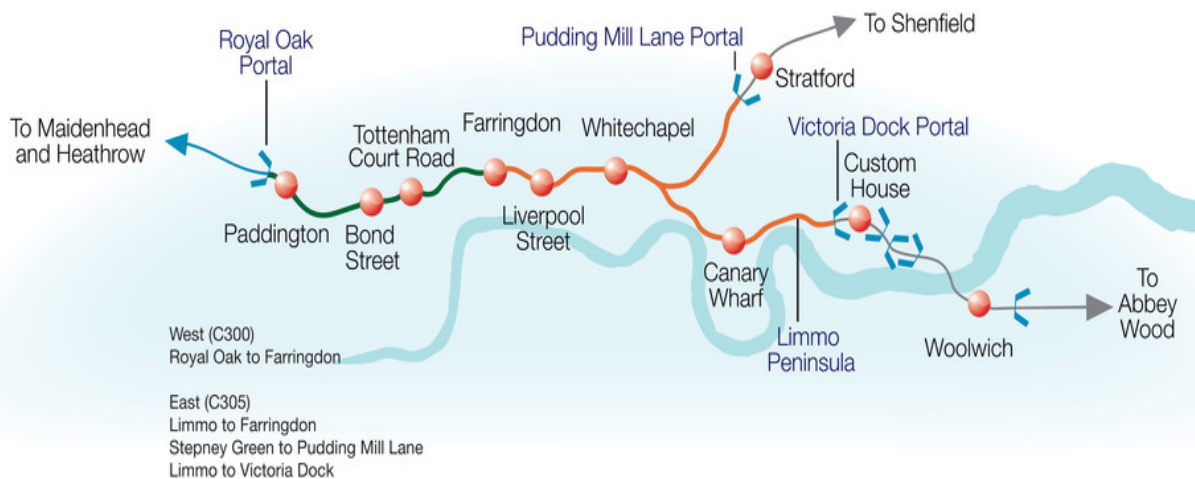




## MEDIA BRIEFING NOTE – CROSSRAIL’S FIRST TBM UNVEILED

### About Crossrail:



Crossrail is Europe’s largest construction project with a total funding envelope of £14.8bn - it will deliver a 118 kilometre rail line that will link Maidenhead and Heathrow in the west with Shenfield and Abbey Wood in the east via 21km of twin-bored tunnels under London.

When completed Crossrail will bring an extra 1.5 million people to within 45 minutes of London.

Crossrail will increase the capacity of London’s rail based public transport network by 10%. It will link London’s key employment, leisure and business districts – Heathrow, West End, the City and Docklands – enabling further economic development to take place.

Passengers will be able to travel from Heathrow to Tottenham Court Road in under 30 minutes and Paddington to Canary Wharf in 16 minutes.

More than 3,000 people are now employed on Europe’s largest infrastructure project.

Thousands more will be employed in building Crossrail at the height of construction in 2013-15. Further jobs will be supported through the supply chain in London and in regionally-based manufacturers and suppliers. At least 400 apprenticeships will be created through Crossrail's contractors.

The new Tunnelling and Underground Construction Academy in east London welcomed its first students in September and will train up to 3,500 people with the skills required to work below ground. The Academy will be fully open by early 2012.

Whilst the UK has tunnelling expertise and knowledge this is the first purpose-built training facility in the UK to act as a focal point for the industry. The new Tunnelling and Underground Construction Academy aims to be a centre of excellence for soft-ground tunnelling skills.

Currently the only other tunnelling training centre in Europe is located at Hagerbach in Switzerland, which specialises in hard-rock tunnelling.

Station works have begun at all of our central London stations: Paddington, Bond Street, Tottenham Court Road, Farringdon, Whitechapel and Liverpool Street.

The tunnel segment manufacturing plant for the western tunnels at Old Oak Common will commence full operations next month producing 74,000 concrete segments to line the western tunnels. A total of 230,000 segments will be needed in total for all tunnel drives.



Crossrail will begin services in the central section in 2018.

## Tunnel Boring Machines (TBMs):



A total of eight tunnel boring machines will be manufactured for Crossrail.

The first of eight TBMs has completed final testing at the Herrenknecht factory in Germany and will shortly be dismantled and transported via road and ship to London before being re-assembled at Westbourne Park.

Crossrail's TBMS weigh 1,000 tonnes and are about 140 metres long. If they were to be laid across a cricket pitch they would fit just inside the oval boundary end to end.

The eight TBMs will undertake a total of ten individual tunnel drives to construct the 6.2m diameter Crossrail tunnels.

The TBM cutter head has a diameter of 7.1m

Six of the Crossrail TBMs are Earth Pressure Balance machines. The two that will tunnel through chalk under the Thames are Slurry TBMs.

### TBM Measurements (Earth Pressure Balanced Machine):

Total length of TBM: approx. 140m

Total weight: approx. 1,000 tonnes

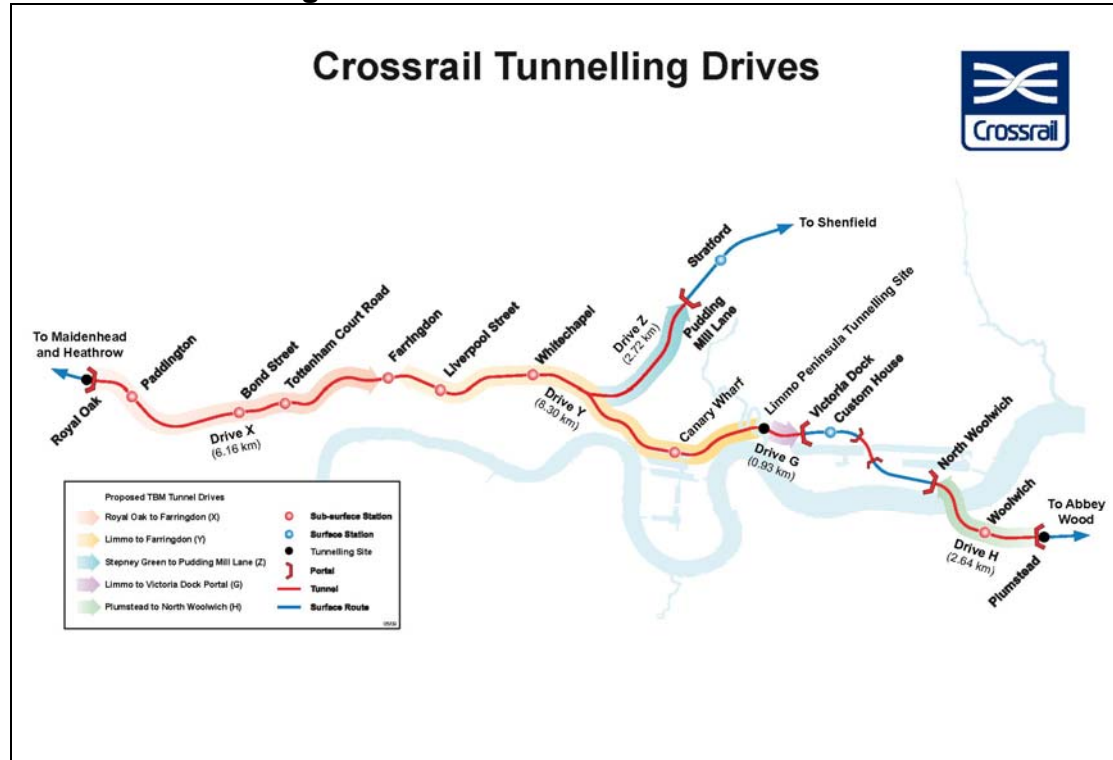
#### Shield

- Shield diameter: 7,080mm
- Operating pressure: max. 3 bar
- Cutterhead diameter: 7,100mm
- Power main drive: 1,920kW
- Main drive max. torque: approx. 9,800kNm
- Cutterhead rotation speed: 0 - 3.19rpm
- Nominal thrust force: approx. 58,000kN
- Screw conveyor diameter: 900mm
- Power screw conveyor: 400kW

#### Backup

- Number of gantries: bridge + 10 gantries
- 2 belt scales
- 1 Refuge chamber
- 1 Personnel container

## Crossrail Tunnelling:



Crossrail tunnelling will get underway in just over three months from now when the first of eight tunnel boring machines will begin burrowing below the streets of London.

Twin bore tunnels running 21km will be required for Crossrail between Royal Oak in west London and Pudding Mill Lane / Plumstead in east London.

Each TBM will be operated by 'tunnel gangs' working in shifts. Each gang comprised of about twenty people – about twelve people on the TBM itself and eight people working between the rear of the machine to the tunnel entrance;

The TBMs will run 24 hours a day, 7 days a week stopping only for maintenance.

The first tunnel boring machine will start tunnelling from Crossrail's Royal Oak Portal in west London to Farringdon in March 2012 with a second TBM launched from Royal Oak a few weeks later.

The eight Crossrail tunnel boring machines are being manufactured by Herrenknecht AG, Germany. There are no UK based tunnel boring machine manufacturers.

Two TBMs will launch tunnelling from the Limmo Peninsula for the eastern running tunnels in mid 2012.

A further two machines will travel from Pudding Mill Lane driving towards Stepney Green later in 2012.

Two Slurry TBMs will be used to construct the 2.6km twin bore Thames Tunnel. They will be launched from Plumstead Portal in late 2012 and will tunnel westwards towards North Woolwich;

- Royal Oak to Farringdon east: 6.4 km;
- Limmo Peninsula in the Royal Docks to Farringdon east: 8.3 km;
- Pudding Mill Lane to Stepney Green: 2.7 km;
- Limmo Peninsula in the Royal Docks to Victoria Dock Portal: 0.9 km;
- Plumstead to North Woolwich: 2.6 km.

Six million tonnes of excavated material will be removed - enough excavated material to fill the equivalent of Wembley Stadium to the roof.

Two-thirds of the excavated material will be transported to Wallasea Island in Essex where it will be used by the Royal Society for the Protection of Birds to create a major new nature reserve. Over 85% of all excavated material will be transported by rail or water.

### **Crossrail Tunnel Portals:**



Construction of Royal Oak Portal, the first of five new tunnel portals to be constructed for Crossrail, commenced in January 2010 and was completed ahead of schedule in September 2011.

The five new tunnel portals to be constructed for Crossrail are located at Royal Oak to the west of Paddington, Pudding Mill Lane near Stratford, Victoria Dock and North Woolwich in the Royal Docks and Plumstead near Woolwich.

These portal structures will be the entry points for the TBMs to construct the new twin-bore tunnels, and in the future will provide an entrance and exit for trains to the underground sections of Crossrail.

### **Royal Oak Portal:**

The Royal Oak Portal works comprise a massive 285m long ramp structure that takes the Crossrail tracks from ground-level down into the underground tunnels.

The portal has been built within a narrow corridor at Royal Oak, constrained by the A40 Westway to the north and the Hammersmith & City and Network Rail lines to the south.

### **Excavated material:**

Tunnelling for Crossrail will produce in the region of six million tonnes of excavated material. Crossrail will provide close to 4.5 million tonnes of excavated material to the RSPB to create a new 1,500 acre nature reserve at Wallasea Island in Essex. The remainder of Crossrail's excavated material will be beneficially reused elsewhere.

Excavated material generated from the tunnelling operations for the western tunnels (Royal Oak to Farringdon) will exit at the Royal Oak Portal and be transported by freight train to Northfleet, Kent where it will be transferred to ships destined for Wallasea Island.

Excavated materials from the eastern running tunnels will be loaded onto ships directly from the tunnel conveyor surfacing at Instone Wharf on the Bow Creek. Material arising from shafts and stations will be brought by road to Crossrail's Docklands Transfer Site at the Barking Riverside jetty.

### **Tunnelling Contractors:**

The western tunnels are being built by the BFK consortium: BAM Nuttall, Ferrovial Agroman and Kier Construction. This is a UK / European consortium.

The eastern tunnels from Limmo Peninsula to Farringdon and Pudding Mill Lane to Stepney Green will be constructed by a joint venture made up of Dragados S.A and John Sisk & Son. This is a UK / European consortium.

The Thames Tunnel starting from Plumstead will be constructed by Hochtief Construction and J Murphy & Sons. This is a UK / European consortium.

## **TBM Q&A:**

### **How do TBMs work?**

The TBM's cutter head rotates and excavates out the soil in a controlled manner. The design and operation of the TBMs ensures that only the required amount is taken out as the machine progresses. Excavated material is removed from the cutter head by an auger screw at a controlled rate and deposited onto a series of conveyors belts (pipes for a slurry machine) which remove the excavated material through the TBM and out the back of the tunnel to the surface.

Precast concrete segments are loaded onto the back of the TBM and as the TBM advances it erects the precast concrete ring in place. The gap between concrete segments and the soil is filled with a cement grout.

A series of hydraulic rams at the back of the cutter head push the machine forward and steer the machine.

### **How much does each TBM machine cost?**

Each machine costs about £10 million. They are expensive but very complex machinery that not only have to carve and remove the excavated material but carry and place the tunnel segments, and control ground settlement as the tunnels are constructed.

### **How long have they taken to build?**

It takes about 10 months per machine to manufacture a TBM. Usually it takes 12 months but as six of the machines are of the same design time savings have been achieved.

### **How long will it take to dismantle the TBMs and transport them to London?**

It takes several weeks to disassemble the machine. It will be transported in sections so each section will be loaded onto a lorry and that lorry will go onto ship and be transported to Tilbury Docks. Work to re-assemble the first Crossrail TBM will commence in January at Westbourne Park. Tunnelling from Royal Oak Portal will commence in March.

### **How many people will be working with each TBM?**

Each TBM will have a tunnel gang of about 20 working on and behind the machine at any one time. These teams will operate in shifts.

### **How much distance will a TBM cover?**

The TBMs will progress about 100 metres a week.

### **How long will it take to go from Royal Oak to Farringdon?**

We expect the first TBM to arrive at Farringdon in summer 2013.

### **When is the expect completion date of the tunnelling?**

We are expecting the tunnelling to be completed by the end of 2014.

### **How do we get the TBMs back out once they have finished tunnelling?**

The TBM will be dismantled and taken back out the tunnel.

### **Why do you require different machines – a slurry TBM to tunnel under the Thames and Earth Pressure Balance Machines for the other tunnels?**

Earth Pressure Balance Machines will be used for the tunnels from the Royal Oak, Pudding Mill Lane and Victoria Dock Portal. These will pass through ground which is predominantly London clay, sand and gravels.

The Thames Tunnel, which is predominantly constructed through chalk, will use a Slurry TBM. The slurry machine works better to tunnel through chalk ground conditions.

### **How do Slurry Machine TBMs work?**

Soft ground that contains water, such as the chalk under London's Thames, requires the use of Slurry Shield TBMs. These machines provide a completely enclosed working environment. Soils are mixed with bentonite slurry, which is removed from the tunnel through a system of slurry tubes that exit the tunnel. The bentonite also works to balance the water pressure in the chalk as the TBM moves through the ground.

### **How exactly will the tunnel segments be put in place?**

Each tunnel ring of segmental elements is built directly behind the shield with the help of an erector. The reinforced concrete lining segments can be positioned and assembled precisely to the millimetre using the lining segment erector. To advance the tunnel, the EPB machine pushes itself off from the last installed segment ring using hydraulic thrust cylinders.

### **When were the TBM contracts awarded?**

The first contract was awarded in May 2011 by Crossrail's eastern and western tunnelling contractors for the first six TBMs. In April, the Thames Tunnel contract placed a contract with Herrenknecht for the remaining two TBMs.

### **Tunnelling and Underground Construction Academy:**



Crossrail is now gearing up for the start of tunnelling in spring 2012 and has recently commenced specialist training for the first of many thousands who will work on the project from late September.



The Tunnelling and Underground Construction Academy (TUCA) at Ilford will have a critical role to play in equipping people, particularly those from along the Crossrail route, with the necessary training and skills to work below ground and has recently welcomed its first students. The Academy will be fully open by early 2012. TUCA will offer training to at least 3,500 people in underground construction over the life of the project.

TUCA will not only ensure that Crossrail has the skills needed for its construction and will be retained post-Crossrail as a specialist training centre for other tunnelling projects.

The volume of tunnelling and underground construction work taking place in London alone over the next decade is unprecedented. Aside from Crossrail, Thames Water will be constructing the Thames Tideway Tunnel sewerage scheme, National Grid will be constructing new electricity cable tunnels, and the Government wishes to construct High Speed 2.

Whilst the UK has tunnelling expertise and knowledge there is not a purpose-built training facility in the UK to act as a focal point for the industry. TUCA aims to be a centre of excellence for soft-ground tunnelling skills. Currently the nearest tunnelling training centre is Hagerbach in Switzerland, which specialises in hard-rock tunnelling.

Crossrail is investing up to £7.5 million in TUCA. £5 million in funding has been provided by the Department of Business Innovation and Skills via the Skills Funding Agency. Further sponsorship has also been pledged by industry.

TUCA students will be made up of people from contractors' existing workforces who want to up-skill or formalise their knowledge through nationally accredited technical and safety training as well as new entrants to the industry.

The Tunnelling Academy will also act as the London centre for the National Skills Academy for Railway Engineering (NSARE).

### **Crossrail Job Brokerage / Apprenticeships:**

Crossrail has formed a partnership with Jobcentre Plus (JCP) which aims to provide local people with opportunities to work on the Crossrail project.

Jobcentre Plus works with a network of local job brokerage and outreach agencies to match vacancies to suitable candidates and arrange interviews for short-listed applicants.

Contractors are obliged to send all employment opportunities to the job brokerage service 48 hours before they advertise them elsewhere. This gives the team an early opportunity to put forward job-ready candidates from the local area.

A wide range of jobs, mainly in construction and engineering, are needed to build Crossrail. These include: plant operators, site foremen, labourers, safety managers, project managers and planners.

Crossrail is committed to delivering at least 400 Apprenticeships through its supply chain over the lifetime of the project. Crossrail contractors are obliged to provide jobs or apprenticeships to local people and those who have been unemployed for more than six months.

Apprenticeships are offered as contracts are awarded and contractors are asked to give priority to those candidates from within the 33 London boroughs.

Apprentice numbers are expected to rise in line with the delivery phase as major tunnelling activity gets underway. Apprenticeships will be offered in a variety of subject areas, providing vocational training in construction, craft and office-based roles.

## **Crossrail Progress During 2011**

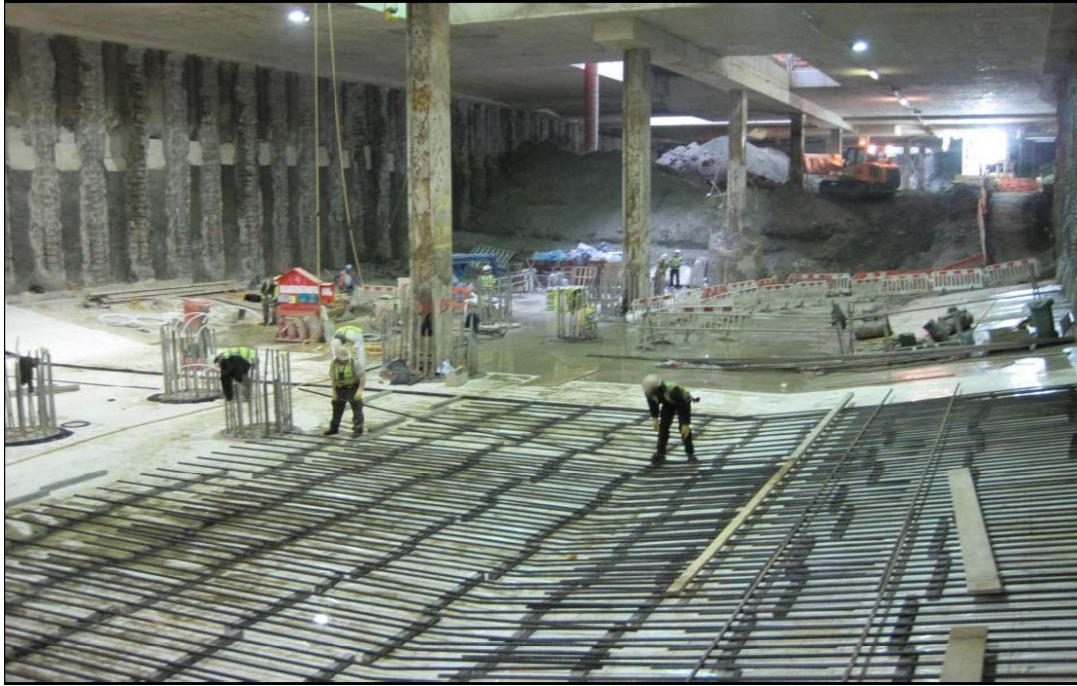
### **Programme Overview:**

- Construction of Crossrail got underway at Canary Wharf on 15 May 2009;
- The Crossrail project has made continued progress throughout 2011;
- Work is underway at all central London station sites;
- Remaining tunnel contracts have been awarded;
- Excavation of Canary Wharf station has completed;
- Main construction contracts awarded for Farringdon, Paddington and Whitechapel stations;
- Herrenknecht selected to build the eight TBMs required for Crossrail;
- Construction of the Tunnelling and Underground Construction Academy complete, fit-out of major vocational training areas underway and first students welcomed;
- First tunnel portal at Royal Oak completed ahead of schedule;
- Construction of concrete segment manufacturing facility completed at Old Oak Common with test pourings underway. Segment factory will support construction of the western tunnels. Facility will commence full operations in January as work to stockpile tunnel segments gets underway; and
- Construction of segment factory for eastern tunnels underway at Chatham.

### **Site Overview:**

- **Paddington** – Utility diversion work is currently taking place on Eastbourne Terrace until the end of the year to enable main construction of the new Crossrail station. At the Paddington Integrated Project site, a series of 22 steel tree columns, with two and four branches are being installed which will support the roof for the new Paddington station taxi rank. The new taxi rank will be located at the Red Star Deck which will allow work for the new station to get underway at Departures Road.

- **Bond Street** – Demolitions for the Western Ticket Hall site has been completed. A substation near Dering Yard has been installed and Piling & Diaphragm wall works for grout shafts have started.
- **Tottenham Court Road** - Piling & Diaphragm walling is complete with construction of guide walls for diaphragm walls in the south box and central wall underway.
- **Farringdon** - Advanced civil works are currently underway at Farringdon station at the Smithfield works site.
- **Liverpool Street / Moorgate** – Utilities diversion works in Moorgate are now complete. Piling and Diaphragm Wall has commenced with construction of the shaft at the western end of the station underway.
- **Whitechapel** – Construction of a protection deck above the London Overground platforms completed. Piling and Diaphragm Wall works have also commenced at Durward Street and Cambridge Heath Shafts.
- **Canary Wharf** – The station structure has been excavated down to track level. The ring seals for the TBMs were installed and cast into the end walls where the two TBMs will punch through the station box.
- **Woolwich Station Box** – Berkeley Homes are responsible for construction of the Woolwich Station Box. Berkeley Homes is currently progressing with the excavation works to accommodate the Station Box. The top 3-4 metres of soil is being removed to expose any features that are of archaeological interest and prepare the site for the main works which are due to commence in 2012. Construction of the Station Box is due to complete in 2013.
- **Royal Oak Portal** – Civil works to construct the Royal Oak Portal are complete and the site has been handed over to the western tunnels contractor.
- **Pudding Mill Lane** –the Pudding Mill Lane Portal Main civils works have commenced. Piling works for the new DLR station and viaduct have also started.
- **North Woolwich & Victoria Dock Portals (utilities)** – Crossrail has successfully completed micro-tunnelling works Victoria Dock.
- **Connaught Tunnel** – The Connaught Tunnel refurbishment contract was awarded in April. As a result of the OCI period, a completely new method of enlarging the Tunnel has been developed. The new method is significantly safer and more efficient with less risk, using coffer dams to perform the work "in the dry". The main enlargement works will commence in early 2013.
- **Network Rail / Surface** – Network Rail appointed Atkins as design consultants for the North East section stations on the Crossrail route between Stratford and Shenfield.
  - **NE section** - Design and site surveys awarded as planned for the Ilford Stabling Yard. A full design and main construction contract will be let in late 2012.
  - **SE section** – NR awarded the contract for Abbey Wood station design to Balfour Beatty. The detailed design process for Abbey Wood station will commence shortly.



**Key Crossrail Milestones for 2012 include:**

- Assembly of first TBM underway at Westbourne Park (January)
- Manufacturing facility for concrete segments (western tunnels) starts full production at Old Oak Common (January)
- Construction of Northfleet rail link completed (February)
- Assembly of second TBM underway at Westbourne Park (February)
- Launch of TBM 1 from Royal Oak to Paddington (March)
- Construction of Stockley fly-over underway (March)
- Launch of second TBM from Royal Oak to Paddington (April)
- First freight train carrying excavated material transported from Royal Oak to Northfleet (April)
- TBM 1 reaches Paddington box (May)
- First shipment of excavated material from Northfleet to Wallasea Island (July)
- Remaining central London stations main construction contracts awarded – Bond Street, Tottenham Court and Liverpool Street as well as Custom House (During 2012)
- Signalling contract awarded (During 2012)
- Major tunnel fit-out contract awarded (During 2012)
- Various over-site development applications submitted including Farringdon and Bond Street - Davies Street (During 2012)