

## Civil Engineering NEWS

### MASS TRANSIT

#### 'East London' Rail Extension, Upgrade Completed Early

**T**HE \$2-BILLION project to extend and upgrade the East London Line (ELL), a 12 km section of mostly north-south rail service on the eastern side of London, has been completed on budget and ahead of schedule. Originally part of the London Underground subway system (although most of its tracks were in opencuts or at grade), the ELL is now part of the evolving London Overground, a \$14-billion orbital urban rail system that eventually will make it possible for passengers to travel around the city without having to pass through its busy central areas.

Operated by Transport for London—the government body responsible for

most mass transit in and around the city, including the Underground system—the Overground is being constructed to improve rail service in previously underserved areas of the city and to provide greater access to the venues that will figure in the 2012 Summer Olympics, explains Ashok Kothari, P.E., a board member of the international engineering firm Parsons Brinckerhoff (PB) and the head of program management for London Overground infrastructure projects. PB has been responsible for program management of the ELL project since 2005. The firm is also working on other aspects of the Overground system, which will eventually connect 20 of the city's 33 boroughs and for 20 percent of Londoners will bring train service within a short walk of their homes or businesses.

An 11-station segment of the new ELL opened in April; the fully refurbished and expanded line, encompassing 21 stations extending from Dalston Junction in the north to West Croydon in the south, opened in May, roughly a month ahead of schedule. Additional expansions are planned for 2011 and

2012 to link the new ELL to existing segments of the Overground, including the North London Line, which PB is also helping to upgrade.

To construct the ELL system, the original 19th-century line, which at its northern end stopped at the Shoreditch High Street station and at its southern end terminated at the New Cross Gate station, was closed in December 2007 so that the tracks and other elements of the system could be replaced; several new bridges, stations, and elevated sections could be constructed; and other portions of the line and its infrastructure could be strengthened, upgraded, or improved. Both the original and the new line pass under the river Thames via the Thames Tunnel, which was constructed by the famed 19th-century engineer Marc Isambard Brunel. This masonry tunnel was an engineering marvel when it opened, in 1843, and was formally recognized in ASCE's Historic Civil Engineering Landmark Program in 1991. The tunnel was refurbished in the mid-1990s, according to a September 19, 2007, news report from the

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BBC. No additional work was required to prepare the Thames Tunnel for the ELL project, Kothari notes.

Although much of the new ELL follows the alignment of the original line, a key section was relocated slightly to the east and constructed on a new concrete aerial structure so that the line could be connected to a disused masonry structure known as the Kingsland Viaduct, which provides access to stations in the northeastern part of London. This new aerial section was located north of the site where a new station was constructed for the Shoreditch High Street stop.

**The expansion and upgrade of the East London Line included a new station at the Shoreditch High Street stop as well as new bridges—a bow arch structure and a Warren truss crossing—at either end of the station.**

Composed of more than 150 Victorian-era arches, the 3 km long Kingsland Viaduct had been part of an earlier railway line's infrastructure that was left in place when the rest of the line was demolished, Kothari says. Much of the viaduct and its numerous arched spans that cross local streets had to be strengthened, refurbished, or replaced as part of a contract covering prepara-

tory work that was performed prior to the closure of the original ELL, he adds. The new aerial structure that links the new Shoreditch High Street station to the Kingsland Viaduct is a four-span, reinforced-concrete viaduct roughly 0.4 km long.

Two new stations were also constructed beneath the arches of the Kingsland Viaduct. At Hoxton it was determined that the arches were strong enough to accommodate the new loads of the ELL even after a portion of the masonry had been cut out to provide additional headroom for the concourse and to install a central staircase and a



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secondary stair at the north end of the platform for emergency egress. At Haggerston, however, a key section of the arches was not considered adequate for the new loads; that section was demolished, and a new concrete structure was erected between the remaining sections of the existing masonry.

A new station was also constructed at the Dalston Junction stop as a podium structure erected adjacent to the masonry retaining wall of an existing building. The podium slab is supported on a series of 750 mm diameter reinforced-concrete piles, and the platform is supported in places by a contiguous wall formed from bored, cast-in-place piles 2 m in diameter. The podium is designed to accommodate future commercial development above the station.

Two new bridges were also constructed at the new Shoreditch High Street stop. To the north of the station a 300 metric ton steel bow arch bridge was erected with a 35 m span. The bow arch rises 11 m above the nearly 13 m wide bridge deck, and there is a minimum clearance of 5.7 m between the bottom of the bridge and the road that the bridge crosses. To the south of the station a steel Warren truss bridge designated as GE19 was constructed, replacing a bridge from the 19th century that had to be demolished to accommodate the elevation of the new station. The 700 metric ton GE19 is approximately 10 m in width and 10 m in height and spans a distance of more than 80 m in crossing a series of main lines in Britain's national rail system. The original bridge at the site was demolished during the week between Christmas 2007 and New Year's Day 2008—the only period when the main lines

could be shut down completely, Kothari notes. GE19 was then constructed on-site and launched during a three-day holiday weekend the following May.

A mishap that occurred as the new bridge was being lowered into place caused some of the falsework for the concrete deck to fall onto the tracks of the main line below. No one was injured and no equipment or trains were

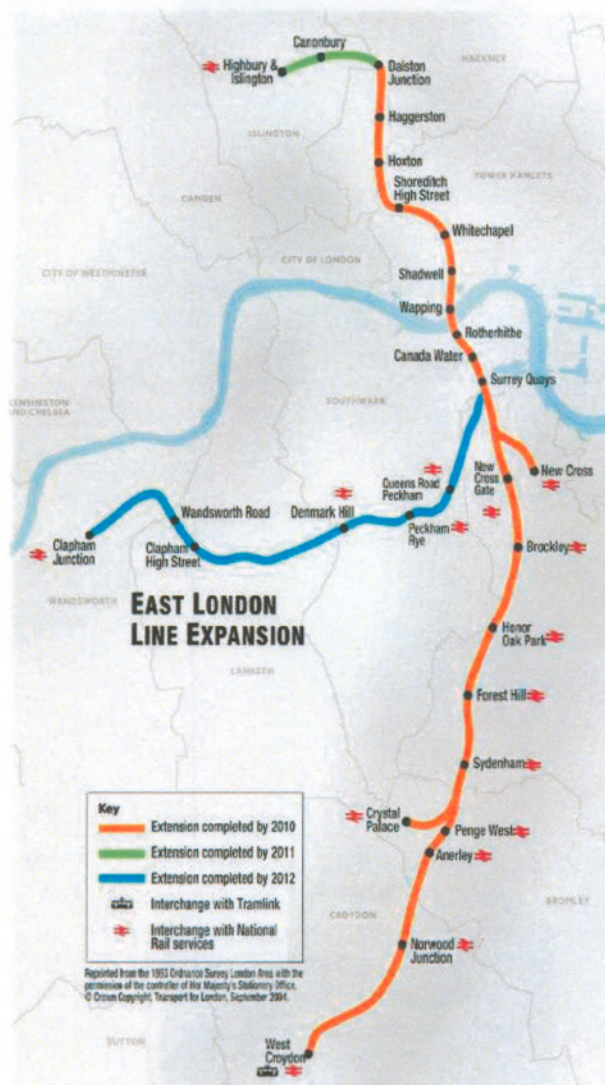
are designed to prevent excessive settlement when a tunnel is constructed for another project, Crossrail. This nearly \$26-billion effort, also under the control of Transport for London, will by 2017 have major new rail connections beneath central London.

A 1,000 metric ton flyover bridge was constructed at the New Cross Gate station to accommodate the extension of

the ELL south to West Croydon, a stretch that includes tracks that the ELL acquired from Britain's national rail network, Kothari notes. Previously passengers had to change trains in transferring between the original ELL service and the main line.

In other locations stations were given a new roof or the level of a floor or platform was altered to provide easier access for passengers. Entrances also were relocated or new entrances were created, and additional elevators and stairs were constructed. Existing stations that are located underground, including the Wapping and Rotherhithe stops, which are located respectively north and south of the Thames Tunnel, were upgraded with new tracks, new train control systems, and other modernizations, Kothari says. In certain open-cut segments along the line, the retaining walls were reinforced, while in segments where tracks were relocated from an open-cut to an at-grade or aerial alignment the cut was filled in.

In addition to its efforts involving the tracks, stations, and bridges for the new line, PB worked with a Transport for London expert to procure new rolling stock for both the new ELL and the upcoming North London Line upgrade. "The client wanted there to be just one source of responsibility, rather than giving management of the rolling stock to someone else," explains Kothari. "We had to be sure we could deliver the trains as well as the infrastructure in time."—ROBERT L. REID



damaged, Kothari notes. However, the bridge itself was carefully examined, and the construction procedures were reevaluated to ensure that all work was being performed safely. Although additional work was required, Kothari says, the bridge was erected on time.

Other aspects of the ELL project included the reinforcement of the platform and the tracks at the Whitechapel station with bored, reinforced-concrete piles 600 mm in diameter. The piles