LOWER LEA VALLEY CABLE TUNNELS – POWER LINES UNDERGROUNDING PROJECT

MURPHY

OLYMPIC SUCCESS FOR J MURPHY & SONS

Murphy is one of the UK's foremost tunnelling and underground construction specialists and able to provide a total service from feasibility study and design through to construction, commissioning and long term maintenance.

The group's broad skill base enables Murphy to carry out all the ancillary civil, building, and mechanical and electrical engineering disciplines that a major project comprises.

In addition Murphy's ability to identify and develop innovative and cost-effective solutions to technical and environmental problems is part of the overall service provided for the private and public sector.

Murphy owns an extensive range of equipment and continues to make substantial investments in modern tunnelling technology. This enables the group to be competitive at all levels and across a wide and diverse range of ground conditions. A considerable depth of management experience, high levels of engineering capability and a dedicated long-serving workforce complements this ongoing development programme.

SCOPE

Murphy completed essential cable and tunnel work for the 2012 Games site at Lower Lea Valley, Stratford.

The removal of overhead power lines across the site, and the installation of the 400,000 volt and the 132kv cables installed in tunnels from West Ham to Hackney, supplies one hundred per cent of the electrical requirements of the 2012 Games and the East London area, post Games.

The challenge of redirecting a massive percentage of the capital's power supply from huge pylons to underground cables was a difficult one, but one that Murphy relished.

The tunnel's north to south orientation passes typically 20-30m under ground, beneath railways, rivers, canals, sewers and various structures that required extensive monitoring to detect any settlement whilst tunnelling underneath.

The project, which began in July 2005, was the first major contract let for the 2012 Games and included the construction of 7,000 metres of 2.82 ID tunnel for EDF Energy and 6,000m of 4.15 ID Tunnel for National Grid.

The four tunnels were driven by two 4.7m and two 3.3m diameter machines.

The contract was completed on time, within budget and with an excellent safety record. Numerous measures were put in place to ensure maximum possible safety at all times during the construction process such as daily work briefings coupled to regular tool box talks, refuge stations, a reduction of crane hoists and strictly controlled tunnel access.

Roy Smith (L), Peter Bermingham (R) (both Murphy employees). In front of one of National Grid's 4.15 tunnel boring machine called "Sonia". The 4.15 tunnel is NG's largest tunnel size. ▶

▲ *"Helen", a 2.82 tunnel boring machine, with the EDF Energy tunnel below. Shows the de-watering tubes and pumps.*

▲ *Dismantling and removing the forward shell of "Helen" tunnel boring machine.*

CONSTRUCTION TECHNIQUES

The shaft sinking phase of the project was linked with the installation of deep well de-watering to lower the level of the water in the Thanet sand. This entailed sinking numerous deep wells into the chalk strata and under-draining the Thanet sand.

This method dealt with the low level water but the control of the water pressure in the Lambeth Group proved to be more of a problem.

Whilst excavating within the Lambeth Group lenses of fine sand with water pressure of over a bar were encountered. This was controlled by jetting in wells and setting up vacuum de-watering from within the shaft.

The Lambeth Group is a set of geological strata in the London and Hampshire Basins; and comprises vertical and lateral varying gravels, sands, silts and clays. It is found throughout the London Basin and underlies some 25 per cent of London at a depth of less than 30m. All shafts started off as caissons to get through the Thames gravels then were changed to a conventional underpin method at various depths to suite the ground conditions.

The four tunnel drives out off the Carpenters Road shafts progressed vary well with good rates of advance being achieved in the Thanet sand.

The NG tunnel at peak progress was advancing at a rate of twenty-nine metres per shift in each drive this entailed handling in excess of one thousand cubic metres of excavated material in a ten hour shift.

The method of muck handling which had never been used by Murphy before was an integral part of this project. This was the use of high angle conveyors in both of the drive shafts which worked very well coupled with some very well set up pit bottom skip handling facilities.

The tunnel and shaft construction produced over five hundred thousand tonnes of excavated material – most of which was reused.

ENVIRONMENTAL CREDENTIALS

Over ninety per cent of the material transported to the site was by rail, with the last part of the delivery from a local rail head to the site by lorry.

Production delays due to weather were kept to a minimum with the mortar for the block work being site batched, at a constant high level and so they could work at short notice when the weather was good. Furthermore there was virtually no waste generated as the mortar was batched as and when required. This also cut out any possible delivery delay or transport issues.

Murphy had just three years to design and build all the tunnels and shafts, complete the M&E works, lay 200km of cable and commission the new lines.

Murphy also ensured as little environmental impact as possible during the work on the cable tunnels, using a minimum amount of materials to achieve the design requirement.

ENVIRONMENTAL CONSTRAINTS

Due to centuries of industrial use, the site is extremely difficult to work upon – geologically the ground consists of man made waste and alluvium, terraced gravels, London Clay, mixed sandy clays and ballast layers as well as saturated Thanet sand.

The company's specialist expertise was employed during Earth Pressure Balance Tunnelling with four tunnels being driven at once with vertical conveyors in the drive shafts to deal with the large volume of excavated material.

The Earth Pressure Balance Tunnel Boring Machines work by controlling the pressure in the Plenum Chamber so that it was slightly above the existing pressure in the virgin ground. This enabled any potential settlement at ground level to be kept to a minimum, which on this particular contract were figures below 5mm. Thus giving us the ability to tunnel under structures that it previously would not have been possible to tunnel under (due to very little settlement). This settlement can now be accommodated by the overlying structures.

The technology of machines used for the tunnelling today has advanced so much that work such as this could not have been done ten years ago.

▼ *EDF-Energy promotional photo of EDF-Energy employees, at the EDF-Energy 4 tunnel shaft at Hackney. A 2.82 TBM called "Fionnuala".*

HEAD HOUSES

Murphy was responsible for the construction of shafts, head houses and mechanical and electrical works which enabled contractors to start work on the Stadium and Aquatic Centre.

As well as this, the cladding on all seven headhouse sites was one hundred per cent carbon neutral and the painted panels are environmentally friendly and no longer contain heavy metals. These were the first collective efforts to meet the commitment to greener construction practices.

All cladding used on these buildings was produced within the UK. Half of the cladding and ninety five per cent of the Rockwool insulation projected for use on the project was removed at the design stage, due to the unique nature of the buildings.

By painting the internal face of the cladding white, instead of the usual grey, while in the factory, Murphy removed ninety per cent of the projected on-site painting package. Thus reducing the working at height content from the head house construction.

Steelwork frame to one of the head-house at Westham for National Grid. ▶

SAVING TIME

Due to the simplified and speedy construction of the site's head houses, Murphy was able to reduce the build package durations and speed up the sequence of work. In turn this allowed maximum uninterrupted access within the buildings.

The use of future proof steel frames allowed for larger column and beam sections to be installed, producing a stronger structure and the need for less steel cross bracing as a result. This in turn can allow for maximum access into the head houses on all elevations, giving more design flexibility for contractors with zero down time for design alterations, reducing the risk of programme extension.

Scaffolding packages on this project were reduced by ninety five per cent due to the reduced requirement for internal painting, coupled with the adoption of an access netting system and stair arrangements for the main frame erection. This saved significant time by allowing perimeter and ground works to carry on un-hindered by scaffold bases and tie-ins to columns.

Murphy was able to accelerate the brick and block laying package by two weeks on each site as a direct result of adopting this system of work.

Clients EDFe and National Grid accepted a 95 per cent standardised base design which allowed Murphy to reduce the supply chain and save time on procurement and deliveries to site. As a result, Murphy had less install contractors to deal with which sped up the whole process, kept site waste to a minimum and reduced contractor interface allowing for a smoother sequence of work project wide.

◀ *Connecting tunnel in National Grid's tunnel between NG1 and NG1a. Kevin McMannus, Murphy Tunnel Manager is in the tunnel.*

MATERIAL MANAGEMENT

All blocks and bricks which were brought to site were delivered on returnable/refundable pallets. This allowed Murphy to easily off load the delivery, safely store the blocks and bricks on site and reduce the risk of damage. Any damaged blocks or bricks that were still useable were reused in ground works, thus saving new blocks being brought in.

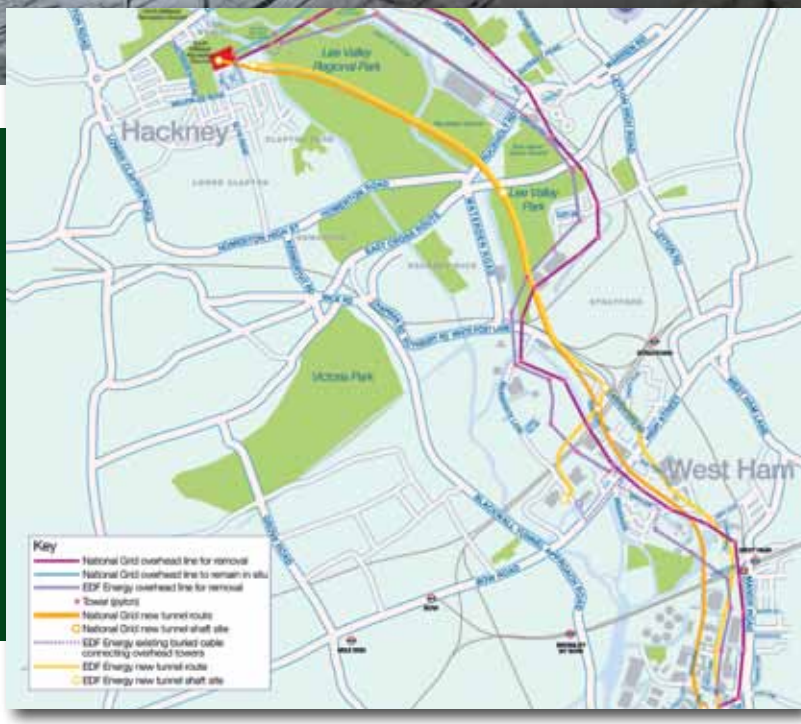
Where weather usually creates the largest loss of production, Murphy could at very short notice work when the weather was good for as long as the site hours allowed as there were no delivery delay or transport issues to contend with.

The consistency and quality of mix was at a constant high level as the batcher produced the very same mix every time and as it was all mixed on site there was virtually no waste generated.

◀ *Internal view of National Grid's 4.15 tunnel.*

OLYMPIC LEGACY

Not only was the Lower Lea Valley Cable Tunnels a great milestone for the project but Murphy's work on the site goes towards the lasting legacy of East London and to the benefit of the community. The removal of the power cables and relocation underground has freed up much space for vital regeneration of the area. The park will also leave a legacy of new transport links, sporting venues, residential and commercial development, in a setting of high-quality parkland. The tunnels were finished on time at the end of 2007, marking the first construction project to be completed.



▲ *Route map.*

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