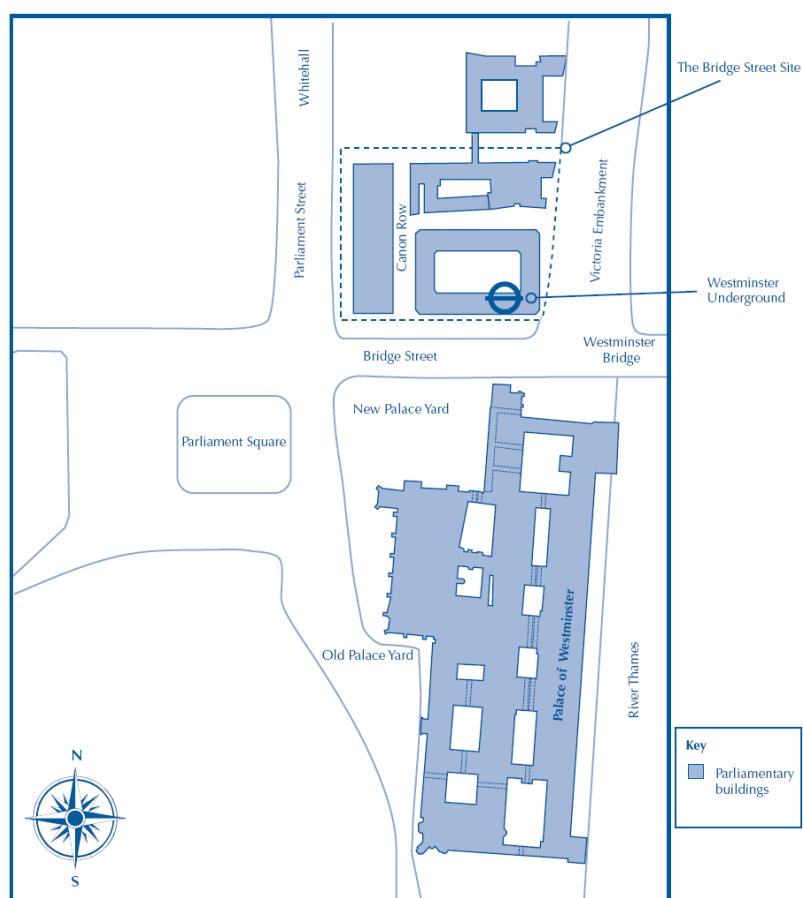
Source: Bailey et al, 2000: 40

Since the middle of the 20th century there had been mounting pressure to increase the amount of accommodation provided to Members of Parliament (Members) and others working in the Palace. Some of the required additional accommodation had been provided by adapting existing space within the Palace and by acquiring other buildings in the surrounding area.

However, as early as 1953 the HoC Select Committee on Accommodation concluded that no substantial progress could be made during the foreseeable future. Attention focused mainly on the area across Bridge Street to the north of the Palace (see Figure 23 below). A series of schemes were brought forward in the 1960s and early 1970s to clear this site and construct a new building on it, but none of these schemes came to fruition. In 1978 the Select Committee on House of Commons (Services) proposed a phased approach to the site, with the better buildings retained and complete clearance limited to certain areas (NAO, 2002: HC750: 11).

In 1990 the announcement of the new parliamentary building contributed to an interwoven relationship between the JLE and the new Parliamentary project, Portcullis House. Originally, it was proposed to build the ticket hall of Westminster station under the green in the centre of Parliament Square, but this idea was not supported by MPs (Willis, 1997: 50). Instead, the decision to combine the provision of Westminster station on the JLE with an existing proposal for phase 2 of Portcullis House at the junction of Bridge Street and Victoria Embankment was therefore taken in a House of Commons Select Committee (Hankin, 2000: 20).

Figure 23: The area around the Palace of Westminster



Source: National Audit Office

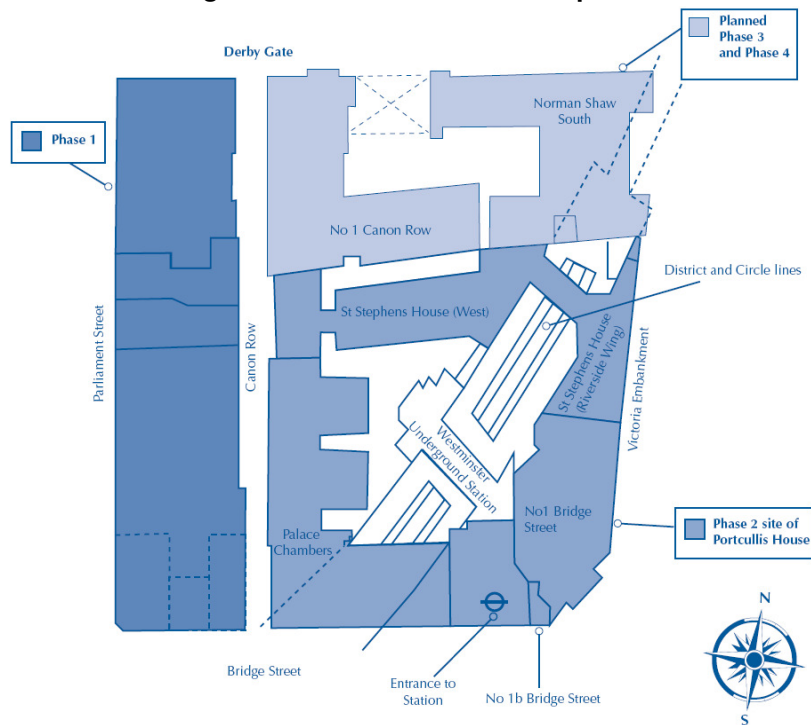
After further feasibility and planning work, the Committee recommended in 1983 that the first phase of work on the site should begin, with the ultimate objective of providing an office for all those Members who wanted one (ibid). Phase 1, involving the reconstruction of the buildings between Canon Row and Parliament Street, now known as 1-3 Parliament Street and 1 Derby Gate, provided offices for around 90 Members, plus other accommodation (Figure 24).

Design work started in 1984 and construction was completed in March 1991 at a cost of £40 million (ibid). Phase 2 was originally envisaged to consist of a mixture of replacement and refurbishment of all the buildings to the east of Canon Row, including 1 Canon Row and the Norman Shaw South building (Figure 25), starting with the buildings on the south of the site. However, proposals announced in 1989 to extend the Jubilee Line, which required the rebuilding of Westminster Underground station, offered the opportunity to demolish all of the buildings south of 1 Canon Row and Norman Shaw South and to cover over the District and Circle Line tracks which ran through this area, thereby providing a larger rectangular site. This would enable the construction of a single building with more accommodation than would have been possible if the station and buildings remained in their original form.

This is the building that was to become Portcullis House. Phase 2 of the development was redefined to concentrate on this building; design work started in 1991 and construction was completed in August 2000 (ibid). Phases 3 and 4 of the development of the site deal with the remaining two buildings, Norman Shaw South and 1 Canon Row. Refurbishment of Norman Shaw South is currently underway at a cost of some £15.2 million, with a planned completion

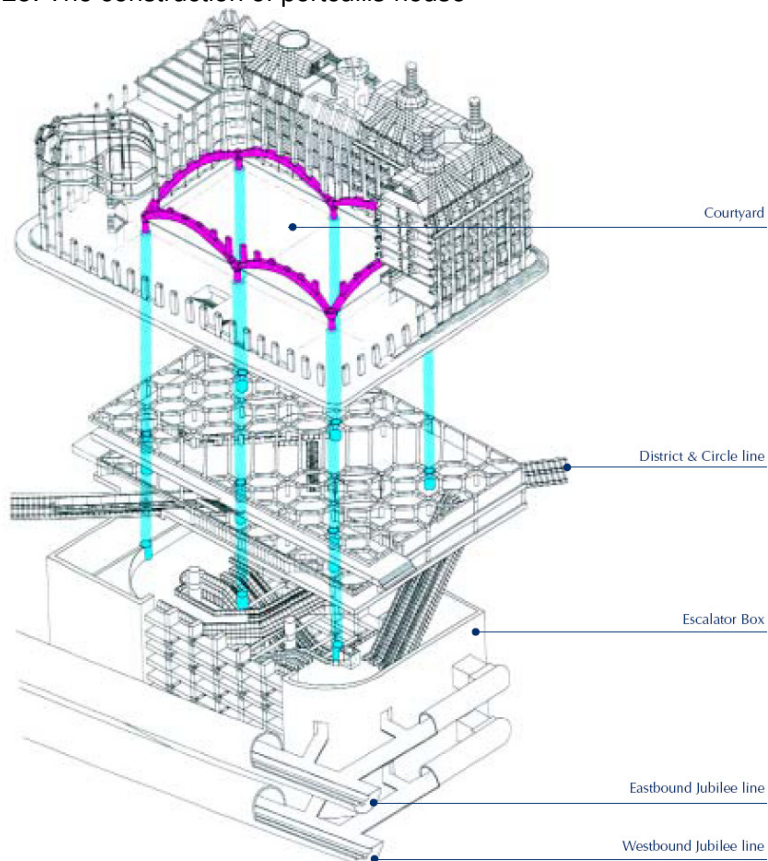
date of December 2002. The refurbishment of 1 Canon Row is planned for 2007-08 except by extensive building operations (ibid, p12).

Figure 24: The Bridge Street site before redevelopment



Source: National Audit Office

Figure 25: The construction of portcullis house



Source Michael Hopkins and Partners

Figure 23: Buildings of Particular Architectural Merit in the Vicinity of Portcullis House



- A** Palace of Westminster (Grade 1 and World Heritage Site)
- B** Westminster Bridge (Grade 2*)
- C** Westminster Abbey (Grade 1 and World Heritage Site)
- D** St. Margaret's Church (Grade 1 and World Heritage Site)

- E** Portcullis House
- F** Norman Shaw South (Grade 2*)
- G** Norman Shaw North (Grade 2*)
- H** HM Treasury (Grade 2*)

Source: NAO

Proposed Development

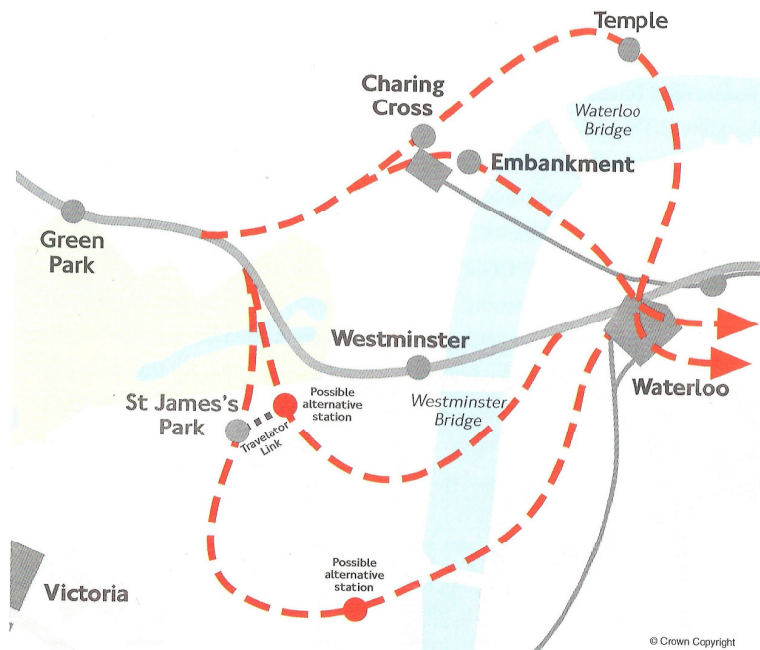
A number of potential route alignments in the Westminster area were considered by the East London Rail Study and included linking Green Park and Waterloo via Charing Cross/Temple, Embankment and St James's Park (Figure 26). However, all of these routes suffered from a number of serious disadvantages, as detailed below in Table 7.

Table 7: Evaluation of Potential Westminster Alignments

Suggested route	Advantages	Disadvantages
Embankment	Minimally satisfactory engineering standards	<ol style="list-style-type: none"> 1. Generating an unacceptable number of additional passengers at Embankment Station, which was used by more than 4 times as many passengers as Westminster and was very crowded. 2. The expansion of Embankment station was difficult, costly and disruptive.
Charing Cross/Temple		<ol style="list-style-type: none"> 1. Requiring the line to double back on itself with very tight curves. 2. Travel times would be extended. 3. Difficult engineering problems. 4. More costly scheme.
St James's Park		<ol style="list-style-type: none"> 1. Longer route. 2. more expensive 3. No adequate service around the important Westminster area.

Source: Adapted from Willis, 1997: 46

Figure 26: Potential Westminster Alignments (from Parliamentary Exhibits)



Source: Willis, 1947: 46

Therefore the decision to route the JLE via Westminster was taken because it offered the best solution in terms of engineering, cost and journey efficiency considerations. However, choosing Westminster as the preferred alignment meant that regular train services would have to be withdrawn between Charing Cross and Green Park, a section of track which had only been opened in 1979! (Willis, 1997: 47). Before construction began, the surface of Westminster station site was occupied by 60% office/retail buildings, 20% by the existing D&C Line station and the remaining 20% was a vacant car park (Bailey et al, 2000: 40). The

new station was forecast to attract four times as many passengers as the old D&C Line station (Bailey et al, 2000: 46) and has been designed to meet two principal aims:

- to make Westminster more accessible to visitors and those who work in the area, and
- to provide an interchange between the Jubilee and D&C Lines (Willis, 1997: 51).

In the event, Westminster was the final station on the JLE to be opened, on 22nd December 1999 – only just in time for the Millennium deadline (Mitchell, 2003: 156).

Key Features

Construction period: December 1993- March 2000

Client: Jubilee Line Extension Project (JLEP)

Planning authority: London Borough of Westminster

Contract value: £20m

Project team: Architects: Michael Hopkins and Partners
Civil Engineers: G Maunsell & Partners

Principal Nodes – Waterloo Station

Introduction

Prior to the operation of JLE, Waterloo station had already been an important transport node (Figure 27), where three levels of transport systems converged: three London Underground lines, South Western trains and, since 1994, international Eurostar services from Brussels and Paris. The JLE project not only served to enhance the importance of this node with its extensive office and cultural facilities around the catchment, but also provide new and modernized facilities in the station.

Figure 27: Location of Waterloo station



Source: Willis, 1997: 52

The Jubilee line crosses the site in an east-west direction, underneath the main line station, and it was decided to connect the Bakerloo and Northern line platforms with the JLE with a system of travelators (passenger conveyors). The architects proposed a radically different solution to simplify the construction and spatial clarity of these connecting tunnels by making use of the New Austrian Tunnelling Method – NATM (Paoletti, 1999: 23, detailed in Figure 29). However, due to concerns over the safety and efficacy of the NATM, although proposals were “taken to an advanced stage”, this design method was not implemented, a decision which, according to the JLEP’s principal architect, meant that an “opportunity was missed” (Paoletti, 1999: 23).

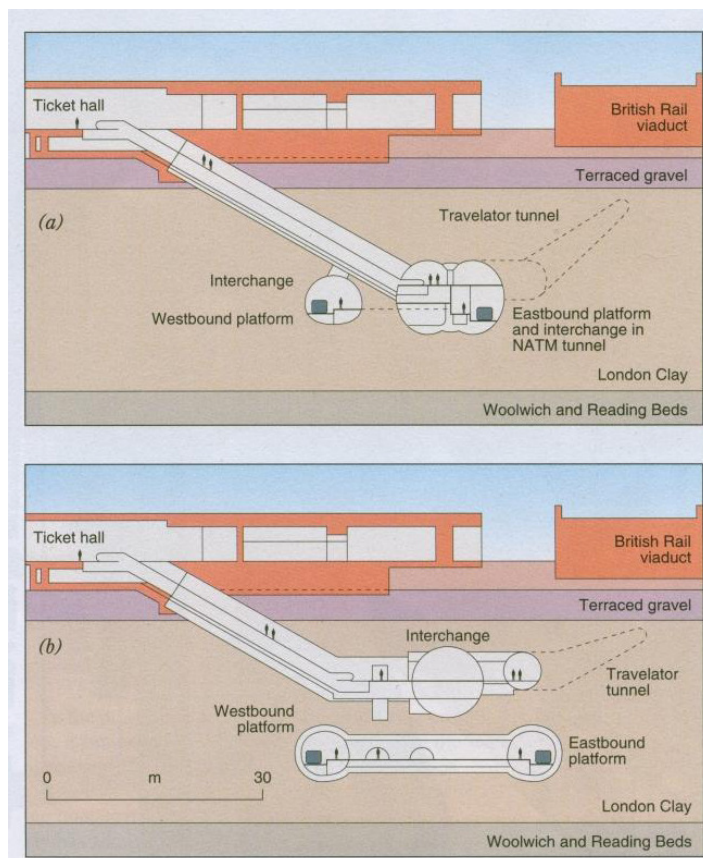
Proposed Development

Figure 28: Waterloo station from the air, showing terminal for Channel Tunnel services and local commuter trains



Source: http://image.guardian.co.uk/Guardian/travel/gallery/2007/nov/13/railtravel/waterloo_aerial1-3322.jpg [accessed 25th June 2008]

Figure 29: Proposed NATM platform design at Waterloo station



Source: Paoletti, 1999: 23

Key Features

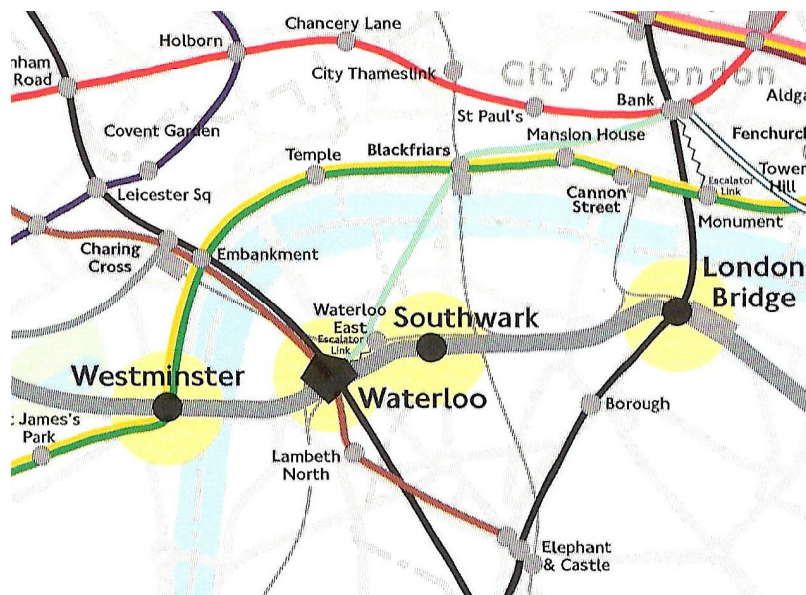
Construction period:	December 1993- March 2000	
Client:	Jubilee Line Extension Project (JLEP)	
Planning authority:	London Borough of Lambeth	
Contract value:	£157m from Green Park to Waterloo Station	
Project team:	Architects:	JLE Project Architects
	Civil Engineers:	G Maunsell& Partners
	Structural Engineer:	Brian Cole

Principal Nodes – Southwark station

Introduction

Southwark station is located at the north west corner of The Cut and Blackfriars Road, and its proximity to nationally important cultural centres such as Tate Modern means that it serves up to 7000 passengers per hour (CABE). Over 50% of these passengers use Southwark station as an interchange point to and from main line services (Willis, 1997: 54).

Figure 30: Location of Southwark station



Source: Willis, 1997: 54

Planning Context

Despite often being regarded as one of the JLE's 'marginal' stations (along with Bermondsey), Southwark station had one of the most contested planning struggles of any part of the line's development and construction. When costs initially began to spiral in 1990, the DoT questioned the economic viability of constructing a node at Southwark. However, a vigorous local lobby, led by Simon Hughes MP, campaigned extensively in favour of the station and this group's social cost-benefit analysis was accepted in October 1990 by Roger Freeman, the then Minister for Transport in London (Willis, 1997: 54). The lobby also highlighted the importance of the interchange link with Waterloo East, allowing commuters to change to the Jubilee line. This interchange became strategically important with the closure of Charing Cross station (Mitchell, 2003: 160).

The station has been demonstrated to have had a considerable uplift effect on both residential and commercial property values in the surrounding area. A 2004 report, published by Jones LaSalle Lang on behalf of TfL, estimated that land values in a 750m radius of the station had increased in value by somewhere in the order of £800 million between 1992-2002 (TfL Press Release, 7th July 2004).

Proposed Development

The station site's surface was initially occupied by vacant office premises, a restaurant and council estate garages (Mitchell, 2003: 161). The ticket hall is approximately 6m high, 20 m in diameter, and clad internally in glass and stainless steel (Figure 31). A third of its volume is above street level. Its gently domed ceiling, built in high quality white concrete, is

supported by four concrete columns, with their lower portion clad in stainless steel. Natural light enters through a round glass-block rooflight at the centre of the dome, and a second larger rooflight in front of the three escalators from this level (CABE).

The escalators descend to an intermediate concourse. This 16m high hall was constructed using 'cut-and-cover'. Although 16m below ground level, it receives natural light via a crescent-shaped skylight. This concourse is linear in plan, with one of its long walls straight, the opposing one curved, and five high level concrete beams between them. The curved wall is 40m long, made of glass, and slopes forward as it rises to the skylight. The straight wall, made of polished and coursed concrete blocks, has three arched openings to escalator tunnels leading to a lower concourse (CABE).

Figure 31: Entrance to Southwark Station



The architects were selected by a competitive tendering process. The brief centred on the three parts of the new underground station: a new entrance and ticket hall, an intermediate concourse allowing a link to Waterloo East, and a lower concourse, allowing passengers to filter to the platforms. The requirements were to maximise space for people moving through as well as passenger comfort and security.

The architects were asked to extend the interchange with Waterloo East by designing a new structure to enclose the Waterloo East ticket hall. This incorporates new stairs to the high level platforms, and subway access to the mainline platforms which are accessed at the level of the ticket hall.

Extensive consultation took place with London Underground Limited, Railtrack, Her Majesty's Railway Inspectorate, London Borough of Lambeth as the Planning Authority, and local interest groups such as the Church Commissioners. Stations designed by Charles Holden (1875-1960) provided a significant reference for the design, as well as the work of John Soane. The inspiration for the blue cone wall came from Karl Friedrich Schinkel's 1816 stage set design for 'The Magic Flute'.

As the station was for a public sector client and built below ground, its development was largely excluded from the planning process. Nevertheless, planning approval was required for the Waterloo East structure. Planning consent was also gained for a 12-storey building over the station, although this has not yet been built. A particular construction challenge

arose from a telecommunications building on the other side of the viaduct. This contains fibre optic cable running along Jones Street, boxed around and covered in concrete, and then tunnelled under for escalators from the Main Ticket Hall.

Figure 32: Interior of Southwark station



Another challenge concerned the escalators down from the intermediate concourse which had to be placed in a 'cut-and-cover' box, deep enough to avoid undermining the railway viaduct. The Waterloo East building is over a live rail network which had to be shut down over weekends. A further challenge was enclosure for the Waterloo East ticket hall, as the existing platform has no structural capacity. The consultants were appointed in January 1991, planning approval was given in 1992, and work commenced on site in 1994. The project was completed and handed over for operations in November 1999 (CABE).

Key Features

Completed:	November 1999
Client:	London Underground Ltd
Planning authority:	London Borough of Southwark
Funding body:	HM Treasury with a small portion of private funding
Contract value:	£70m
Contract:	Bespoke engineering contract
Awards:	* RFAC Trust and BSKyB Building of the Year Award 2000 (Special Commendation) * RIBA Award for Architecture, 2000

Project team:	Project Management:	JLEP
	Architects:	MacCormac Jamieson Pritchard
	Landscape Architects:	Whitelaw Turkington
	Civil Engineers:	Babtie
	Structural Engineers:	Aspen Group
	Quantity Surveyors:	Mouchels, RWS
	Services Engineers:	Drake & Skull
	Acoustic Consultant:	Paul Gillieron
	Lighting:	Maurice Brill Lighting Design Ltd

Principal Nodes – London Bridge station

Introduction

The Jubilee Line Extension (Figure 33) transformed what had been a deficient transport node at London Bridge – previously served only by the City branch of the Northern line – into a 21st century transport hub, providing an interchange with National Rail services, Thameslink and local bus services (Willis, 1997: 56). The existing Northern line station was built in 1890 and had become seriously congested by the late 1980s, leading to proposals for its redevelopment (Field et al, 2006: 26).

Figure 33: Location of London Bridge station



Source: Willis, 1997: 56

Planning Context

In the wake of the 1987 King's Cross fire and the resulting Fennell Report (1988) into the disaster, 21 stations on the Underground network were scheduled for a £600 million package of enlargement and modernisation (Mitchell, 2003: 164). London Bridge station was included in this package, and in 1989 London Underground Limited deposited a 'Safety Measures' Bill which covered works at London Bridge, Holborn and Tottenham Court Road. In 1990, during the early stages of planning and design of the JLE, it was decided to integrate the measures detailed in the 'Safety Measures' Bill into the JLEP. The works at London Bridge were therefore completed under what became known as Contract 104 (Figure 34) of the JLE project (Mitchell & Weavin, 1999: 4-10).

Figure 34: Principal Contractors on Contract 104

Activity	Contractor
Main contractor	Costain-Taylor Woodrow joint venture
Design consultants (technical contractors)	Mott MacDonald, Weston Williamson, JLE design team
Passenger rolling stock	GEC Alsthom-Metro Cammell (now Alsthom Transport Ltd)
Signalling system	Westinghouse Signals Limited (now Invensys)
Power supplies, cabling and conductor rails	Cegelec Projects Ltd (now Alsthom Drives and Controls Ltd)
Communications	Marconi Communications
Station and tunnel ventilation	Emcor (UK) Ltd and Drake & Scull Engineering Ltd joint venture
Station and tunnel services	Emcor (UK) Ltd and Drake & Scull Engineering Ltd joint venture
Lifts and escalators	O&K Escalators Ltd
Underground ticketing system	Westinghouse Cubic (now Cubic Transportation Systems)
Platform edge doors	Westinghouse Brakes Ltd
Signal control	Alcatel Canada Inc.

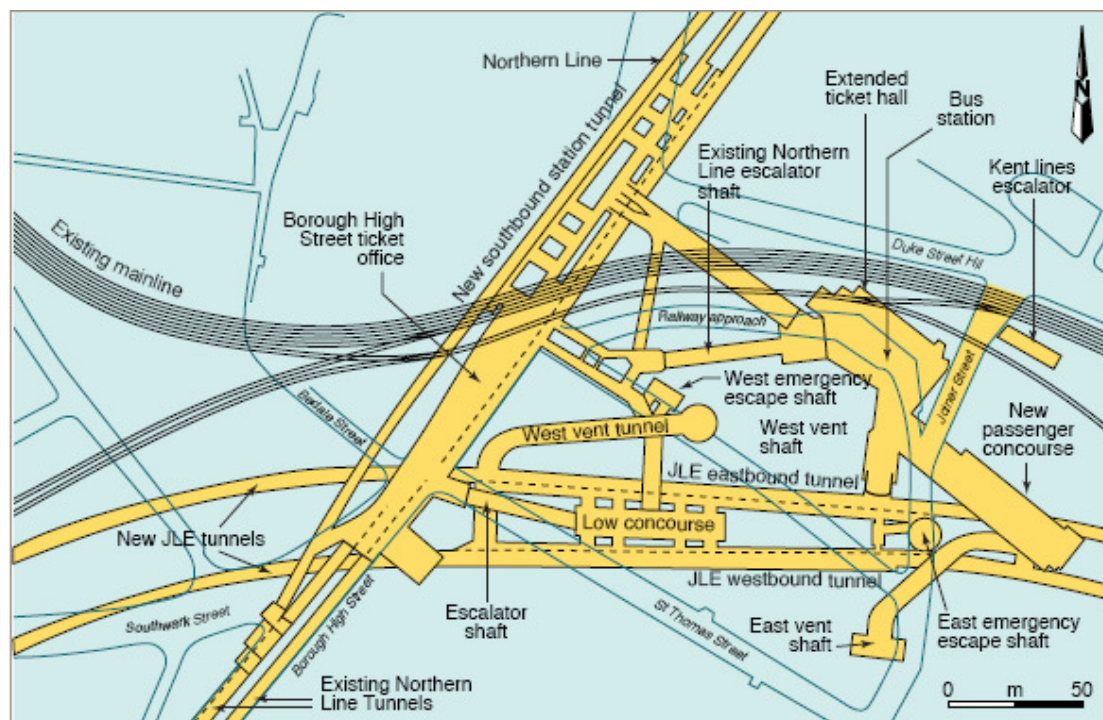
Source: Field et al, 2000: 39

Proposed Development

The original modernisation plans laid down in the 1989 'Safety Measures' Bill failed to address the key problem of poor passenger flow through the original Northern line station, with resulting congestion at the entrances/exits (Mitchell, 2003: 165). The works therefore included the expansion of the existing Northern line station and the construction of a new entrance and ticket hall for both the Northern and Jubilee lines on Borough High Street as shown in Figure 35 and Figure 36 (Willis, 1997: 56). A number of the original tunnels and building shafts have been re-used by the JLE to provide ventilation, cable routes and draught relief (Mitchell, 2003: 164). Creative use was made of the original brick vaults, dating from various periods of the nineteenth and twentieth centuries, which were used to support the floor of the main line station and create a much enlarged Underground ticket hall.

The construction of the station necessitated the permanent closure of Joiner Street and extensive traffic studies were carried out in order to convince the Department of Transport that diverted traffic could be satisfactorily accommodated on adjacent roads (Willis, 1997: 56). The end result, as Mitchell (2003: 165) describes, is a "fine example of how old infrastructure can be adapted to modern requirements...[enhancing] links with the local community." London Bridge station was predicted to be used by up to 17,000 passengers each weekday morning peak hour, with 55% of this total using the station to change to and from main line services (Willis, 1997: 56).

Figure 35 :Layout of works at London Bridge station



Source: Field et al, 2000: 26

The construction of the JLE also related to potential development in the neighbouring area. The project involved the demolition of an existing 1970's building, Southwark Towers, and the construction of a 305m high, 60-storey building comprising 127,493sq m of offices (with the potential to accommodate 5,300 employees), a hotel and 14 apartments together with retail, restaurant and a health and fitness club. Only 48 car parking spaces are being sought, reflecting the close proximity to the station. The development was granted planning consent in November 2003 following a Public Inquiry. The consent is dependent on improvements to London Bridge mainline station being carried out. This will be a landmark building of

considerable architectural quality (designed by Renzo Piano). The JLE makes development at London Bridge more attractive to developers with its much improved accessibility to the West End and to the Isle of Dogs (and Canary Wharf Estate).” (University of Westminster WP54).

Key Features

Construction period: December 1993- Sep 1999

Client: Jubilee Line Extension Project (JLEP)

Planning authority: London Borough of SouthWark

Contract value: £ 76M

Project team: Architects: JLE Project Architects (1990-1999)
Weston Williamson (1991-1994)

Civil Engineers: Mott MacDonald

Figure 36: The extended main Underground ticket hall was carved out of the brick arch undercroft beneath the mainline station



(Source: Field et al, 2000: 35)

Canada Water station

Introduction

The Canada Water station where the JLE intersects the East London line is located at the junction of Deal Porters Way and Surry Quays Road and also in the domain of the London Docklands Development Corporation (LDDC). Apart from the new JLE link, a bus station is also built as part of the integration of transport interchanges (Figure 37).

Figure 37: Interchange at Canada Water Station



Source: http://www.ejal.com/PAGES/1_4_3.html [accessed 30th June 2008]

Planning Context

The location of Canada Water is within the old Canada Dock which partly belonged to the Surry Docks' Estate. (Mitchell, 2003: 169) Canada Water station is the only station of the JLE which was close to the proposed Fleet Line –Surry Docks (ibid, p.170). Due to poor transport links, the area initially did not expand in line with London, and most of the development in Rotherhithe focused more on the areas closer to the river. This changed in 1999 when the newly opened Jubilee line extension brought a much needed boost to local transport infrastructure. With the opening of the new Canada Water tube station, the area is now well connected to the rest of London, with Canary Wharf one stop, Westminster less than 10 minutes, and Bond Street around 15 minutes away by tube. (LBS, 2009).

Proposed Development

A number of development projects were located around the station. For example, “the Surry Docks area has undergone much redevelopment in recent years, with substantial new housing on the peninsula, the building of Surrey Quays Shopping Plaza and Associated Newspapers’ printing plant close to the station site.” (Willis, 1997:60) Furthermore, “some 6,000 jobs and 10,000 residents are estimated to be within a 15 minute catchment of the station on completion of development, and around 6,700 passengers will use the station in the morning peak hour” (ibid, p60).

According to the impact study of the JLE, “Southwark Council has recently chosen a developer for the development of 16 hectares (40 acres) of land adjoining the Canada Water site. The development will comprise public facilities, a market, affordable housing and commercial development. It will include 2,000 new homes, 9,300 sq.m (100,000 sq.ft) of offices and live-work space (with the potential to accommodate 1,000 employees), a department store, a library and community facilities. Whilst it has taken some time for a large-scale development to emerge (this was in part due to some of the land being required for the construction of the JLE), it now seems that a much more intense development appropriate to a station with a high level of public transport accessibility will be achieved. The scale of development is likely to have been much reduced if the JLE were not available and may have been similar to the earlier low-density development in the Canada Water area.” (University of Westminster WP54)

Key Features

Construction period:	November 1993- May 1999
Client:	Jubilee Line Extension Project (JLEP)
Planning authority:	London Borough of Southwark
Contract value:	£ 22M
Project team:	
Architects:	JLE Project Architects (1991-1999), Herron Associates (1991-1993)
Civil Engineers:	Sir William Halcrow & Partners
Structural Engineer:	Benaim Works, Buro Happold (Glazed drum)

Canary Wharf station

Introduction

Canary Wharf station is the focal point of the JLE because it was located in the heart of the Isle of Dogs, close to the Canary Wharf development and regarded as a catalyst to enhance the regeneration effects of the Isle of Dogs' area. "The land around the station has already undergone major redevelopment and it is anticipated that the construction of the line will trigger a second wave of development on the remainder of Canary Wharf, Heron Quay and North Quay sites" (Willis, 1997: 62). The primary role of the station is to "serve the huge and expanding Canary Wharf development but it also provides an interchange with the Docklands Light Railway and local bus services" (Mitchell, 2003: 172).

Prior to Canary Wharf JLE, the Docklands Light Railway was the only existing line to serve the Canary Wharf development area. The new Jubilee line station could not be conveniently integrated with the DLR due to the uncertainty surrounding funding for the JLE and the potential delays this could have caused to building the office development. "Interchange will be available with the Docklands Light Railway at Canary Wharf but disappointingly it will not be very convenient. With the elevated DLR station in the heart of the development and the low level Jubilee line away from the main axis to the south, the interchange time will be 4-5 minutes and involve a street level walk. In the early stage of planning an option to put the JLE much closer to the centre of development was considered. However, with the uncertainty over the funding and approval of the line, developers Olympic & York could not afford the inevitable delay this would have caused to the office construction programme" (Willis, 1997: 62) The London Underground Limited (LUL) commissioned an enabling works¹⁰ in advance of the main station works that might also have contributed to the difficulty of integration of DLR and JLE at Canary Wharf. For instance, "Back in 1990, Olympia & York wanted to retain responsibility for design and construction of the new station and has produced initial designs for LUL's consideration. However, LUL wanted to retain direct control within the project team and it was agreed that O&Y going into administration in May 1992, it was decided to undertake a separate enabling works contract in advance of the main station works" (Mitchell, 2003: 173).

Architecture and construction of the Canary Wharf station were unique and regarded as a good example of a modern underground station (See Figure 38, Figure 39 and Figure 40) (Willis, 1997:62) More details of the features were described as follows. "Constructed using 'cut-and-cover' techniques, the station itself is entirely underground. The only elements of the building that are visible externally are the vaulted glass canopies above the entrances. The roof of the station - the building's 'lid' - has been landscaped as a public park, with grass, trees, seating, fountains and paths. On entering the station concourse from either the platforms or from surface level at Canary Wharf, the large size of this space makes a notable impact. Internally, the station's scale is monumental. However, effective organisation of the space and clear design, including good lighting, create a reassuring passenger experience within the space. The building is commended for its clarity, simplicity, spatial quality and memorable image."

(Source: <http://www.cabe.org.uk/default.aspx?contentitemid=1096>)

¹⁰ Concerning the details of the enabling work, please refer to Mitchell, 2003: pp 173-174.

Figure 38: Entrance to Canary Wharf Station



Source: <http://www.wirednewyork.com/forum/showthread.php?t=6580&page=8> [accessed 24 June 2008]

Figure 39: Canary Wharf Station Ticket Office



Source: <http://www.wirednewyork.com/forum/showthread.php?t=6580&page=8> [accessed 24 June 2008]

Figure 40: Platform with Safety Barriers at Canary Wharf Station



Source: <http://www.wirednewyork.com/forum/showthread.php?t=6580&page=8> [accessed 24 June 2008]

Planning Context

The background of planning Canary Wharf station in the alignment of the JLE had been associated with regeneration of the Isle of Dogs. How to integrate the Isle of Dogs with the rest of London was a core issue identified in the London Docklands Strategic Plan. “In 1976 the London Docklands Strategic Plan identified the need for a major upgrading of all forms of transport. It also established priorities such as the immediate need to improve bus services, a new underground line into Docklands, construction of new local roads and the building of a new relief road between Canning Town and Limehouse”.

The redevelopment of the Isle of Dogs was restricted as access to the river and dockside was limited by the absence of direct underground lines, the infrequent bus services running around the outside of the Isle of Dogs peninsula, and extremely poor pedestrian and cycle facilities. Despite the advent of Docklands Light Railway, which was decided in 1982 and opened in 1987, the provision of DLR could not meet the demand as further office developments were announced by O&Y. “In 1984, 8 million sq. ft (740,000 sq. metres) of development was projected for the Isle of Dogs and the railway was planned accordingly. By 1987 12 million sq. ft (1.1 million sq. metres) was committed to be built at Canary Wharf alone.” Therefore, further extension and upgrade of the DLR was implemented. “The DLR extension to Bank and upgrading to accommodate double length carriages was agreed by Olympia & York with London Underground when the development deal was done with the Corporation. The Bank extension, partly funded by Olympia & York, opened in 1991, the Beckton extension, funded for the most part by the LDDC, in 1994.”

Despite the DLR and its extension to Bank, the JLE alignment across the LDDC area was the final and decisive link for the Canary Wharf development “ensuring close transport

contact with the West End ... due to open before the end of 1998. This will make travelling to Canary Wharf from London Bridge, Waterloo, and Green Park, just as convenient and fast as a journey to the City."

Source: <http://www.lddc-history.org.uk/iod/index.html#EZ> [accessed 24 June 2008]

Proposed Development

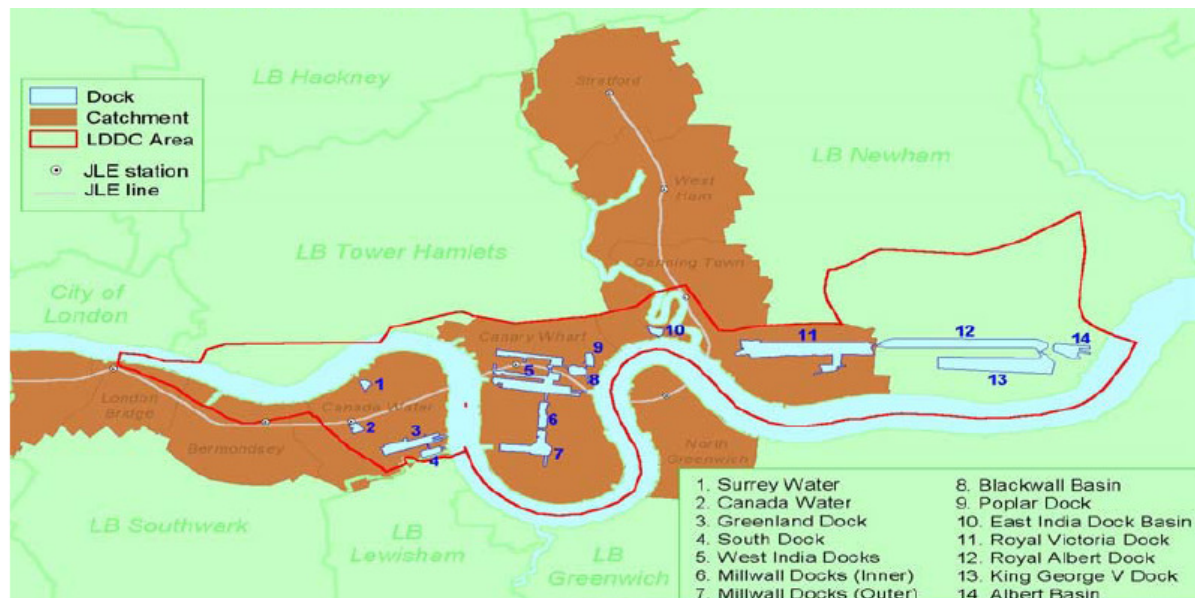
The new Canary Wharf station in the JLE alignment is the core area for the London Docklands Development (LDDC), particularly for the Isle of Dogs. "It is forecast that, on completion of development, Canary Wharf station will eventually be used by up to 40,000 passengers in the morning peak hour, making it one of the busiest on the Underground" (Willis, 1997:62)

In order to regenerate the post-industrialised area, the establishment of LDDC was made in the early 1980s, prior to the JLE.

London Docklands Development Corporation (LDDC)

The London Docklands Development Corporation (LDDC) (see **Error! Reference source not found.** below), an urban development corporation, was established on 2nd July 1981, the second to be established by the then Secretary of State for the Environment, Michael Heseltine, under s.136 of the Local Government, Planning and Land Act 1980. Its object was to secure the regeneration of the London Docklands Urban Development Area (UDA) comprising 8½ square miles of East London in the Boroughs of Tower Hamlets, Newham and Southwark. This was a response to a huge decline in the economy of the area brought about by the progressive closure of the docks in the 1960s onwards (Figure 42).

Figure 41: Relationship Between the Route of the JLE and the LDDC Area



Source: <http://www.lddc-history.org.uk>

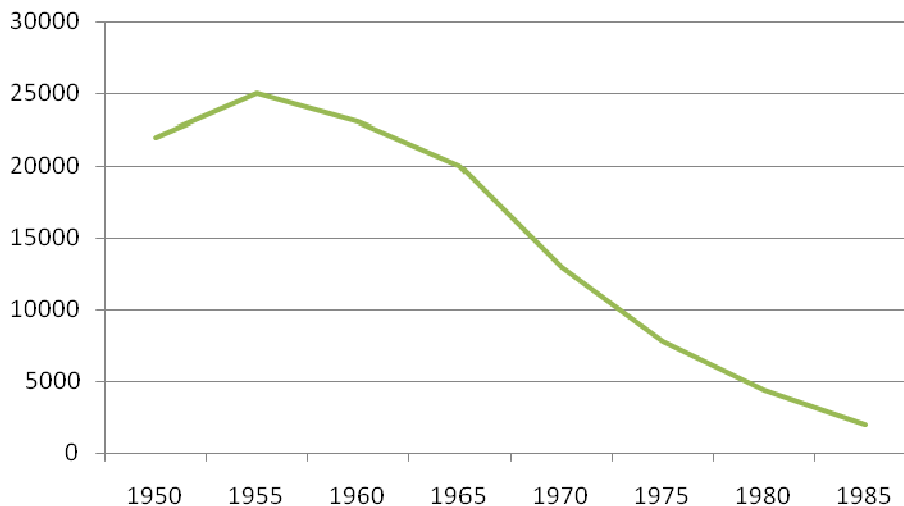
The economy had been decimated by the closure of the docks:

- The population of London Docklands fell by 20% between 1971 and 1981.

- The unemployment rate in London Docklands in 1981 was 17.8%.
- In the three years between 1978-1981 10,000 jobs were lost in London Docklands.
- In 1981 60% of the area was derelict, vacant or under-used.

Source: <http://www.lddc-history.org.uk/lddcachieve/index.html> [accessed 22nd June 2008]

Figure 42: Graph Showing Docklands Employed from 1950 to 1985 (thousands)



Source: <http://www.123helpme.com/view.asp?id=120871>

Canary Wharf development

“The current plans for Canary Wharf Estate are to continue development to a total floorspace of 2.4 million sq.m (26 million sq.ft). The full development of the estate may depend on upgrading the JLE and further public transport services to the Isle of Dogs.” (JLEISU, 2004)

“To the south of the Canary Wharf Estate, plans for the regeneration of the Millennium Quarter are beginning to materialise illustrating the effect of achieving a ‘critical mass’ in order to secure development in adjoining areas. The plans for the Millennium Quarter provide for 465,000 sq.m (5 million sq.ft). of commercial floorspace (with the potential to accommodate 19,000 employees, including already *in situ*) and 2,000 residential units.” (ibid, 2004). 40 buildings are currently listed as under construction on the site, of these 11 are complete and 9 are nearing completion. (Emporis, 2009).

“To the east of the Estate, plans for the regeneration of Wood Wharf have been put forward in a masterplan supported by the various landowners and Tower Hamlets Council. The plan includes about 335,000 sq.m (3.6 million sq.ft). of commercial floorspace (with the potential to accommodate 14,000 employees) and 1,500 residential units.” (JLEISU, 2004)

“All of the above development will be within accepted walking distance of the Canary Wharf station and the scale and density proposed is far in excess of what would have occurred if the JLE had not been built.”

“It is clear that the accessibility provided to the Isle of Dogs by the JLE has enabled a very dense development to proceed in the immediate area around the station and is now spreading to areas further away from it. Confidence of developers has been restored by the

arrival of the JLE, which had flagged after the property recession of the early 1990's." (ibid, 2004)

"At present, approximately 14.1 million square feet of office and retail space has been constructed. The first tenants moved into Canary Wharf in August 1991. Now over 90,000 people work here. Currently the development comprises over 30 completed buildings and over 200 shops, bars and restaurants within four retail malls. It also has a conference and banqueting centre, two Dockland Light Railway stations, a Jubilee Line station, car parks and approximately 20 acres of landscaped open spaces." (Canary Wharf Group, 2008)

Table 8 below charts the development of the Isle of Dogs into the Canary Wharf Development

Table 8: The history of transformation of the Isle of Dogs into Canary Wharf development as below:

Year	Month	Events
1970s		New technology and containerisation meant that London Docklands couldn't keep up with its competitors and by the early 1970's most of the docks had closed - West India Dock closed in 1980.
		In 1971 the PLA employed 6,000 people and only 3,000 by 1981.
		Between 1966 and 1976 the five London Docklands boroughs lost 150,000 jobs. This represented 20% of all jobs in the area. This can be compared to 2% for the whole of Great Britain.
		The Port of London Authority closed the East India Dock in 1967 and St. Katharine and London Docks in 1968.
		During the 1970's there was massive disinvestment in Docklands as businesses closed or moved away with the progressive closure of the dock system.
		Between 1978 and 1980 the PLA closed the West India and Millwall Docks.
1980-1981		The London Docklands Development Corporation (www.lddc-history.org.uk) was created by the local Government Planning and Land Act 1980. It's job was to secure regeneration by: <ol style="list-style-type: none"> 1. Bringing land and buildings into use. 2. Encouraging industry and commerce. 3. Creating an attractive environment. 4. Assisting in the provision of housing and social facilities to encourage people to live and work in the area. 5. The PLA close the Royal Docks.
1981	July	Speaking of the plight of London Docklands in 1981, the Environment Secretary Michael Heseltine said: "The area displays more acutely and extensively than any area in England the physical decline of the urban city and the need for urban regeneration. It represents a major opportunity for the development that London needs over the last twenty years of the 20th Century: new housing, new environments, new industrial developments, new architecture - all calculated to bring these barren areas back into more valuable use."
1982-1985		The Isle of Dogs becomes an Enterprise Zone which offered tax allowances to both investors and developers. The enterprise zone designation had a 10 year life cycle.
		G Ware Travelstead proposed building a 10 million sq. ft office complex on Canary Wharf. G Ware Travelstead was unable to fund his scheme and it was taken over by North American developers Olympia & York.
		Following detailed negotiations with Olympia & York Canary Wharf Ltd., the Private Bill for the extension to Bank on the Docklands Light Railway was deposited, receiving Royal Assent in Nov. 1986. The extension opened in 1991.
1987		Docklands Light Railway opened. London City Airport opened. Canary Wharf contract signed. The Newham Compact signed. Daily Telegraph and Guardian

		move from Fleet Street to the Isle of Dogs.
	July	The master building agreement was signed between Olympia & York and the LDDC (www.lddc-history.org.uk) for a 12.2 million sq. ft. development at Canary Wharf
	October	London City Airport opened for business.
		Docklands Light Railway starts running, Britain's first ever automated light rail transit system.
1988	May	Construction begins at Canary Wharf.
1990	November	The steel pyramid is placed on One Canada Square.
1991	August	First tenants move to Canary Wharf (State Street).
1992	April	Telegraph Group Ltd move into One Canada Square.
	May	Olympia & York Canary Wharf Ltd. goes into Administration.
1993	October	Olympia & York Canary Wharf Limited exits from Administration, renamed Canary Wharf Limited.
	December	Jubilee Line Extension construction starts at Canary Wharf. Working population approximately 7,000. 15 shops and restaurants.
1994	December	Working population approximately 12,800. 27 shops and restaurants.
1995	June	Live TV starts broadcasting from Canary Wharf. Docklands Light Railways weekend service commences.
	December	Sale of Canary Wharf to international consortium completed. Principal investors: Paul Reichmann; CNA Financial Corporation (83% owned by Loews Corporation); Franklin Mutual Series Fund; Affiliates of Republic New York Corporation; HRH Prince Al Waleed bin Talal bin Abdulaziz al Saud. Canary Wharf is 75% leased. Working population approximately 13,000. 42 shops and restaurants.
1996	December	Working population approximately 14,000
1997	February	Hotel Properties Ltd, Pidemco Land Ltd and Canary Wharf Limited sign joint venture agreement to develop Canary Riverside.
	December	Working population approximately 25,000.
1999	February	Canary Wharf existing buildings are 99.5% let. Boots become the first retailer to sign for the new Canada Place shopping mall at Canary Wharf.
	April	Canary Wharf floats on London Stock Exchange.
	September	Canary Wharf's Jubilee Line station opens on 24th September
	November	Docklands Light Railway extension to Lewisham opens.
	December	-Jubilee Line Extension opens through to Green Park, completing its through route from Stanmore to Stratford. -Working population approximately 27,000. -90 shops and restaurants.
2000	March	Canada Place retail mall opened on 28th March 100% pre-let.
	December	Working population approximately 35,000.
2001	December	Working population approximately 41,000.
2002	November	The first Green Canary Day is held to promote environmental awareness in the workplace. This new initiative, set up by Canary Wharf Group, is a free event featuring a series of displays and exhibition stands.
	December	Working population approximately 55,000.
2003	July	A third retail mall opens to the public on 18 July 2003. 38 shops, bars and restaurants open at Jubilee Place, an additional 89,500 sq ft retail mall. Marks & Spencer Food is the anchor store.
	October	The East Wintergarden, a new events venue, opens. This glass-covered atrium, designed by Cesar Pelli, is a unique space accommodating up to approximately 800 people. It features a 27-metre high arched glass roof structure, 682 sq m of uninterrupted Italian marble floor and steamed beech

		wooden wall panelling.
	December	Working population approximately 60,000. There are now over 200 shops, bars and restaurants on the estate.
2004	February	London Pedicabs launches a new free, sustainable transport initiative at Canary Wharf.
	May	On 21 May the Songbird Acquisition Limited ('SAL') offer for Canary Wharf Group plc, the ultimate parent company of the Canary Wharf group of companies, was declared wholly unconditional.
	July	When the SAL offer closed on 15 July 2004, SAL, together with its parent company Songbird Estates plc, held 66.3% of Canary Wharf Group plc. Canary Wharf Group plc was delisted from the London Stock Exchange.
	December	Working population approximately 64,000.
2005	January	British Waterways names Canary Wharf Group as the preferred partner in its re-development of the Wood Wharf site, which lies adjacent to the Eastern side of the Canary Wharf estate. The masterplan scheme will be approximately 5 million sq ft of mixed commercial, residential and retail.
	September	Canary Wharf becomes Europe's largest business district to offer WiFi technology.
	December	Working population approximately 82,000.
2006	January	Construction re-commences at Canary Wharf with agreement reached to construct 4 new buildings.
	December	Working population approximately 90,000.
2007	June	Formed a joint venture with Morgan Stanley Real Estate Fund V (MSREF V) and Exemplar Developments LLP, on behalf of Omega Land BV to undertake the redevelopment of the 300,000 sq ft Drapers Gardens scheme in the City of London and also acquired 20% of the share capital in the companies that own the property.
	October	The Government agreed to finance Crossrail and we reached an agreement to design, build, finance and contribute to the new Crossrail station at Canary Wharf.
	December	Working population approximately 93,000.

Source: Canary Wharf Group, 2008

Figure 43: Development in Canary Wharf - 1992



Source: JLEISU (2004)

Figure 44: Development in Canary Wharf - 2003



Source: JLEISU (2004)

Key Features

Completed: 1999

Client: Jubilee Line Extension Project (JLEP)

Planning authority: London Borough of Tower Hamlets

Funding body: Public and a small portion of private financing

Contract value: £30m

Project team: Architects : Foster and Partners

Quantity Surveyors: Davis Langdon and Everest

Structural Engineers Architectural Fit-out: Ove Arup and Partners

Civil Engineers: Posford Duvivier and De Leau Chadwick

Electrical and Mechanical Consultants: JLEP

Electrical and Mechanical Contractors: Drake and Skull

Landscape Consultants: Land Use Consultants

Source: <http://www.cabe.org.uk/default.aspx?contentitemid=1096&aspectid=8>

North Greenwich station

Introduction

“North Greenwich is the largest station on the Jubilee Line Extension. It was built to serve the Millennium Village and other developments on the Greenwich Peninsula, both new and existing.” The station is not only a new underground node but also a multi-modal transport interchange, including “a new bus station and potentially a large car parking area to support “park and ride” facilities” (Mitchell, 2003: 177)

“It is situated totally underground and is approached through a new bus station, with which it forms an integrated transport interchange. The bus station is at ground level, and the actual entrance to the underground station is the top of the escalators that take passengers down from the concourse of the bus station. The underground station is expressed externally only by its ventilation shafts.” (CABE, 2009)

Figure 45: Construction of North Greenwich JLE Station



Source: <http://www.gold.ac.uk/world/millen/planning/northgreen.html>

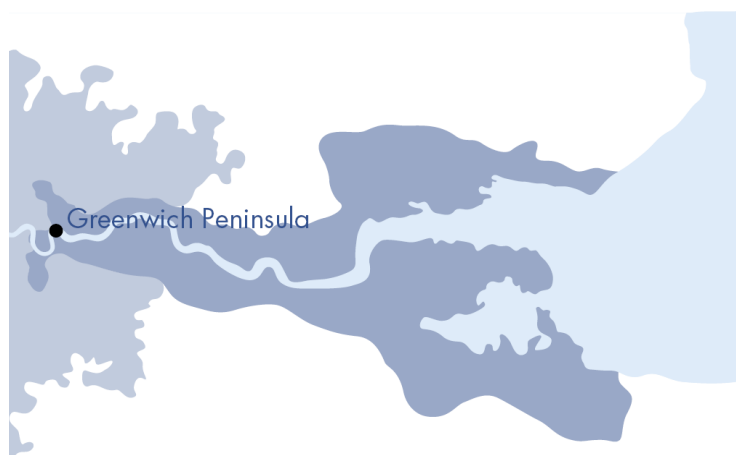
Planning Context

The surrounding area in North Greenwich was historically a base known for a range of manufacturing industries. “In 1867, the Greenwich Peninsula was known as Greenwich Marshes with Blackwall Point or Lea Ness as its northern extremity and mainly consisting of fields except for the isolated Blakeney Ordnance Company Works and chemical works on the banks of the Thames. Further south, there was the London Steel and Iron works and the Iron Boat Building Yard. From these industrial beginnings, one of the largest gas works in Europe Grew to dominate the area along with various other industries” (Mitchell, 2003:176).

North Greenwich station was not adopted in the original parliamentary bill lodged in 1989. (Mitchell, 2003:177) “The railway between Canary Wharf and Canning Town was routed north of the Thames via Brunswick instead. This option, and the alternative of crossing to North Greenwich and back again, both featured in the East London Rail Study” (Mitchell, 2003: 177)

The further decisive factors for changing to the Northern Greenwich station are twofold. Firstly, the great regeneration potential was proposed in the North Greenwich and further development at Brunswick was enhanced. Therefore, the effect of the Jubilee line extension via the Brunswick area would be relatively small. The North Greenwich area was barely served by the public transport and had a great potential of redevelopment around the Greenwich Peninsula. In addition, the Reuters offices, the Financial Times printing plant and a major office complex were developed around the Brunswick area. Secondly, the financial support from the landowners, British Gas were provided (Willis, 1997:45).

Figure 46: The Greenwich Peninsula in Relation to the Thames Gateway



Source: NAO 2005

Proposed Development

Initial plan

“The main purpose of bringing the line south of the river at this point was to stimulate and support regeneration of the large areas of land formerly occupied by the largest coal gas plant in Europe, but when authority was given to start construction , there were no firm plans for development around the station” (Willis, 1997: 64)

Millennium Dome

The millennium Dome was announced by the Government to be located at the site of around North Greenwich station after the construction work of the JLE for the main UK celebration to mark the end of the Millennium. “Plans are to focus on a large exhibition dome which could attract up to 100,000 visitors a day. With the aim of ensuring that nearly 100% of visitors travel to and from the site by public transport the Jubilee line extension was a critical element in the decision to choose the North Greenwich site” (Willis, 1997: 65). In addition, Mitchell (2003) argues the station site “was at least five years before the Greenwich Millennium Dome had been thought of and, in fact, the station was the catalyst for the Dome and not the other way round” (Mitchell, 2003: 177).

Regeneration of the Millennium Dome and Associated Land

“Following the closure of the Dome at the end of 2000, the Government has been identifying future uses of the Dome and its disposal together with land around the building. The purchaser, Meridian Delta, have recently submitted a planning application for the site, currently owned by English Partnerships, for a 26,000-seat sports arena (in the Dome) and a mixed-use scheme, including 340,000 sq.m (3.65 million sq.ft) of offices (with the potential to accommodate 14,000 employees). The Masterplan also includes 33,000 sq.m (355,000 sq.ft) of retail, over 10,000 new homes, a school and a hotel. The Plan proposes that the new homes will be built in eight to ten storey blocks, with residential towers up to nineteen storeys on the riverside.” JLEISU (2004)

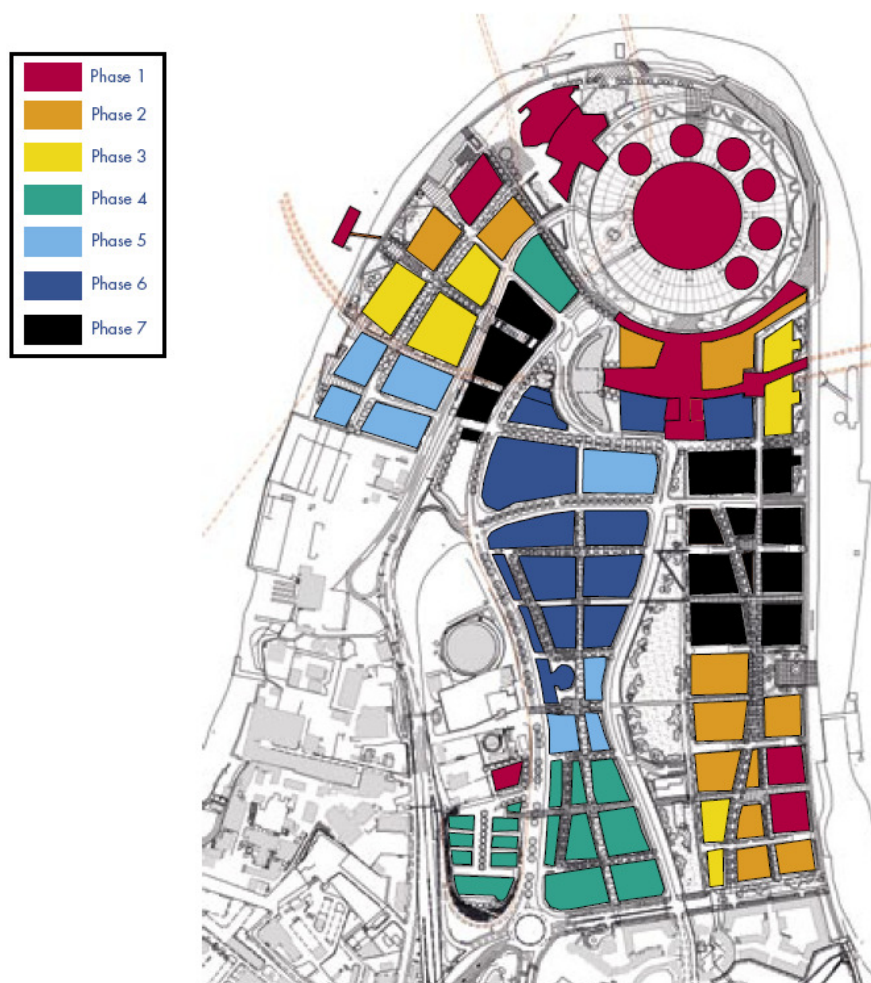
“Greenwich Council support the proposal but consider that the office development should be limited until the JLE is upgraded and other transport infrastructure is provided. The type and density of development proposed has been made possible by the transport capacity of the JLE and it would appear that developers now have confidence in the peninsular, which was not there prior to the construction of the new line. However, it should be noted that considerable expenditure was made on land decontamination and other infrastructure to enable the Dome to be built for the Millennium Exhibition.” JLEISU (2004)

Figure 47: The Millennium Dome and Associated Land



Source: NAO 2005

Figure 48: Development Phases for the Greenwich Peninsula



Source: NAO 2005

Key Features

Completed: 1999
Client: Jubilee Line Extension Ltd
Planning authority: London Borough of Greenwich
Funding body: Jubilee Line Extension Ltd
Contract value: £110m circa, including station, section of tunnelling, satellite access and ventilation structures

Project team: **Design team:** Alsop Architects (formerly Alsop and Störmer)
Project initiated by: Alsop Lyall and Störmer
Engineers: Benaim Works Joint Venture
Main Contractor: McAlpine - Wayss & Freytag - Bachy Joint Venture
Main Contractor (M&E Service): Drake & Skull Ltd.

Source: CABE, 2009

Canning Town station

Introduction

Canning Town station is an interchange between DLR, Bus service and the JLE. “The new station at Canning Town was one of the most difficult to get right. The end result, however, was worth waiting for as the new rail and bus interchange is proving a spur to regeneration and making travel by public transport in this part of the capital a lot easier”(Mitchell, 2003: 180)

The complication of integration of different transport modes can be reflected in the station design. “The station design includes a double deck arrangement with the Docklands Light Railway platforms above the Jubilee line and alongside those of the North London Line. Beside the railway station complex there will be an important new bus interchange station, providing feeder routes to the large neighbouring residential areas to the east and accommodation for a dedicated shuttle bus service to the growing London City Airport”.(Willis, 1997:66)

Figure 46 – Canning Town Station Canopy and Bus Interchange



Source: <http://www.chiark.greenend.org.uk/>

Figure 47 – Jubilee Line Platform 3



Source: <http://www.chiark.greenend.org.uk/>

Planning Context

“Before the advent of the JLE, Canning Town was in desperate need of improved transport”.

“When detailed planning of the JLE started, it was realised that whatever solution was chosen, it would have an impact on the DLR. Moreover, the desire to create a transport interchange, including a bus station, posed a tremendous challenge because of the confined site.”

“The preferred scheme for LT on cost-benefit grounds was the one combining the DLR and JLE side by side in a new station south of the A13-leaving the BR station marooned to the north in its existing location. It was proposed to provide a new subway joining the two stations. The new bus station would be located alongside the DLR/JLE station, adjacent to Victoria Dock Road.”

The proposal was opposed strongly, especially by the local authority, the London Borough of Newham. The negotiation and understanding between different organisations were needed and a final scheme which challengingly and properly integrated different transport modes and create a good transformation was achieved. (Mitchell, 2003: pp180-182.)

Key Features

Construction period: January 1994- October 1998

Client: Jubilee Line Extension Project (JLEP)

Planning authority: London Borough of Newham

Contract value: £ 10.5M

Project team: Architects : JLE Project Architects Van Heyningen & Haward (1994-1999)

Structural Engineer: Kenchington Ford/WSP consulting Engineers

West Ham station

Introduction

West Ham Station provides the link to the important district and Hammersmith & City lines serving outer areas of east London and a key route for those travelling to work in Docklands and southern parts of the central area. (Willis, 1997:67)

Figure 49: West Ham Station



WikiCommons (2009)

Figure 50: Platform at Westham Station



WikiCommons (2009)

Planning Context

The site at West Ham was also difficult to cope with because two railway alignments converge here on different levels and almost at right angles. "At the upper level, LUL's District and Metropolitan lines run alongside the LT&S main line. At the lower level, the North London line was paralleled by two semi-disused freight tracks, the intention being that the JLE would take over the freight tracks." (Mitchell, 2003:183)

The project team initially created an improved interchange on this challenging site, linking the District line with the new Jubilee line and the North London line "Behind the gateline"(Mitchell, 2003:184) however, different considerations from BR and budget point of view could not lead to an agreement. The Her Majesty's Railway Inspectorate (HMRI) involved in the solution to the contradiction. (Mitchell, 2003:184)

Proposed Development

"West Ham station is at the heart of the Stratford Development Partnership area and has the potential to greatly assist in the stimulation of local development. The borough is also keen to encourage local tourists and leisure facilities, focusing on the nearby historic Abbey mills." (Willis, 1997:67)

Key Features

Construction period: November 1993- May 1999

Client: Jubilee Line Extension Project (JLEP)

Planning authority: London Borough of Southwark

Contract value: £ 22M

Project team: Architects: JLE Project Architects (1991-1999) , Herron Associates (1991-1993)

Civil Engineers: Sir William Halcrow & Partners

Structural Engineer: Benaim Works, Buro Happold (Glazed drum)

Stratford station

Introduction

The Jubilee line extension platforms at Stratford are located at the west of the North London line and south of the high level platforms on the existing Railtrack station complex.(Willis, 1997:68) The main role of this station is to offer an interchange between mainline services and the Central line and eventually Crossrail (ibid).

“Stratford Station is a new surface level building comprising 4000m² of internal accommodation, concourse and subways.” (Cabe, 2009b)

“It serves as a terminus for the new Jubilee Line Extension to the London Underground. The building replaces a below ground station that served four separate lines: the North London overland rail service, which runs roughly north-south parallel to the Jubilee Line between Canning Town and Stratford; London Underground’s Central Line which runs east-west; the Great Eastern mainline rail service to Liverpool Street Station; and the Docklands Light Railway.” (Cabe, 2009b)

“The project therefore involved provision of an interchange between existing lines and the new one. The station was also intended as a catalyst to regenerate the Stratford area.” (Cabe, 2009b)

“The architects designed an elegant building, rectangular in plan, with a curved roof. The envelope is substantially glazed. The interior provides concourse accommodation on two levels, and access by tunnel to the Central Line and mainline service to Liverpool Street. “ (Cabe, 2009b)

Figure 51: Stratford Station



source: http://www.astecprojects.co.uk/market_sectors/transport/rail/

Figure 52: Gantry at Stratford Station



Source: Cabe, 2009b

Planning Context

During the earlier planning process, the London Borough of Newham made a suggestion about an additional station in the south of Stratford to serve possible developments and an existing residential area around Stratford Market. However, despite of the proximity of both Stratford and West Ham stations, the forecast of passenger demand was not sufficient to justify the cost involved. (Willis, 1997: 68)

Afterwards The Channel Tunnel Rail Link at Stratford which would be an international and domestic station was not confirmed until 1996. This enhances the importance of Stratford station by not only regionally provides a very attractive link for commuters from Kent, on the proposed fast domestic services on CTRL, to work in Docklands, but also internationally connects to the international services at Waterloo(1994-2007) and St. Pancras international station(since 2008). (Willis, 1997: 68)

The improvement of the transport in the Stratford station has been realised. "Aspirations to improve access to the major rail station at Stratford have been around for at least 20 years-the

Claustrophobic and circuitous subways linking the station to the bus station and town centre have characterised the station for many years. With the London Borough of Newham taking the lead, the extension has finally provided the impetus to rebuild the station." (Willis, 1997: pp68-69)

Proposed Development

"The GLA, TfL, the borough Councils concerned and the Lea Valley Regional Park Authority have recently published a Framework Plan for the Stratford Rail Lands. The framework includes an area around the CTRL and London Underground stations to be known as Stratford City. The type, scale and density of development proposed - which includes office space of 465,000 sq.m (5 million sq.ft); retail space of 150,000 sq.m (1.6 million sq.ft) and 4,500 residential units - would only be possible with the public transport services available or planned. Whilst most of this development can be ascribed to the CTRL, it can be argued that

the JLE was influential in securing the CTRL station at Stratford and is, therefore, a contributory factor in the Stratford City development. The JLE will provide an important link to the Isle of Dogs and to the South Bank. It is unlikely that the scale of development would be achieved without the JLE.” JLEISU (2004)

Key Features

Completed:	1999
Client:	LUL Jubilee Line Extension Ltd Stratford Development Partnership Ltd London Borough of Newham
Planning authority:	London Borough of Newham
Funding body:	Various
Contract value:	£25m

Project team:

Architects:	Wilkinson Eyre Architects
Structural and Services Engineers, Landscape Architects:	Hyder Consulting Limited
Civil Engineers:	Ove Arup & Partners
Quantity Surveyor:	Frankline & Andrews
Main Contractor:	Kvaerner Trollope & Colls
Steelwork Contractor :	Tubeworkers

Source: Cabe, 2009b

Project Costs

London Transport's original base estimate for what has sometimes been referred to as "the most expensive piece of railway ever built" was £884 million, at June 1989 prices (Mitchell, 2003: 329). Of this, £400 million was to have been contributed by the private sector (principally by the Canary Wharf developers, Olympia & York).

Table 6 below shows how this initial estimate increased during 1990 by between £100-150 million to £1034 million by the following upgrades to the Client's requirements:

Table 9: Additional requirements requested by London Transport (1990)

	Cost (£m)
Larger tunnels	£30-£60
Walkways in tunnels	£60
Refurbishment of existing rolling stock	£12
Three platform station at Canary Wharf	£29-£44
Cut-and-cover station at Canning Town	£10
Stratford Market depot roof	£4.5

Source: Mitchell, 2003: 331

Between September and October 1990, a further review of cost estimates was carried out, resulting in a new project cost of £1879 million at June 1990 prices. The bulk of this increased cost was attributed to safety improvements in the wake of the King's Cross fire (Fennell Report, 1988). However in June 1991, the then Project Director, Russell Black, still felt the need to remind those in the Project Team about their responsibility to keep costs down (Mitchell, 2003: 334).

Table 10: Comparison of Victoria Line, Fleet Line and JLE project costs

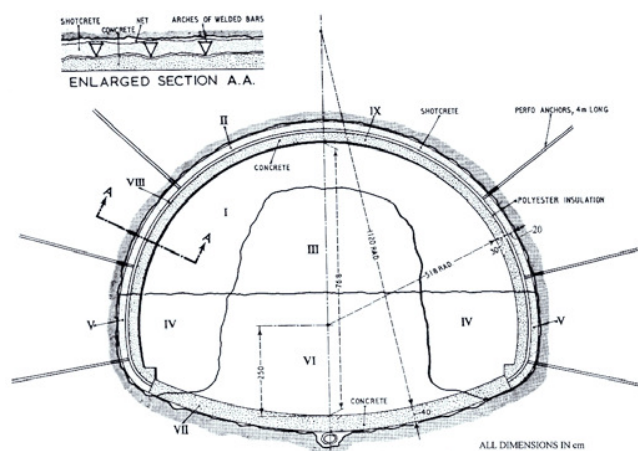
	Victoria Line (inc. Brixton Extension)	Original Jubilee Line (Fleet Line)	Jubilee Line Extension
Length (km)	16	4	16
No of stations	16	3	11
Cost at approval (£m)	73	35	2100
Cost on completion (£m)	91	90	3500
Cost on completion at 2000 price levels (£m)	800	275	3500
Cost per km (£m/km)	50	70	220
Estimated time for construction (months)	54	72	53
Actual time for construction (months)	66	90	73
Actual time as % of estimated time	122	125	138

Source: Mitchell, 2003: 313

Flyvbjerg (2002) notes that the costs of mega-urban transport projects (MUTPs) have been consistently under-estimated for a considerable time. Jon Willis (1997: 88) argues that two unforeseen occurrences were largely responsible for the delays and subsequent cost increase to the JLE project.

The first of these concerned the 21 October 1994 collapse of tunnels during the construction of the Heathrow Express rail link. These tunnels were being constructed using the New Austrian Tunneling Method (NATM – see Figure 52 below), the same system used on the contracts for Waterloo and London Bridge stations (Wolmar, 2002: 86), which meant that work had to be suspended for up to six months on some sections of the tunnelling between Green Park and London Bridge, while the Health & Safety Executive carried out a review of the soundness of the NATM technique.

Figure 53: The NATM Technique

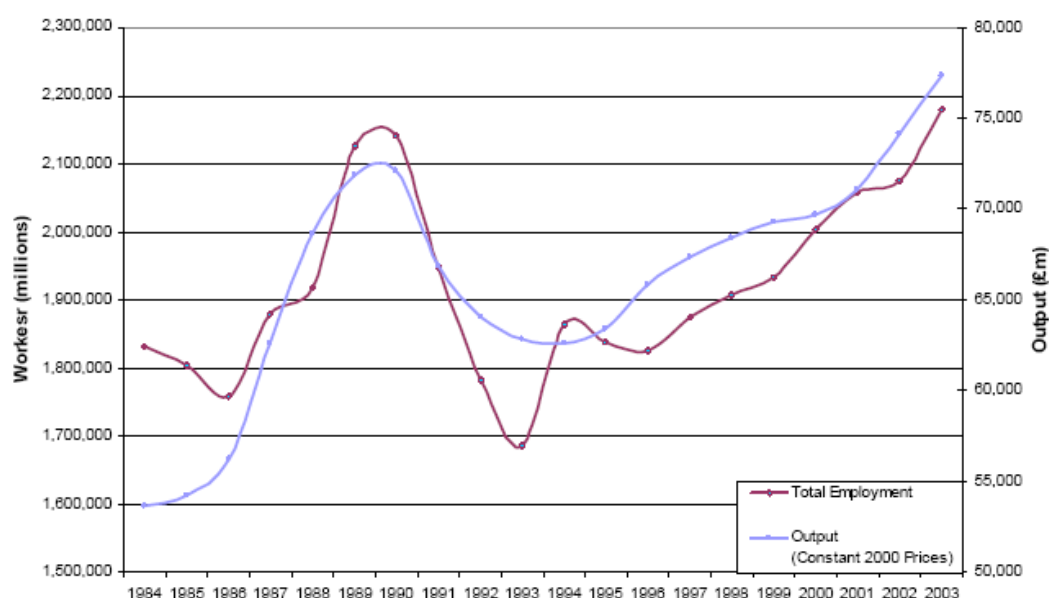


Source: Marakus & Fowell 2004

Willis states that the second issue which dramatically raised the costs associated with the JLE project was the “greater complexity of...construction in some areas than originally envisaged” (Willis, 1997: 88), particularly at Westminster station, where engineering works had to be carried out in close proximity to the existing District Line railway and the Houses of Parliament.

Changes in the economy during the planning and construction of the JLE also played a part in cost overruns. Due to a sharp recession in the construction industry in 1990-91, the quotes offered by contractors were low because there was a shortage of contracts, but according to a senior project manager, “as the scheme progressed, there was no longer a shortage of work and the economics changed. All the way through, contractors used every opportunity to get more money out of the system” (quoted in Wolmar, 2002: 85). This highlights both the effects of time and human nature on MUTPs, factors which are difficult to build into mechanistic tools such as cost-benefit analysis. Although the project’s ‘official’ CBA, as calculated in July 1992, was 0.95 (and so should not have gone ahead on the basis of this calculation alone), it was recognised that a number of wider social and economic benefits were incalculable and so the decision was taken to proceed.

Figure 54: UK Employment in Construction 1984 to 2004



Source: NGRF 2009

Mitchell (2003: 344) estimates that some £600 million of the eventual cost overrun could be attributed to 'time-related' factors, such as claims for delay and disruption, acceleration measures or Project extensions. Meeting the immutable deadline imposed by the construction of the Millennium Dome and its subsequent celebrations cost £45 million alone (Mitchell, 2003: 344). Realising that they had the Project Team 'over a barrel' in terms of the Millennium deadline, more than 500 Drake & Scull electricians launched a ten-day 'wildcat' strike from 18-27 November 1998, who demanded bonuses of up to £5000 from the Client (Mitchell, 2003: 273).

Table 11: Where the money went – Value of the new JLE assets

Category	Value (£m)	% of total
Tunnels and earthworks	£1,153	33
Rolling stock	£368	11
Station structures	£322	9
Station fit-out and finishes	£305	9
Signalling	£218	6
Station services	£175	5
Communications equipment	£172	5
Ventilation systems	£126	4
Electricity supply	£126	4
Permanent way	£87	2
Land	£79	2
Lifts and escalators	£73	2
Third party assets	£58	2
Depot	£31	1
UTS	£22	1
Platform edge doors	£20	1
Miscellaneous	£161	5

Source: Mitchell, 2003: 343

Table 12 details the project's cost increases from October 1993 to its completion in December 1999.

Table 12: Rise of out-turn estimated cost of JLE, 1993-1999

Date	Estimated final cost £m	Reasons for increases
October 1993	2141	Agreed at Project go-ahead
August 1995	2345	The NATM's costs, reappraisal of contingencies, unforeseen design/advance works costs
July 1996	2626	The NATM's costs, acceleration and programme delays relating to civil works, redesign costs and delays relating to E&M, higher design/advanced works costs, allowance for commissioning not provided for in original scope, addition of further £50 million contingency
February 1997	2693	Inclusion of interim maintenance, cost of delayed line opening to summer 1998
October 1997	2768	Cost of delayed line opening to September 1998, prioritisation of signalling on extension rather than existing Jubilee line, adoption of signalling fixed-block fallback option and additional staff costs
August 1998	2852	Cost of delayed line opening to April 1999 with fixed block signalling, additional staffing costs, reappraisal of contract claims and delays
October 1998	2927	Prolongation costs, reassessment of claims and compliance costs, power control issues, Bechtel costs, commissioning costs and staffing increases
December 1998	3205	Remeasurement, reassessment of claims and compliance costs, prolongation for phased opening, electrician payments and claims, provision for Canary Wharf liquidated damages, LUL internal costs
June 1999	3429	Additional contract costs and claims, additional staff costs, snagging costs, inclusion of new contingency allocation of £150 million, commercial settlement allocations
December 1999	3496	Inclusion of agreed additions to scope items

Source: Mitchell, 2003: 339

Although central government ring-fenced over £2 billion of funds for the project, cost overruns during 1996 were beginning to affect LUL's core Underground investment budget, which had an adverse effect on the renewal and upgrading of existing Underground infrastructure. Out of a total project cost of £3.5 billion, 2.2 billion was ring-fenced, meaning that the balance of £1.3 billion had to be diverted from LUL's core investment programme (Mitchell, 2003: 340-343). For example, a planned £9.5 million 'facelift' for Brixton station on the Victoria Line had to be deferred as this money had to be diverted to the JLE project (Mitchell, 2003: 274).

Table 13: JLE Cost Time Line from TFL

Month	Year	Cost (£billion)	Description / Comments
	1989	1.258	Parliamentary bill deposited
	1990	1.879	
Early	1991	1.804	
End of	1991	1.75	18-month delay while private sector funding was sought
October	1993	2.14	Project given go-ahead
	1995	2.35	6 month delay following collapse of Heathrow Express tunnels in October 1994
	1996	2.63	North Greenwich chosen as site for Millenium Dome in January
	1997	2.77	
	1998	2.85	
Early	1999	3.21	
Mid	1999	3.47	
	2002	3.45	

Source: TfL, Hansard

Table 14: Predicted versus actual cost of JLE

Predicted (in year of decision to go ahead)	Actual :
£ 2.1bn	£ 3.45bn

Somewhat paradoxically, the large cost overrun on the JLE project has been used repeatedly by the Labour government to justify their support for the Public Private Partnership (PPP) system of project financing (Wolmar, 2002: 84).

After the London Jubilee Line Extension project was complete, the oversight Consultant's report to the UK Secretary of State regarding cost and schedule overruns (Arup, 2000) noted that the project was a "...safe achievement, bringing significant benefits." but that "...time and cost overruns could have been minimized with a more established strategy at the very beginning of the project". They stated that London Underground Limited (LUL) "...lacked (early) strategy, structure and continuity of management to ensure the delivery of a working railway."

Table 15 below shows the expenditure on new roads and rail lines from 1990 to 2005. The total expenditure for the JLE was £3.455 billion although The JLE figure for 1999–2000 reflects an estimated accrual in London Transport's accounts for 1999–2000 to cover Jubilee line extension works in future years

Table 15: Expenditure on the construction of new roads and rail lines

	National roads	Jubilee line extension
1990–91	1,270	41
1991–92	1,277	62
1992–93	1,309	67
1993–94	1,345	255

1994-95	1,218	371
1995-96	1,125	588
1996-97	1,007	657
1997-98	875	476
1998-99	714	283
1999-2000	663	655
2000-01	677	0
2001-02	829	0
2002-03	1,032	0
2003-04	1,003	0
2004-05	1,196	0
2005-06	1,206	0
Total	16,746	3,455

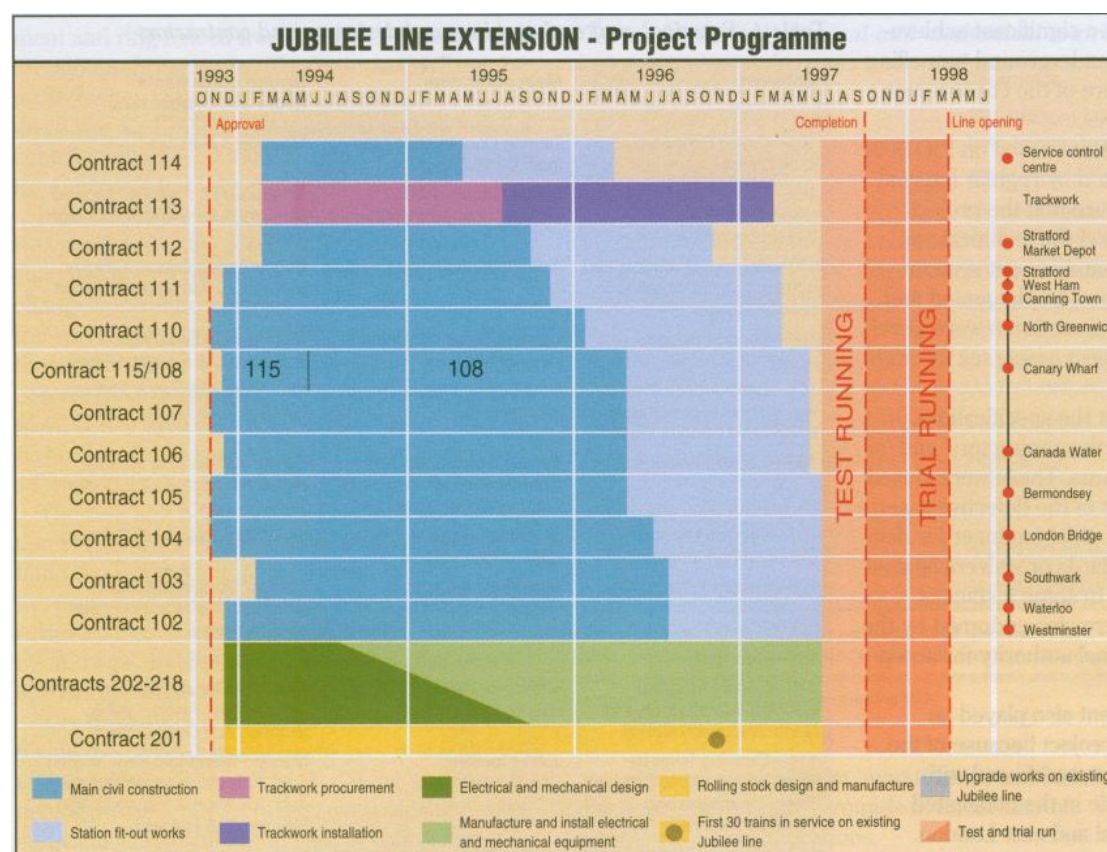
Source: Hansard, *21 Nov 2002 : Column 266W*

Project Management of JLE

The Project Team for the JLE was recruited in early 1990, drawing principally on a mix of existing experience from within LUL and supplemented by skills and knowledge gained on Hong Kong's Mass Transit Railway (MTR) built in the 1970s and 1980s (East & Mitchell, 1999: 11-12). The contract strategy was also closely modelled on the MTR experience.

In November 1993, 24 Major contracts were awarded with a total value of £1.2bn (Metais, 2001). One of the most fiercely criticised elements of the JLE's funding structure was the manner in which contracts were divided and allocated. The most serious contract issue concerned the decision to split contracts 202 and 213 for signaling and communications equipment between two competitors, Alcatel and Westinghouse, who both advocated the implementation of an untried signalling system known as Moving-Block System (MBS), as opposed to the tried and tested fixed-block signalling system.

Figure 55: The JLE's original 53-month project programme, showing individual contracts



Source: East & Mitchell, 1999: 13

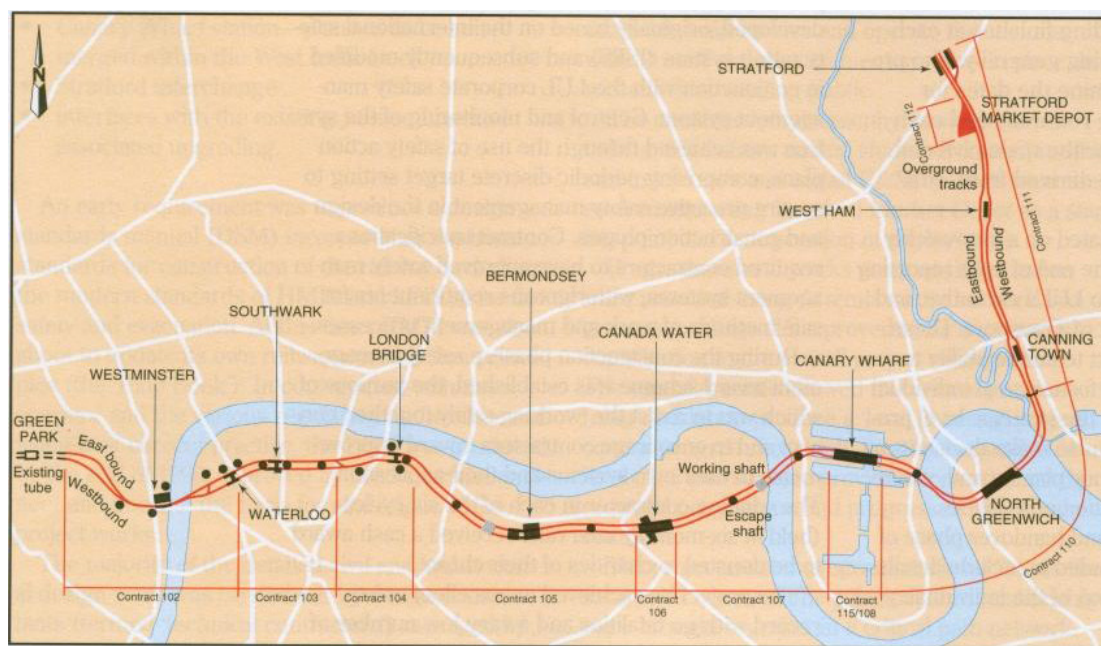
The JLE was reported as on schedule in October 1996, although costs were escalating. Concern began to mount in March 1997 relating to the escalating project delays: Two months before Labour's Land Slide victory, Sir George Young, the then Secretary of State announced "It looks likely that the extension will not open in full in March next year". In June 1997 the opening date of JLE was estimated as end of September 1998 by Glenda Jackson, Secretary of State for the Environment, Transport and the Regions. Reports indicate the delays.

In 1997 there were also signs 'all was not well with the "high-tech moving block train control and signaling system" In response to growing doubts about development progress being made by contractor Westinghouse, and in the knowledge that any delay could seriously impact the line's opening date, a shadow team was set up by the JLE project to look at contingencies. 'We started working in parallel to consider a conventional fixed block alternative,' says David Waboso, commissioning manager at the JLE who since 1996 had been seconded to the project from management consultant Nichols Group. 'Initially this was really just as a back-up. It was quite a while before the realisation dawned that we really were not going to make it with the main system.' (NCE, 1999)

By July 1998 LE bosses were required to file a fortnightly update to officials at the Department of Environment, Transport and the Regions detailing progress on the project.

In August 1998 Bechtel were called in to draft a report on the JLE. Ralph Mason, Bechtel's surface transportation manager was leader of the 12-strong team who conducted the report in 6 weeks. Their initial findings were presented to JLE project director Hugh Doherty in September, along with Glenda Jackson, London Underground chief executive Denis Tunnicliffe and commercial director David Bailey. By September Hugh Doherty was replaced as chief executive by Bechtel's Clifford Mumm, (CN, 1998; NCE, 1998)

Figure 56: Route plan of the JLE showing civil engineering contracts



Source: East & Mitchell, 1999: 14

Metais reported that in September 1998 the project was forced to face the reality that it would not be delivered on time. An Independent audit showed that a third deadline (two already missed) for opening the entire line by Spring 1999 could not be achieved. Bechtel was retained to manage project to completion

In September 1998 Bechtel Identified three parameters which could be changed in order to meet the 1999 Deadline. These were Costs, Human Resources and Conformity to Initial Scope. The following shows how the 3 parameters were adapted by the LUL/Bechtel team to meet the deadline (Source: Metais 2001)

Adapting Human Resources

Organisation

- New thinking towards meeting the deadline was provided by a new project board and by 40 new key managers with a hands-on attitude
- To meet its operating deadline the project team had to become commissioning-driven. Therefore the Project was reorganized into 3 main divisions (Construction, Commissioning, Finance & Administration) with the strengthening of the project controls section.
- A dedicated commissioning team was created to coordinate tests & operations and to adequately train the operating team.
- Close coordination was regularly established with the “clients of the JLE project: the London Underground Chief Engineers Group, the Jubilee Line Operating Unit, the London Fire and Civil Defense Department, the representative of HMRI (Her Majesty Railroad Inspectorate), and the London Underground business Unit
- At least once a week, a coordinating meeting of key managers was held in the “war room” instead of the multitude of other regular (and largely unproductive) meetings previously held.

Job Definition and Baseline Documents:

- To facilitate interrelationship and the control of the production of the needed documents, the project issued:
 - clear job descriptions
 - baseline documents describing in detail the scope and the contractual terms for each phases of the project commissioning

Morale:

- Introduction of a “can do” attitude by empowering the doers
- Safety was re-emphasized
- Achievable progress targets were set and met (changing losers into winners)
- Improvements ideas were actively thought out from the doers and implemented when they helped to meet the schedule.

Adapting the Initial Scope:

Technical Specifications:

- The too ambitious technical program with too many unproven systems was toned down:
 - the implementation of the chosen unproven moving block system was deferred
 - a conventional (but including microprocessor controlled interlockings) fixed block system compatible with the existing Jubilee Line, was installed
 - a key milestone was reached when the new centralized Service Control Center at Neasden was opened, albeit on the reduced scope for the train control system and with less integrated communications work stations.

Staging:

- The commissioning schedule was broken into three manageable pieces:
 - phase 1: from Stratford to North Greenwich
 - phase 2: from Stratford to Waterloo
 - phase 3: from Stratford to Stanmore (through running)
- The on-time opening of phase 1 had a tremendously positive effect on the project team by showing that the dateline of the following phases was attainable (see *Morale* above) .

Performance:

- Since the implementation of the moving block system that would allowed a 36 trains per hour operation was deferred, the capacity of the line had to be reduced to the “normal” level of 24 trains per hour
- As planned, the safety record of the project was excellent: no fatalities.
- The expected (and unrealistic) integration of the various control and communications systems could not be delivered. More conventional descoped stand-alone systems were ultimately installed.

Costs:

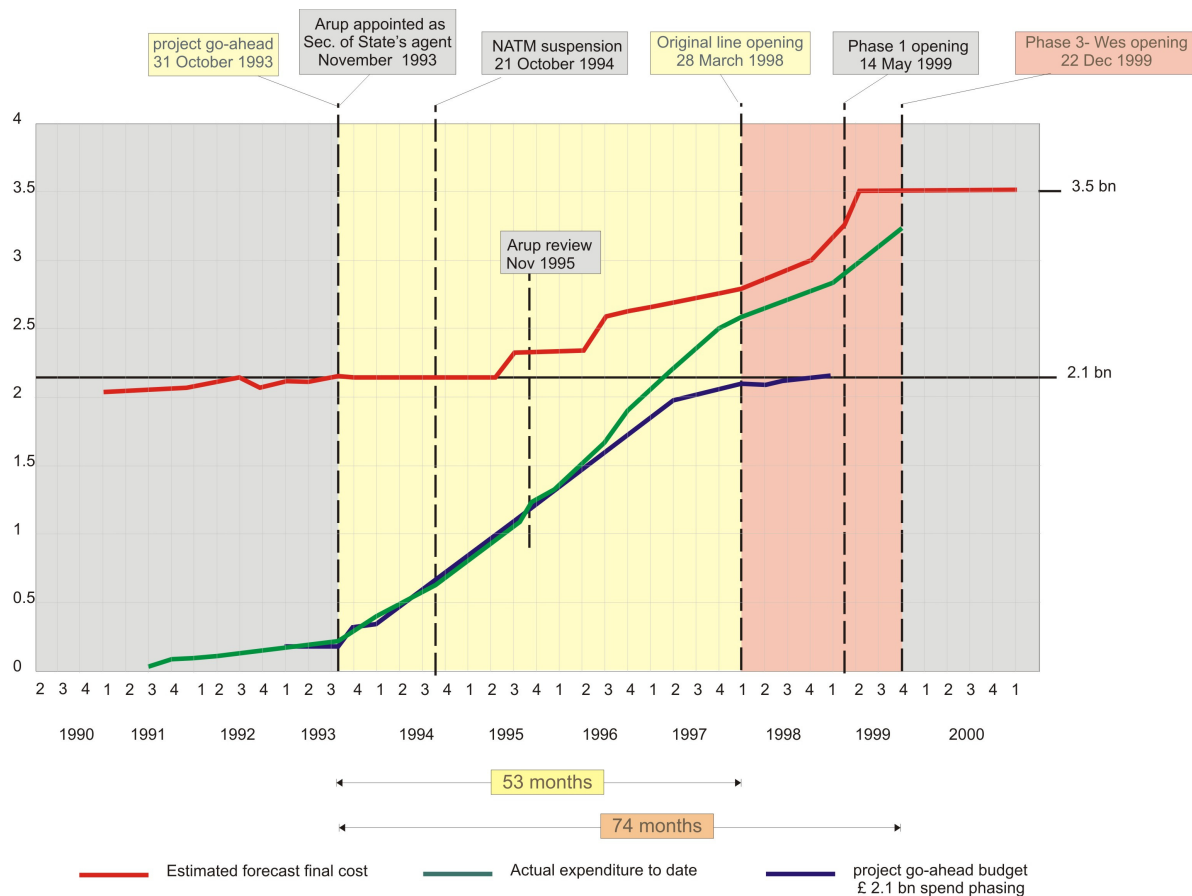
Overall Costs:

- Because of:
 - The delays caused by many external factors
 - Change in specifications leading to rework
 - Issues in Industrial Relations
the initial budget could not be met, since meeting the deadline was a sine qua non condition.

Cost Control:

- Costs and schedule were strictly controlled and the payment of work was prorated to the progress of the work. These actions minimized the overrun of the budget.

Figure 57: JLE Progress to Time and Cost (£Bn)



Source: Arup, 2000: p.5

Project Delivery:

The JLE project was delivered 21 months later than initially planned. The main causes of this delay are attributed to:

1. Collapse of Olympia York (due to economic downturn) and the treasury's determination to secure alternative private funding before the project could proceed
2. The requirement to review and adapt the JLE tunnelling techniques after problems experienced using the NATM tunnelling technique on the Heathrow Express tunnel.
3. Problematic Electrical and mechanical work on the line related to the untried and untested signalling system known as Moving-Block System (MBS)

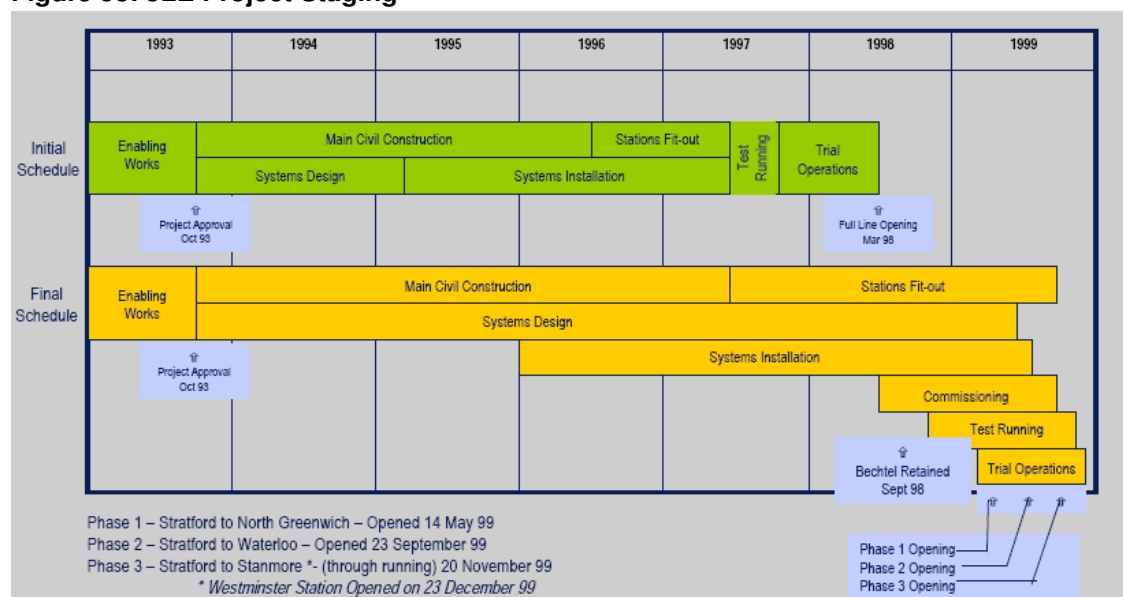
Table 11 and Figure 57 below outline the Actual and Forecast delivery dates for Key project milestones.

Table 16: Principle Project Dates

Decision to proceed with project - Mar. 1992 - Royal assent granted		
	Forecast	Actual
Enabling Works Finish	Oct 2003	Oct 2003
Main Civil Engineering Completion	Jun 1996	May 1997
System Design and Installation Completion	May 1997	Aug 1999
Commencement of Use	Mar 1998	Dec 1999
		14 May 1999 (Stratford to North Greenwich) 17 September 1999 (North Greenwich to Bermondsey) 24 Sep 1999 (Waterloo) 7 Oct 1999 (London Bridge) 20 Nov 1999 (whole line including link to Green Park, except Westminster) 22 December 1999 – Westminster station opens and whole line is operational.

Source: Arup, 2000; Metais 2001

Figure 58: JLE Project Staging



Source: Metais 2001

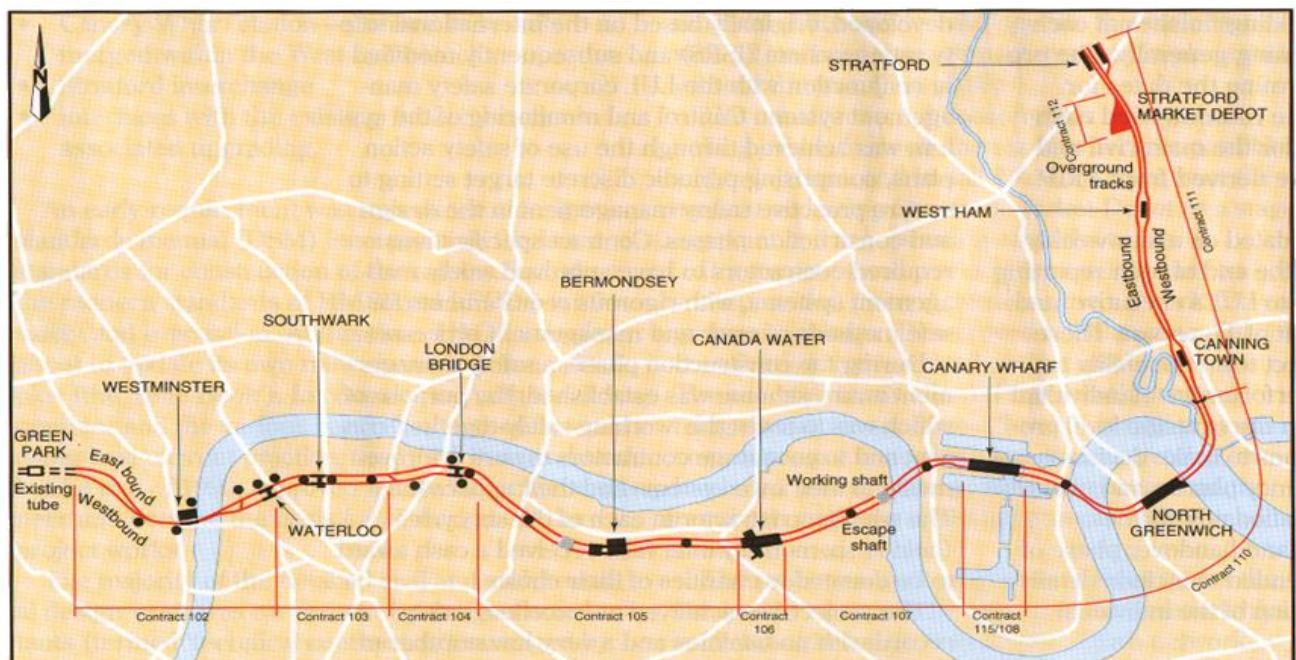
Main Engineering Features

Overview of Main Engineering Features:

- 16km extension of existing Jubilee Line including 12km of 4.5m diameter twin tunnels, with 4 crossings under the River Thames and 11 new passenger stations
- New line control center at Neasden and new train depot at Stratford

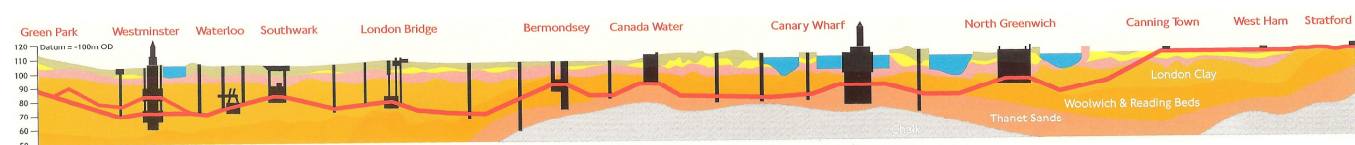
Bored tunnelling was carried out using the New Austrian Tunnelling Method (NATM) – the first use of NATM in London for a project other than trial tunnel – as well as conventional precast segmental linings in cast-iron and concrete. Owing to the large volume of ground removal during tunnelling – over 100 000m³ from a two hectare densely developed area of central London – innovative settlement prevention methods were specified for use in conjunction with the tunnel excavation. Performance limits were specified for the use of claquage, intrusion and compaction grouting techniques in the gravel and London clay, as

Figure 59: Geographical Location of JLE Contracts



Source: Metais, 2001

Figure 60: The Jubilee Line Extension in Cross Section Showing Tunnel Levels and Depth of Stations Shafts



Source: Willis, 1997: 73

The moving block train control and signaling system

Westinghouse was signed up to develop a new computerised system for the line. By continuous radio interchange of data between the trains, line-side computers and a central control, trains would run much closer together but remain safe. Just how close would depend on train speed and location, with the system calculating a continuous stopping 'envelope' which moved along with the train. Unlike the fixed blocks in conventional signal systems, the moving envelope gets smaller as speed decreases.

The computer, tracking every train on a geographic map would make sure no other train entered its envelope, sending cab displayed warnings to following trains and triggering automatic braking overrides if necessary.

The Westinghouse system was to give an hourly line capacity of 36 trains, 50% more than the 24 trains per hour (tph) with which the Jubilee Line will now achieve with a conventional system. (NCE, 1999)

Details of Main Contracts

Table 12: Contract award dates and values

No.	For	Award date	Completion date	Sum (£ m)	Contractors
101	Green Park	3 Feb 1995	17 April 2000	10.9	Tarmac Construction Ltd
102	Green Park to Waterloo	29 Oct 1993	6 Mar 2000	157.8	Balfour Beatty-Amec Joint venture
103	Waterloo to London Bridge	1 Nov 1993	15 Oct 1999	64.0	Aoki: Soletanche Joint Venture
104	London Bridge	10 Nov 1993	13 Sep 1999	76.2	Costain Taylor Woodrow joint venture
105	London Bridge to Canada Water	1 Nov 1993	9 Dec 1998	69.6	Aoki: Soletanche Joint Venture
106	Canada Water	2 Nov 1993	15 May 1999	21.9	Wimpey Construction Ltd (Later novated to Tarmac)
107	Canada Water to Canary Wharf	19 Nov 1993	5 Dec 1997	31.9	McAlpine-Wayss & Freytag-Bachy joint venture
108	Canary Wharf	12 Nov 1993	26 June 1999	31.3	Tarmac-Bachy joint venture
109	Not used				
110	Canary Wharf to Canning Town portal	5 Nov 1993	31 July 1998	71.0	McAlpine-Wayss & Freytag-Bachy joint venture
111	Canning Town portal to Stratford	1 Nov 1993	3 Oct 1998	49.0	John Mowlem Construction plc
112	Stratford Market depot	2 Nov 1993	20 Nov 1998	18.2	John Laing Construction Ltd
113	Trackwork	2 Mar 1994	7 July 1998	20.4	Tarmac Montcocol TP joint venture
114	Service Control Centre	26 Nov 1993	31 July 1999	4.4	John Laing Construction Ltd
115	Advance works- Canary Wharf	1 Nov 1993	29 Feb 1996	8.4	Christiani-O'Rourke Joint venture
117	Stratford interchange	29 Mar 1996	30 Oct 1999	15.4	Trafalgar House construction
118	Canada Water bus station	7 Mar 1997	18 Sep 1999	3.2	Tarmac construction Ltd
201	Passenger rolling stock	29 Oct 1993	Not yet certified	248.8	Alstom Transport Ltd
202	Signaling	19 Nov 1993	Not yet certified	56.4	Westinghouse Signals Ltd
203	Track power and cables	1 Nov 1993	30 April 1999	52.7	GEC ALSTHOM transmission and distribution projects Ltd
204	Communications	1 Nov 1993	5 July 2001	61.0	GPT
205	Ventilation	3 Dec 1993	29 Mar 2000	34.1	JWP(UK) Ltd and Drake & Scull Engineering Ltd Joint venture
206	Station and tunnel services	4 Nov 1993	29 Mar 2000	39.8	JWP(UK) Ltd and Drake & Scull Engineering Ltd Joint venture
207	Lifts and escalators	1 Nov 1993	1 Sep 2000	52.7	O&K escalators Ltd
208	Underground ticketing system	1 Nov 1993	13 Dec 1999	10.6	Westinghouse Cubic Ltd
210	Platform edge doors	8 Dec 1993	20 April 2000	9.4	Westinghouse Brakes Ltd
211	Works trains	1 Nov 1993	25 May 1996	6.4	SCHOMA Schottler Maschinenfabrik GmbH
212	Floodgates	25 Aug 1994	1 Feb 1997	0.7	GEC Alstom Engineering Systems Ltd
213	Signal control system	16 Nov 1993	Not certified at mid 2001	9.9	Alcatel Canada Inc.
214	Works wagons	1 Nov 1993	22 Dec 1994	2.4	Bombardier proraail Ltd
215	North London line signaling	22 Nov 1993		2.3	GEC Alstom Signalling Ltd

296	Works trains operations	17 Feb 1995		5.2	Wimpey Construction Ltd (later novated to Tarmac)
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Source: Mitchell, 2003: pp301, 302,305

Figure 61: Tunnels between Canary Wharf and Canning Town



Source : Mott MacDonald, 2009

Legal Aspects of Contracts

John Major has set out the Government's position on the long-running funding problems of the £1.8 billion Jubilee Line extension. Answering a parliamentary question last week, he appeared to tell bankers that contractors' late completion penalties were a like-it-or-leave-it substitute to the completion-by-2000 clause which the Treasury removed from the funding deal. He said work would start only when private finance was in place and would take 53 months. 'The draft funding agreement specifies that swingeing penalty payments will come into force if the line is not completed seven months after that,' Mr Major said. (Construction News, 1993)

Project Timeline

Year	Month	Type of Decision/Event	Key Decision/Event
1943		Pre-stage	Proposal for new underground link between Waterloo, London Bridge and the Surrey Docks is published.
1960s		Pre-stage	Victoria Line constructed (a north-east to south-west route).
1965	April	Pre-stage	New tube line to southeast London via Baker Street - Cannon Street discussed in Times article after completion of Victoria Line ("More Tube Lines Discussed". The Times. 27 April 1965). "The Fleet Line" is proposed to run from Baker street to New Cross and Lewisham and is estimated to cost £57 Million (around £650 Million at 2001 prices). The new line is planned to be constructed in 4 stages.
1969		Pre-stage	Parliamentary powers for the Fleet line (stage 1) granted
1971		Pre-stage	Construction begins on Fleet Line.
1973	April	Pre-stage	London Rail Study Report – River Line identified
1976	Jan	Pre-stage	Docklands Joint Committee formed
1977		Pre-stage	Fleet Line name changed to Jubilee Line following pledge made by Conservatives during GLC election of 1977, in honour of Queen Elizabeths' Silver Jubilee Year.
1979	April	Pre-stage	Jubilee Line opened by Prince of Wales on 30 April 1979; passenger services start on 1 May 1979.
1979	May	Pre-stage	Public opening of the Jubilee line from Stanmore – Charing Cross. The cost of stage 1 grew from (£ 35 Million in 1971 to around £90 million, a cost overrun of over 250%.
	June	Line Haul	Conservative Minister of Transport, Norman Fowler, in discussions with GLC concerning extension of Jubilee Line to Fenchurch Street.
	July	Project Initiation	Norman Fowler, after consultation with Tory Leader of GLC Sir Horace Cutler, agrees that "there should be a pause in the planning of extensions to the Jubilee line while we examine together the possibility of lower-cost options"(HC Deb 18 July 1979 vol 970 c747W).
		Project Initiation	John Cartwright MP argues that JLE "is an essential boost for the development of Docklands...[and] a vital link for

			Thames-mead."
		Financing	Total cost of potential JLE estimated at £325 million.
	October	Project Initiation	Second reading of London Transport Bill, which authorises the extension of the Jubilee line from Fenchurch Street to Woolwich Arsenal and Beckton.
		Project Initiation	Redevelopment of Docklands estimated to generate 20,000 to 30,000 new jobs which would provide a £100 million annual boost to the economy.
1980	April	Financing	Norman Fowler announces publication of report into lower cost alternatives to JLE, which details five cheaper alternatives to the full Jubilee Line, including two routes for express bus services, a street tramway system, an automated light rail transit system and a reduced version of the Jubilee Line proposal. The estimated capital costs ranged from about £15 million to £200 million. (Study of lower cost alternatives to the Jubilee Line in Docklands Report of DoE, DTp, GLC. Docklands Development Organisation and London Transport Executive Working Party. April 1980).
1981		Pre-stage	London Transport (LT) gives up on extending the Jubilee line; powers to extend the line from Charing Cross to Fenchurch Street allowed to lapse.
1981	July	Pre-stage	London Docklands Development Committee (LDDC) comes into being on 2nd July.
1981	November	Financing	Total cost of potential JLE (to Thamesmead) estimated at £440 million.
1984		Pre-stage	Royal Assent for two Docklands Light Railway (DLR) Bills granted.
1984		Pre-stage	The construction of the DLR begins.
1985		Pre-stage	Massive £4bn development at Canary Wharf announced by consortium headed by US developer G. Ware Travelstead, backed by First Boston and Credit Suisse banks. This proposal causes a rapid rethink of public transport provisions to Docklands
1985	Oct	Pre-stage	Original developer's master plan for Canary Wharf submitted to LDDC and approved 15 days later. Enterprise Zone status granted for 79% of the 71 acre site.
1985	Nov	Pre-stage	Bill for DLR City Extension to Bank submitted.
1986	July	Financing	Total cost of potential JLE (to Docklands) estimated at £500 million.
1986	Aug	Pre-stage	Planning application for Canary Wharf submitted to LDDC by G. Ware Travelstead consortium for part of the Canary Wharf scheme outside the EZ (half of the Westferry Road roundabout and approximately 1 million square feet of office

			development).
1986	Dec	Pre-stage	Royal assent for DLR City Extension to Bank given.
1987		Pre-stage	Initial stretch of DLR between Tower Gateway, Stratford and Island Gardens opens.
1987		Pre-stage	Olympia & York (O&Y), a Canadian development company takes over Canary Wharf development.
1987	July	Pre-stage	O&Y contributes £ 68 million to part-fund DLR extension to Bank (quadrupling the capacity of the line).
1988		Pre-stage	Foundations of Canary Wharf development are laid.
1988		Pre-stage	O&Y proposes stand-alone line running between Waterloo and Canary Wharf and on to Westcombe Park where the depot would be located.
1988	January	Pre-stage	The Central London Rail Study is commissioned by the Department of Transport (DoT), British Rail (network south east) and London Transport. It concludes that a further study should be undertaken into extending the Jubilee line from London Bridge to Docklands as an alternative to the stand-alone line being proposed by Olympia & York. The report also resurrects the East-West Crossrail scheme due to a projected massive growth in employment through to the end of the century. But the two schemes will compete with each other in the same period.
1988	November	Project Initiation	Fennell Report into Kings Cross fire of 1987 is published.
1989	January	Project Initiation	Conservative government announce intention to build JLE.
	July	Line Haul	East London Rail Study (commissioned by the Department of Transport) is published. The report recommends as the best option for improving rail access from central London to docklands an extension of the Jubilee line via London bridge and the Isle of Dogs and ultimately to Stratford. Halcrow Fox Associates, the report authors, estimate that the cost of the projected extension will be £900 million (at late 1988 prices).
		Line Haul	Cecil Parkinson, Conservative Minister of Transport agrees with East London Rail Study findings that further work should concentrate on the recommended alignment running from Green Park via Waterloo to London Bridge rather than the alternative which might start from Charing Cross and run via Ludgate Circus.
	October	Project Initiation	JLE extension to Canary Wharf via Waterloo described as "essentially a developer's railway" by Nigel Spearing MP. Michael Portillo, Minister of Transport concedes that "a key factor for the Jubilee line will be the contributions forthcoming from developers who will benefit from the line." HC Deb 30 October 1989 vol 159 cc6-8.

	November	Financing	O&Y confirm their contribution of £400 million towards the cost of the JLE and sign Heads of Terms which stipulate an up-front payment of £100 million, with the remaining £300 million to be paid in annual instalments over 24 years, beginning one day after the JLE comes into operation.
	November	Financing	Cost of extending Jubilee Line to Woolwich estimated at £285 million and to Thamesmead at a further £135 million.
		Project Initiation	Between Green Park and Canary Wharf the number of people travelling daily eastward in the morning peak period is forecast to vary between 17,000 and 30,300 and the number travelling westward between 8,000 and 32,100.
		Line Haul	LRT authorised to deposit a Bill for the extension of the Jubilee Line, to be routed from Green park via Westminster, Waterloo and London bridge, along the south bank of the Thames to Surrey docks, beneath the river again to Canary wharf on the Isle of Dogs, and thence via Canning Town to Stratford.
		Financing	The total cost of the JLE is estimated at £1 billion, with a private-sector contribution of £400 million
1990	January	Project Initiation & Line Haul	The North Greenwich Additional Provision 1990 is lodged, changing the alignment from the original route via Brunswick to the North Greenwich.
1990	February	Line Haul	LRT given leave to deposit an additional provision to re-route the Jubilee line extension, from Canary Wharf to Canning Town via Greenwich point.
		Project Initiation	JLE Project Team assembled under Director Russell Black, the personal choice of LT Chairman Wilfred Newton.
		Financing	Planned government investment in JLE for 1990/91: £40 million; for 1991/92: £190 million; and for 1992/93: £300 million.
	March	Financing	Value of British Gas contribution towards routing JLE via Greenwich estimated at £25 million.
		Project Initiation	First meeting of JLE Project Team on 13th March, to prepare for forthcoming parliamentary sessions, research engineering & construction of Victoria line in 1960s and establish points of interface between JLE and existing LUL network.
		Project Initiation	Meeting between JLE Project Team and O&Y to discuss key issues such as influential landowners in vicinity of Green Park, opposition from Lambeth Council regarding Waterloo and Southwark proposals and connections between the JLE and DLR.
		Financing	The cost of building the Jubilee line extension via Greenwich is estimated at about £1,030 million at September 1989 prices.
		Project Initiation	JLE Environmental Statement (ES) published.

		Financing	Value of Olympia & York's contribution to the £1 billion cost of the JLE now estimated at £115-£145 million (HC Deb 23 March 1990 vol 169 cc1342-411 1342 9.36 am).
	May	Project Initiation	Project proposals confirmed in presentation given by JLE Project Team to Secretary of State for Transport, Cecil Parkinson on 18th May.
	May	Project Initiation	British consultants accuse LUL of favouring overseas firms for design work on JLE. Only one British firm on tender shortlist for £4 million E&M design contract (Mitchell, 2003: 25).
	June	Project Initiation	Project Director, Russell Black, and the JLE Construction Manager both visit a site in Frankfurt on 12th/13th June to observe the New Austrian Tunnelling Method (NATM) in action. According to Black, "Nothing was observed that would change our view that there is a place for the NATM in London Clay" (Mitchell, 2003: 197).
	June	Project Initiation	Minister of Public Transport, Roger Freeman, estimates that the JLE will be in service by the beginning of 1996.
		Financing	Details of cost -benefit analysis used in East London Rail Study released:1988–89 prices discounted to 1989 (£ million) Capital costs (690) Operating cost (90) Additional revenue 290 Funding gap (490) Passenger benefits 730 Road user benefits 200 Net benefit 440 Benefit: cost ratio 1.56:1
	July	Line Haul	Traffic forecasts revised; stations should be designed to cater for a service frequency of 27 trains per hr, with a contingency of +20%.
	July	Project Initiation	JLE Project Team sets up dedicated Parliamentary Co-ordination team to aid progress of Bills through Parliament.
	July	Financing	O&Y dividend income hit - rumors mount that Olympia and York is experiencing financial troubles – Philip Reichman does much to fan this rumour during December meeting with real estate brokers (too big to fail p. 215)
	July	Project Initiation	Second reading of London Underground Bill.
1990	October	Project initiation	Client confirms that the JLE should be designed for full wheelchair access.
	October	Line Haul	Southwark and Bermondsey confirmed as nodes on the JLE by Transport Minister Roger Freeman.

1990	November	Project Initiation	Topping-out ceremony of Canary Wharf Tower, No.1 Canada Square.
	December	Financing	£748 million of the LRT grant allocated to JLE for the coming three years.
1990	December	Project initiation	London Underground No.2 Bill is deposited, dealing with various minor changes and the requirements of improved station designs, oarticularly at London Bridge. These amendements to the project were subsequently amalgamated into the consolidated Bill which became the principal Act.
1991		Project Initiation	The city branch of the DLR is completed and opened, but the line's expected capacity and frequency is not achieved until three years later, in 1994.
1991	February	Project Initiation	Committee proceedings underway on 19th February to debate London Underground Bill; sits for 22 days until 1st May.
1991	November	Project Initiation	Publication of JLE Project Update, concerned with the environmental impacts of building the line.
1991	November	Project initiation	Two further Bills - the London Underground (Jubilee) Bill and London Underground (Green Park) Bill are deposited to cater for additional works in Westminster, Lambeth and Southwark, due to design changes and for works to relieve congestion and provide safety improvements at Green Park station. The works at Green Park station involve the construction of a second ticket hall under the northern end of St. James's street. But the Bill is thrown out by Parliament following vociferous objections from third parties.
1991	November	Implementation	New project schedule issued with 1 July 1996 completion date.
1991	December	Project initiation	House of Lords committee proceedings commence on 2nd December, with approval granted on 15th December.
1992	March	Project Initiation	London Underground Bill receives Royal Assent on 16th March and becomes London Underground Act 1992.
1992	March	Financing	Financial Times of 25th & 26th March reports that Olympia & York faces massive financial difficulties with debts of \$20 billion.
1992	April	Project Initiation	Russell Black resigns as Project Director, to be replaced by Hugh Doherty on a pro-tem basis.
1992	May	Project Initiation	John MacGregor, Minister for Transport, insists that he sees "no prospect of my authorising the start of construction until and unless the agreed [private sector] contributions are assured" (HC Deb 18 May 1992 vol 208 c12 12).
1992	May	Financing	According a a Financial Times report of 16th May, Canary Wharf has vacancy rates of 40%.

1992	May	Financing	O&Y goes into administration on 28th May.
1992	May	Project Initiation	Steve Norris, Minister for Transport states: "In terms of the measurable costs and benefits normally taken into account in such appraisals, the line does not meet the established criteria for approval. We would not normally be prepared to proceed with projects that failed to meet those criteria." (HC Deb 18 May 1992 vol 208 cc119-28).
1992	June	Financing	Cost of JLE now estimated at £1.5 billion, at June 1990 prices.
1992	June	Project Initiation	Steve Norris, Minister for Transport, refuses point-blank to change his government's policy of seeking a £400 million contribution from the private sector before work can begin on the JLE.
1992	June	Financing	In response to a question from Joan Ruddock MP, Steve Norris estimates that £118 million of public money has been spent on research, development and associated costs on the JLE.
1992	June	Project Initiation	In response to a question from Joan Ruddock MP, Steve Norris estimates that 4000 jobs will be created on-site in the construction of the JLE, with a further 20,000 off-site jobs in manufacturing and supply.
1992	July	Financing	Updated cost-benefit analysis of JLE provided by Steve Norris: (Mid 1991 prices discounted to 1991 £ millions) Capital costs -1,505 Operating cost -180 Additional revenue 340 Funding gap -1,345 Public transport user benefits 1,025 Road user benefits 230 Net benefit -90 Benefit:cost ratio 0.95:1
1992	July	Financing	Cost of JLE now estimated at £1.853 billion, at 1992 prices.
1992	September	Project Initiation	Architect-in-Charge of the JLE, Roland Paoletti, exhibits his vision for the project at the Architecture Foundation in London.
1992	October	Project Initiation	Evening Standard claim that '£2bn Jubilee Line scrapped' in their front page of 7th October.
1992	November	Project Initiation	Lord Rogers of Quarry Bank argues that the government "should stop dithering about the Jubilee Line and talking nonsense about getting landlords to pay when the nation as a whole will be the beneficiary of its completion. It is a very dangerous principle, and to the best of my knowledge a new one, that major new transport projects in the national interest should be pursued only when a private sector godfather is 1449 available to share the costs." HL Deb 04 November 1992 vol 539 cc1431-516 1431.

1992	November	Financing	Delay in announcing the start of building of the JLE estimated at £10 million by Under Secretary of State for Transport Steve Norris.
1992	November	Financing	Funds ring-fenced for JLE in Autumn Budget by Chancellor Norman Lamont but project still on-hold due to lack of private sector contribution.
1992	November	Project Initiation	JLE expected to be completed in 53 months once the go-ahead from central government is given - an "ambitious but achievable" target according to the JLE Project Team (Mitchell, 2003: 19)
1992	February	Financing	Steve Norris announces that the government have spent £160 million in preparing to build the JLE.
1993	February	Project Initiation	Site of phase 2 Parliamentary Building (Portcullis House) handed over to LUL - site due to be handed back to HoC in February 1997.
1993	April	Financing	European Investment Bank agrees to finance first installment (£98 million) of private sector contribution to JLE.
1993	May	Project Initiation	Prime Minister John Major announces in the House that the "draft funding agreement specifies that swingeing penalty payments will come into force if the line is not completed seven months after [the scheduled 53 month building programme]" (HC Deb 27 May 1993 vol 225 cc661-2W).
1993	July	Financing	Steve Norris announces that the government have spent £180 million in preparing to build the JLE.
1993	October	Project Initiation	Olympia & York discharged from administration on 29th October and is now backed by a consortium of 11 banks. Secretary of State for Transport, John MacGregor announces that contracts to build the JLE will be let.
1993	October	Line Haul & Hubs	Contract 104, worth £76 million, to build London Bridge station, let to Costain-Taylor Woodrow joint venture.
1993	October	Financing	Cost of the JLE estimated at £1.9 billion, with 22,000 jobs expected to be created across the UK.
1993	October	Line Haul & Hubs	Contract 102, worth £157.8 million, to build new JLE stations at Westminster and Waterloo, awarded to Balfour Beatty-Amec joint venture.
1993	November	Financing	John MacGregor announces that the government have spent £190 million in preparing to build the JLE.
1993	November	Line Haul & Hubs	Contract 106, worth £21.9 million, to build Canada Water station, awarded to Wimpey Construction Ltd.
1993	November	Project Initiation	24 major contracts to build sections of the JLE awarded by the end of the month, collectively worth £1.2 billion (Mitchell, 2003: 48).
1993	November	Line Haul & Hubs	Contract 108, worth £31.3 million, to build Canary Wharf station, let to Tarmac-Bachy joint venture.

1993	November	Line Haul & Hubs	Contract 110, worth £70.97 million, to build North Greenwich station, awarded to Sir Robert McAlpine-Wayss & Freytag-Bachy joint venture.
1993	November	Financing	Olympia & York's outstanding contribution of £300 million in cash to be paid over 24 years starting one year after the first day of operation of the JLE.
1993	November	Line Haul & Hubs	Contract 105, worth £69.6 million, to build Bermondsey station, let to Aoki:Soletanche.
1993	November	Implementation	DETR appoints Ove Arup & Partners as Secretary of State's Agent to provide DETR with impartial and expert advice on the construction phase of the project and to make objective reviews of the JLE Project's ability to meet its cost and programme targets.
1993	November	Line Haul & Hubs	Contract 103, worth £64 million, to build Southwark station and tunnels running between Waterloo and London Bridge let to Aoki:Soletanche.
1993	December	Project Initiation	Prime Minister John Major drives the first pile on the site of Canary Wharf station.
1994	May	Implementation	LUL agrees to become one of the first tenants of Canary Wharf at a much reduced rental and a benefit cost ratio of almost 2:1 (Mitchell, 2003: 46).
1994	August	Implementation	Tunnelling starts at North Greenwich.
1994	October	Line Haul	Partial collapse of tunnels of Heathrow Express construction project during early hours of 21st October leads to suspension of New Austrian Tunnelling Method (NATM) on JLE. Overall delay to the project estimated at six months.
1994	December	Implementation	First tunnelling breakthrough at Canning Town portal
1995	March	Line Haul	East London Line closed for seven months on 25th March to facilitate construction of Canada Water station.
1995	September	Line Haul & Hubs	Topping out ceremony of Stratford Market train depot held on 21st September. The depot subsequently wins several major design awards, including the Financial Times Design Award 1997, the RIBA Commercial Architecture Award 1997 and the Structural Steel Design Award (Mitchell, 2003: 138).
1995	September	Line Haul	4.5km running tunnels between Green Park and London Bridge completed with breakthrough at Waterloo on 21st September.
1995	December	Line Haul & Hubs	Topping out ceremony at North Greenwich station.
1996	January	Line Haul & Hubs	Completion of all tunnelled river crossings on 23rd January.

1996	February	Implementation	LT Chairman, Peter Ford, visits North Greenwich with Millennium Commission team.
1996	February	Line haul & hubs	Tory government confirms Greenwich Peninsula as the site of the Millennium Dome.
1996	March	Line Haul	Ceremony presided over by LUL Managing Director, Dennis Tunnicliffe, to mark the coming into service of the first two locomotives on the JLE (built under Contract 211 by the German firm Schoma).
1996	April	Line Haul	Steve Norris announces in Parliament that the JLE "is still on track to open on 28 March 1998" (HC Deb 03 April 1996 vol 275 cc424-34 424)
1996	May	Financing	Cost of JLE now estimated at £2.1 billion..
1996	August	Line Haul	Completion of all running tunnels on 5th August.
1996	October	Line Haul	Opening date of JLE estimated as 28th March 1998 by John Bowis in the HoC.
1996	October	Financing	Cost of JLE now estimated at £2.6 billion.
1997	January	Implementation	FURTHER hold-ups on the Jubilee Line Extension at Westminster will mean a four-month delay before work can start on a 200 million office block for MPs. Joint venture contractors Balfour Beatty/Amec had originally planned to complete a concrete deck above the station by February 1997 but work had been complicated by the cramped and complex nature of the site, bordered by Bridge Street and Victoria Embankment.
1997	March	Line Haul	Sir George Young, Secretary of State for Transport admits that "It looks likely that the extension will not open in full in March next year" (HC Deb 10 March 1997 vol 292 cc10-1)
1997	March	Project Initiation	Handover date of phase 2 Parliamentary Building (Portcullis House) moved back to 29th July 1997
1997	May	General	Tony Blair's Labour Party elected in landslide victory on May 1st.
1997	June	Line Haul	Opening date of JLE estimated as end of September 1998 by Glenda Jackson, Secretary of State for the Environment, Transport and the Regions, in the HoC.
1997	June	Financing	Gavin Strange argues that the "Jubilee line cost over-run is so great that it is damaging the basic investment that is required in the fabric of the [rest of the LUL] network" (HC Deb 25 June 1997 vol 296 cc861-904)
1997	September	Implementation	Switch from moving block to fixed block signalling system confirmed.
1997	December	Line Haul	First of the new (1996) rolling stock planned for the JLE put into operation on the existing Jubilee line on 24th December.

1997	December	Financing	Cost of JLE now estimated at £2.76 billion.
1997	December	Project Initiation	Handover date of phase 2 Parliamentary Building (Portcullis House) moved back to 5th January 1997.
1998	February	Implementation	Opening date of JLE estimated as February 1999 by LUL.
1998	June	Implementation	The New Millennium Experience Company (NMEC) estimates that over 50% of visitors to the Millennium Dome will use the JLE for the final leg of their journey (HC Deb 16 June 1998 vol 314 c153W).
1998	June	Implementation	1.6 million passenger journeys on JLE estimated during the busiest period of operation of the Dome.
1998	June	Implementation	Glenda Jackson announces that 'contingency measures' are in place in the event that the JLE is not open in time for the Millennium.
1998	June	Implementation	LT announce that by 1st January 2000, they expect to operate 24x6 carriage trains per hour on the JLE, providing a capacity of over 24,000 passengers in each direction.
1998	June	Implementation / Political	Deputy Prime Minister John Prescott promised JLE would be finished by Spring 1999.
1998	July	Implementation	Last 1983 stock trains on Jubilee line taken out of service on 9th July.
1998	July	Implementation	First train runs under signalled control from Stratford to West Ham.
1998	August	Implementation	Bechtel carry out their review of the project.
1998	September	Implementation	Bechtel present the results of their review on 17th September.
1998	September	Implementation	Hugh Doherty resigns as Project Director on 25th September.
1998	September	Implementation	Bechtel take over management of the JLE with Cliff Mumm as Chief Executive on 28th September.
1998	October	Implementation	JLE now planned to open in three phases: Phase one to open the extension between Stratford and North Greenwich in late spring 1999. This section includes four stations: Stratford, West Ham, Canning Town and North Greenwich. Phase two to follow in late summer. This section will include six stations: Canary Wharf, Canada Water, Bermondsey, London Bridge, Southwark and Waterloo. The third and final phase to complete the extended line by linking Waterloo with the existing line at Green Park in autumn 1999.
1998	October	General	7.2 km long Paris Meteor Metro line opens on 15th October, at a cost of £665 million.

1998	November	Financing	Cost of JLE now estimated at £2.85 billion.
1998	November	Implementation	LUL Managing Director, Dennis Tunnicliffe, appears before parliamentary Culture, Media and Sports Committee, chaired by Gerald Kaufman MP, on 26th November to explain project delays.
1998	November	Implementation	Ten day wildcat strike by more than 500 Drake & Scull electricians comes to an end on 27th November.
1999	January	Financing	To date, British Gas have paid £7.5 million of £25 million of their contribution; further payments dependent on land sales (HC Deb 11 January 1999 vol 323 c50W).
1999	January	Implementation	Deal is struck with striking electricians, who will now receive over £2000 in severance pay if project deadlines are met.
1999	February	Implementation	Derek Smith takes over as Managing Director of LUL from Dennis Tunnicliffe.
1999	February	Implementation	"Crashing" control unit may further delay opening of Tube stretch serving the Millennium Dome. Electronics group GPT, now trading as Marconi Communications, is running the £61m Contract 204 to install the communications system. It refused to comment.
1999	March	General	Proposed Heron Quays development unveiled by Canary Wharf Ltd.
1999	March	General	Ex-LT Chairman, Peter Ford, offers a personal bet of £1000 with the Financial Times, that the JLE pre-Millennium opening date will be met (Mitchell, 2003: 275).
1999	March	Financing	Cost of JLE now estimated at £3.2 billion.
1999	May	Implementation	LT opens Phase 1 of the JLE, between Stratford and North Greenwich, on Friday 14 May. This section includes four stations: Stratford, West Ham, Canning Town and North Greenwich. Phase 2, which includes six stations (Canary Wharf, Canada Water, Bermondsey, London Bridge, Southwark and Waterloo) scheduled to open in late summer. The final phase, which includes two stations (Westminster and Green Park) planned to open in late autumn.
1999	July	Implementation	Opening of Neasden Service Control Centre and transfer of control of the JLE from Stratford Market Tower on 26th July.
1999	September	Line Haul & Hubs	Canary wharf, Canada Water and Bermondsey stations open on 17th September.
1999	September	Line Haul & Hubs	Waterloo station opens on 24th September.
1999	October	Implementation	Keith Hill announces in the House that the government expects "the whole Extension to be fully operational by 31 December" (HC Deb 19 October 1999 vol 336 cc496-7W).

1999	October	Line Haul & Hubs	London Bridge station opens on 7th October.
1999	November	Line Haul & Hubs	DLR Lewisham extension is opened on 22nd November by John Prescott.
1999	December	Line Haul & Hubs	The final node on the JLE, Westminster station, is opened on 22nd December by Keith Hill, Transport Minister for London, in a low-key event.
1999	December	Implementation	The Prime Minister, Tony Blair, and his party travel on the Jubilee line from Westminster to the Millennium celebrations at the Dome on 31st December.
2000	February	Operation	69 incidents of delays longer than 15 mins on JLE between 20th November 1999 and 22nd January 2000, due to problems with new signalling technology (HC Deb 29 February 2000 vol 345 c186W).
2000	March	Operation	Baker Street station reopens for Jubilee line passengers on 3rd March.
2000	June	Financing	Secretary of State for the Environment, Transport and the Regions, John Prescott, announces that the Canary Wharf developers have to date made payments in the order of £150 million towards the cost of the JLE and that a further, final, payment of £50 million is due on 1 November 2000 (HC Deb 05 June 2000 vol 351 c57W).
2000	October	Financing	Final cost of JLE estimated at £3.5 billion (18 months late and £1.5 billion over budget).
2001	January	Operation	20 instances of station closure reported on JLE since its operational opening in December 1999.
2001	July	Legal	Canary Wharf seeks damages from Underground over Jubilee Line service. The property group, which owns the familiar high-rise tower on the Isle of Dogs, contributed to the building of the line on the understanding that 24 trains an hour would run during peak times. It now wants millions of pounds of its money back and has taken London Underground to arbitration
2001	December	Operation	LUL advise that between 7 January and 13 October 2001, signal failures caused 75 delays of 15 minutes or more on the Jubilee line. The total initial delay resulting from these incidents was 51 hours.

Project funding and finance

Introduction

As noted at the outset of this project template, the JLE was a highly political project, nowhere more so than in the proposed funding mechanisms. The Conservative governments of the day (led by Margaret Thatcher and then John Major) were determined to use the JLE as a model to show the benefits that could accrue from a partnership between public and private sector backers. Of the £400 million that O&Y had promised to deliver, £40 million was to be paid on 31 March 1992, £60 million on 31 March 1993 and the remaining £300 million spread over 24 years from the date of the line's opening (Mitchell, 2003: 333). However, O&Y were unable to pay even the first instalment of £40 million at the end of March 1992, and went into receivership six weeks later (Willis, 1997: 87).

British Gas was the second major source of private sector funding, agreeing to contribute £25 million, as well as the provision of a (highly contaminated) site at North Greenwich. Regalian Properties (owner of the Heron Quays Development) was the third and final source of private sector investment, agreeing to pay the sum of £2.4 million towards the project (Mitchell, 2003: 333).

The collapse of O&Y in June 1992 meant that the project was without its principal private sector backer and thus the government was unwilling to proceed as sole backer, leading to an 18-month hiatus (Willis, 1997: 87). Eventually, in October 1993, the deadlock was broken when Canary Wharf Ltd, now owned by a consortium of 11 banks offered to pay £98 million up front, with a further £300 million staged over 25 years, an offer which was accepted by the Major government (Willis, 1997: 88).

As the project over ran during construction, partly due to the Heathrow Express tunnel collapsing, as well as other problems, London Transport had to foot the bill for cost increases.¹¹

Funding Sources

Central government (£2015m ringfenced in 1993)

London Transport (£226m + cost overruns)

Olympic & York/Canary Wharf Ltd (£400m, staged during construction and for 24 years after opening)

British Gas £25m (1989 prices)

Regalian £2.4m (1992 prices)

Funding resource from private finance

According to Hansard, the official report, Mr. Parkinson said "The Jubilee extension will cost about £1 billion in today's prices (1989) to which developers will over time be making a cash contribution of over

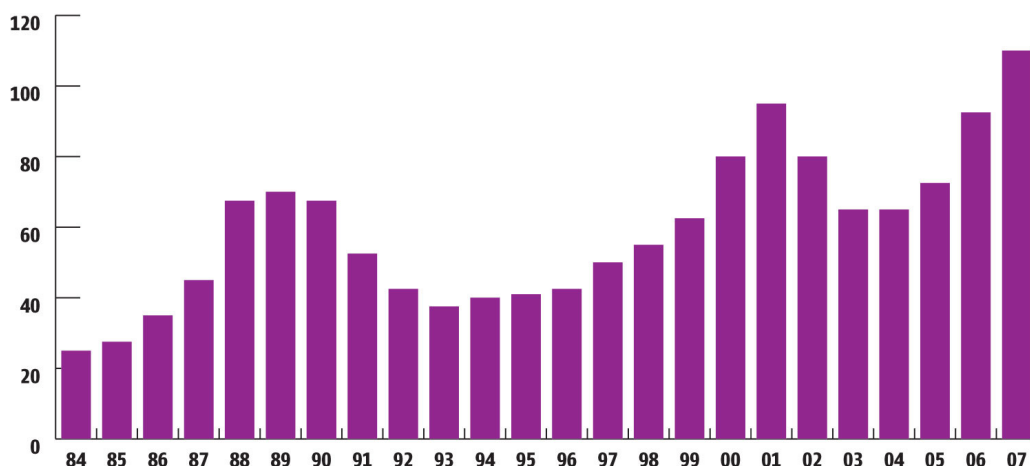
¹¹ Willis, Jon. *Extending the Jubilee line: The planning story*, London Transport, 1997

£400 million. I warmly welcome this contribution, which is of an unprecedented scale. This is a further example of public and private sector co-operation to the mutual benefit of both. The net cost to Government is approximately £40 million in 1990-91 and £150 million and £240 million in the following two years. My right hon. Friend the Chief Secretary to the Treasury has agreed that these sums should be made available from the public expenditure reserve which was set with this in mind.”

Source: UK Parliamentary Publications and records: House of Commons Hansard Debates for 16 Nov 1989: column 398 , London Rail studies.

Olympia and York was to have contributed £400 million cash, comprising £40 million on 31 March 1992; £60 million on 31 March 1993; and a stream of payments over 24 years, or a single discounted payment, once the extension was opened. At the time the company went into administration, due to collapse of the office retail market – See figure 61, it had not completed its funding agreement with London Underground Limited—LUL—setting out the terms under which its contributions were to have been made.”

Figure 62: West end Office Rents 1984-2007



Source: Property Week, 2009

Heron Keys Development Limited was to have made a single payment of £2.4 million at November 1989 prices, uplifted by 10 per cent. per annum and payable in June 1992. The company, which was a joint venture company owned partly by Olympia and York, and partly by Regalian Homes Limited, told LUL it could not proceed once Olympia and York had gone into administration.

British Gas was to make contributions in cash and kind, estimated in 1989 to be worth £24.7 million. Some of those contributions were to be uplifted at 12 per cent per annum to the dates on which they were. The detailed terms under which the contributions are to be paid, including the length of time over which they would be paid, was specified in the funding agreement with LUL.

According to Hansard, the official report, Mr. Portillo said “ Agreement has been reached with British Gas on behalf of its joint development on the Greenwich peninsula. It will contribute towards the cost of the Jubilee line extension cash and benefits in kind that have been

evaluated by the Department and its advisers as having a present value of more than £25 million in September 1989 prices.”

Source: UK Parliamentary Publications and records: House of Commons Hansard Debates for 13 March 1990: column 146, Jubilee Line.

Source: Hansard. http://hansard.millbanksystems.com/written_answers/1992/jun/23/jubilee-line, [accessed: 20080613]

The 1993 agreement was renegotiated in 1999 so that Canary Wharf Limited (CWL) would make an earlier single payment in the order of £50 million in 2000, which sum had an equivalent value to the net amount outstanding under the 1993 agreement. It also provided that the extension would open at a specified time and with a certain capacity that would increase over time.

In 2003, a further agreement was reached between LUL and CWL that in satisfaction of rebates of £95 million due to CWL in respect of its contribution, LUL would deliver specified improvements to the Jubilee line or face penalties. These improvements include the additional capacity at Canary Wharf station provided in 2004, the seventh car for existing trains provided in 2005 and the introduction of new signalling and train control systems by 2009.

<http://www.publications.parliament.uk/pa/ld200708/ldhansrd/text/71128w0002.htm>

Funding resource from LRT (London Regional Transport)

According to Hansard, the official report, Mr. Portillo mentioned “The figures shown for LRT exclude investment in the Jubilee line extension for which provision is shown separately in the White Paper. Planned investment in this project during the plan period is as follows:”

£ million	
1990-91	40
1991-92	190
1992-93	300

Source: UK Parliamentary Publications and records: House of Commons Hansard Debates for 26 Feb 1990: column 51 , Public Transport.

1992 Finance Restructure

The failure Olympia and York to pay the first instalment of £40 million at the end of March 1992 threw the project into turmoil. Significant uncertainty surrounding the £400m contribution for O&Y forced many key stakeholders to consider their position. "How long can you maintain the project team and keep on spending money if there's a chance of there not being a final

result?"There is enough design work to keep the team busy in the near future. But London Underground will be reluctant to keep paying people to twiddle their thumbs" (CN, 1992)

Negotiations between the government, O&Y and Canary Wharf investors continued until September when bankers to the failed Canary Wharf development in London Docklands agreed a financing package for the extension of the Jubilee Line which was hoped would allow the scheme to go ahead. A formal offer was made to the government which was in a form replicating the original offer from Olympia & York which had been agreed but was never signed. The 11 banks to Canary Wharf agreed to put up £170m - an initial payment of £80m with the remainder over 25 years. In return for the financing, the banks were also believed to be insisting that the Government choose Canary Wharf as the site for the relocation of about 3,000 civil servants from the Department of Environment and the Department of Transport. (Telegraph, 1992)

Hansard tells us discussions related to this offer were had in the House of Lords on the 2nd November, 1992. "It seems to me that the Minister is aware that London Transport anticipates reducing by about £230 million the amount expected by the Government from developers. Does the Minister know that London Transport has spent £150 million in preparatory work? As regards relocating Marsham Street staff to Canary Wharf, can the Minister say when the first decision was taken to relocate the staff and therefore to pull down the building? Were the Government aware that London Transport has decided to move 2,000 staff to Canary Wharf or were they not told?" However overall the debate indicated little progress had been made on reaching a financing agreement. London Underground Limited had been given money to continue the preparatory work in order that the scheme can go ahead if and when a decision is taken, but the Government was holding fast to the requirement that "the line would only be built if sufficient contributions are forthcoming from property developers and other landowners who would benefit"

This was despite Lords highlighting the possible creation of up to 12,000 jobs if the JLE went ahead, the importance of the scheme to "to get the construction industry moving" and the foolishness of allowing "a piece of important infrastructure such as the Jubilee Line to rely entirely on the whims of market forces"

In May 1993 the issue came under debate in the House of Commons. § Mr. Austin-Walker (Labour Seat in Woolwich asked Mr Norris, the then Parliamentary Under Secretary of State for Transport and Minister for Transport "Whether it is the dead hand of the Treasury or the dithering of the Prime Minister, does the Minister agree that the time to invest in our infrastructure is before we come out of recession? Is the hon. Gentleman aware that 85 per cent. of the contracts for the building of the Jubilee line are ready to go, with the prospect of between 10,000 and 30,000 jobs being created? "*HC Deb 24 May 1993 vol 225 cc558-61 558*

However the government refused to back down from their original goal "It is quite obvious that all the way through our message has been very straightforward. The Government are prepared to contribute around £1.5 billion to the project on the basis that the private sector comes forward with its own contribution of £400 million in cash. I regret the delay as much as the hon. Gentleman. He and I have debated the issue many times. We are making progress and that progress will continue. When the process is complete—and it is impossible for me or the managing director of London Underground or anyone else to set a date at this stage—we will begin construction of the line"

There were also questions related to the Treasury trying to delay or scrap the project “ Will the Minister make it quite clear that he is not being pressurised by the Treasury into scrapping the Jubilee line extension altogether? That is what the newspapers and various people in the private sector are saying. Is not the Minister fully aware that unless the Jubilee line extension goes ahead, a large number of question marks will hang over the development in docklands, the City airport, Canary wharf and the whole of the east Thames corridor initiative?

The Government's position has been clear throughout and I will restate it for the avoidance of doubt. It is that the Government remain committed to putting money into the project once the private sector contribution is concluded and assured. I readily accept the hon. Gentleman's point about the 561 impact of the Jubilee line extension, particularly on those areas south of the Thames which stand to benefit substantially when the extension is built. I hope that a satisfactory conclusion can be arrived at so that the line can go ahead. But it must depend on the private sector contribution.

Complexity of reaching agreement with the creditors of O&Y and the possibility of delays being extended by the bankers “ The complexity of arriving at an agreement with the creditors of Olympia and York, which I understand was the largest property company in the world when it went into administration, was underestimated. That has necessarily meant that the process of arriving at a new arrangement has been extremely complex and hazardous. I should like to put it on the record that the Government believe that all the parties to negotiations have acted throughout in good faith. Important and difficult negotiations have taken place. I regret the delay in the creation of jobs and opportunities, but I am convinced, as I know is my hon. Friend, that it is right to press the developers, who will gain materially from the development in return for their contribution”

Despite the original offer to the Government from the Bankers in September 1992, negotiations were not completed until October /November 1993, almost 20 months after O&Y defaulted on the first installment. “CREDITORS of Olympia & York's Canary Wharf development in London Docklands voted unanimously in favour of a pounds 1.1bn rescue package yesterday. Canary Wharf is set to emerge from administration at the end of the month and the pounds 1.8bn Jubilee Line extension should get the go-ahead soon afterwards.” The 'yes' vote clears the way for the administrators to sign an agreement with London Regional Transport over the Jubilee extension in the next week or so. This will have to be confirmed by the Secretary of State for Transport when Canary Wharf officially emerges from administration, on 31 October. Digging should then start before the end of the year, with completion pencilled in for 1998.

The 10 banks that control Canary Wharf were 'relieved' the 1,400 unsecured creditors, mostly construction companies, had given their backing to the deal. There will now be a 28-day 'cooling off' period during which creditors can lodge further claims with the court supervising the deal. But the banks are cautiously optimistic that, with 90 per cent of claims already agreed, there should be no further stumbling blocks.

The unsecured creditors will receive up to 15p in the pound under the deal. A further 25p in the pound will be paid to 130 construction trade creditors who will be required to provide warranties on work they have done already.

Administrators Stephen Adamson, Nigel Hamilton and Alan Bloom were appointed to run the development and construct a rescue plan on 28 May 1993. They will apply to the courts to be discharged from the administration, the biggest in British history, in the next few days.

Mr Adamson said: 'After protracted and complex negotiations with numerous parties we believe this is the best deal for the unsecured creditors who would otherwise have received nothing.'

The deal leaves 10 banks, led by Lloyds, as owners of Canary Wharf, under the guise of a new holding company, Sylvester Investments. A new trading company, Canary Wharf Ltd, will continue to build the development, and two senior executives are set to be appointed to run it. One is Sir Peter Levene, the former head of procurement at the Ministry of Defence who is now heading the Docklands Light Railway, and the other is Charles Sanderson, a director of Savills, the property agents.

Two new tenants for Canary Wharf have agreed to move in, on the condition that it successfully leaves administration. Mirror Group Newspapers and London Underground's engineering staff are both ready to move in the autumn and new year, bringing the occupancy rate of the massive office scheme up to 50 per cent.

<http://www.independent.co.uk/news/business/canary-wharf-creditors-wave-through-rescue-deal-digging-for-jubilee-line-extension-should-start-before-year-end-1508030.html>

Status of Private contribution as of 2007

In a house of Commons debate held on 28th November 2007, Lord Berkely asked "In respect of private sector contribution to the Jubilee line extension, how much money was committed at the time of the announcement of the funding of the project, how much was actually paid, and whether the amount of such contributions was in any way dependent on achieving a particular completion date for the project?"

The response to which (given by Lord Bassam of Brighton) was "I am advised by LUL that agreement was reached between LUL and Olympia & York (later Canary Wharf Limited (CWL)) in 1993 that CWL would provide £398 million in total towards the JLE. This consisted of payments before and during the construction of the JLE and for 25 years after its opening. Payments totalling £145 million were made by CWL

The 1993 agreement was renegotiated in 1999 so that CWL would make an earlier single payment in the order of £50 million in 2000, which sum had an equivalent value to the net amount outstanding under the 1993 agreement. It also provided that the extension would open at a specified time and with a certain capacity that would increase over time.

In 2003, a further agreement was reached between LUL and CWL that in satisfaction of rebates of £95 million due to CWL in respect of its contribution, LUL would deliver specified improvements to the Jubilee line or face penalties. These improvements include the additional capacity at Canary Wharf station provided in 2004, the seventh car for existing trains provided in 2005 and the introduction of new signalling and train control systems by 2009.

In 1990, an agreement was reached between LUL and British Gas regarding the JLE and in particular North Greenwich, which consisted of cash and benefits in kind that were estimated to have a value of around £25 million in 1989."

Operations

Reported Traffic Volume

- In 2002 approximately 1.6m passenger kms per weekday were made on the JLE, with on average 150,000 passengers per weekday being carried on the busiest section of the line between Waterloo and London Bridge.
- The JLE is estimated to have saved 14.4 million hours in travel per year.
- The additional capacity provided by the JLE has reduced crowding on key sections of the underground, including the District and Central Lines. The JLE has also reduced levels of crowding on the DLR and has provided an alternative route to reach Docklands, with 71,000 trips per day being made to and from the Isle of Dogs by the JLE in 2003.

Source: Summary of the main benefits of the Jubilee Line Extension.

The latest feature of number of passengers on the Jubilee line was shown on the official website.

Weekday	Saturday	Sunday	Annual (mil)
405,878	271,739	182,480	127.584

Source: <http://www.tfl.gov.uk/tfl/corporate/modesoftransport/tube/linefacts/?line=jubilee>
[accessed 21st June 2008]

How traffic forecasts were formulated

The method of traffic forecast for the JLE was The DoT's London Transport Study (LTS) transport planning model which was the main tool used in the demand forecasting and was aimed at assessing the travel needs of a fully developed Docklands. The model showed that a maximum of 133 million passenger journeys per annum could be expected on the JLE with use forecast to rise to 170 million journeys per year on the Jubilee Line as a whole. This would almost treble the use of the original section between Stammore and Green park.

Three different loading cases were defined for the traffic forecasts- a base case, an intermediate case and an ultimate case. These produced a range of predictions against which design options could be assessed (Mitchell, 2003:122):

- The Base Case was to be used to determine the initial service requirements when the extension was first opened, the design passenger flows being based on the design year 2001.
- The Intermediate Case was equivalent to the Base Case but with the addition of a higher employment scenario in the Isle of Dogs, with an end-state assumption of 100000 jobs. It was felt that this employment level was unlikely to be achieved before 2005.
- The Ultimate Case represented the passenger flows for an upper capacity scenario and has the same planning assumptions as the intermediate case with the addition of the Woolwich branch of the extension. The route of the Woolwich branch assumed for the

Ultimate Case was North Greenwich to Woolwich Arsenal via Prince regent and Silvertown with a possible extension to Thamesmead via Plumstead.

The loading cases equated to a train service frequency as follows (ibid):

- Base case 27 trains per hour
- Intermediate case 30 trains per hour
- Ultimate Case 36 trains per hour

In terms of the numbers of people to be carried in the Ultimate case, in the morning peak hour, the maximum flow forecast was 26543 passengers per hour on the westbound section between North Greenwich and Canary Wharf. Moreover, the ridership was expected to be above 20000 passengers per hour over the entire section between North Greenwich and Westminster. In comparison, the Base Case over the same section was forecast as 70% of the ridership of the Ultimate Case. (Mitchell, 2003:123)

The expected number of travellers on the proposed extension to the Jubilee Line both from Docklands westwards and from west to Docklands in each of the first 10 years of operation was estimated that "Forecasts have been made only for the morning peak three-hour period in 2001. The number of passengers predicted to use the line varies from link to link along its length. Between Green Park and Canary Wharf the number of people travelling daily eastward in the morning peak period is forecast to vary between 17,000 and 30,300 and the number travelling westward between 8,000 and 32,100."

Source: UK Parliamentary Publications and records: House of Commons Hansard Debates for 16 Nov 1989: Column 394, Jubilee Line.

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