

## KING'S CROSS ST PANCRAS: INTRODUCTION

A massive transformation has taken place at London's busiest Tube station, resulting in a doubling of capacity and a safer environment for passengers. Managing this complex project, with 50 different stakeholders, three work sites and immovable deadlines, has been the biggest challenge ever undertaken by Balfour Beatty Management. **Margo Cole** talks to the key players in the delivery of the King's Cross St Pancras station

# JUST THE TICKET FOR LONDON

**W**hen passengers started using the Northern Ticket Hall at King's Cross St Pancras Underground station last November it marked the culmination of a 10-year project to double capacity at London Underground's busiest station, and a triumph for collaborative working. The new ticket hall, taking up the area of a football pitch and the depth of a four-storey building, has been built to a tight deadline and a fixed budget alongside the listed structures of a mainline railway station.

Given those parameters, there was plenty of opportunity for things to go wrong, and certainly for the project to run over time. So it is no wonder that the client, London Underground (LU), the project manager ABBT, led by Balfour Beatty Management, and contractor Balfour Beatty were celebrating when those first passengers started using the Northern Ticket Hall.

"It's been a great challenge, but from the project management side it's been an absolutely excellent job by everyone," says LU head of stations upgrade programme Andy Eastaugh.

The Northern Ticket Hall is the third part of an £800M government-funded project that

### MAJOR PROJECT KING'S CROSS UNDERGROUND TICKET HALLS

has seen two new ticket halls built beneath London's streets and the existing ticket hall doubled in size. At the start of the project 55,000 passengers an hour used the station during the three hour morning peak; since then, the area around King's Cross has undergone massive re-development, High Speed 1 has opened, and new domestic train services have been introduced at

**"It's been a great challenge, but from the project management side it's been an absolutely excellent job by everyone"**

Andy Eastaugh



**Final phase:** The Northern Ticket Hall is the third part of the £800M government-funded project

St Pancras, as a result of which the Tube station now has to cope with over 80,000 passengers at peak. Those numbers could reach 100,000 by 2014.

London Underground had been planning major improvements to the King's Cross St Pancras Underground station since a devastating fire swept through the existing ticket hall in November 1987, but the process of getting from there to the scheme's completion has been far from straightforward.

Fire and smoke detection systems were improved immediately after the tragedy, but a more radical solution was needed to ensure passengers would be able to exit platforms more safely if an event like that ever happened again, and to alleviate congestion caused by the ever-increasing passenger numbers. LU started a major upgrade scheme, but while it was being planned the government announced the go-ahead for the channel tunnel rail link, which would terminate at St Pancras – bringing thousands more passengers into the Tube station every day.

LU's plans to upgrade the Underground station were then incorporated into the Channel Tunnel Rail Link Act in 1996, and the government committed

to fund the work. A development agreement was then drawn up between LU and the Secretary of State to agree when the project would be delivered and the numbers to be accommodated from the channel tunnel rail link.

The plan was to expand the existing ticket hall, which sits beneath the front of King's Cross station, and to build two completely new ticket halls, the Western Ticket Hall beneath the forecourt of St Pancras station and the Northern Ticket Hall between King's Cross and St Pancras. Spreading passengers out between three ticket halls relieves congestion and also makes it easier for people to get out if there is an emergency, as well as making enough space for the international passengers.

The government agreed to continue funding the existing ticket hall upgrade and the new Western Ticket Hall (Phase 1), but the Northern Ticket Hall (Phase 2) was put on hold.

To complicate matters further, when Phase 1 got the go-ahead in 1999 London Underground (LU) was in the middle of transferring responsibility for maintenance and upgrade work on the Tube to private infrastructure companies ("infracos") under a 30-year private public

partnership (PPP) agreement. An infracon had been set up for the sub-surface lines (Metropolitan, Hammersmith & City, East London, District and Circle) and was being "shadow run" by LU.

The organisation decided to use that infracon to procure and manage the Phase 1 projects, eventually handing them over to Metronet when it won the PPP contract in 2003.

"We let the design contracts [to Arup] just before shadow running started, and these were novated across to the shadow company, then novated across to Metronet," explains LU's King's Cross project sponsor Mike Crabtree. "In turn, LU had a works agreement with the shadow company, which was eventually restated at the time Metronet was formed, and then in turn ABBT joined."

ABBT (a joint venture of Metronet companies Atkins, Balfour Beatty Management and Thames Water) took on the task of project managing delivery of Phase 1, soon after the main elements of construction started. The two elements of Phase 1 were built simultaneously and completed in 2006.

"Foremost in the minds of the team was that we had to do the best job possible in Phase 1

because we wanted to get Phase 2, so we had to create some sort of confidence in the people supplying the money that we had a good idea of what we were doing and could cope with anything that came along," recalls John Hester, who was then Balfour Beatty's tunnelling operations director.

Although Phase 2 was put on hold until funding was sorted out for Section 2 of the channel tunnel rail link, LU took the decision to install all the piles for the northern ticket hall so it could be built at a later date.

The Department for Transport finally released the funding for the Northern Ticket Hall in 2005, and the race was on to get it built in time for the influx of passengers from the new terminal at St Pancras (see p30).

**"Foremost in the minds of the team was that we had to do the best job possible in Phase 1 because we wanted to get Phase 2"**

John Hester

### EXISTING TICKET HALL

**When the project started the single ticket hall at King's Cross St Pancras had to cope with passengers entering, leaving and interchanging between five different underground lines, two main line stations and one suburban station.**



**Rush hour:** Passenger priority

During Phase 1 the ticket hall was extended by 50% by demolishing existing subsurface structures used by LU and incorporating them into the public areas to improve circulation. New "back of house" areas were created by building within a bored pile excavation, and a new slab put on the top of the ticket hall to raise headroom.

From an engineering perspective this project would have been fairly straightforward were it not for the fact that the site is extremely congested, and the ticket hall had to remain in operation throughout the four years of construction. The solution was to work in stages, to minimise disruption to passengers.

But every stage effectively created a new layout for the

ticket hall, each of which had to meet LU's requirements for an operational station in terms of fire and safety certification, including appropriate lighting and handrails. In all there were 15 of these "interim stations" during the course of the project.

All that time there were 70,000 people going through the complex. "This project is about the travelling public, and we've had them in spades," says Balfour Beatty Management managing director David James.

### WESTERN TICKET HALL



**What lies above:** The Western Ticket Hall threw up numerous challenges

**The two storey Western Ticket Hall sits beneath the cobbled forecourt of St Pancras station, bordered north and south by listed structures, including the Victorian station façade.**

The new underground building improves access to the Circle and Metropolitan lines and houses all the electrical power supply equipment for the station system.

One of the trickiest elements was building a new link structure over the shallow eastbound Circle and Metropolitan lines.

Limited space between the tunnel and the Euston Road meant the only way the new structure would fit in was by reducing the height of the running tunnel.

The crown of a length of 45m of the tunnel was sliced off and replaced with a thin concrete roof.

Building a new two storey concourse between the Metropolitan and Circle line running tunnels involved top-down construction, including excavating a section of the Euston Road. Two lanes of traffic had to be maintained throughout the work, so the project team opted to install a temporary bridge to carry the eastbound carriageway while work continued underneath. The bridge was in place for 18 months.

In all there were eight different traffic management phases on the Euston Road to enable contractors to build the new concourse and a new pedestrian subway.

## KING'S CROSS ST PANCRAS: MANAGEMENT

# UNDER COVER DELIVERY

Meeting key milestone dates was the secret to completing the Northern Ticket Hall on time, but that could only be achieved if everyone pulled together.

The Northern Ticket Hall and its associated tunnels did not just present the delivery team with an engineering challenge, but also a programming challenge. Right from the start time was tight: London Underground (LU) had contracted with the Department for Transport (DfT) to complete Phase 2 by 2010, but a redesign just before construction began put even more pressure on the programme.

Building on good relationships developed on Phase 1, LU and the ABBT project management JV adopted a collaborative approach that eventually included both the contractor and the DfT. It paid off, when the scheme came in on time and within the agreed target price.

Phase 2 takes in the Northern Ticket Hall and more than 300m of tunnels. Detailed design began in 2002.

"In 2004 the government called a halt to the works for a ministerial review, because Network Rail wanted to extend its concourse to the west. Our Northern Ticket Hall had to be redesigned to accommodate that new concourse over the top," explains LU King's Cross project sponsor Mike Crabtree. "Phase 2 was reactivated in 2005, and

**"If we had delivered it in any other way we wouldn't have delivered on time"**

David James

## MAJOR PROJECT KING'S CROSS UNDERGROUND TICKET HALLS

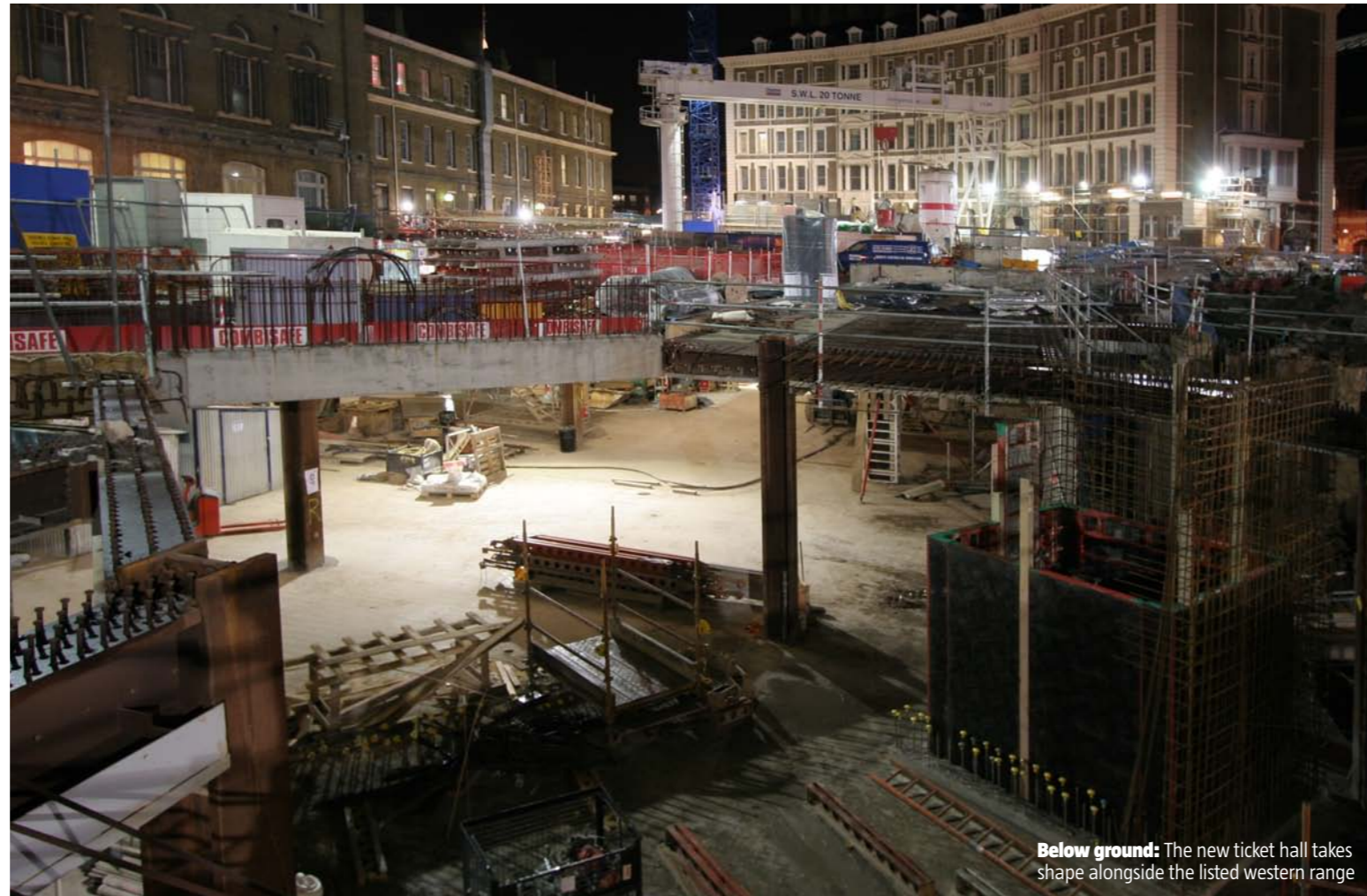
at that point the works became part of the deliverables for the Olympics."

Construction contracts were let to a JV of Morgan Est and Beton & Monierbau for the tunnelling, and to Balfour Beatty Major Projects for the ticket hall construction. This created the interesting situation where Balfour Beatty Management (the main player in the ABBT JV) was responsible for delivering a project where its sister company was the main contractor (see overleaf).

In reactivating the project the government set a maximum combined price for both the LU and Network Rail schemes, which meant revisiting the ticket hall design and trying to find efficiencies.

Before the completion date could be reached there were some critical interim stages. One was that the ticket hall would be operational by the end of November 2009, to coincide with the start of high speed domestic services between St Pancras and Kent. The other was to give Network Rail a clean ground slab for its new western concourse development by September 2008.

This slab is, in effect, the roof of the Northern Ticket Hall. Closing the slab with over a year



**Below ground:** The new ticket hall takes shape alongside the listed western range



**Slab:** Materials were delivered through openings in the concrete roof



**Tunnels:** 300m of new tunnels were excavated and fitted out



**Safety:** Site workers use the escalator to watch a safety presentation

### COMPLETE: NORTHERN TICKET HALL

The new ticket hall takes up the area of a football pitch, and consists of four basement levels. It has been built in a very tight space between the listed "Western range" of King's Cross station and the Great Northern Hotel.



The entire structure has been built inside a contiguous bored piled "box", with piles reaching depths of 37m in places. It has a series of concourses, the first, at 5m below ground, giving direct access to the new High Speed One and domestic terminal at St Pancras. From here passengers can walk through tunnels to the extended main ticket hall or to King's Cross mainline station.

A large bank of escalators takes passengers down from this level to the main concourse 20m below ground. Here new pedestrian tunnels give step-free access

to the Victoria line, with two banks of escalators plunging still deeper underground to take passengers down to the Northern and Piccadilly line.

#### Key facts

- 41,300m<sup>3</sup> of excavation
- 11,900m<sup>3</sup> of structural concrete
- 1,800t of structural steel
- 10 new escalators
- 5 new mobility passenger lifts
- Fit out of 300m of new tunnels
- Two periods of 1,000,000 man-hours without reportable accident

of the project still to run took away Balfour Beatty's main access route for getting materials.

Designer Arup set contractor Balfour Beatty a very strict sequence of digging and propping to form the excavation for the new structure. From ground level to -1 excavation was done from the surface, and then the slab was cast on the ground, leaving openings to get muck out. Excavation for the next level continued beneath this ground slab, and a second slab, at level -2, was cast at the end of 2007.

Excavation for the main ticket hall down to level -4 then began in January 2008, with the excavation supported by heavy steel tubular props while concrete walls were built.

"In our original programme there would have been a minimum overlap between the heavy civil engineering followed by the building and M&E fit-out," explains Balfour Beatty Major Projects operations director Iain Wilson. "In point of fact we didn't have time to do that."

One of the critical path activities was getting the main banks of escalators built and commissioned. In addition to the visible elements escalators require a lot of support that is not seen from above, including large steel trusses, all of which had to be brought into the ticket hall box before the slab was sealed up.

"We had to deliver the

**"We didn't have time for a minimum overlap between the heavy civil engineering and the building and M&E fit-out"**

Iain Wilson,  
Balfour Beatty

escalator trusses before we had finished the excavation at level -4," recalls Wilson. The trusses were stored inside the congested excavation until they were needed. "We wouldn't have chosen to deliver those until we finished the civil works, because they took up a large part of our working area, but it allowed us to close up those openings and hand over the slab to Network Rail," says Wilson.

The logistics of having both civils and finishing trades working inside the congested excavation at the same time could have proved tricky, but Balfour Beatty attempted to ensure all the subcontractors knew where they, and their materials supervisors, were supposed to be at all times. Subcontractors were asked to wear different coloured hard hats, so they could be clearly identified and Balfour Beatty

## KING'S CROSS ST PANCRAS: MANAGEMENT

» took charge of all material deliveries and waste handling.

Installing the escalators was not only the major critical path item. "The communications and fire systems and the station management systems here are really complicated, and getting those commissioned and working at the end of the day became most critical," says LU programme manager Graham Sims.

Sign-off protocols and procedures at LU can be challenging, but at King's Cross the paths were smoothed by the close working relationships. "Since the box has been finished the required rate of progress has been remarkable," says Balfour Beatty Management operations director Elwyn Griffiths. "It certainly couldn't have happened if we hadn't had Graham's [Sims] team integrated with us. And that integration wouldn't have happened unless all sides were committed to that end goal."

Hitting the September 2008 deadline for handing over the ground slab "gave everyone the confidence that the work was heading in the right direction", says Wilson.

"It was a great motivator for the team: if we can hit that date we can hit the end date."

It also sent an important signal to the project's financial backer – the government – that the scheme would not be delayed.

"When we set those targets the first major test was that 1 September 2008 date," says LU head of stations upgrade programme Andy Eastaugh. "Really nobody thought that was going to be achieved, but for us it was a matter of pride. It was a good test of everybody from the Department [for Transport] down to the suppliers."

But, as Eastaugh says, it "wasn't a foregone conclusion" that the team would hit that first milestone. The Northern Ticket Hall box went through a lot of redesign once Network Rail announced its improvement plans for King's Cross, to integrate the two schemes as much as possible and make efficiency savings.

The main escalator box was moved from the east side of the ticket hall to the west, resulting in a major change to passenger flows around the ticket hall, and a new location was found for the main ventilation shaft from the Tube station.

"All of these issues and redesigns and interfaces with Network Rail delayed the start

**"It's been a challenging job but it would have been a lot more challenging if we hadn't got that integrated approach"**

Ben Dunlop, Atkins

of getting on with those works," recalls LU King's Cross sponsor Mike Crabtree.

Under traditional contractual arrangements that delay could have been enough to push back the completion date by quite a few months. But rather than square up over claims for extension of time, LU, ABBT and BBCEL took a collaborative approach, agreed that it was best for all parties if the end date was achieved, and negotiated a deal that incentivised that result.

"We agreed what the cost to make that date would be," says Wilson. "Having made that commitment, and showed the client what he wanted to see, that cut out all the contractual nonsense."

A collaborative approach between the main parties had started during Phase 1, but became a fundamental part of the way Phase 2 was managed. LU, ABBT and the contractor were all co-located, along with the DfT's representative, MPG, a joint venture of Mott MacDonald, Parsons Brinckerhoff and Gibb.

"In Phase 1 they were more there to police and oversight and challenge," says Eastaugh. "But as we moved out of Phase 1 and into Phase 2 there was a conscious effort to work in a more collaborative way."

"If we had delivered it in any other way we wouldn't have delivered on time," says Balfour Beatty Management managing director David James. "With the collaboration there was a good mix of thinking that meant the solutions we found were very often generated by people you wouldn't expect. We worked it out by contractors not being contractors and consultants not being consultants."

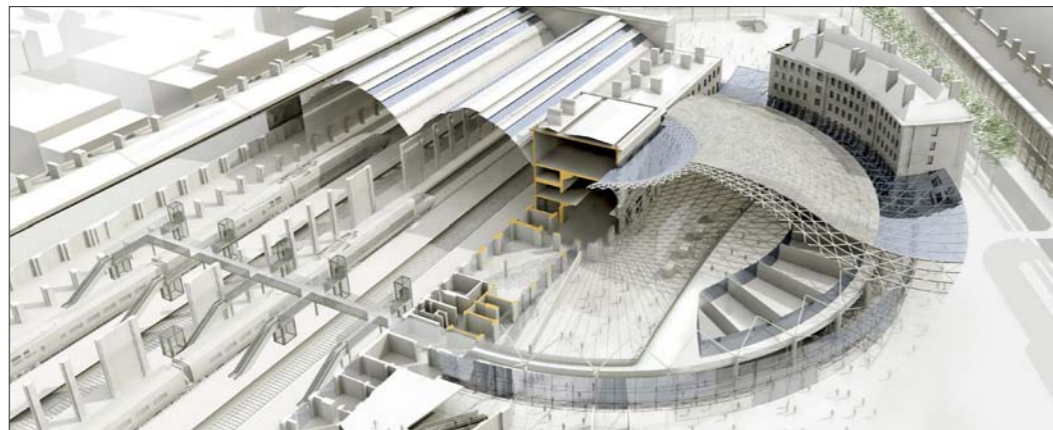
Atkins regional manager Ben Dunlop adds: "It's been a challenging job but it would have been a lot more challenging if we hadn't got that integrated approach."

### TUNNELS

**Both phases of the King's Cross station improvement involved an element of tunnelling, but the largest chunk fell within Phase 2, when new pedestrian routes were built to link the three ticket halls and take passengers from new concourses to the tube lines.**

"Tunnelling was a major concern," says Balfour Beatty former tunnelling operations director John Hester. "We were below a listed building with big trains and we were going to build tunnels only 7m below the track and 11m in diameter. Failure was not an option."

The team's approach was to "de-risk" the tunnelling activities as much as possible, redesigning where necessary to find safe ways of doing the work that would prevent any chance of settlement. "You can't put an estimate on the cost of having a train drop six feet into a tunnel," says Hester. "We could not allow anything to go wrong underneath King's Cross."



**Vision:** Network Rail's King's Cross extension sits directly on top of the Northern Ticket Hall

### BALFOUR BEATTY – PROJECT MANAGER AND CONTRACTOR

**With Balfour Beatty Management staff making up a large proportion of the ABBT project management team, eyebrows were bound to be raised when Balfour Beatty Major Projects won the contract to build the Northern Ticket Hall.**

"Phase 2 was competitively tendered," explains Balfour Beatty Management commercial director Paul Pethica. "Balfour Beatty won the contract for the ticket hall and

Morgan Est got the tunnels."

Before awarding the contract ABBT had to get London Underground's approval to use one of its group companies. "I think it was a good test for us, because if we were found to transgress in our role we would have failed," says Balfour Beatty Management managing director David James. "I suspect Iain's team would say we were over-zealous."

'Iain' is Balfour Beatty Major

Projects operations director Iain Wilson, who says: "I've been with Balfour Beatty for 28 years, so there were already established working relationships."

Although the two Balfour Beatty group companies maintained a professional distance, the collaborative approach eventually led to people from the ABBT project management team working within the contractor's organisation to help with delivery.

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**TUBE PROJECT COMPLETES**  
THE NORTHERN TICKET HALL  
IS THE FINAL STAGE IN AN  
£800M SCHEME TO DOUBLE  
PASSENGER CAPACITY

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**KINGS CROSS: INFOGRAPHIC**

# CONNECT THREE

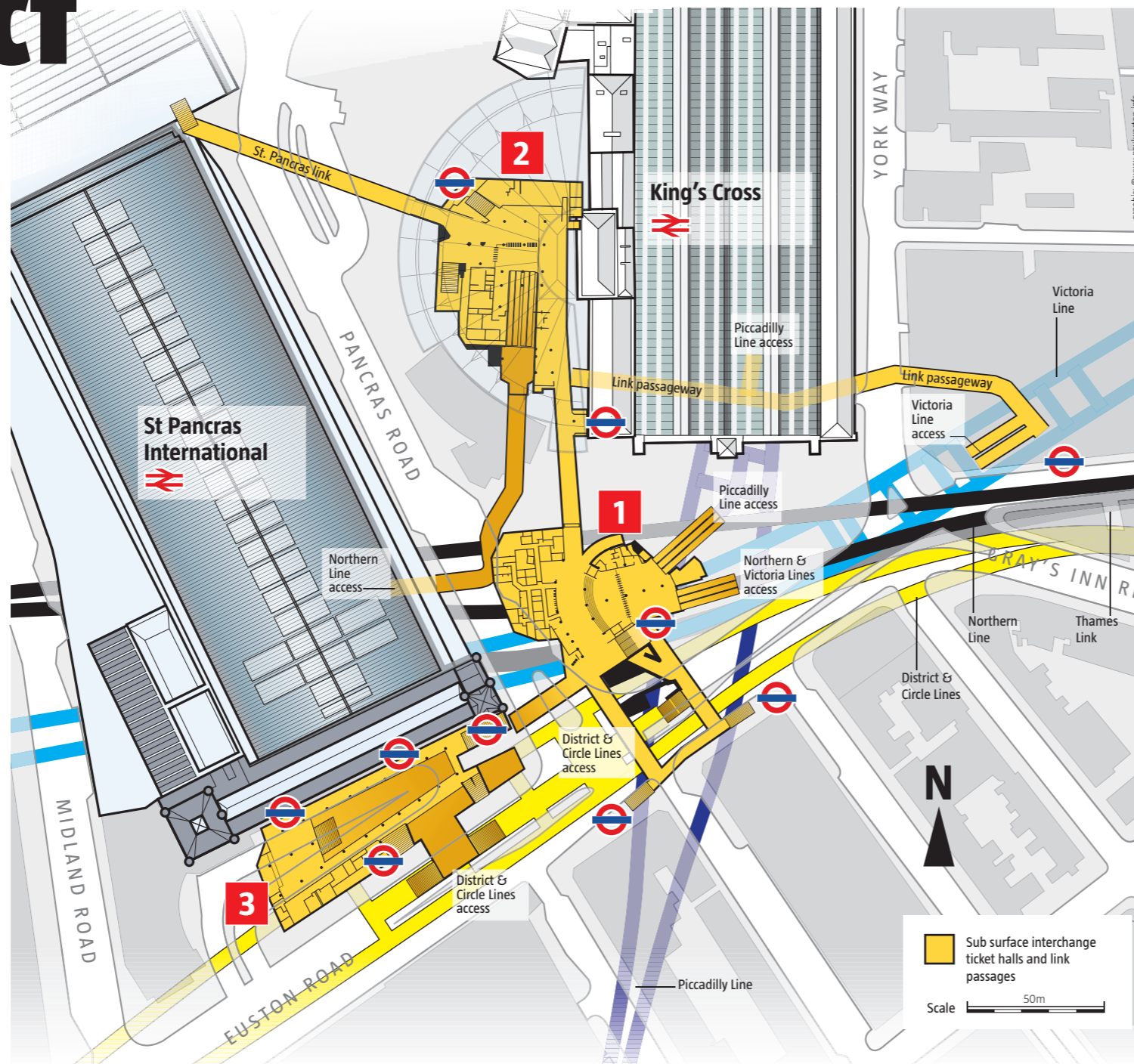
Three new ticket halls will allow 105,000 passengers a day through the station

## MAJOR PROJECT KING'S CROSS UNDERGROUND TICKET HALLS

The £800M scheme to double capacity at the Kings Cross St Pancras Underground station consists of three separate elements: extending the existing ticket hall and building two completely new ticket halls.

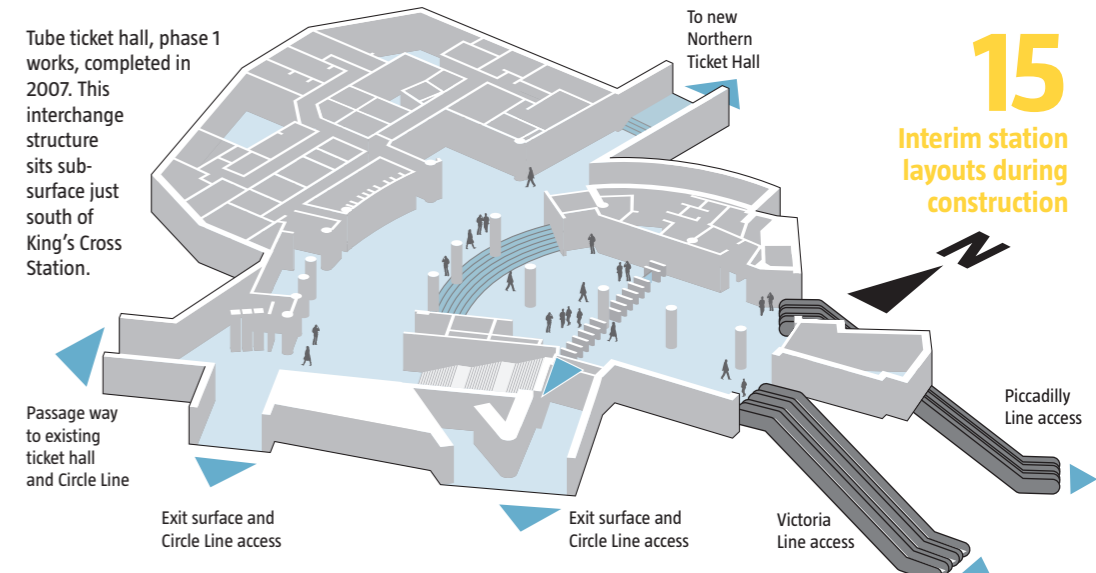
All three structures are entirely below ground, and the station has remained open throughout the project. With the opening of the Northern Ticket Hall to passengers last December, the three elements of the station became linked together for the first time.

When the project started 10 years ago, 55,000 passengers an hour used the station during peak hours. Numbers have since risen to 80,000, and the new station can cope with more than 100,000.



### 1 EXISTING TUBE TICKET HALL

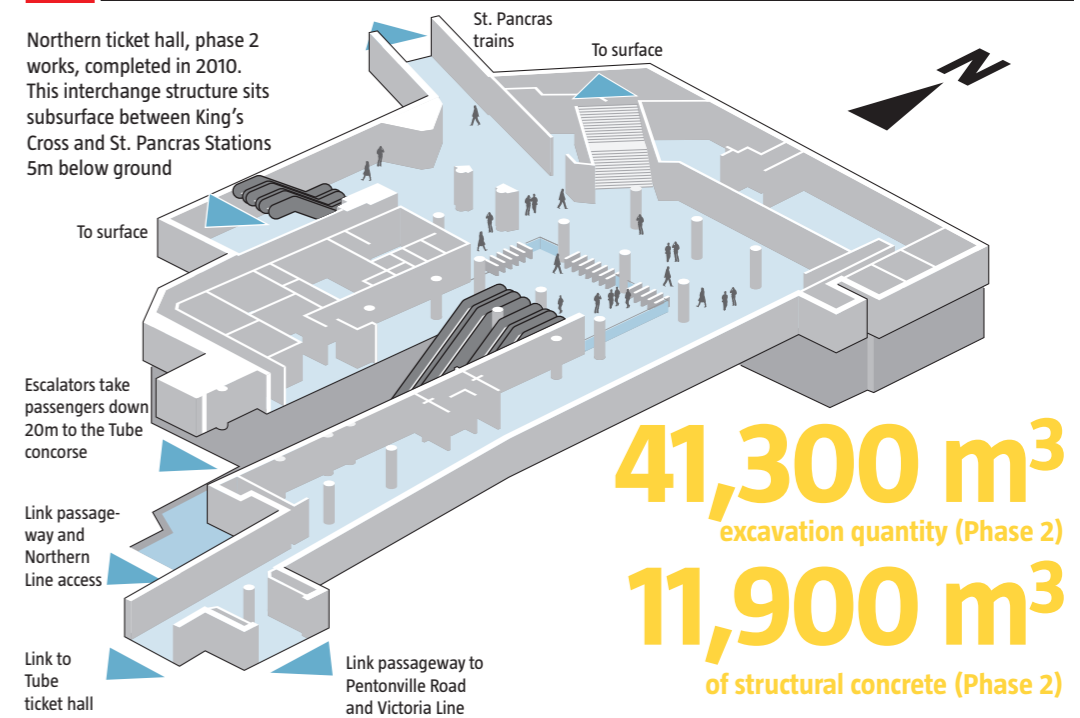
Tube ticket hall, phase 1 works, completed in 2007. This interchange structure sits sub-surface just south of King's Cross Station.



**15**  
Interim station layouts during construction

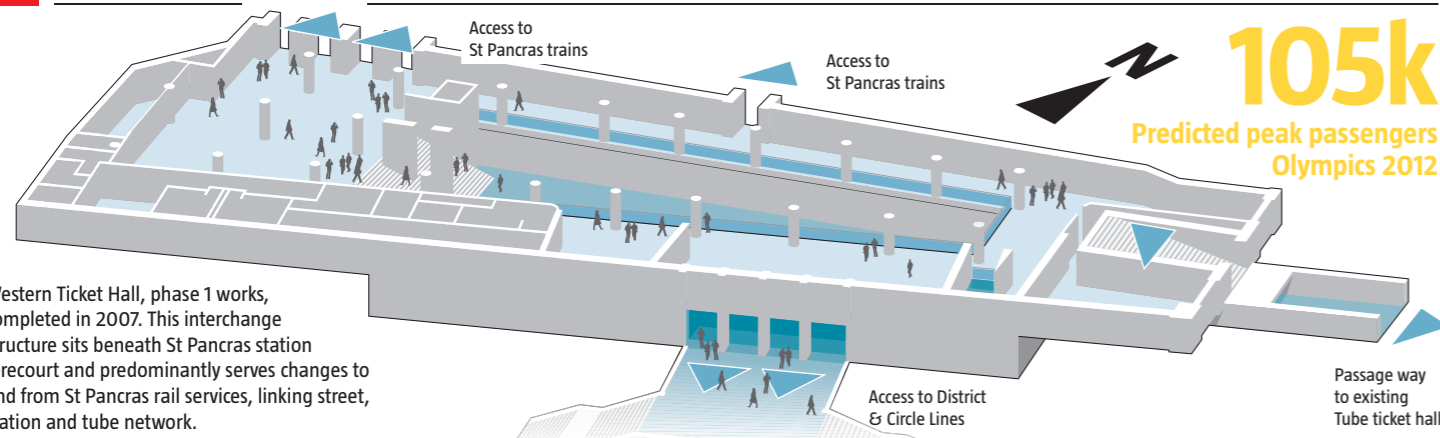
### 2 NORTHERN TICKET HALL

Northern ticket hall, phase 2 works, completed in 2010. This interchange structure sits subsurface between King's Cross and St. Pancras Stations 5m below ground



**41,300 m<sup>3</sup>**  
excavation quantity (Phase 2)  
**11,900 m<sup>3</sup>**  
of structural concrete (Phase 2)

### 3 WESTERN TICKET HALL



**105k**  
Predicted peak passengers Olympics 2012

Western Ticket Hall, phase 1 works, completed in 2007. This interchange structure sits beneath St Pancras station forecourt and predominantly serves changes to and from St Pancras rail services, linking street, station and tube network.

### NORTHERN TICKET HALL - CONSTRUCTION PHASING

