

A white silhouette of the London skyline against a dark blue background, featuring landmarks such as the London Eye, Big Ben, and various skyscrapers.

Crossrail 2012

Challenges and Solutions

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Technical Director

Institution of Mechanical Engineers
20th February 2012

A white silhouette of the London skyline against a dark blue background. Key landmarks visible include the London Eye, Big Ben, the Gherkin, and various other city buildings.

***Delivering a world-class
affordable railway safely
through effective partnerships***

Crossrail



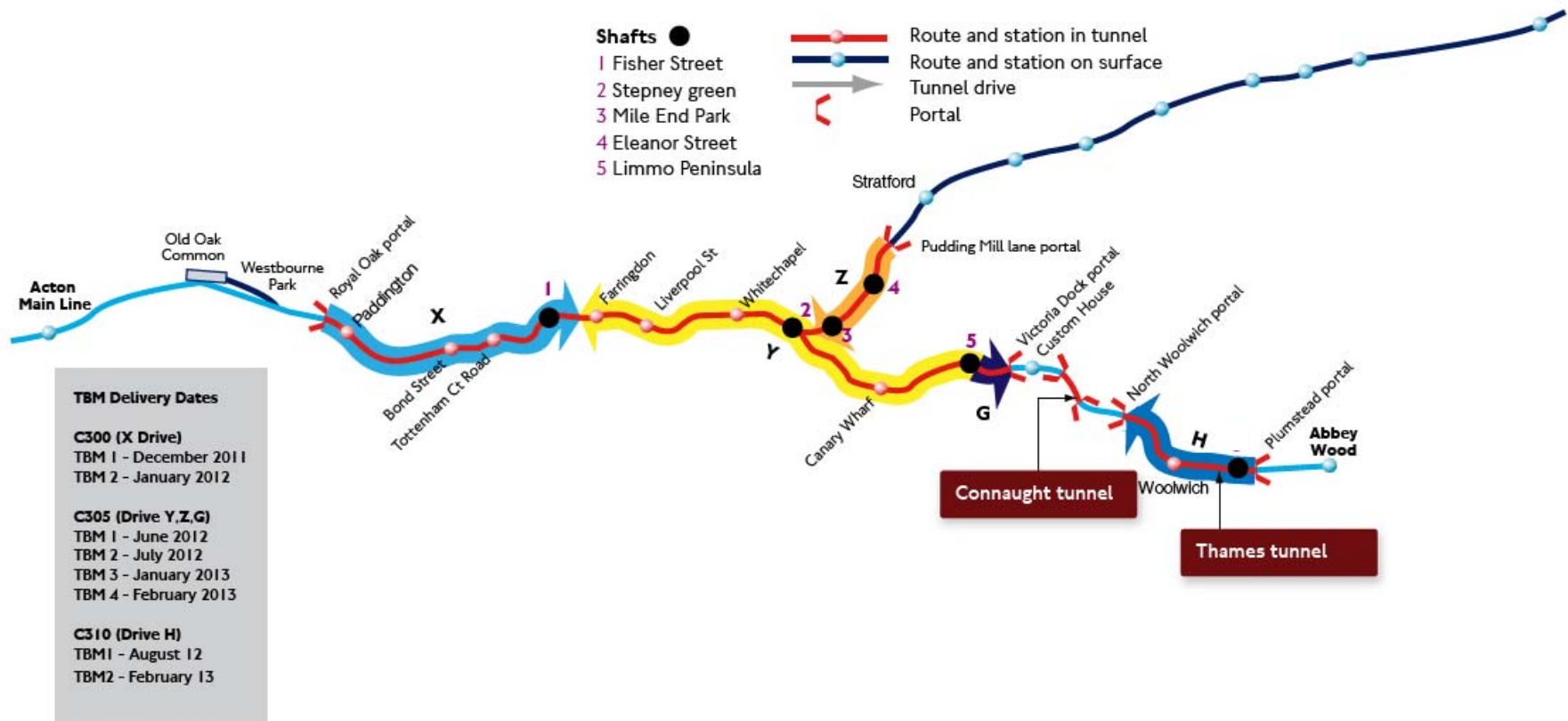
200,000,000
36,000
24
2018
14,800,000,000

200,000,000 passengers expected in first year of operation
36,000 passengers per hour in Peak
24 trains per hour
21km twin-bored tunnels
Planned completion 2018
£14.8bn (originally £15.9bn)

Crossrail Central Route

8 new sub-surface stations and one new surface station

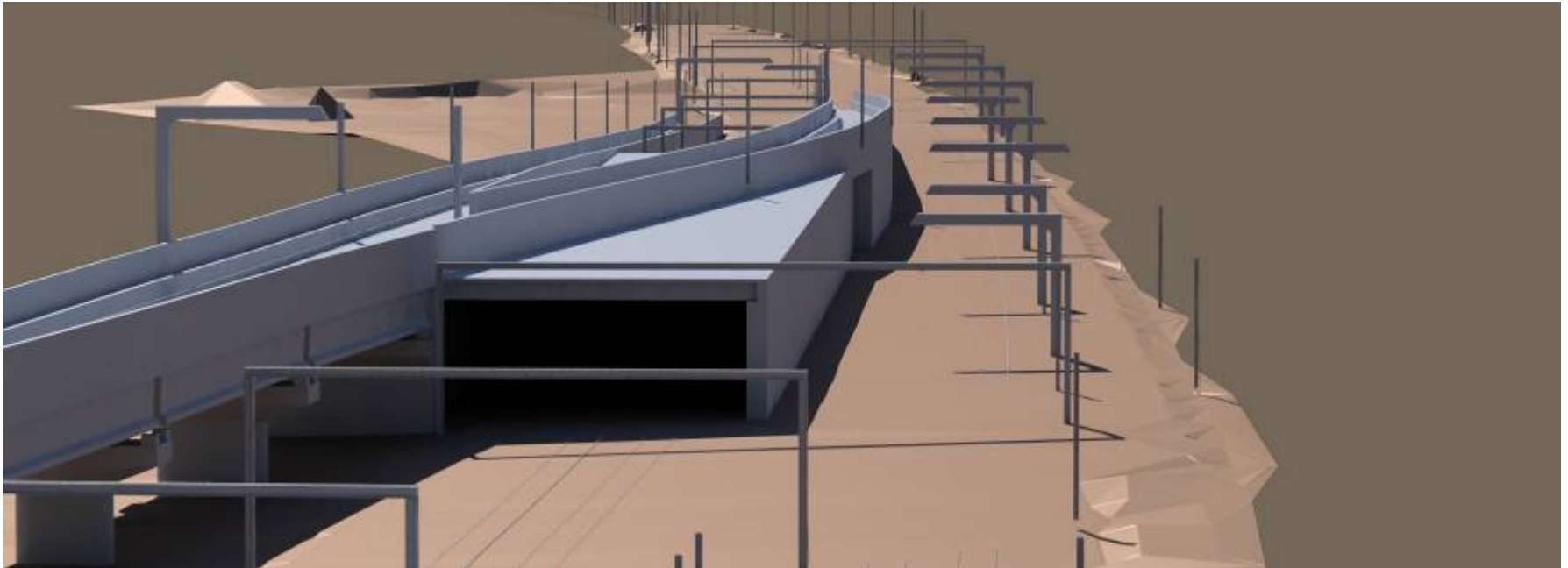
- Paddington, Bond Street, Tottenham Court Road, Farringdon, Liverpool Street, Canary Wharf (*Project Managed by Canary Wharf Group*), Whitechapel, Woolwich (*Project Managed by Berkeley Homes*), and Custom House



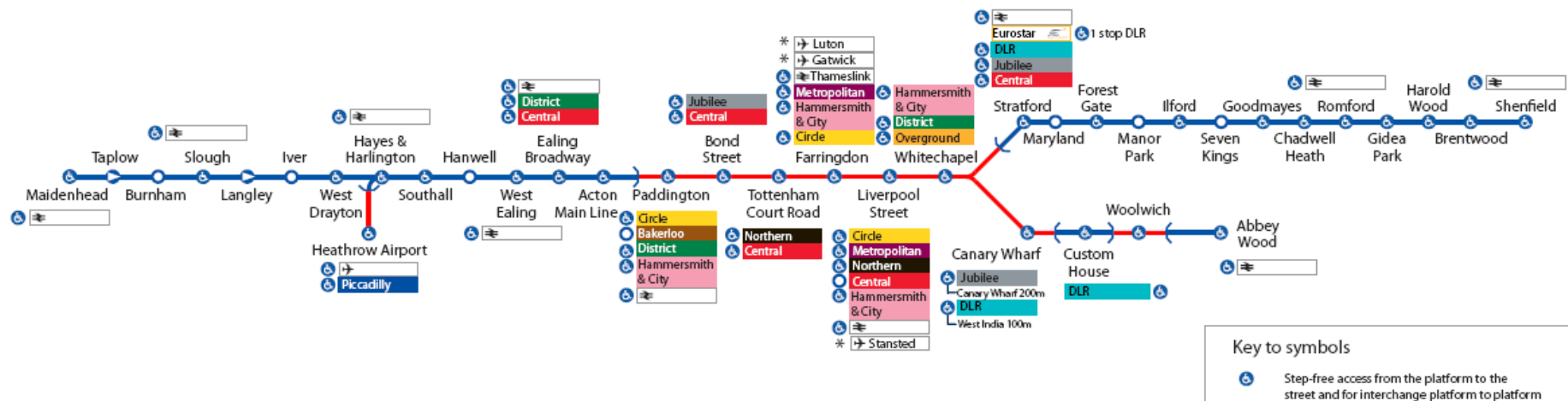


Crossrail Surface

- Network Rail are best placed to deliver the works
- Agreement for Network Rail to be Crossrail's 'Industry Partner':
- New assets will become part of their asset base
- Facility charges will be paid by the operator over 30-50 years
- Crossrail is the 'customer'

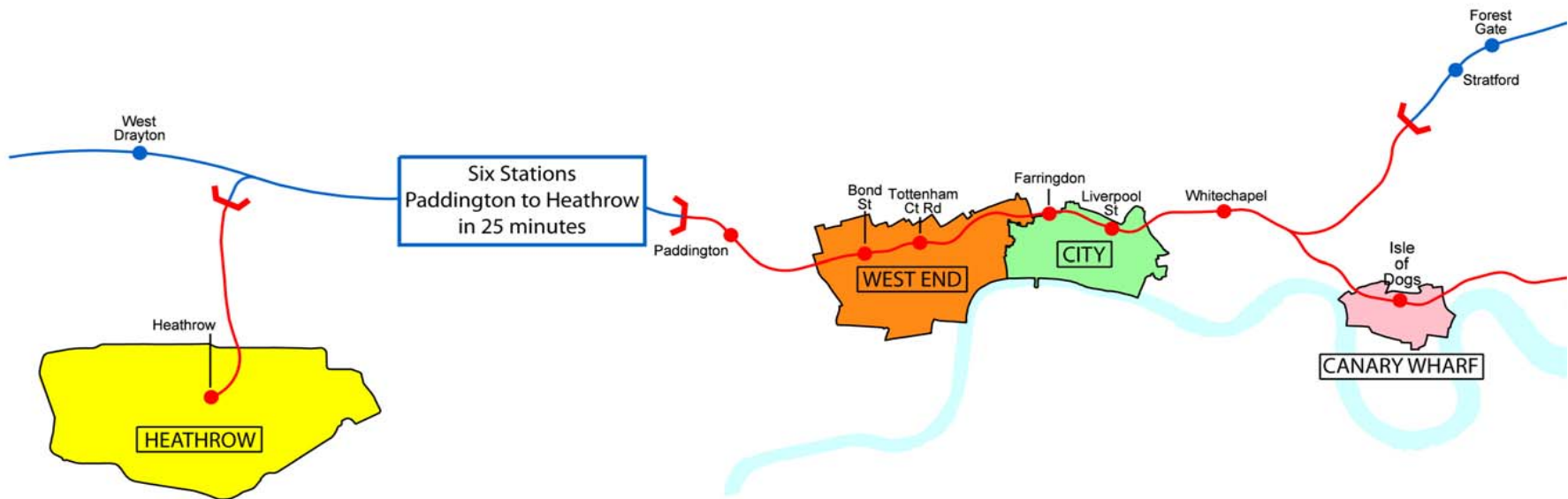


Connections with other services





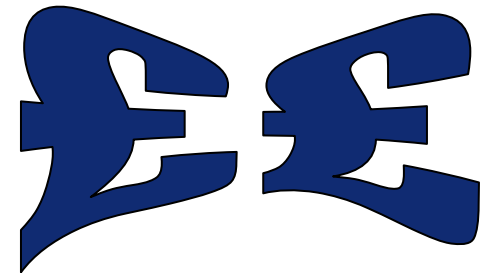
Linking London's key business and regeneration areas





Funding

- Full project £14.8 billion
 - TfL & GLA contributions
 - Government – DfT contribution
 - Business contributions
- Contributions:
 - City of London
 - BAA
 - Canary Wharf Group – Canary Wharf Station
 - Berkeley Homes – Woolwich station





Transport Benefits

- Relieve overcrowding on existing Tube and train services
 - 10% extra rail capacity for London
 - Bring an additional 1.5 million people within 45 minutes commuting distance of London's key business districts
- Decrease journey times into and across London
 - 24 trains per hour
 - Reliable, efficient service
 - Additional commuter services
- Links to commuter lines
 - Heathrow, West End, City and Canary Wharf connections
 - Supports London as a world city and finance centre



Decreasing journey times

	Current journey time	Crossrail journey time
Slough to Tottenham Court Road	55 minutes	36 minutes
Ilford to Bond Street	35 minutes	22 minutes
Heathrow to Liverpool Street	55 minutes	36 minutes
Liverpool Street to Abbey Wood	40 minutes	22 minutes
Paddington to Canary Wharf	30 minutes	17 minutes



Economic benefits

- Key part of London's plan for growth
- Support sustainable economic development by increasing transport capacity and reducing congestion
- £42 billion boost to the economy
- Over 35% of future employment growth in London expected to be located in areas served by Crossrail
- Up to 14,000 people employed on Crossrail at the peak of construction
- National and regional benefits
 - Better connectivity
 - Services of a wide range of suppliers required



Programme

Tunnelling

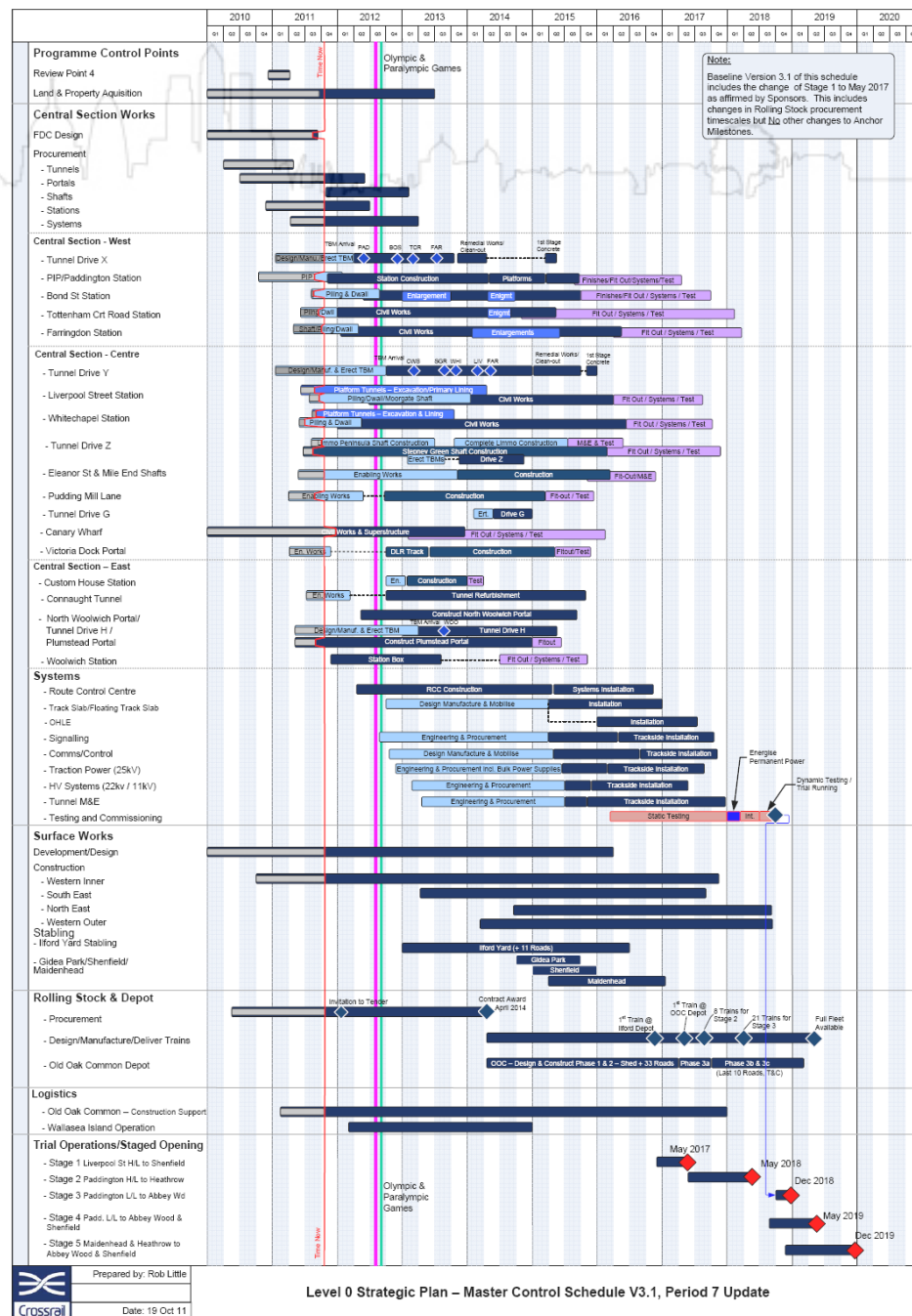
Tunnel Drive	TBM Launch	Tunnel Drive Complete
First Tunnel Drive - Royal Oak to Farringdon (Drive X)	March 2012	Third Quarter 2013
First SCL works (C510)	Dec 2011	First Quarter 2016

Portals and Shafts

Location	Construction Start	Works Complete
First Portal Westbourne Park / Royal Oak Portal	May 2010	Sep 2011

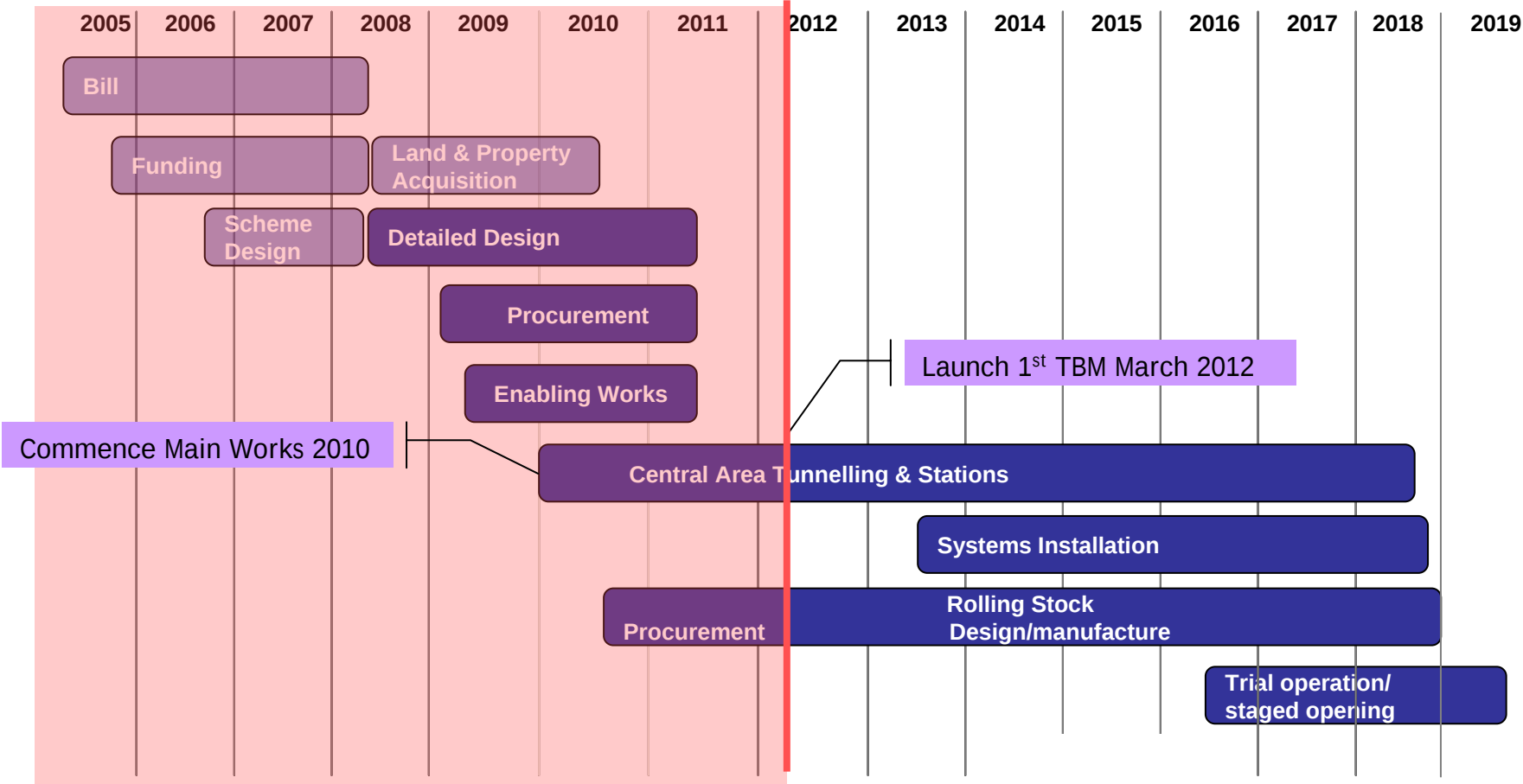
Stations

Location	Construction Starts	Main Civil Works Complete
First Station works - Canary Wharf	May 2009	Third Quarter 2017
Last Station works - Whitechapel	Feb 2011	Third Quarter 2018





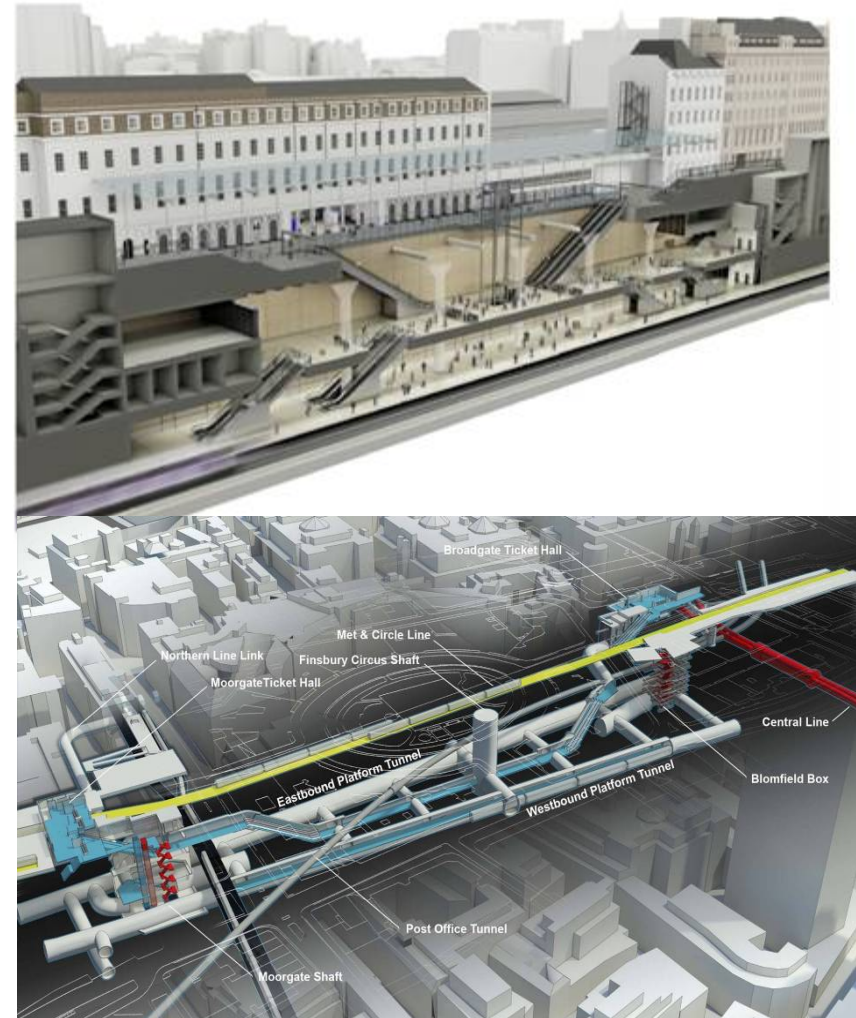
How are we doing?





Stations

- Main works contracts awarded for Paddington, Farringdon and Whitechapel
- Advance works underway at all central London stations
- Paddington Integrated Project relocated taxis from Departures Road in February 2012
- Liverpool Street and Tottenham Court Road main works contracts will be awarded this year
- Bond Street main works contract will be awarded in early 2013
- Woolwich Station construction underway
- Canary Wharf station well advanced

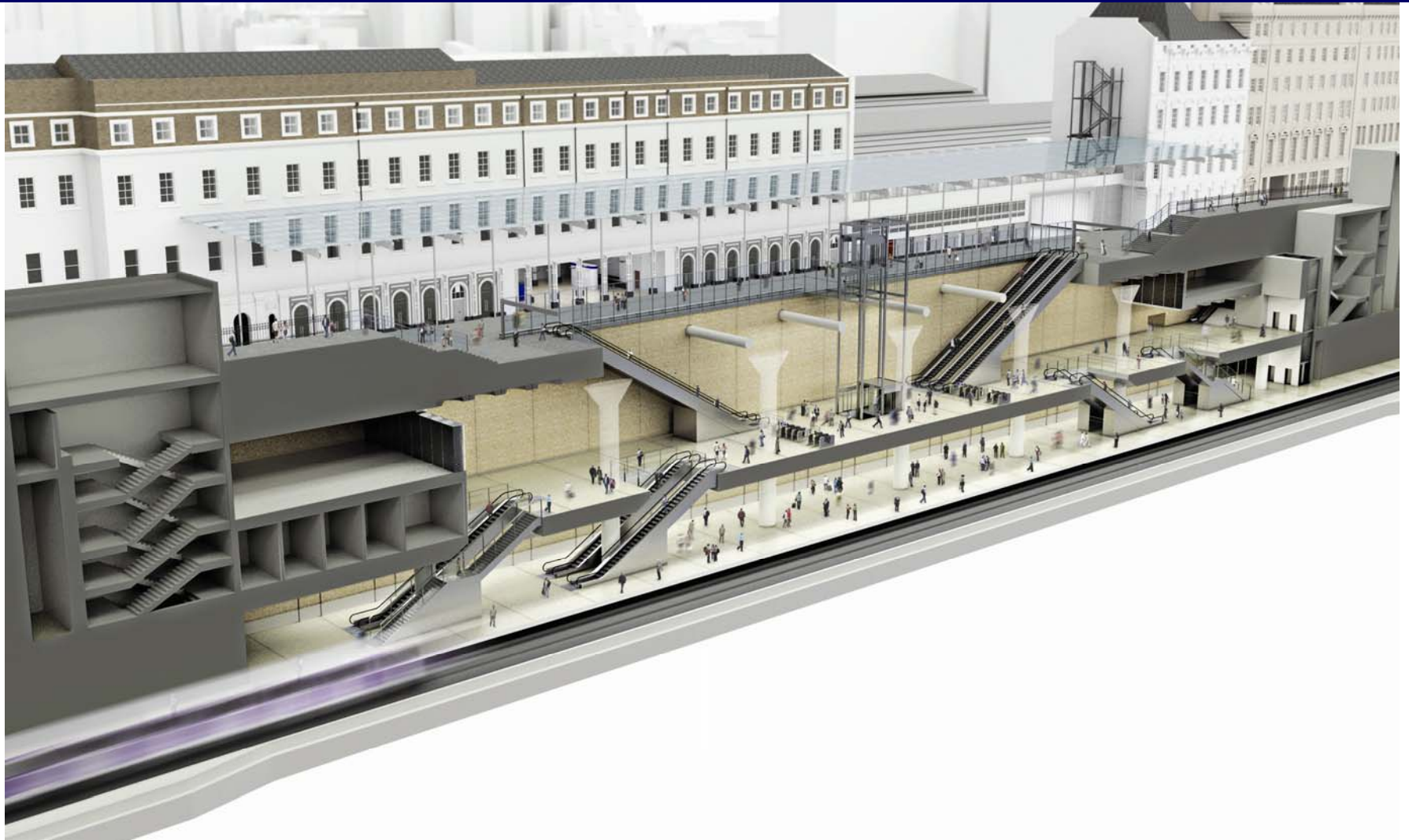


Paddington Integrated Project – new taxi facility



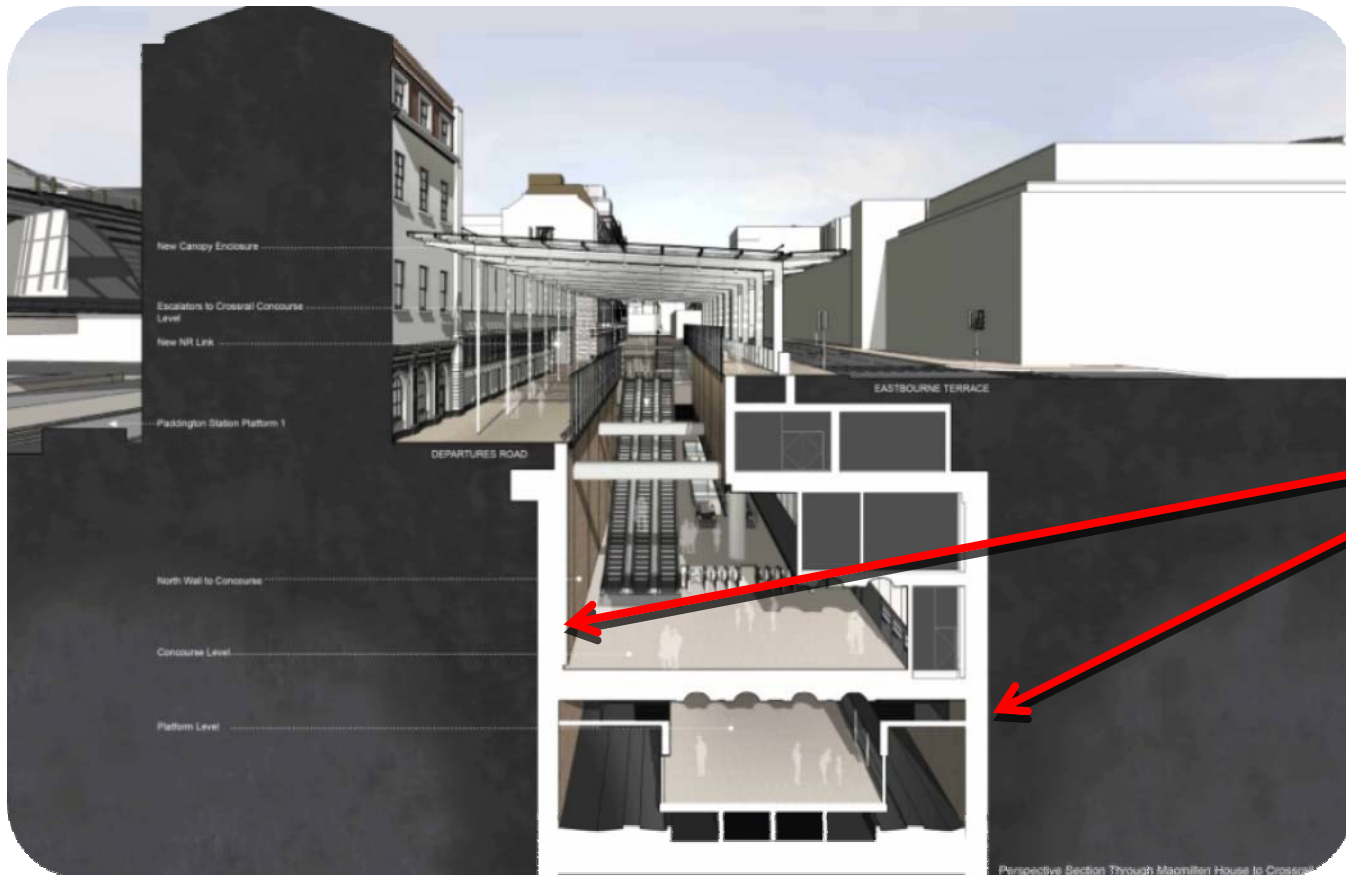


Stations



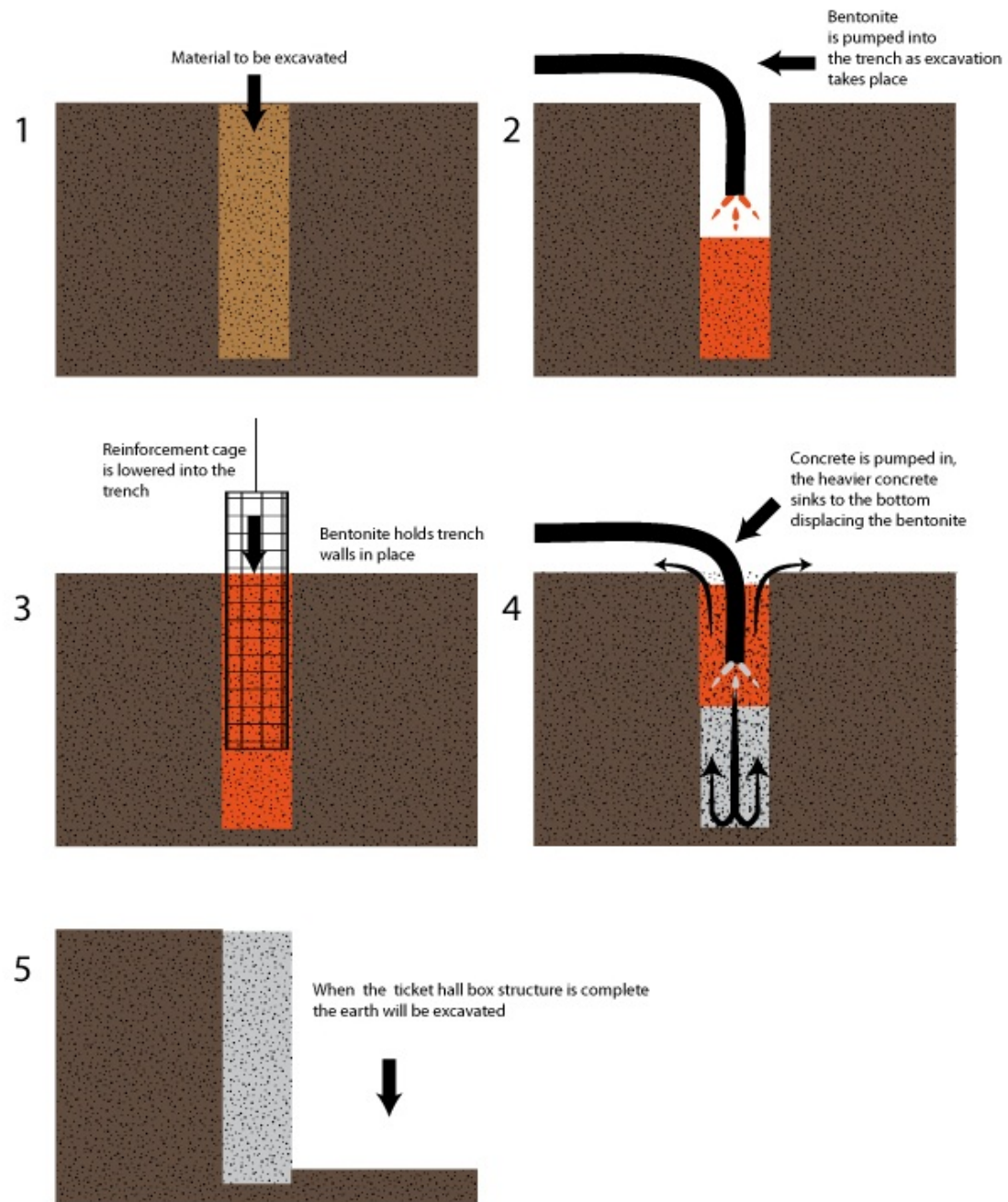


How do we build it?



**Diaphragm
walls**

Construction methodology



Bond Street East Ticket Hall November 2011

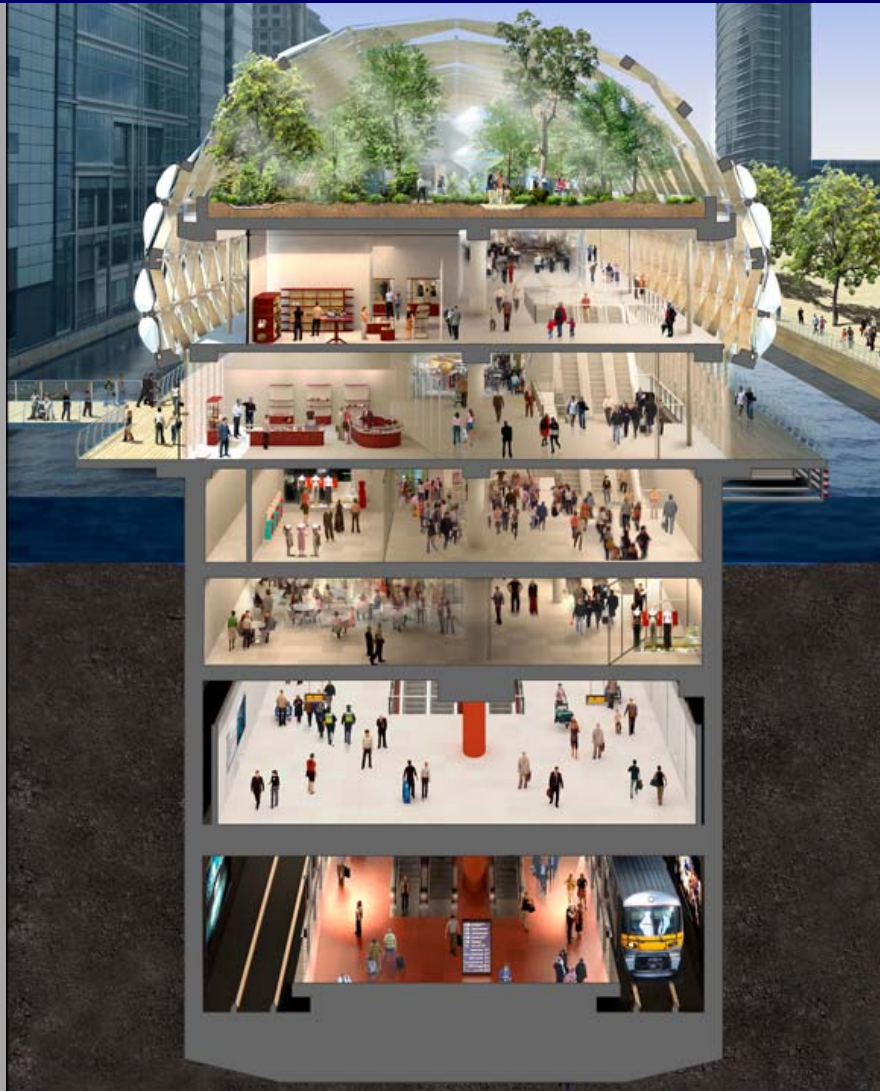


Whitechapel





Canary Wharf station – located in North Dock



Canary Wharf January 2012





Station construction in 2012

- Paddington: Complete diaphragm walling of station box
- Bond Street: Commence Spray Concrete Lined (SCL) Platform construction at Western Ticket Hall. Complete shaft excavation at Eastern Ticket Hall. Award main station works contract early 2013
- Tottenham Court Road: Complete piling and diaphragm walling of main box. Award main station works contract
- Farringdon: Complete Eastern Ticket Hall advanced works piling
- Liverpool Street: Commence SCL platform tunnel construction. Award contract for main station works
- Whitechapel: Diaphragm walling at Cambridge Heath and Durward Street shafts. Commence SCL platform tunnel construction
- Canary Wharf: Preparation of lower level for arrival of Tunnel Boring Machines

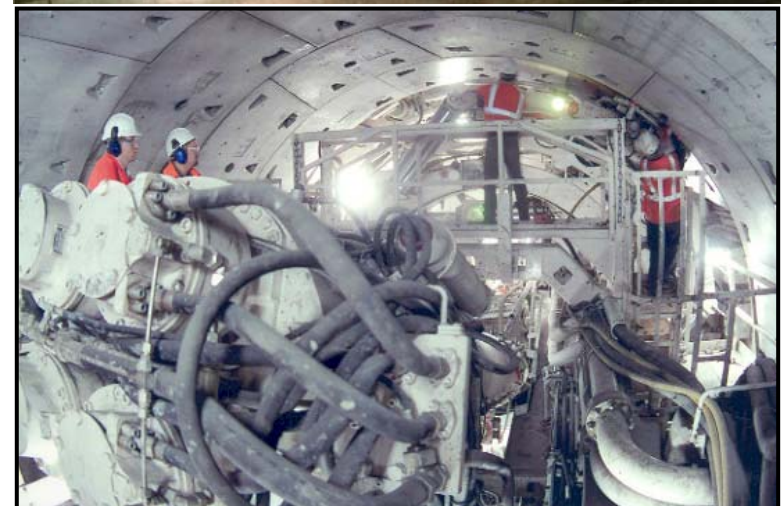
Tunnelling





Tunnelling

- All contracts awarded
- Royal Oak portal completed and handed over
- Conducted Factory Acceptance Test of first TBM
- Shaft construction underway at Limmo Peninsula, Stepney Green, Liverpool Street and Whitechapel
- Segment manufacturing facility commissioned
- Portal construction underway at Pudding Mill Lane and Plumstead
- First TBM launches March 2012 from Royal Oak Portal



2012/13

- Critical dates and volume
- Currently Delivery ~16.6% complete (P9); by end March 2013 ~35%
- All station contracts awarded (Tottenham Court Road, Bond Street, Custom House and Liverpool St)
- Launch TBMs (14900m bored to March 13)
- Commence SCL works (1200m to March 13)
- Thames Tunnel Eastbound TBM ready





The Challenges

- Build a new railway
 - Safely
 - Under London
 - In a complex environment
- Technical challenges
 - Design – “the controlling mind”
 - Tunnelling
 - Rail Systems
 - Rolling Stock
 - Systems integration
- Sustainability



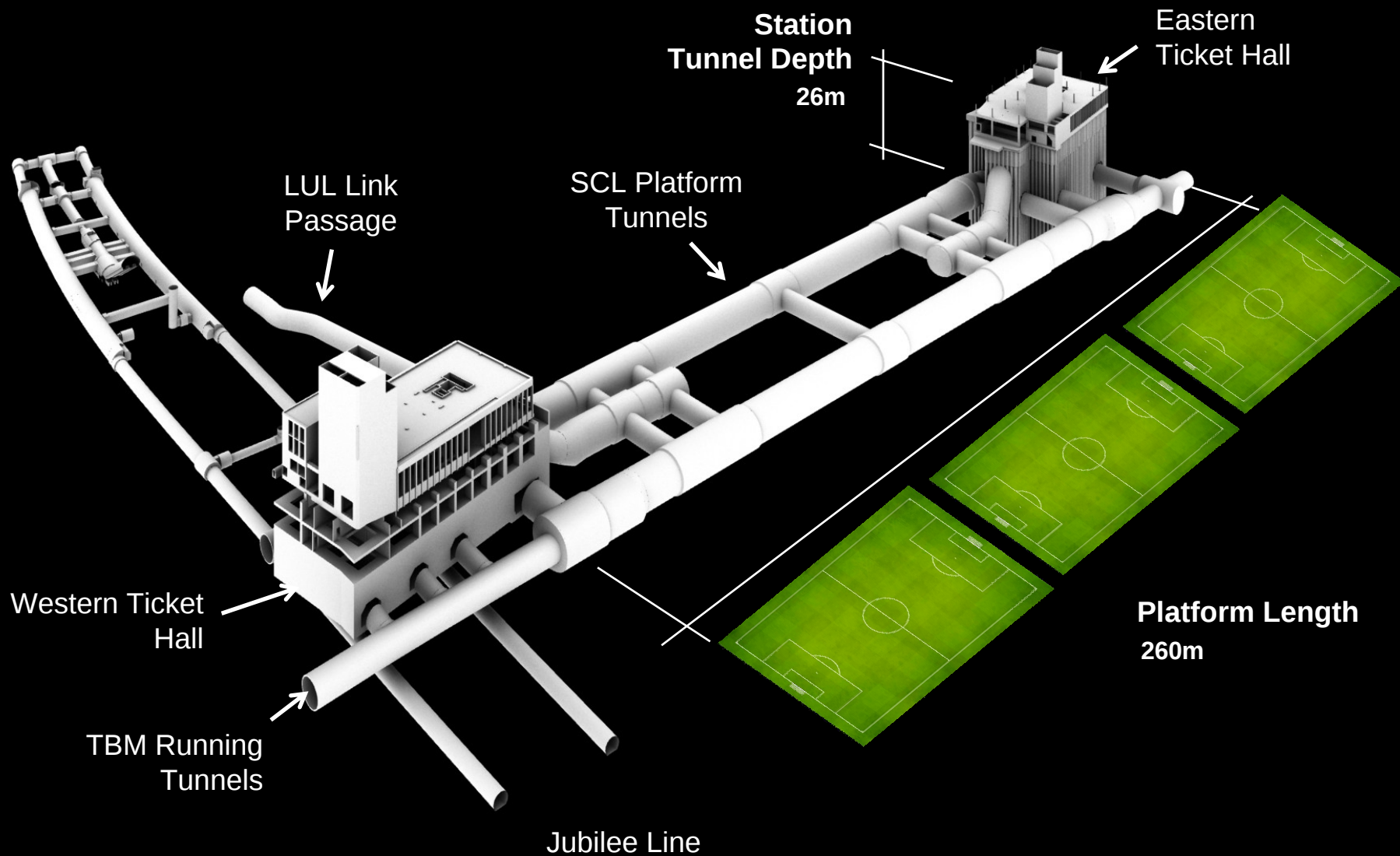
Zero Harm – Making it Personal



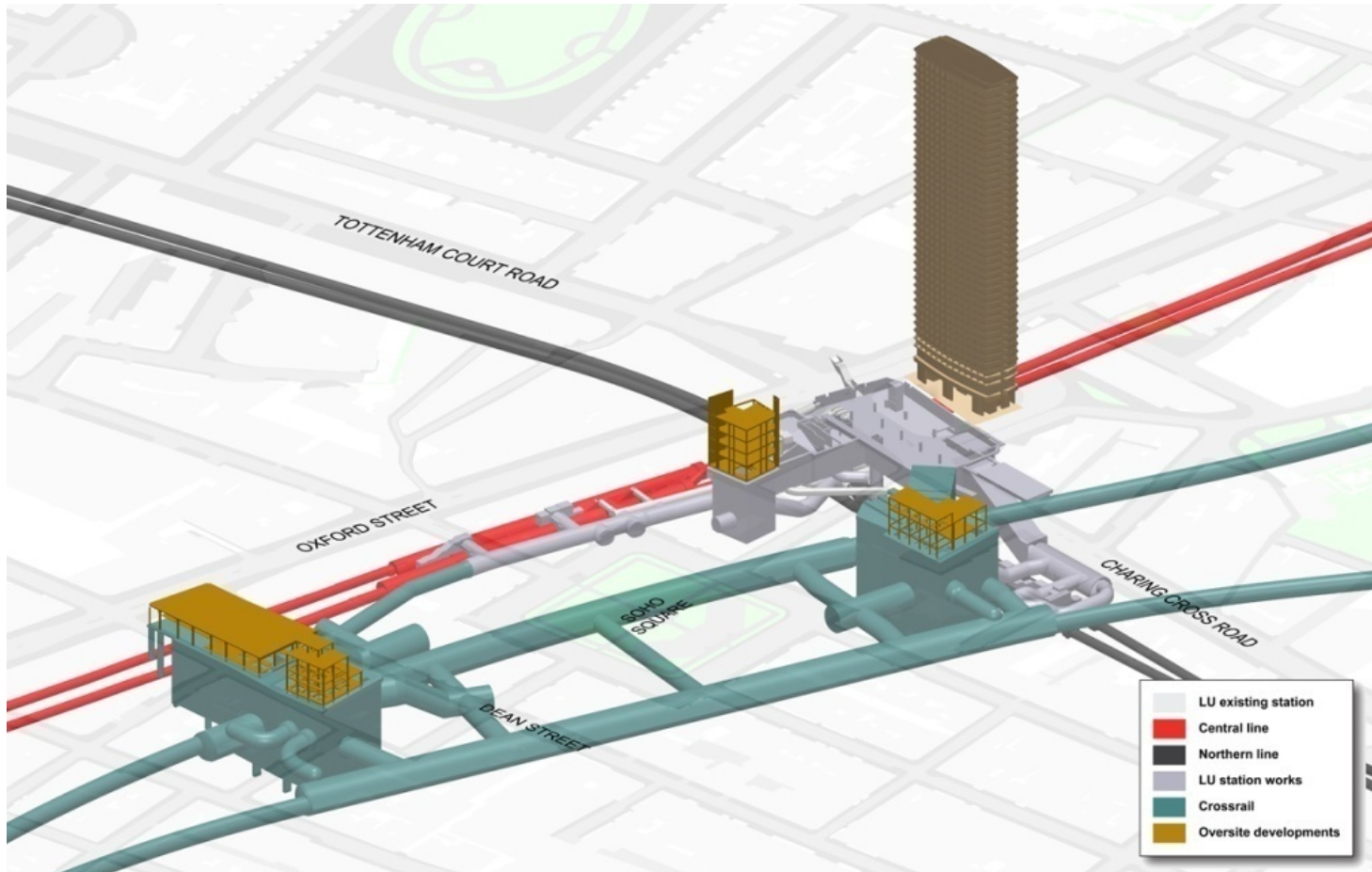
A STATE OF MIND

- ⌘ **We all have the right to go home unharmed every day**
- ⌘ **We believe that all harm is preventable**
- ⌘ **We must all work together to achieve this**

Typical Crossrail Station



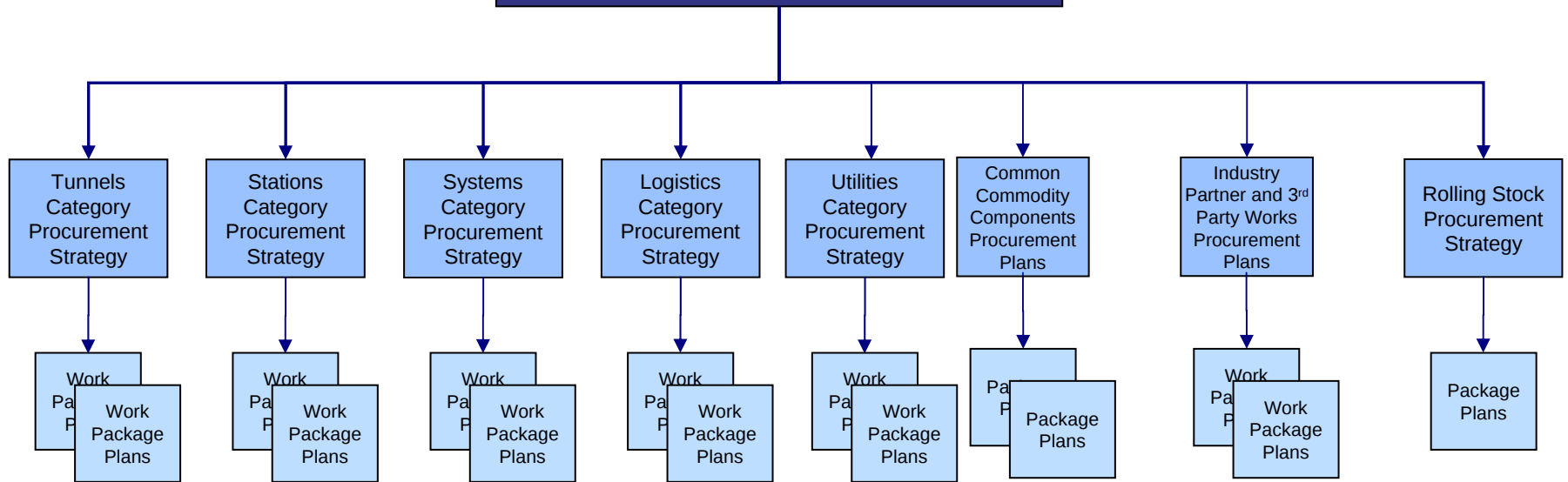
Tottenham Court Road Station





Managing Design

Crossrail Packaging Strategy





Role of the Chief Engineer

- Technical Authority for Crossrail
- Provide Technical Assurance for Design and Design in Construction
- Maintain Design Configuration
- Contract Administration of Framework Design Consultants (FDC)
- Engineering Managers on each contract, reporting to the Chief Engineer

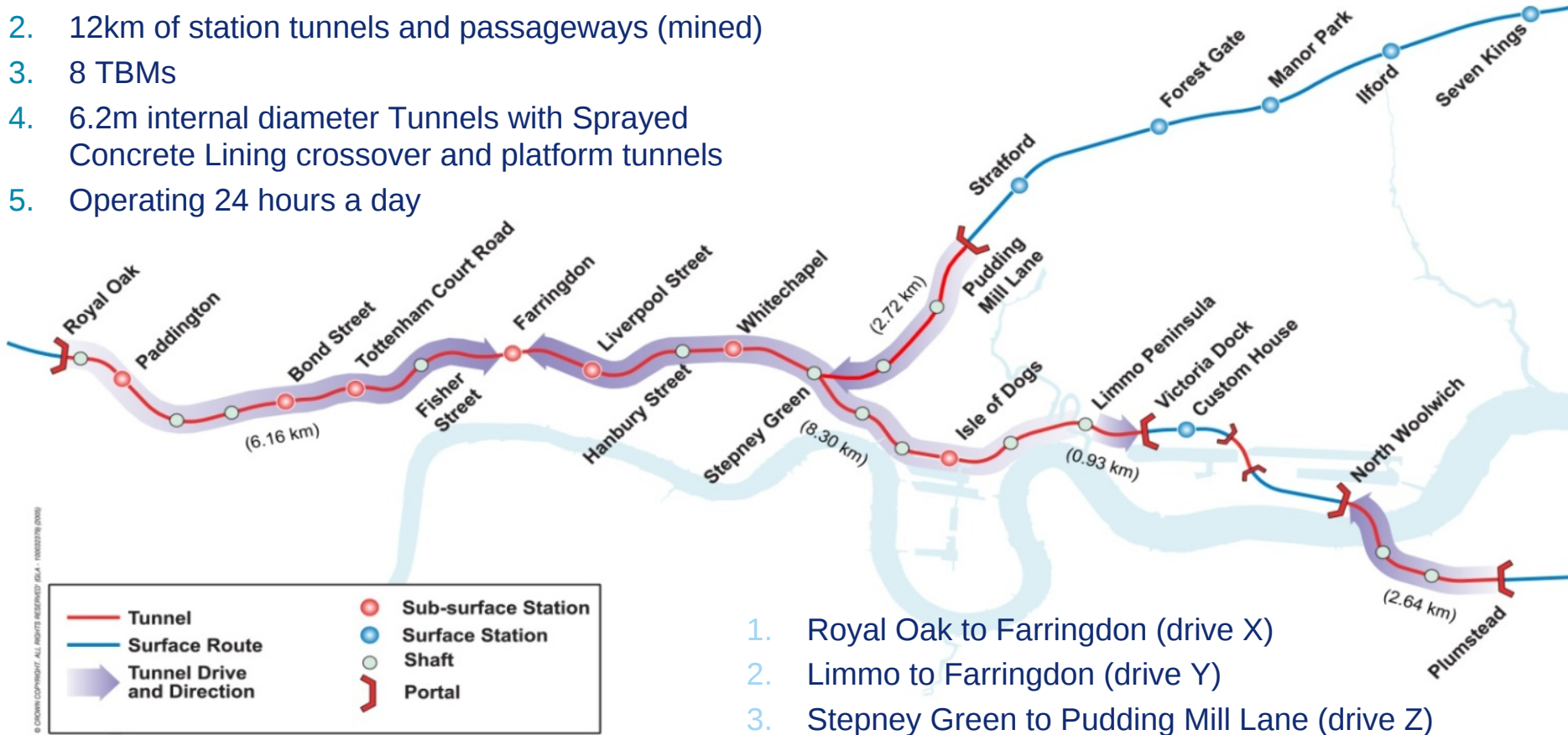


Platform Mock-up



The Tunnelling Challenge

1. 42km of bored rail tunnels
2. 12km of station tunnels and passageways (mined)
3. 8 TBMs
4. 6.2m internal diameter Tunnels with Sprayed Concrete Lining crossover and platform tunnels
5. Operating 24 hours a day

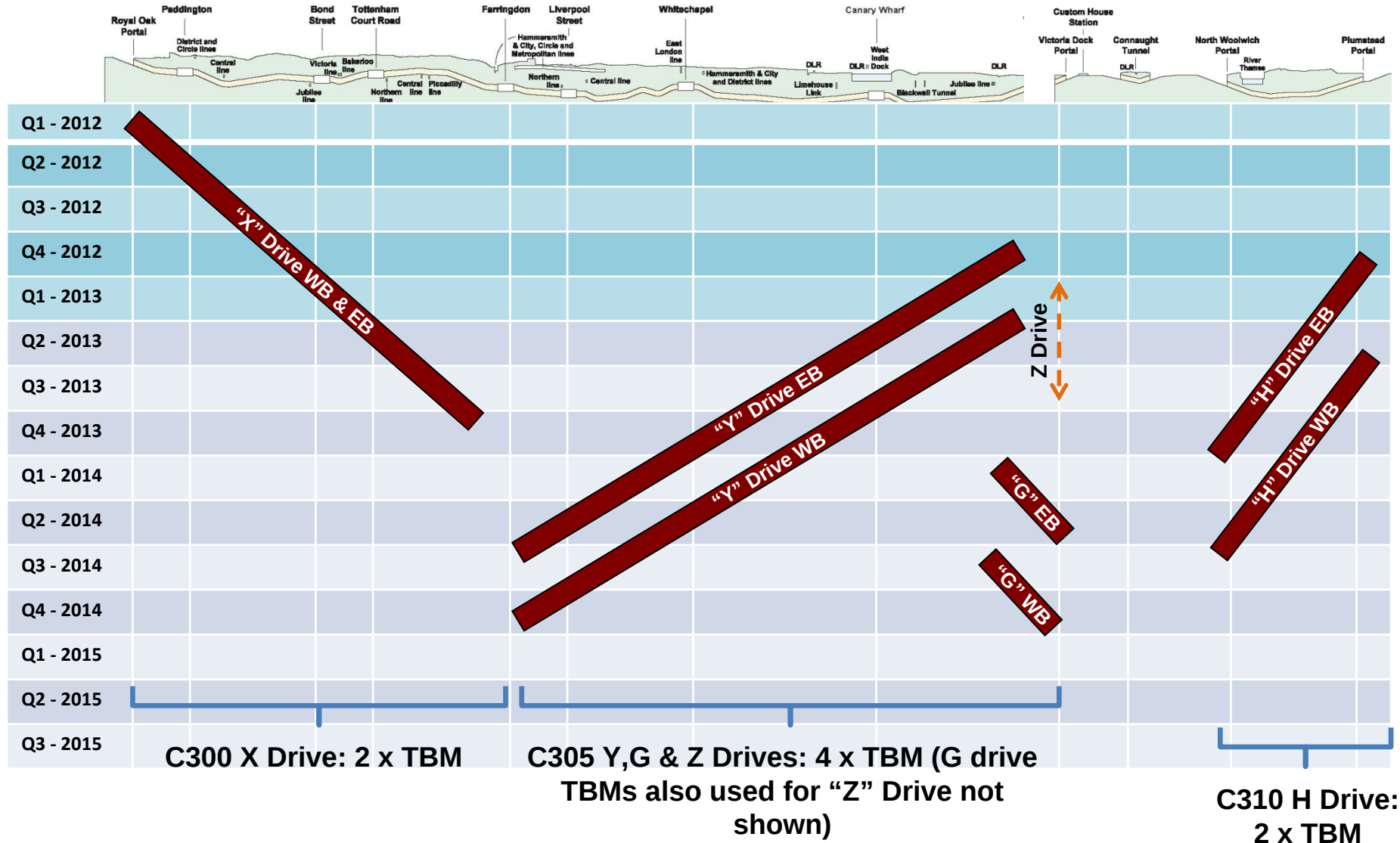


1. Royal Oak to Farringdon (drive X)
2. Limmo to Farringdon (drive Y)
3. Stepney Green to Pudding Mill Lane (drive Z)
4. Limmo to Victoria Dock Portal (drive G)
5. Plumstead to North Woolwich (drive H)

Crossrail Tunnelling – Royal Oak Portal

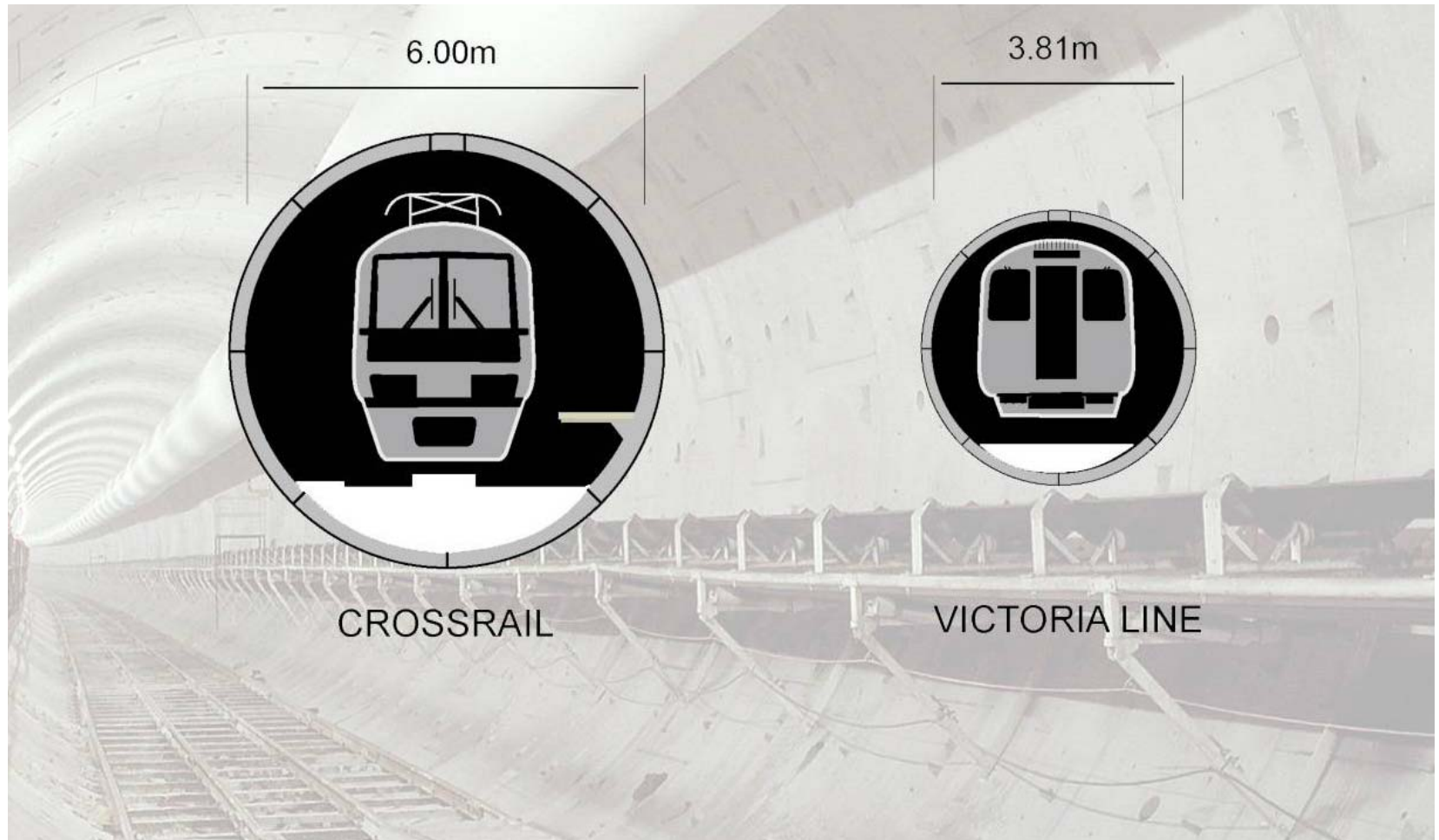


High Level Tunnelling Programme



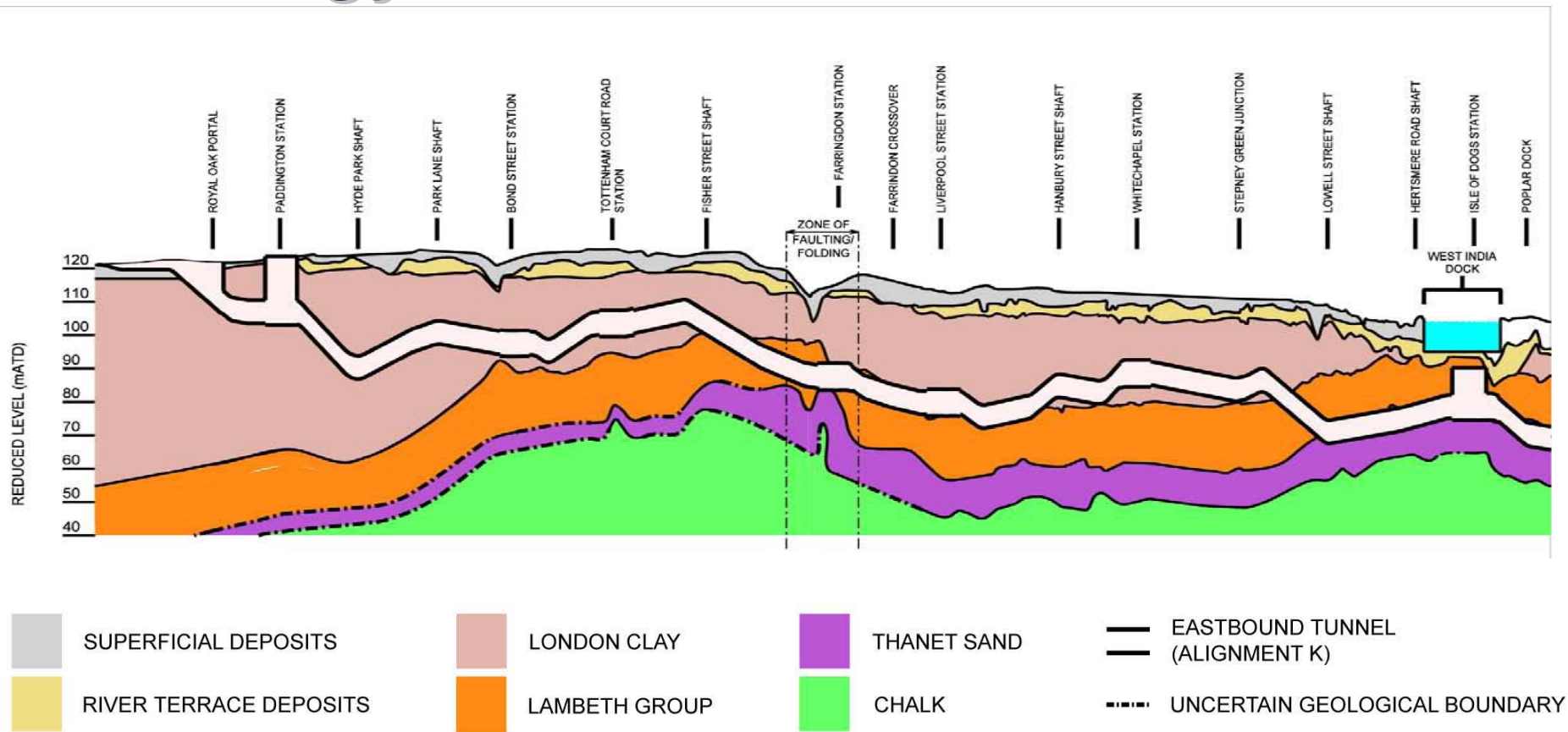


Comparison of Running Tunnels





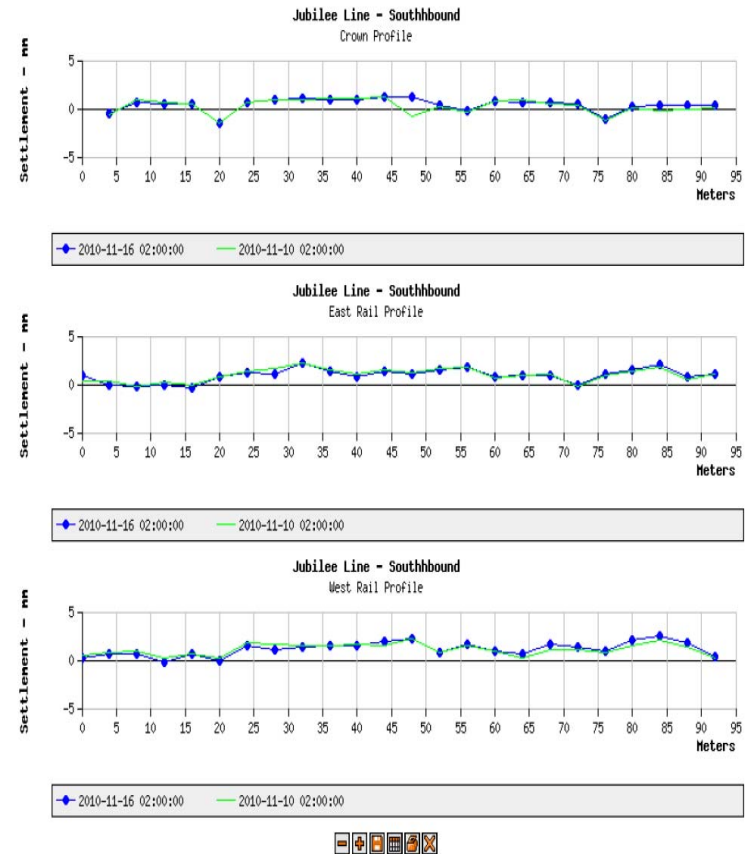
Geology





Settlement Monitoring

- Tens of thousand of readings taken hourly, generating millions of individual data points
- They are fed into the underground construction information management system (UCIMS)



Finsbury Circus access shaft





Wales

Western

Maintenance

Track Renewals

7 Day Railway

Reading

Signalling

Electrification

IEP

National Stations Improvement Programme

Other Enhancements

CASR

NASR

Signalling

Electrification

IEP

ERTMS

Signalling

Electrification

Signalling

Electrification

ERTMS

Crossrail West

Signalling

Electrification

IEP

ERTMS

Cardiff

Newport

Bristol

Bath

Swindon to Kemble

Swindon

Didcot

Reading

Newbury

Signalling
Electrification

Maidenhead

Slough

Heathrow

Kensal Green
Junction

HS2

CRL Depot
POC

CTS
Interface

IEP Depot
North Pole

FTN/GSMR



Dealing with Complexity - BIM

CRL BIM Objective

To set a world-class standard in creating and managing data for constructing, operating and maintaining railways by:

- o Exploiting the use of BIM by CRL, contractors and suppliers
- o Adoption of CRL information into future IM & operator systems

Three workstreams:

Technology Development

- ☐ Technology Partnership with Bentley
- ☐ Information Academy
- ☐ Industry Expert Panel

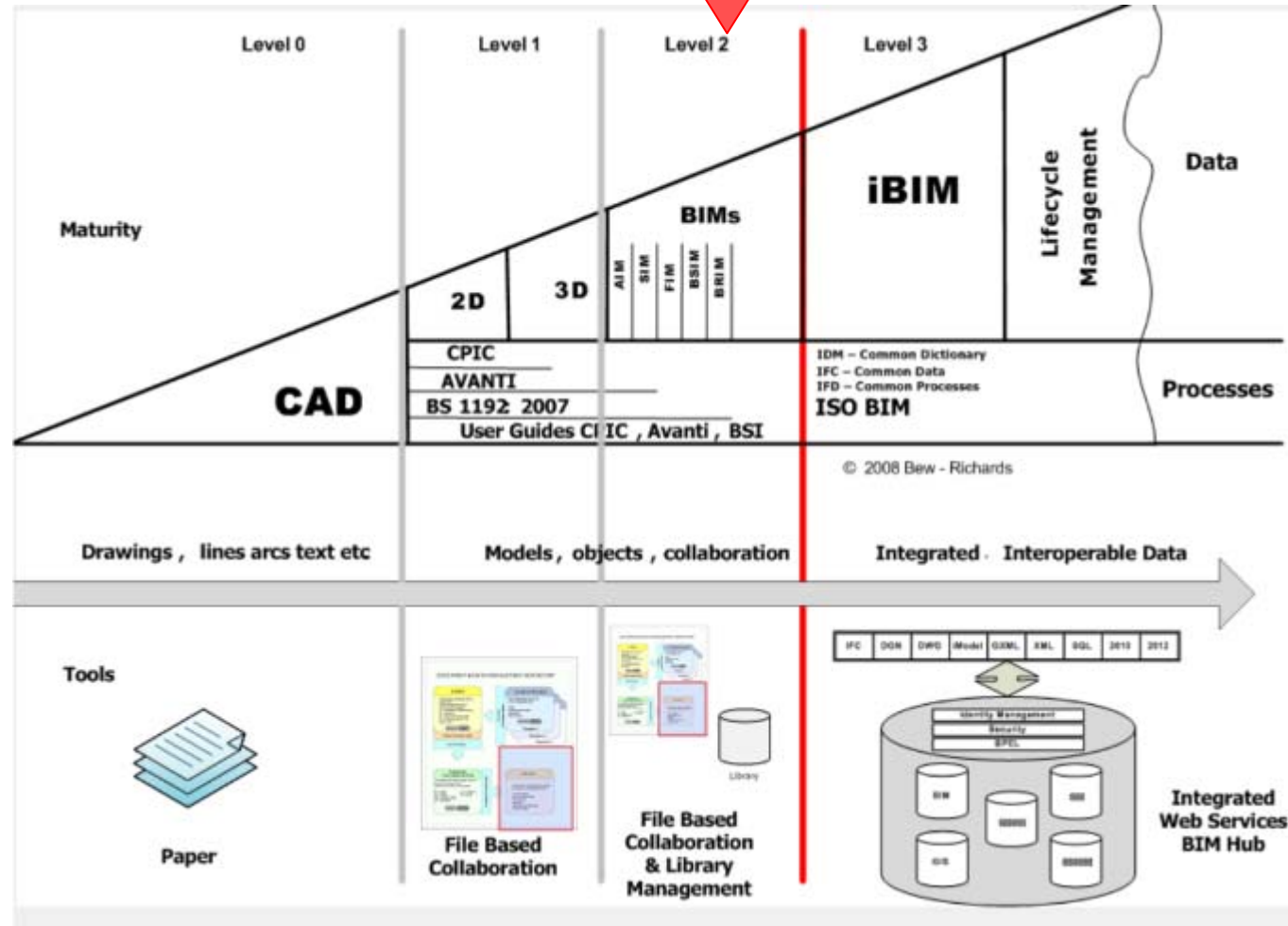
Adoption of Data into IM Systems

- ☐ Vision for TfL asset management
- ☐ Harmonisation of LUL/RfL/NR asset classification systems
- ☐ Migration strategy

Leading BIM in Construction

- ☐ Maximising use of data and technology
- ☐ Visualisation “Toolbox”
- ☐ 4D analyses to mitigate interface risks

Progress



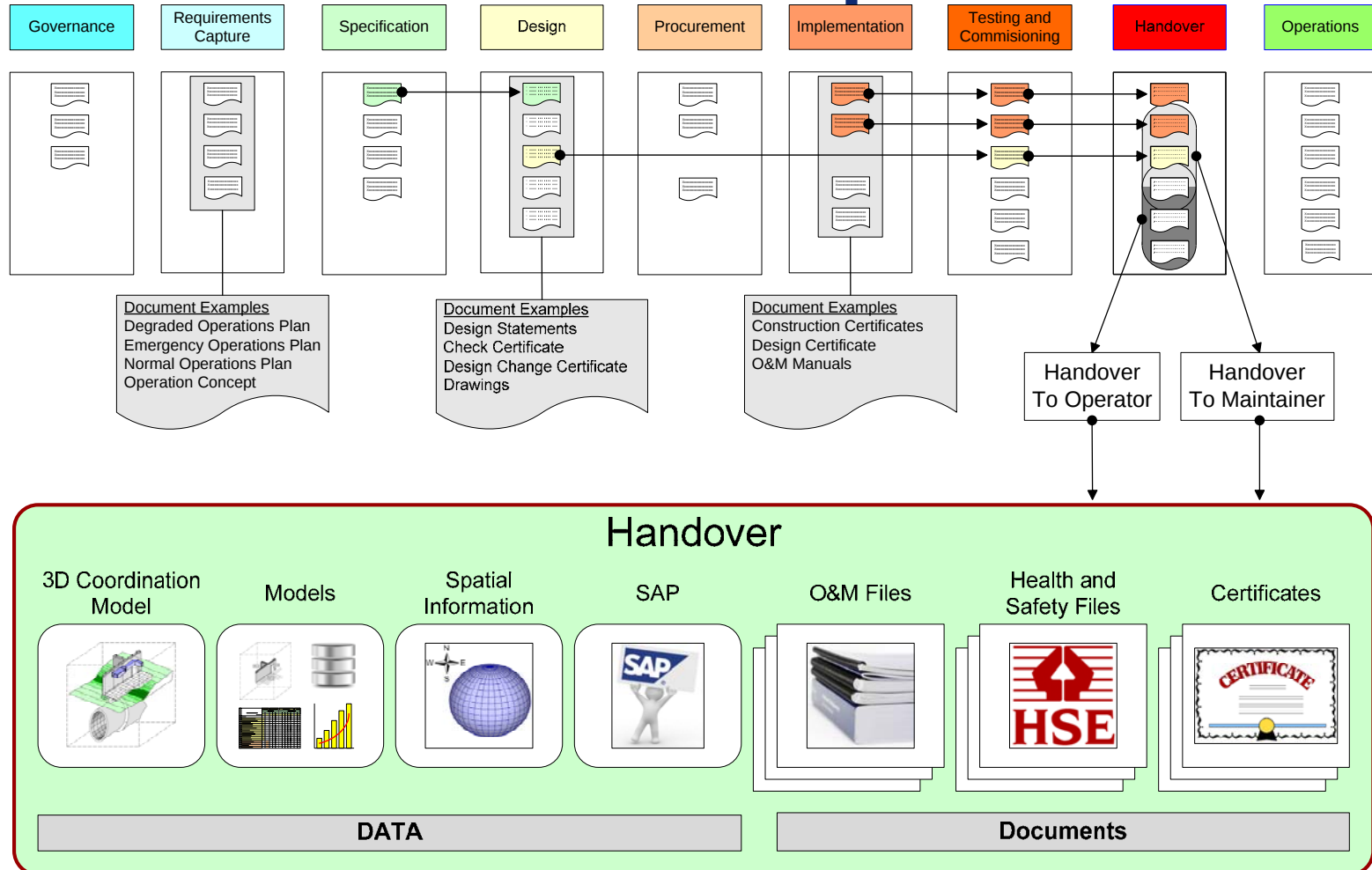
Cabinet Office

Government
Construction
Strategy

May 2011



Information Roadmap





Rolling Stock

- Lightweight energy efficient trains (10 to 18% lighter)
- Maximised passenger capacity – 200m long 10-car trains with wide aisles
- 1,500 seated & standing passengers per train at peak times
- Regenerates energy during braking (major savings in energy and CO₂ emissions) - minimises heat energy into the tunnel





Interior vision





Systems Integration Challenges

- Complex route connecting 2 existing major railways with a large new central section
- Project delivery includes industry partners
- Delivery through a multitude of contracts which must be managed in alignment to deliver a fully integrated and functional railway
- Multiple Infrastructure Managers
- Many external stakeholders
- Technically complex project with very high specified performance outputs



Systems Integration Authority (SIA)

- Technical Authority for end-to-end route Integration
- Ensures System Integrity is maintained
- “Owns” the configuration of the whole railway
- Ensures coherence between the design, operations, maintenance and safety
- Reviews integration issues and change proposals
- Communicates Integration status
- Provides co-ordination and support to delivery teams

Crossrail Environmental Vision

- “Setting the standard for environmental performance and leaving the legacy of a sustainable railway”
- The ‘**Step Up to the Green Line**’ scheme is a strategy to create awareness and achieve positive environmental behaviour change across Crossrail’s sites
 - Contractors and Crossrail site teams will be involved in the scheme



Skills Challenges - London Today

- In London, 38 per cent of the engineering workforce is aged 45-64, and only 10 per cent is aged 16-24
- Clearer pathway between vocational and graduate learning
- Structures for providing young engineers with a broad range of skills: specialisation happens very early
- Skills gap: 14 per cent of engineering organisations in London reported skills gaps
- Impact of recession on young people: large number of graduates but too few entry-level positions



Crossrail's Skills and Employment Strategy

- **Strategy is underpinned by four key objectives**

- Maintaining safety
- Inspiring future talent
- Local labour
- Revitalising our tunnelling skills base

- **Crossrail Priorities**

- 400 Apprenticeships
- 350 work placements
- Creation or safeguarding of jobs via Crossrail contractors
- Graduate training scheme
- Workforce skills
- Work experience





Tunnelling & Underground Construction Academy (TUCA)

- Brand new training facility to address national shortage of tunnelling and underground construction skills
- Up to 3500 workers to be trained at TUCA
 - More than 400 apprenticeships will be created through the Crossrail supply chain
- To date
 - Up to 100 people per week undertaking key pre employment training
 - Over 70 apprentices
 - New workforce development courses available
 - Tunnel Safety Card – 720 tests taken



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