Network Rail

King's Cross Station Enhancements

Impact on Existing Structures

Report ref
54200/206

FINAL

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Impact on Existing Structures

August 2006

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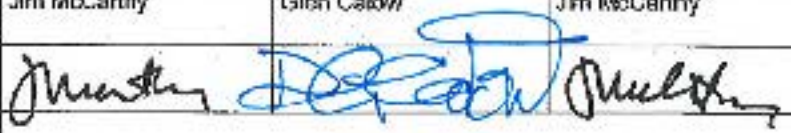
Job number 54200-60

ARUP

Document Verification

Job title	King's Cross Station Enhancements		Job number 54200-60
Document title	Impact on Existing Structures		File reference
Document ref	54200/206		

Revision	Date				
Draft 1	15/08/06	Filename	20644.doc		
		Description	First draft		
			Prepared by	Checked by	Approved by
		Name	Jim McCarthy	Glen Calow	Jim McCarthy
		Signature			
Final	18/08/06	Filename	206_final.doc		
		Description	Final issue for submission		
			Prepared by	Checked by	Approved by
		Name	Jim McCarthy	Glen Calow	Jim McCarthy
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

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1 Executive Summary

This report has been produced in support of the planning submission for the Network Rail Enhancement works in July 2006. This includes the refurbishment of the West Range Buildings and the station shed as well as the construction of a new Western Concourse.

The report gives detailed information on the impact that the proposals have on the framing to the basement area and the ground floor of the southern end of the Western Train Shed.

The new Western Concourse structure has been designed to be “stand-alone”. It has its own stability system above ground and there are movement joints between the new structure and the adjacent, existing buildings.

Any structural alterations in the existing Western Range buildings are designed to avoid affecting the existing stability systems in those buildings. It is recognised that the Western Range buildings contribute to the overall stability of the King’s Cross train shed and the new development will not affect the existing stability systems.

There have been studies into the effects of the new development on ground movements in the area of the station.

2 Introduction

This report covers the proposed alterations to the existing Grade 1 listed Western Buildings to accommodate circulation and concourse provision associated with the new Western Concourse; and for the new Shared Services Yard (Network Rail Plantroom Link Building) basement, constructed adjacent to, and in conjunction with, the reconfigured southern end of the Suburban Train Shed.

The report also considers the structural interface of the proposals with the LUL Northern Ticket Hall and Main Train Shed Renewal works. The works are complex and undertaken within a restricted site, whilst maintaining areas of the buildings operational.

The preliminary appraisal of the structural sensitivity of the existing buildings to the proposed alterations includes an overall assessment of the transverse structural performance of the Kings Cross Station Train Shed roof

- Inclusion of the 'Bomb Gap' reconstruction works as part of the LUL Phase II works, as a 'shell and core' structure.
- Extensive reconfiguration and stiffening of the southern end of the Suburban Train Shed.
- Construction within the Old Parcels Yard of a structurally independent two-storey extension to the North West Building linked to the new southern roof of the Suburban Station.
- Omission of the OBS tunnel under Platform 8 and the substitution of a narrower services tunnel, which continues to utilise the existing underground toilet and barbers shop and links the southern spur of the Old Parcels Tunnel with basement areas of the Western Range central area.
- Demolition of the bomb damaged and incomplete southern bay of the North Wing of the Western Range, and its reconstruction as a framed structure monolithically connected to the 'Bomb Gap' structure.
- Reuse of the Old Booking Hall as a two storey height ticket hall and the introduction of a new lift within the hall serving the existing first floor balcony.
- Relocation of the lift shafts in the central Old Booking Hall area and southern wing of the Western Range.
- Alteration to the configuration of the southern end of the Shared Services Yard and the proposed, early, phased construction of the southern end for use as a plant room and OBS facility.
- Lowering of the southern end of the Link Block basement to the level of the adjacent Old Parcels Tunnel, formation of a new entrance and construction of a new lift shaft and staircase.
- Formation of a new stair core within existing loadbearing masonry walls to the north end of the Link Building.
- Introduction of pedestrian and mezzanine bridge links into the penultimate bay of the North Wing; and the formation of an OBS basement entrance from the NTH concourse level into the gable end bay.
- Replacement of the existing main train shed overbridge with a new bridge.

3 Existing Buildings

Kings Cross Station is a Grade I listed building, designed by Lewis Cubitt and completed in 1852.

The station originally comprised the Western Range, Northwest Building and Link, Main Train Shed and Eastern Range. The Suburban Shed was originally constructed in 1875; and extended and re-roofed in 1895. The Northern Building is believed to have been constructed as part of, or immediately following, the construction of the original Suburban Shed.

The existing buildings and structures directly affected by the Kings Cross Enhancement works comprise:

- Northern Building
- North West Building and Link
- Western Range
- Suburban Train Shed
- Main Train Shed Overbridge

A general description of the construction of each of the following buildings is set out in this report:

- Main Train Shed
- Eastern Range
- Old Parcels Tunnel
- Platform 8
- Foundations – General

In this report the Western Range refers to the principal station building occupying the southern section of the western perimeter and comprising

- Southern Wing
- Old Booking Hall
- 'Bomb Gap'
- Northern Wing

4 Site Investigations, Movement Monitoring & Archive Searches

4.1 Geotechnical

A site investigation will be required, with the following objectives

- To confirm the stratigraphy;
- To undertake appropriate in-situ tests to assess the design parameters;
- To sample the soils and undertake laboratory tests to derive design parameters;
- To sample the soils for assessment of potential contamination at the site;
- To locate foundations of existing buildings/structures to be retained;
- To investigate the groundwater profile.

A combination of deep boreholes and shallow trial pits will be required. Details of the scope of this investigation are covered under Arup Geotechnics Specification and Bill of Quantities Document 112 dated March 2003.

4.2 Site Investigation (Structural)

The survey work will be accompanied by the sampling, insitu and laboratory testing and inspection of structural materials.

A presumptive Survey in accordance with the Control of Asbestos at Work Regulations 2002 and sampling for anthrax in accordance with the relevant standards will be required prior to the commencement of any preliminary structural works. (Refer to *Pre-Tender Health and Safety Plan for Preliminary Structural Works* Document 124 dated April 2003)

Sampling for the presence of asbestos (and where appropriate anthrax) needs to be undertaken at each opening up location in the building fabric; and where found will be required to be contained and removed before survey work proceeds.

4.3 Movement Monitoring

To ensure that the sequence and methods of construction are not causing undue movement to the existing buildings and structures, a comprehensive system of monitoring will need to be installed and maintained throughout the construction period. This will include the monitoring of ground movements and movements induced by the works with new and existing adjacent buildings and structures associated with ther projects; and would be designed to give early warning of movements occurring which differ from those predicted, allowing remedies to be made at an early stage. In order to obtain a set of reliable base eadings, adequate period should be allowed prior to any construction work to install the necessary instrumentation and undertake these initial readings.

4.4 Archive Searches

Archive searches have been undertaken in connection with the structural performance of the Main Train Shed and further searches are to be undertaken as part of a future Stage E appraisal, assessment and risk valuation studies in connections with the structural performance of the buildings and the impact of alterations under current proposals.

Sources researched will include the Public Records Office, British Architectural Library and the Institution of Civil Engineers; and further searches will be undertaken at the Network Rail archives (York and Manchester).

5 Principal Structural Assumptions

5.1 General

Principal design assumptions, on which the structural outline proposals have been based, are repeated below.

5.2 Western Range

5.2.1 'Bomb Gap' Reconstruction

The proposed permanent arrangement for the LUL Vent is to provide for the extension of an approximately 10.0m wide basement mezzanine air duct into the western area of the 'Bomb Gap'. The works include the construction of a new 'Bomb Gap' infill building between the North Wing gable end wall cladding and the north face of the Old Booking Hall, together with the reconstruction of the north east corner of the Old Booking Hall.

The works include the retention of the existing central basement corridor, which is to be environmentally isolated from the surrounding works and remain operational during the construction of the Bomb Gap structure and following Network Rail construction works within the Western Range.

The movement joint between the NTH construction and the 'Bomb Gap' to be incorporated on the line of the existing end (eastern) wall of the contiguous/sheet piled two storey basement spur, currently provided for the (now abandoned) temporary vent shaft location.

Imposed loadings to plant areas to be designed for a uniformly distributed loading of 7.50 kN/m2. Suspended slabs to all other areas of the 'Bomb Gap' infill structure are to be designed for a uniformly distributed imposed loading of 5.00kN/m2.

5.3 Shared Service Yard and Network Rail Plantroom Link Building

5.3.1 General

A 2.0m approx. structural zone to be maintained between the external face of the Suburban Train Shed western wall and the inside face of the eastern reinforced concrete lining wall of the Shared Services Yard.

The construction of the Shared Services Yard basement, under the Network Rail Enhancement works, will be restricted to the initial southern phase. The works will comprise a two storey basement served by lift cores to ground level and linked to the north west corner of the Northern Ticket Hall concourse level; and accommodate OBS facilities together with NR plant at mezzanine level.

5.3.2 Ground floor (roof) structural level 116.500ATD.

The general roof area of the southern area of the Shared Services Yard basement will be located at SSL 116.500ATD. The roof would initially support construction and delivery traffic.

5.3.3 Northern Ticket Hall Safeguarding

It is assumed that the LUL safeguarding of basement development to the north of gridline 22, currently to a depth of 6.5m (approximately 110.000) (Arup LUL document 571451468 Draft dated November 2002), will be increased locally to permit excavation for the Shared Service Yard to 105.600 ATD formation level at the western end of the Northern Ticket Hall.

5.4 Western Buildings: Imposed Loadings

5.4.1 Definition

The design imposed / live loadings are those assumed to be produced by the intended occupancy or use, including distributed, concentrated, impact and inertia loads, but excluding wind loads; and are derived in accordance with BS 6399 Part 1.

5.4.2 Existing Floors

Existing floors will be appraised for their live load capacity based on the results of structural investigation works. Floors will be assessed individually against the specific class of usage, and strengthened as necessary to minimise the scope and extent of the strengthening, and the impact of such measures on the historic construction

6 LUL / Renewals / Western Concourse Interfaces

6.1 General

This section of the report covers the structural implications on the LUL Northern Ticket Hall (NTH), and NR Main and Suburban Train Shed renewals works, resulting from interfaces with the Existing Building and Shared Service Yard interfaces; and those associated with the new Western Concourse Enhancement works:

- LUL Northern Ticket Hall (NTH) Phase II Works
- Western Range LUL Vent/ 'Bomb Gap' 'shell and core' construction.
- NTH Concourse OBS corridor.
- North Wing Basement OBS Entrance
- OBS Old Parcels tunnel link.
- North East Escalator.
- Shared Service Yard link with NTH north west lift core

The relocated Southern stair and lifts to ground level to the south of the Western Range leading from the Northern Ticket Hall/Tube Ticket Hall Link is now to be constructed as part of the early LUL NTH Phase II works; and operational interfaces maintained with the section of the NR Southern Concourse retained during the construction; until these are finally demolished as part of the Enhancement works.

- Main and Suburban Station Platform and Roof Renewals Works
- Main Train Shed Roof Renewals
- Main Train Shed Platform Renewals
- Suburban Shed Roof Renewals
- Western Concourse
- Western Range interface with the Western Concourse roof.
- Western Range north wing ground floor and mezzanine pedestrian links.

6.2 Western Range - 'Bomb Gap'

6.2.1 General

Under the Stage C proposals major and complex works accompanied the location of the subsurface NTH concourse extension and the easterly positioning of the LUL Vent within the 'Bomb Gap'; and the lowering of the adjacent Old Booking Hall basement to accommodate the escalator and stair link from the NTH to the Western Concourse. The proposals resulted in an extensive LUL/NR interface incorporating north wing gable, main train shed flank wall and Old Booking Hall.

6.2.2 Network Rail Works.

The remaining structural works within the 'Bomb Gap' will comprise:

(a) Construction of a new, self supporting western external masonry faqade, restrained by the new reinforced concrete structure by ties designed to accommodate differential movements associated with frame shrinkage, and brickwork movements under thermal and moisture effects.

(b) Reconstruction of the rear (eastern) walling built upon partially completed post- war main shed flank wall construction; and restrained by the new 'Bomb Gap' infill structure.

(c) Provision of staircases and service risers.

6.2.3 Sequence of Construction.

The new structure will be arranged around and bridge over the existing basement On-board Services (OBS) corridor, which will be maintained in operation as a link between OBS areas at the south end of the Western Range and the Old Parcels Tunnel to the north.

6.3 Northern Ticket Hall OBS Corridor

A dedicated OBS service corridor is to be provided from the Shared Service Yard mezzanine floor link, adjacent to the NTH North West stairs to the new Western Range north wing basement entrance. The route, comprising a ramped slab supported on the NTH Concourse floor slab, will be situated on the northern perimeter of the NTH 'box'.

The ramp and corridor works will be carried out under the LUL NTH Phase II works.

6.4 North Wing Basement OBS Entrance

A new, short reinforced concrete basement link tunnel is to be constructed between the eastern perimeter of the Northern Ticket Hall HTH and the western perimeter of the reconstructed north wing gable bay to connect the NTH OBS corridor with the Western Range OBS corridor.

The formation of the connection includes the following works:

- Breaking through the north-east corner of the existing NTH box contiguous pile wall at high level.
- Construction of the tunnel in an approximately 3.0m deep excavation between NTH piled wall and North Wing basement wall. The excavation and construction of tunnel would be undertaken in a restricted area and would include breaking down approximately 2m of 3No large diameter piles originally provided for Western Concourse structure, and situated between contiguous piled wall and north wing basement.

6.5 OBS / Old Parcels Tunnel Link

The extant western end of the Old Parcels Tunnel is to be extended and will connect with the NTH OBS corridor to provide direct connection between the NTH OBS corridor and the platform lifts, served from the Old Parcels Tunnel.

The LUL safeguarded sheet piled breakthrough provision in the north wall of Northern Ticket Hall at concourse level aligns with the extended section of the Old Parcels Tunnel and allows for the formation of an entrance at the NTH/Old Parcels Tunnel interface.

6.6 Main Train Shed Roof Renewals

The Main Train Shed structure shares a common (western) flank wall with all Western Buildings, and the Main Train Shed roof performance and interaction with the Western Buildings is a major interface with the Enhancement Works. The wall supports vertical reactions from the Western barrel roof, applied by the arch ribs to cast-iron stanchions embedded in the brickwork and to the cast-iron/stone springing at the base of the roof arches.

The Western Buildings also provide resistance to lateral loads applied by the Main Train Shed roof, including wind loading and the horizontal component of the main train shed arch rib gravity loadings.

The Western flank wall provides, (in conjunction with the central spine wall and diaphragm action of the roof) longitudinal stability to the Main Train Shed western arched roof, and contributes to longitudinal stability of the Western Buildings.

Upper bound preliminary values of lateral and vertical forces for the existing roof construction applied by the existing arch ribs have been provided by Network Rail (WYG/Strategic Renewals/Existing Loading/Grip 2 Load Data, issued 18.10.2005).

The reactions to the Main Train Shed loads are accompanied by lateral and vertical movements of the supporting existing and new structures. Assumptions on the ground movements and building stiffnesses associated with the derivation of the reactions; and location specific information on foundation vertical and lateral forces, and where applicable, moments, are required for review and development of the design.

These values should cover future roof loadings where these are greater than existing..

6.7 Main Train Shed Platform Renewals

The principal elements of the Platform Renewals which interface with the Enhancement Works comprise:

- Platform 8: Interfacing with

(a) Platform 8 Service Duct

(b) New Overbridge Works

(c) Western Building rear wall (Main Train Shed flank wall works)

- Platforms 6/7: Interfacing with

(a) Refurbished Large OBS Platform Lift

(b) New Overbridge Works

- Platforms 4/5: Interfacing with

(a) Refurbished Large OBS Platform Lift

(b) New Overbridge Works

- Platforms 2/3: Interfacing with

(a) Refurbished Large OBS Platform Lift

(b) New Overbridge Works

- Platform 1 Eastern Range: Interfacing with

(a) New Large OBS substructure spur and shaft construction

(b) New Overbridge Works

6.8 Suburban Shed Roof Renewals

The suburban station roof is supported on the western facade of the North West Building and Northern Building; and the suburban station structural performance and interaction with the Western Buildings is a major interface with the Enhancement Works.

The stability system to the Link and North West Buildings are to be enhanced to restore calculated stiffness lost by the previous, progressive removal of crosswalls to the buildings and designed to provide sufficient stiffness and stability to resist horizontal loadings (including Main Train Shed arch thrusts) without reliance on any contribution from the presently connected stiff northern section of the Suburban Shed, which is to be removed as part of the Enhancement Works.

Information of the required resistance of location specific lateral and vertical forces, applied by the renewal and reconfigured suburban station to the Western Buildings is required for review and development of the design of each building.

The ground slab of the concourse structure is generally supported by the roof of the LUL Northern Ticket Hall box. The slab will be cast to a level of 116.8 up to the face of the Western Range and incorporate a movement joint to maintain separation.

6.9 Interface with West Range building

The interface with the Western Range building has been dealt with by minimising the vertical support structure adjacent to the historic façade. By adopting edge columns around the curved edge of the roof and only one central funnel support along the Western Range building, the majority of the façade remains free from vertical support structure.

To ensure that the new structure is structurally independent of the existing Western Range building, the main roof is set back from the façade varying from 2 to 4 metres. To maintain a sheltered environment within the concourse building a warped glazed wall has been adopted at the concourse building edge adjacent to the Western Range. The structural members supporting the glazed wall form a deep truss to the edge of the roof and provides the necessary 'stiff edge' support to the diagrid shell. This glazed wall is angled away from the Western Range building (i.e. the bottom of the wall is connected along the edge of the Western Range building while the top is connected to the edge of the Western Concourse roof). Loading to the Western Range from the glazed wall has been minimised and only notional lateral restraint is required from the existing brick facade.

7 Western Range - Scope Of Works

7.1 Southern Wing

7.1.1 1975 Alterations

Significant alterations to the internal layout of the Southern Wing were made during 1975 to suit the change in use of the area to what is now Gingham's Restaurant. The main alterations involved the installation of new steel columns and beams, supported on piled foundations, to allow the removal of many of the internal loadbearing longitudinal and crosswalls between ground and first floor.

These alterations were concentrated in the southern part of the wing and extended from the south gable wall up to the 4th internal crosswall. As this area is the same as that to be subject to the proposed Network Rail alterations, they will have a significant impact on the proposed construction works.

The steel stanchions extend from pilecap level to new beams underneath the first floor slab. The stanchions pass through the existing ground floor slab, apparently without providing additional support at this level

Additional alteration work carried out in 1975 comprised the formation of new openings between piers on the east elevation between ground and first floor. These alterations required the introduction of lintels above the new openings bedded onto strengthened pier sections.

7.1.2 Substructure Works

Substructure work within the southern wing involves the construction of new piled foundations, pilecaps and ground beams within the area bounded by the main train shed western wall, the southern and western walls of the western range and the existing crosswall, grid line 8; approximately two thirds up the length of the southern wing.

Access for piling works within the existing basement is very restricted due to the available headroom and the presence of existing construction. Pile sizes would therefore be limited by the type of rig that could operate in the available space.

Once foundations are constructed, reinforced concrete columns and shear walls would be constructed to support the new ground floor and the loads from the superstructure above.

The northern end of the new works, including shear walls and stair and lift core are located over the proposed passenger tunnel linking the NTH and Piccadilly line: and the substructure works include a 2m thick piled transfer slab bridging the tunnel.

Existing piles, installed as part of the 1975 Works are generally remote from the new foundation positions, and are abandoned.

7.1.3 Superstructure

The formation of a new five bay concourse entrance structure at the south end of the Southern Wing requires the removal of all existing internal walls and structural steelwork installed as part of the 1975

In order to replace the support previously provided by these elements, it is proposed to construct a new reinforced concrete frame structure, pinned up tightly to the underside of the existing first floor. A solid reinforced concrete slab below first floor level acts as a horizontal diaphragm to transfer lateral loads from the main train shed roof and also wind and stability forces from the upper floors into new transverse reinforced concrete shear walls.

Vertical loads from the existing structure above would be supported by reinforced concrete columns arranged with two rows running north-south down the centre of the building and

two further rows positioned immediately behind the existing piers on the east and west elevations between basement and first floor levels. The columns and beams on the west elevation also support point loads at mid-span arising from the removal of alternate piers between ground and first floor.

The level of the reinforced concrete slab and associated beams constructed under the existing first floor has been raised to ensure that perimeter beam soffits are coincident with the external soffits of the new openings formed in the east and west facades; and are to be designed to support the severed intermediate window piers and associated first floor spandrel masonry above. The existing timber and central corridor stone first floor construction will be temporarily removed as necessary to enable the high-level ground floor concrete slab to be constructed and the timber joists and boarding reinstated.

The existing timber floors at second floor level would be retained with strengthening work carried out where the proposed new usage of the floor areas required higher imposed loadings than the existing structures were assessed as being capable of supporting.

Light steel framed, timber decked mezzanine structures are to be constructed at ground floor to the north west area of the southern wing, supported on the existing basement loss and spine wall structure.

7.2 Old Booking Hall

7.2.1 General

The scope of works to the basement and ground floor of the Old Booking Hall, described in the Stage C report has been substantially reduced by the relocation of the main escalators and stairs from the Old Booking HallI 'Bomb Gap' interface to the Western Concourse, and the return of the ground floor for use as the Western Concourse ticket hall. Provision of two new lift shafts within the eastern cellular bays of the buildings remains, although their location has been altered.

7.2.2 Substructure

The relocation of the main escalator and stairs from the Old Booking Hall under the Stage D proposals removes the requirement to lower the existing basement and obviates the extensive piled foundations, and underpinning which accompanied the Stage C basement construction. The existing basement structure is to be retained and the internal walling (which has been substantially modified) strengthened and repaired as required following the appraisal of the capacity of the masonry and associated ground floor beams, based on the results of structural investigation works.

The formation of an entry for the service tunnel under Platform 8 into the basement of the Booking Hall requires that existing longitudinal walling is removed. In order to replace the supporting action of these walls, new steel frames would be inserted around the new opening, encased in reinforced concrete. Allowance should be made for local strengthening of the foundation masonry to ensure that the loads from the frame are redistributed uniformly to the exiting foundation.

New piled foundations will be installed in the central area below the ticket hall to support a pit and steel framed shaft to the new twin lifts serving the ground and first floor levels of the Old Booking Hall.

7.2.3 Superstructure

The Works associated with the opening-up of the ground floor north gable wall to form a connection through into the 'Bomb Gap' are omitted and the existing ground floor slab construction generally retained and strengthened as necessary following the investigation and appraisal of the construction and condition. New trimming structure is to be introduced to accommodate the penetration of the new twin lift shaft within the ticket hall; and repair

and strengthening works are to be designed to accommodate, and phased to maintain the basement OBS corridor and facilities in operation.

The lift shaft structure to the ticket hall comprises a welded structural steel rectangular hollow section rigid framework; with a steel framed, composite reinforced concrete decked first floor walkway linking the lift to the exiting first floor balcony. The walkway primary structure will be supported on the main rear walling of the Old Booking Hall to avoid loading the existing cast iron cantilever, stone decked balcony.

The existing floor construction at second and mezzanine floor levels are to remain largely unchanged. Where the required imposed load capacity of these floors under the proposed usage is greater than the assessed capacity of the floors, then strengthening of the floors will be provided.

At roof level, the existing roof comprises a large span roof truss of hip ended construction on the west elevation and a small span roof truss also of hipped ended construction, on the east elevation. It is proposed to remove the large span roof trusses and replace them at this level with a reinforced concrete slab acting compositely with new steel floor beams, to support light mechanical plant.

The existing roof on the east elevation is planned to remain with the space below utilised as additional plant space. In this area, it is proposed to construct a new reinforced concrete slab on top of the existing steel beams within this space to support plant and water tanks.

Supplementary support of the new roof level plant room slab, comprising reinforced concrete columns set within the western façade masonry piers and supported at basement level has been provided. The requirement for the columns will be reviewed following the investigation and appraisal of the existing masonry and alternative methods of distributing the new loading regime into the existing structure considered.

Works also include the removal of the mezzanine plantroom, currently occupying the Old Booking Hall at first floor level, and returning the hall to its original two storey volume.

7.3 'Bomb Gap' Reconstruction

7.3.1 Historical Background

The 'Bomb Gap' is situated immediately to the north of the Western Range Old Booking Hall. A length of approximately 23 metres of the original four storey North Wing was destroyed by a high explosive bomb in May 1941, together with five bays of the western station roof and three roof arch ribs. Contemporary reports indicate that an adjoining 18 m section of the station buildings to the north and 58m to the south were seriously damaged.

The 'Bomb Gap' extends from the end wall of The Old Booking Hall northwards to the temporary 'gable end' wall of the North Wing currently faced with metal profile sheeting. The 'Bomb Gap' includes the north west corner of the Old Booking Hall.

The temporary 'gable end' bisects the original two bay open plan platform grill room, the southern bay of which was destroyed. Historical drawings indicate that the walls on the line of the 'gable', currently concealed behind cladding, were relatively slender and not of the stocky construction generally associated with cross wall construction. The load bearing masonry spine walls, other internal walls and floors above the northern bay of the old grill room, are carried on longitudinal and cross beams supported at platform level on two central masonry cruciform columns. The northern bay was retained and stabilised as part of the wartime and post-war repair works, to become the present North Wing gable end bay.

7.3.2 Existing Construction

The main station masonry flank wall was rebuilt up to 1st floor level and infilled to the roof eaves with metal profiled cladding. The walling supports a replacement steel main station

roof arch rib at the southern alterations. In addition, alternate piers on the west elevation are to be removed between ground and first floor levels.

The end of the 'Bomb Gap', is strutted at 1st and 2nd floor level by a storey height flying lattice beam back to the section of rebuilt cross walling enclosing the northern end of the Old Booking Hall. The two steel replacement arch ribs to the north are carried on freestanding stanchions incorporated into the rebuilt flank wall and with substantial concrete encased braced steelwork foundations, occupying the full height of the basement storey. The wrought iron station roof arch adjacent to the gable end is supported on a partially rebuilt extension of the original flank wall construction; and tied above the bottom springing of the arch.

The basement walling configuration is generally original, but with the additional encased foundations to the replacement arches occupying the eastern basement area. The masonry walling is founded on shallow corbelled brick footings. The platform (ground) level floor above appears to have been extensively reconstructed in reinforced concrete, cast on profiled metal decking.

The 'Bomb Gap' has been infilled with a single storey steel framed building with a duo pitched roof over the main space and a flat roof over the destroyed north east corner of the Old Booking Hall.

7.3.3 Proposed Structure

The LUL Northern Ticket Hall Vent is to be incorporated into the western section of the new 'Bomb Gap' infill building as a large reinforced concrete shaft with concrete dividing walls, providing the two exhaust and one air inlet ducts. The vent will be part of and be surrounded by a monolithic insitu reinforced concrete slab and framework infilling the 'Bomb Gap'. The new structure will be supported on piled foundations.

The NTH air duct steps up from the NTH mezzanine level of 106.950 AOD to a lowest level of 11 1.765 AOD within the Bomb Gap; approximately 2m below the adjacent OBS corridor. Works to secure the corridor through the Bomb Gap site will include strengthening of the existing ground floor slab over the corridor, infilling of openings in the corridor spine walls, and underpinning or otherwise retaining the foundation of the OBS western corridor wall which runs adjacent to and parallel with the vent shaft base piled raft slab, situated approximately 2m below the OBS corridor floor.

The new structure will be arranged around and bridge over the existing basement OBS corridor, which will be maintained in operation as a link between OBS areas to the south, and the North Wing and Old Parcels tunnel to the north.

Lateral loads, including wind loading on the building and the horizontal component of the main ribs, applied by the upper and lower bifurcated arch springings to the main flank wall stanchion support, will be resisted, (where required as part of the Network Rail Renewals Works), by the vent shaft acting in conjunction with the horizontal diaphragm action of the reinforced concrete floor plates.

The new structure will be designed to accommodate planned service risers and vertical circulation provision within the 'Bomb Gap' area. The shaft and the associated Bomb Gap structure is to be constructed as part of the Phase II LUL NTH works; and will be built as 'shell and core' for subsequent fit-out under the Network Rail Western Concourse Enhancement Works, including the construction of the facades and internal non-loadbearing walling.

The vent shaft terminates at roof level, with the exhaust shafts turned into the roof space as dormers, venting to the east side of the building. The inlet shaft will be cranked over to occupy part of the third floor construction before rising vertically within the roof space to vent from a vertical face through louvres set in the western roof slope. The area of the roof

affected by the vent will be constructed as part of the vent construction in reinforced concrete, with surrounding areas of the pitched and hipped roof framed in steel and clad as part of the later Enhancement Works.

The 'Bomb Gap' infill works will incorporate the reconstruction of the structure to the north east corner of the Old Booking Hall, including the reinstatement of the eastern section of the Old Booking Hall northern cross wall and the introduction of new floor slabs and roof structure.

7.3.4 OBS Basement Corridor

The OBS basement corridor, which runs the entire length of the present OBS facilities in the Western Range, is to be maintained in operation through the 'Bomb Gap' during the reconstruction works.

7.3.5 Retention of existing North Wing gable end bay structure during the LUL Vent/Bomb Gap works

(a) Prior to any Vent/Bomb Gap works being undertaken, temporary strengthening works would need to be undertaken to the existing North Wing gable end structure, under the LUL NTH Phase II Works.

(b) The extent of these works would be dependant upon the findings of the structural survey of the area, but are likely to include:

- Structural masonry infilling of the gable wall, or other measures to stiffen the 'gable'
- Underpinning of foundations, (particularly to the Western area of the gable end bay), affected by the excavation for the LUL Vent which is located approximately 3m from the gable.
- Strengthening of the isolated cruciform ground floor and basement masonry piers
- Tying-in of existing floors to walls
- Bracing of main train arch rib No.17 upper and lower springing points at First and second floor levels, back to adjacent cross walls. (The lateral support and other propping of the southern extension of the flank wall and springing points of the associated arch rib No. 16 (together with arch tying) would be undertaken as part of the LUL Bomb Gap works).
- The gable end and penultimate bay would need to be vacated prior to commencement of the adjacent works.

7.4 Northern Wing

7.4.1 General

The proposal to remove the top, fourth storey of the building to provide an elevation that incorporates the reconstructed 'Bomb Gap' structure to match the Southern Wing, is omitted.

Bomb damage occurred to extensive areas of the south end of the northern wing and significant structural damage and substantial wartime repairs remain evident. The extant 'gable wall' generally comprises isolated elements of loadbearing brickwork clad in metal sheeting on timber studwork.

The North Wing comprises four fill 6.0m bays (including the gable end bay) and one half bay of brick cross wall construction, intercepted by an off-centred corridor and twin spine walls. Much of the original spine wall construction has, in the past, been removed at ground floor level to the northern and penultimate bays, and an open area has always existed in the centre bay which accommodates the entrance hall and main hanging stone staircase. One intact spine wall remains, situated in the penultimate bay to the north of the staircase. The

floor construction comprises boarded timber joists to the front and rear rooms, and stone slabs to the central corridor.

Main train shed arch ribs 18 - 21 (Grids 20 -23) spring from flank wall piers which approximately coincide with cross walls within the North Wing.

It is proposed to demolish the end bay of the residual section of the north wing and replace the bay with a reinforced concrete frame and slab, monolithically connected to the 'Bomb Gap' infill structure to provide the open floor plan required as part of the architectural planning of the southern end of the north wing.

The works will require the retention of the Main Train Shed flank wall supporting a currently tied, roof arch: and include the proposed OBS basement entry from the Northern Ticket Hall into the reconstructed gable end bay.

Links through the structural bay to the north of the main staircase are to be formed at ground level and at concourse mezzanine level, and a new reinforced concrete framework is to be introduced to carry the new ground and mezzanine pedestrian links and to support original loss walled construction over. The mezzanine link will be constructed below the existing first floor level; and the first floor construction to the northern bay will be lowered to match.

7.4.2 North Wing Gable End Bay

Extensive alteration to the end bay of the North Wing abutting the Bomb Gap is proposed to accommodate a new basement OBS entry route from the west and a new stair core to the east as part of the Western Concourse Enhancement Works.

Bomb damage occurred to extensive areas of the North Wing; particularly to the Gable End Bay, where significant structural damage and substantial wartime repairs remain evident. The gable end bay structure was weakened as a result of the destruction of stiff intermediate cross wall construction to the south (forming the end wall of the former grill room) and the absence of walling on the line of the ground floor 'gable' which would otherwise act as shear panels to carry lateral loads at the end of the North Wing to the basement walling and foundations. The efficacy of the existing construction, including the action of the timber floor construction as a diaphragm, to accommodate and transfer main roof arch horizontal forces applied to the unbutressed main train flank wall of the gable end bay to the foundations, is uncertain.

Wall and ceiling linings conceal the condition of the gable end bay and adjacent areas of existing structure, and the efficacy and durability of wartime repairs. Whilst the gable end structure appears to have performed adequately in its weakened, altered and repaired state over the past sixty years the level of the performance under existing conditions, during adjacent construction works, and changes in loadings arising from the station roof Renewals Works is unknown. The structure is subject to investigation and appraisal as part of the LUL Vent/Bomb gap design and will include opening-up works to establish the nature of the construction and to enable the condition, and particularly, the extent of the residual damage and structural weakness, to be assessed.

The existing construction was part of a larger structural element and lacks the intrinsic structural integrity possessed by other bays which are defined by heavy cross wall construction coincident with main train arch ribs. The Western Concourse proposals include the demolition and reconstruction of the gable end bay as a reinforced concrete structure incorporated into 'Bomb Gap' construction.

The new works would be monolithically connected to the adjacent 'Bomb Gap' structure; to extend the open floor plan to the reconstructed 'Bomb Gap'.

The reconstruction of the gable end bay would be carried out in an area confined by the train shed wall, retained northern wing construction and LUL Vent1 Bomb Gap construction,

contained within a site approximately 7m wide by 15m deep. Access to the site would be from the west only, and depending on phasing, undertaken across the roof of the Northern Ticket Hall. The reconstruction work would form an early phase of the Enhancement works to accommodate the connection of OBS operations from the temporary location in the northern section of the shared services yard, through the NTH corridor to the existing OBS corridor within the Western range.

Light steel framed, timber deck mezzanine structures are to be constructed at ground level to the eastern area of the bay.

7.4.3 Platform and Mezzanine Bridge Links

The new ground floor and mezzanine bridge link require openings formed through the existing North Wing construction at ground and first floor level within cross walls to the bay immediately to the north of the staircase, between grids 21 and 22. The works will remove the remaining intact ground floor spine wall and two spine wall sections at first floor level; requiring the introduction of additional compensating stability frames into the building.

The removal of these ground and first floor spine walls to create the walkways will require the introduction of additional heavy structure within bay grid 21-22, and extending from high level 1 floor to foundation level, to carry existing 2nd, 3rd and roof construction within the bay. The works will include strengthening of the existing basement walling and foundations to carry the altered existing loading regime and loads applied by the new mezzanine bridge and ground floor link constructions.

The introduction of the new mezzanine bridge link within 21 and 22 comprises the reconstruction of the 1st floor, designed for crowd loading, approximately 1.2m lower than existing. The existing masonry cross walls on grids 21 and 22 (which have chimney breasts fronting onto the links) will require significant adaption and alteration to accommodate the change in geometry; and need additional lateral restraint to accommodate the increase in slenderness at first floor level.

Additional structure will be required to frame two storey openings formed in the front and rear (main train shed flank wall) facades of bay 21-22. The bridge link entrance design into the main train shed will take account of the arch ribs and main flank wall piers on grids 2 1 and 22; and allowance made for additional structure integrated into the historic fagade to accommodate the adjacent rib arch forces which were previously dissipated into the flank wall panel.

The condition, strength and suitability of the existing ground floor is to be appraised for crowd loading and allowance made for the replacement or strengthening of the floor construction to the link. Special strengthening measures may be required over the central basement corridor to allow the OBS operation to be maintained uninterrupted.

The lowering of the first floor of the northern bay (grids 22-23) to match the mezzanine bridge link level and extension to the North West Building public house will require substantial reconstruction of the first and ground floor internal structure to accommodate the change in level and the previous ground floor alterations.

The north wing was reported to have suffered serious wartime damage. The extensive structural alterations required to the existing structure which will accompany the formation of the ground and mezzanine links are likely to involve additional strengthening of repaired or weakened structural elements, which under the current loading regime and structural configuration are presently performing satisfactorily.

7.5 Old Parcels Tunnel

The proposed OBS route formed as a corridor within the NTH concourse slab to the Western Range includes the supplementary linking of the NTH ramped corridor to the extant south western end of the Old Parcels Tunnel situated to the west of the Link Building. This

provides alternative access to the goods lift to the northern end of the Western Range basement.

Part of the external section of the Old Parcels Tunnel currently houses an electrical plantroom.

The Old Parcels Tunnel currently runs at a level of 112.1 50 with headroom of 2.44m and will ramp up to the NTH corridor entrance level 1 13.160. To maintain the existing headroom, the roof of the tunnel, comprising a 350mm concrete slab reinforced with steel joists, will be removed and rebuilt in reinforced concrete with a maximum soffit level of 115,600; approximately 0.9m below ground level.

The reconstruction works within the tunnel will include the introduction of a 1: 20 ramp from the NTH corridor and requiring approximately 20m of the parcel tunnel roof to be reconstructed.

The end of the Old Parcels Tunnel aligns with the sheet piled safeguarded breakthrough provision in the NTH contiguous piled wall and the works would include a short 8m extension to the Old Parcels tunnel to complete the link.

8 Suburban Train Shed - Scope Of Works

The southern end of the Suburban Train Shed is to be extensively altered and works comprise the removal of the southern entrance and return walling, offices entrance roof and two bays of train shed roof construction.

The southern end of the suburban shed is currently stabilised by the stiff masonry gable to the concourse entrance, and it is proposed that stability of the southern end of the retained station structure is maintained by a stiff structural steelwork portal frame connected to the existing roof as part of the overall Suburban Station Renewals works.

In order to provide a clear link from the existing suburban platforms, nos. 9, 10 and 11, the existing last two roof bays will be demolished together with their supporting masonry walls. A new roof will be provided that will be a stand-alone structure between the remaining suburban roof and the new concourse roof. The perimeter will follow the façade lines of the existing Western range masonry walls, curve alongside the edge of the new concourse roof, with a nominal gap, and return northwards approximately along the projected line of the masonry wall to the west of the suburban shed.

The main part of the roof consists of a lightweight deck supported at a 1 in 60 fall on a grid of level east-west beams, the centres to suit the optimum deck span. Along the edge of the concourse roof a curved steel truss supports the roof edge. The roof deck falls will be formed by stooling up from the main steelwork. The stability of the roof structure is provided by two portals in the east-west direction and by concrete walls and columns in the north-south direction.

The two 600 thick concrete walls provided are parallel to the suburban platforms, one on either side, and are designed to carry any impact loading arising within the railway influence zone. The requirement to take account of railway loads will need to be confirmed before further development of the design. The infill roof to the east of the main roof, which protects the pub mezzanine below, falls away from the Western range on to the main roof. This will be glazed, also laid to a 1 in 60 fall, spanning between purlins stooled up from a level steelwork frame. As the horizontal stiffness of the roof glazing may not be reliable, the east frame against the Western range will be portalised above the mezzanine.

The floor to the pub mezzanine is provided by a composite concrete and steel structure. The framework is supported on one of the concrete walls along its west edge (See drawing S1002).

The two concrete walls at ground floor will be founded on piled strip footings and these will carry the main roof loads as well as resisting the railway impact loads (see drawing S1001). Other isolated columns will be supported on existing foundation structures wherever possible.

9 North West Building & Link - Scope Of Works

It is proposed that the ground floors of the North West and Link Building and the first floor of the North West building are upgraded for retail use. The existing level of the ground floor slab is also to be lowered to match the Link floor level and platform level. The ground slab is ground bearing in the North West building but is suspended within the Link building. The existing slabs are to be broken out and the slabs reconstructed at the required level. Site investigation will be required prior to demolition to determine the action of the slabs and appropriate temporary works installed to transfer any loads that the existing slabs may be supporting. The new slabs will be designed with an appropriate imposed load allowance to suit the change of use.

The first floor of the north west building is believed to consist of timber joists supported on masonry walls at the perimeter and wrought iron beams and columns arranged internally around the atrium void. Both timber and wrought iron spans are considerable. Significant strengthening works would be required to upgrade this area for retail use, which will included additional columns. The additional imposed dead loads would be taken into account in the general upgrading of the first floor structure.

The existing lift from basement level is to be upgraded and extended to serve all floors. The revised structural openings at ground, first and second floors will require additional trimming beams and supporting columns extending to basement level.

An on-floor plantroom is proposed at second floor level towards the northern end of the North West building. The existing second floor structure is of timber construction and partially suspended from timber roof trusses by wrought iron drop rods, of which a number have been severed.

The original structural configuration of the building which utilises the principle of the suspension of the second floor from the trussed roof, has been retained, but the roof structure and suspension system will be heavily strengthened and supplemented by new steelwork members to restore structural robustness and accommodate the imposed loadings associated with the proposed change of use.

The roof strengthening and structural enhancement works will be extensive and designed as 'reversible' to enable the existing timber structure to be retained in its original form. The second floor will be similarly strengthened to suit the change of use and upgraded to include fire and mitigation of noise and vibration requirements.

Additional service risers will be required through the first and second floors and roof. These will require the addition of local trimming beams around the openings.

A new circulation route is to be provided at ground floor level through the stiff stair core bay to the north of the North West building. Additional openings will be required through the two substantial masonry crosswalls either side of the existing staircase. The action of this part of the building is important in terms of overall stability and containment of the main train shed roof arch thrusts due to the inherent 'weakness' of the central section of the north west building. The openings would need to be trimmed with stiff 'picture frames', such as concrete encased steelwork with moment resisting foundations, to maintain the overall stiffness of the walls.

Provision of an enlarged skylight through the roof over the atrium would require careful consideration in relation to the performance of the timber roof trusses and their stability. Structural trimming will be required around the new opening and additional bracing may be required to maintain the stability of the roof trusses. The location and size of the roof light will be governed by the existing location of the roof structure. The roof covering is currently felt and has probably replaced an original slated roof. Renewal of the roof covering would

need to be considered in the overall structural design in terms of the dead loads applied to the roof structure

A previous report on the findings of the preliminary structural appraisal desk study of the North West and Link Buildings includes a review of the stability of the buildings; and the possible reliance for a degree of lateral stability on neighbouring buildings, resulting from the loss of stiffness by the progressive removal of cross walls within the ground floor area of the buildings during the late 19'~an d first half of the 2oth Century, and due to the original structural configuration of the North West Buildings.

Substantial stability systems, comprising horizontal bracing to suspended floors, and braced and portal vertical framing are to be installed as 'reversible' elements to restore calculated required stiffness and stability to resist horizontal loadings (including Main Train Shed arch thrust) without reliance on any contribution from the presently connected stiff northern section of the Suburban Shed, which is to be removed as part of the Stage D Enhancement works.

The two southern bays of the Link Building are to be altered and works will include the lowering the existing basement floor and the introduction of lift shaft E, and a staircase. The works are required to enable goods from the shared Services Yard to be delivered, via the western end of the Old Parcels tunnel, to the new lifts within the Link Building; and the existing Link building basement needs to be lowered approximately 1.45m to match the tunnel level of 112.1 50 ATD

The proposed alterations will involve very extensive ground and temporary works and will constitute a major and complex area of construction. The work will be undertaken in confined areas and will include the modification of structure already previously altered; principally in the 1930's.

The works will include extensive underpinning, involving excavations to depths of up to 3.75 m below existing basement level. Underpinning to the perimeter walls and retained internal wall will comprise traditional mass concrete, with pins installed in a predetermined sequence and dry packed. Brick corbelling and projecting concrete footings will need to be removed on faces where the line of the existing wall is to be retained over the lowered depth. The works will include extending the existing walls in engineering brickwork or shuttered concrete from pin foundations, with the work being undertaken as part of the general underpinning sequence. All underpinning and other excavations will be shored and propped; and excavation to underpinning will include access trenches.

10 Northern Building - Scope Of Works

There is only limited impact on the Northern Building structure, arising from the Renewal proposals, with alteration works principally restricted to the provision of corridor openings through the western section of crosswalls. The formation of the openings is routine in nature with the support presently being provided by the load bearing walls being replaced by a steel box frame designed to provide both vertical support to the walls above and lateral support to wind and stability forces, together with thrusts from the main train shed roof. The frames would also be designed to provide local lateral support to the west flank wall of the building.

Local strengthening of timber floors will be required to:

- Rectify and repair decayed, damaged, deteriorating or defective wall plates, bearings joints and in some instances, individual timber elements
- Upgrade the strength of timber bearings, joints and elements as necessary to satisfactorily support the new loading conditions, or to rectify a previous inadequate structural performance where no change of use is proposed.
- Improve the stiffness in excessively springy floors.

11 Parcels Yard Infill Building - Scope Of Works

The Parcel Yard Infill Building comprises the first floor extension to the Public House located within the adjacent North West Building and situated between the Suburban Train Shed and the North West Building on an area of land previously used only as an open yard.

Vaulted brick basements exist to the east of the site, but the ground has otherwise not been used to accommodate or support railway structures. The land was developed for housing prior to 1852 and may contain shallow basements and foundations, although much of the area would have been disturbed during the construction of the Western Buildings and later Suburban Train Shed.

The building is now to be structurally linked to the reconfigured roof structure to the southern end of the Suburban Train Shed.

12 Service Duct Under Platform 8

The service duct under Platform 8 replaces that section of the western service tunnel (the 'rat- run'), which is demolished as part of the 'Bomb Gap' works. The duct occupies part of the redundant below platform.

Gentleman's Toilets, which were originally constructed in the 1930's; and the remaining section of the original lightwell to the basement areas of the eastern faqade of the Western range.

The adjacent OBS tunnel, proposed under Stage C, is omitted.

The duct is approximately 1.5m wide with a minimum clear height of approximately 2.15m , with the western perimeter defined by the basement flank wall of the main train shed. The western (track side) walling comprises dense concrete masonry within the redundant Gentleman's Toilet block and reinforced concrete lined contiguous mini-piled walling to the north of the toilets. The works include the provision of new precast concrete and insitu reinforced concrete platform slabs.

The level of the original lightwell floor (approximately 1 14.1 50 ATD) within the Gentlemans toilets will be maintained to avoid undermining the adjacent Main Train Shed flank wall; and thus the need to underpin the foundations solely to accommodate the duct.

The duct breaks out from the northern end of the redundant toilet end wall. The tunnel would pass under, and support the columns to the existing main train shed overbridge and access stair on platform 8; and involve extensive and complex underpinning and temporary works. However, the adoption of the proposal to replace the existing overbridge with a new bridge relocated one bay to the north, would permit the new support to bridge at Platform 8 to be integrated into the tunnel design and reduce the complexity of the works.

The duct will break through the 1.2m thick concrete side wall of the southern spur of the Old parcels tunnel over a length of approximately 2m. The roof of the spur, which is supported on the wall, comprises 350mm insitu concrete reinforced with steel joists and the works would include the local removal of the spur roof construction and platform construction above and the reconstruction of the roof as part of the platform over the reconfigured duct entrance into the Old Parcels Tunnel. The work would extend to the face of the east (main train shed flank) wall of the North Wing and require the closure of the adjacent Goods Lift operation during the construction.

The eastern (track side) contiguous piled and lining walls of the new duct within approximately 5.5m of the platform edge and these works together with the works associated with the north spur break through require the partial closure of Platform 8, with the works carried out under Platform 8 possession.

13 OBS Storage Existing Gentlemen's Toilet: Platform 8

The existing Gentlemen's toilet is located below platform 8, within an existing masonry and concrete chamber constructed in the 1930's. The toilets will be relocated as part of the Enhancement works, and the chamber used as an OBS storage facility.

The level of the existing lightwell floor at approximately 114.150 ATD adjacent to the Main Train Shed flank wall will be maintained and used as part of the new service duct. The existing, piered, separating partition wall supporting the platform was replaced with a new steel frame founded on a reinforced concrete foundation forming a continuous step in construction between the service duct and the existing chamber floor slab of 113.140.

The new opening through the Main Train Shed flank wall will be formed from the rear of the basement of the Old Booking Hall to allow access into the chamber from the Western Range OBS basement corridor; and a ramp from the entrance formed within the chamber to connect the Western Range basement floor of 113.700 with the existing 113.140 floor level of the chamber.

14 Southern Staircase

The Southern staircase and lift core are located to the south of the Western Range in an area currently occupied by NR plantrooms below the King's Cross Southern Concourse Travel Centre. The stairs and lift will be accessed from the NTH/TTH passageway to the west.

The works are now omitted from the Enhancement project and are to be designed and constructed by LUL (Metronet) under an early stage of the NTH Phase I works.

15 OBS Large Platform Lifts

15.1 Existing Construction

15.1.1 Main Train Shed Spine and East Flank Walls

Spine Wall (General)

The central spine of the main train shed runs for the full length of the trainshed along the centreline of island Platforms 4/5. The spine is pierced by arched openings between substantial masonry piers at 6096mm centres supporting the twin semi-circular main train shed roof arches. The central and southern areas of the train shed are longitudinally stabilised by discrete masonry spandrel panels and to the northern end of the building the panels become continuous. The discrete panels are arranged in pairs and support 12.2m span masonry arches carrying roof arch reactions over omitted masonry pier locations. Roof arch loads are similar under dead load conditions and thrusts balanced at the central spine.

The spine wall foundations comprise brick corbelled footings on continuous concrete strip foundations founded approximately 4.25m below platform level.

The support of the spine wall in the vicinity of the Old Parcels Tunnel was substantially altered as part of the tunnel construction works, with the masonry piers and associated spandrel underpinned and supported at platform level on needles and twin girders. The girders are supported on a 2.75m deep by 3.35m mass concrete pier formed in the southern wall of the tunnel, and on a box girder spanning between existing lift mass concrete side walls to the north.

East Flank Wall

The wall forming the eastern flank wall of the train shed adjacent to platform 1 originally comprised substantial masonry columns separated by masonry arches, supporting a heavily trussed and pitched cab roof and the eastern shed roof arch ribs. The roof to the cab road was removed at the end of the 19th Century and the walling extended by the construction of two storeys of office accommodation to form the Eastern Range. The insertion of a steel framed mezzanine, under the Eastern Range and fronting platform 1 was undertaken mainly in the 1950's.

The foundations to the piers comprise corbelled brickwork on concrete foundations, which extend between the piers to support inverted masonry spandrel arches. The foundations are situated approximately 4m below platform level.

The Old Parcels Tunnel terminates to the west of the foundations; and the original lift shaft (now an escape stair) built between adjacent, underpinned column foundations.

15.1.2 Old Parcels Tunnel and OBS Below-platform Lift Shafts

A tunnel, linking the old parcels office to the west of the main station with the Eastern Range, was constructed in 1939. The tunnel is situated below the southern end of the Link building, immediately to the north of the end bay of the Western Range, and runs under the tracks and platforms to the face of the main train shed East flank wall at a level of approximately 112.150 ATD. The tunnel, with approximately 2.3 metre headroom, is constructed with mass concrete and brick sidewalls (up to 1.2m thick). The walls support a heavy, deep filler joist insitu concrete roof under platforms and precast filler joist slabs under track beds; and utilise 300mm deep RSJ sections at approximately 600mm and 400mm centres respectively. The roof is set approximately lm below the main shed track level.

The section of tunnel skirting the end of the Western Range basement and running eastwards under the main station tracks towards Platform 1 is connected to the central basement corridor of the Western Range and used for the distribution of On Board Services (OBS). The tunnel construction included the provision of four lift shafts serving the island

platforms comprising two accessed through openings to the southern wall of the tunnel to platforms 2/3 and 6/7, one shaft accessed via a spur chamber formed in the northern wall of the tunnel under platform 5/6 and a shaft at the eastern end of the tunnel serving platform 1. (See 3.1.2). The pits extend approximately 1.2m below the tunnel floor and adjacent foundations to the historic building.

Apart from the lift to platform 2/3 the lift shafts are redundant with shafts to platforms 4/5 and 6/7 sealed and capped and the shaft to platform 1 converted to an escape stair.

15.1.3 Platform Construction Over Old Parcel Tunnel and Spurs

The platform was reconstructed following the completion in 1939 of the Old Parcels Tunnel. The construction is believed to comprise asphalt finished precast concrete planks spanning approximately 2.1m between 215mm brick sleeper walls built off the roofs of the tunnel and spurs. The platform walls comprise either 225 thick brickwork or horizontal precast planks built into terminating crosswall piers.

15.2 Existing Below Platform Shafts/Pits

The existing concrete shafts below platforms 2/3,4/5 and 6/7, which are constructed as spurs from the Old Parcels Tunnel, are to be retained and reused without substantial structural alterations.

Works will include breaking out of sealing walls, and platform level and lift pit caps; and the removal of pit filling material.

The shafts to platforms 2/3 and 6/7 carry the support structure to the new escalator walkway, which is to be integrated with the OBS lift shaft superstructure.

15.3 New Spur Shaft Below Platform I

The new shaft below platform 1 carries the support structure to the new escalator walkway serving the new overbridge and the design is to be integrated with the walkway support structure, lift shaft superstructure and the platform renewals.

15.4 Platform Lift Design and Construction

15.4.1 General

The installation of the spur lift shaft to Platform 1 represents major temporary alteration and new constructional works.

15.4.2 Design

Any short-term ground movement effects on the adjacent tracks during the excavation of the lift shafts are to be assessed as part of an detailed design stage.

The shaft substructure is to be designed to resist surcharge loading resulting from train loading on adjacent tracks.

The head of the substructure eastern wall to the lift shaft to Platform 1 is to be stiffened by a reinforced concrete apron, constructed at platform level and spanning horizontally between the northern return wall of the shaft and the existing Old Parcels Tunnel to limit ground movements which may affect the adjacent eastern flank wall foundations; and resist and disperse additional local horizontal loading effects on the lift side wall arising from Platform Y construction and existing eastern flank wall foundation loads.

15.4.3 Enabling Works

Allowance should be made for the diversion/rerouting of existing services running parallel and within the platforms; and those services running transversely under tracks in the area of the works. The protection and where necessary the diversion of services within the Old Parcels Tunnel should also be taken into account.

Allowance should also be made for the reconstruction of platform areas and associated supports adjacent to the sites of the platform lifts, prior to the commencement of the lift shaft works.

15.4.4 Platform 1 Lift Construction

15.4.4.1 General

The following elements of the existing construction affect the location of the lift or potentially affect the design and/or construction:

Masonry columns forming the eastern flank wall of the Main Train Shed

The new platform lift shaft runs adjacent to, and parallel with the corbelled footings and inverted arches of the eastern flank wall foundations. The location of the shaft with respect to the masonry columns is determined by the requirement to avoid disturbance and underpinning of the existing foundations, mitigation of surcharge pressures on the shaft retaining walls and provision of sufficient clearance between the shaft superstructure and masonry columns such that the movement of passengers is not unduly restricted.

Platform Y Works.

The timing and sequence of works for Platform Y would need to be coordinated with those for the platform 1 lift to ensure that design assumptions are not locally compromised by the prior construction of the platform lift shaft.

The design of the platform lift shaft would need to take into account any local short-term heave effects on the existing masonry foundations during the construction of the shaft and the any cumulative effect with ground movements attributable to Platform Y. The lift shaft design and construction sequence and method would need to be arranged to ensure that ground pressures and factors of safety adopted for a previously constructed Platform Y, are maintained.

Piling

A contiguous piled outer wall to the new substructure shaft and spur would be installed from rebuilt or temporarily strengthened platform level, by mini-pile rig.

Ring Beam

An initial section of the reinforced concrete ring beam would be constructed at platform level and monolithically connected to the contiguous piled wall. Temporary connection would be made to an infill suspended 'knock -out' slab acting as stiffening and protection and which would be retained until the construction of the reinforced concrete lining wall is completed.

Underpinning Works

Allowance should be made for site investigation works and the underpinning of existing tunnel wall foundations adjacent to new openings.

New Tunnel Level Lift Entrance

The tunnel roof is to be temporarily supported by heavy duty props at the proposed new entrances, existing 1.2m thick masonry and mass concrete walling broken out, walling reveals strengthened or rebuilt as required and new structural steel roof beams over entrances installed and connected to platform level ring beams.

Excavation

The lift pit to Platform 1 is located approximately 2.5m below the formation level of the eastern flank wall and an unknown depth below the associated mezzanine footings. Additional propping and more complex sequence of construction will be required to safeguard the foundations.

Spoil to be excavated from the newly created entrances in the south sidewall of the tunnel, with horizontal propping between the contiguous piled caisson sidewalls installed as excavation into the side of the caisson proceeds.

Spoil would be removed through the newly created entrances and through designated haulage routes within the Old Parcels Tunnel.

Reinforced Concrete Works.

Reinforced concrete lift pit and lining would be constructed from tunnel level against the contiguous piled walls; and subsequently monolithically connected to the ring beam at platform level in sections, following the sequential removal of the platform level 'Knock-out' panel (see Piling above).

Other Works

The Platform Renewal works will include the reconstruction of the platforms and associated supporting structure around the area of the lift, bridge link and escalator supports. Allowance should be made for the diversion/rerouting of existing services running parallel and within the platforms; and those services running transversely under tracks in the area of the works.

16 Platform Overbridge

16.1 Existing Construction

The present overbridge was constructed by A Handyman & Co in 1893 giving access between the East and Western Range offices; and spanned between platforms 1 and 8; with intermediate support on platforms 4/5 and 2/3. The primary bridge structure comprises twin braced upstand lattice girders supporting the bridge deck to the bottom flanges of the girders. The lattice girders to the western side of the station span uninterrupted between platform 8 and the central platform (4/5) and are deeper than those to the shorter spanning eastern sections of the bridge which have an intermediate support. An early photograph of the western span of the bridge shows the deep girder section currently existing.

It is believed that both sections of the bridge are original, comprising wrought iron girders with cast iron columns, arranged as a cluster of four at each support. The bridge survived the bombing in May 1941 when part of the adjacent North Wing of the Western Range was destroyed but the western section may have been partially rebuilt.

Apart from the closure of the lattice between the girders either side of the platform 2/3 staircase positions and changes to the platform 1 staircase, the eastern section of the bridge appears unaltered.

The western section of the bridge lattice girder contains a central section of lattice panelling, the top flange of which is unbraced. A contemporary photograph of the bridge suggests that the design of the bridge may have allowed for the formation of an opening to accommodate a future island platform and staircase; or otherwise was heavily modified to accommodate future intermediate staircases to both north and south. The southern lattice girder is propped by two steel riveted compound stanchion sections installed to support the severed girder as part of the accommodation of the new city end stair in 1939. The northern girder continues as a full span between platform 8 and 4/5 with its top flange unrestrained by a curved brace over the central section.

Network Rail has confirmed that the bridge passed its structural assessment and can take an imposed loading of 5 kN/sq m. They have noted that the cast iron stairs are cracking and that the cast iron treads should be replaced with steel. NR has further noted that concrete on the underside of the deck is beginning to spall.

16.2 New Overbridge

16.2.1 Existing Condition

The existing platform overbridge is located one arch bay south of the proposed new location.

16.2.2 Location

A new platform overbridge, linking the eastern and western range is proposed to replace the existing overbridge and will provide access to all platforms (1 to 8) and incorporate new escalators and lifts for mobility impaired persons (MIP).

The new bridge is proposed to be located south of the existing bridge and will align with the concourse mezzanine level link bridge. This alignment will provide for an unimpeded pedestrian flow from the concourse retail area to the platforms.

16.2.3 Structure

16.2.3.1 General Arrangement

The main overbridge decks span between run-off piers. The run-off piers are structures in the middle of each platform which provide access from the main overbridge, which runs east-west, to the escalators on the northern side and the MIP lifts on the southern side.

The main overbridge has an internal width of 3.0m between glass balustrades. The run-offs which lead to escalators and lifts have an internal width of 2.5m. The glass balustrade will have a height of 1.8m above finished floor level.

There are four spans over the tracks spanning between run-off piers. The spans vary between 10.0m and 12.5m. The five run-off piers are structures with 15.3m length, supported on a central column and two pairs of outer columns at either end.

Finished floor level of the bridge is proposed as +121.30m. Platform level is generally taken to be +116.60m throughout.

At this stage the planning of the proposed access staircase from the over bridge to platform 1 and Eastern Range building is not available for incorporation into this report.

16.2.3.2 Deck

The bridge decks are proposed to be steel decks consisting of longitudinal edge beams with a transverse spanning stiffened deck plate. The longitudinal edge beams are hot rolled square hollow sections. The transverse stiffener plates are spaced at 500mm centres.

The central run-off deck to platforms 4 and 5 has a reduced internal width due to its proximity to the existing central spine wall that separates the two sheds of the station. The cantilevering part of the deck between the existing brickwork spine wall is enclosed by rectangular hollow sections which provide support for the glass balustrade.

The proposed deck will have 50mm Chinese granite finishes.

All edges are fitted with a 1.8m high glass balustrade which is fixed to the longitudinal edge beams.

16.2.3.3 Columns

The run-off pier decks are supported on steel columns which are integral with the deck. There are two sets of square hollow section columns on either end of each run-off pier. In the centre there is also a circular hollow section column.

It is proposed that the end column adjacent to the lift will also form part of the lift enclosure and provide support to the escalators.

16.2.3.4 Foundation

Foundations for the steel columns are provided underneath platform level in form of mass concrete pad foundations. The foundation extends 500mm into the underlying clay strata. Escalator – and lift pits which also support the bridge are reinforced concrete structures with mass concrete pad foundations underneath.

On platform 1 there will be a new lift pit required for the new OBS lift (see section 4.20).

At locations where there are existing foundations for the central spine wall in the ground a special “bridging” foundation for the bridge columns will be introduced. This will be in form of a horizontal reinforced concrete beam which supports the column above the existing foundation and which is supported on pad foundations on either side.

At locations where the existing parcel tunnel is located underneath the proposed bridge foundation a horizontal reinforced concrete cross beam will be introduced which supports the bridge columns and which is bearing on the existing parcel tunnel walls.

16.2.4 Proposed Construction Sequence

After constructing the mass concrete foundations and reinforced concrete beams the 5 run-off piers on each of the platforms will be built. This can be undertaken while the OLE wires are still in position.

It is proposed that the foundation works will be undertaken during the platform renewals replacement works.

The main bridge spans can be prefabricated and delivered to site by rail. For the installation of the main spans the OLE wires will have to be temporarily removed. A mobile crane will be required to lift the main spans into position during an overnight possession. Due to the simplicity of the pinned and sliding pinned connection with the run-off piers the installation process will be straight forward and quick.

16.2.5 Related Works

Prior to the installation of the run off piers it will be necessary to remove the existing platform bridge and relocation of the OLE support frames.

The removal of the existing bridge will also require relocation of existing signals and communication cabling.

The enabling works and sequencing of these related works is outside the scope of this report.

The structural analysis for the scheme design has been carried out with a 3D linear elastic space frame model.

17 Structural Remedial Works

A schedule giving a preliminary assessment of remedial work has been prepared and includes the following

- Repairs attributable to LUL NTH and TTH works
- Major strengthening and reconstruction works associated with works to the southern end of the Western Range northern wing and North West Building
- Works associated with the alteration of existing buildings

The works are to be undertaken in order to restore the buildings to a sound and serviceable condition.

The schedule has been derived from the general knowledge of the building gained from walk-round inspections and in order to refine the schedule, it is proposed under the next stage of work to carry out opening up inspections and intrusive investigations.

The extent of repair works established by preliminary and detailed site investigation will be further evaluated and appraised during the opening up of the structure as part of the initial enabling works to the main contract.

It is proposed that repair and strengthening work is to be carried out to a principle of minimum intervention and where possible, on a 'conserve as found' approach using reversible strengthening details. Elements will be appraised individually or as groups of similar detail and defect, as appropriate, to determine the necessity and scope of remedial work. Repair work will be undertaken to historic restoration standards.

In view of the listed building status, proposals for repair will be discussed and agreed with English Heritage.

The work will include specialist surveys for items such as timber grading and infestation, asbestos, brick and mortar strength, metal strength and quality and moisture content.

18 Construction Sequences And Temporary Works

18.1 General

The close proximity of construction works to the NTH structure and other existing structures, the requirement for deep excavations and the extensive internal alterations will severely restrict site operations and require careful planning of the construction sequence.

The requirement to reconfigure the superstructure of buildings will involve the design and installation of temporary support, while work to extend and lower basements will involve underpinning and strutting and propping of excavations.

18.2 Underpinning

Wherever basement floor slabs are to be lowered to an extent that they would reduce the bearing capacity of the buildings foundations then the foundation of these walls will need to be underpinned. Particular situations in the Western Range where this situation applies include:

- The lowering of the basement to the Link Building
- The formation of the new OBS link tunnel to the Western Range North Wing.
- The construction of new lift pits within existing buildings

Where possible, underpinning would comprise traditional mass concrete underpinning constructed from local excavations in a planned sequence.

In many situations however, the requirement for underpinning is required in parallel to the requirement to support additional loadings. In these situations underpinning involving the construction of piles adjacent to existing walls with new pile caps and ground beams being constructed below the existing foundations. Where the proposals involve reducing the ground level on one side of the wall so that out of balance earth pressure will occur, new reinforced concrete lining walls will be provided to support the out of balance forces. In this situation temporary strutting and propping across excavations will also be required.

In situations where areas of the existing buildings that are to be underpinned occur next to areas that do not require underpinning, the possibility of damage due to differential settlement exists. In order to avoid this damage, run-out beams will be provided to give a transition between the deep and the shallow foundations.

18.3 Superstructure Reconfiguration

The reconfiguration of the building superstructures requires the removal of internal loadbearing walls and the installation of new structural elements to replace the support they were providing. In order to make the transition from the existing arrangement to the new, an extensive system of temporary works will be required. Conventional construction methods would involve the insertion of steel beam needles through existing walls, supported on steel props. These would be designed to carry the loads from the existing construction while the new structure was being constructed below.

Final pinning up of the new construction to the existing may in certain situations, involve the use of flat jacks to ensure that positive support is provided before the temporary props are removed.

As an alternative, proprietary systems (e.g. 'Pynford' type beams) exist whereby steel stands are inserted into walls around which reinforced concrete beams are constructed. These methods generally reduce the congestion caused to the site by temporary props.

18.4 Main Train Shed Arch Stability

The accommodation of horizontal forces to the existing superstructure, arising primarily from the horizontal component of arch thrusts must be provided at each stage of the construction to maintain the existing equilibrium and geometry of the main train shed arches. Temporary measures should include:

- Introduction of 17 No temporary ties installed across both bays of roof arches affected by the works.
- Provision in all temporary propping and restraint arrangements for the introduction of calibrated jacking and monitoring systems to enable the degree of applied restraint to be controlled and varied as construction proceeds.

18.5 Monitoring of Movement

In order to ensure that the sequence and methods of construction are not causing undue movement to the existing buildings and structures, a comprehensive system of monitoring will need to be installed and maintained throughout the construction period. This would be designed to give an early warning of movements occurring which differs from those predicted, allowing remedies to be made at an early stage.

Monitoring of the works are required to:

- Check that the behaviour of the structural elements and ground conditions comply with design assumptions
- Determine ground movements in the vicinity of the works
- Check the performance of the temporary works and determine any required modifications
- Determine the direct effects of the construction works on the existing building and the effects of related ground movements

The monitoring works will include condition surveys, basement 'mortar course' surveys and 'baseline' movements associated with the pre-construction state and the competition of the construction works. The baseline' monitoring will also be used to correlate the existing condition with historical movements.

Results are to be monitored against trigger and action levels established as part of the global monitoring regime.

Local monitoring of the completed structural works is to continue until all settlement and movement due to the works has effectively ceased for a period of three months.

18.6 Outline Sequences of Construction

18.6.1 Link Building: Lowering Of Basement; Lift Shafts And Staircase

18.6.1.1 General

This section covers the outline sequence of construction for lowering the existing basement floor of the Link Building and introducing lift shaft E, and a staircase into the two northern most bays of the building.

The works are required to enable goods from the Shares Services Bay to be delivered, via the southern end of the Old Parcels tunnel, to the new lifts within the Link Building; and the existing Link building basement needs to be lowered approximately 1.45m to match the tunnel level of 1 12.150 ATD.

The proposed alterations will involve very extensive ground and temporary works and will constitute a major and complex area of construction. The work will be undertaken in confined areas and will include the modification of structure already previously altered; principally in the 1930's.

The works will include extensive underpinning, involving excavations to depths of up to 3.75m below existing basement level. Underpinning to the perimeter walls and retained internal wall will comprise traditional mass concrete, with pins installed in a predetermined sequence and dry packed. Brick corbelling and projecting concrete footings will need to be removed on faces where the line of the existing wall is to be retained over the lowered depth. The works will include extending the existing walls in engineering brickwork or shuttered concrete from pin foundations, with the work being undertaken as part of the general underpinning sequence. All underpinning and other excavations will be shored and propped; and excavation to underpinning will include access trenches.

Perimeter walling to the north act as a gravity retaining wall, upholding soil to 116.600ATD. The increase in depth of the basement may require strengthening of the wall and allowance should be made for extra works to the rear of the wall to accommodate the additional depth of soil.

The southern wall adjacent to the Old Parcels Tunnel is already partially underpinned as part of the introduction of the parcels tunnel in the 1930's and would need to be completed from the Link basement side. The existing tunnel wall foundations incorporate grillage and other foundations carrying structural steel frames supporting first floor Link Building superstructure. These foundations are likely to intrude into the proposed lowered basement area and will require a detailed structural study to establish the extent of their impact on the proposed scheme.

Permanent flat jacks will be used to adjust loads into new foundations from existing stanchions and control movements in the existing superstructure.

Excavation for underpinning and new foundations will be undertaken in stiff London Clay. Allow for creation of sumps and pumping of water encountered in made ground, just above the interface with the London Clay.

Outline Sequence of Construction

(1) Generally needle and prop the existing ground floor frameworks from 1st floor through to existing basement level.

(2) Underpin wall [L 124-251]. Backfill to existing basement level and remove propping to frame over.

(3) Underpin wall [25/L-MI]. Backfill to existing basement level

(4) Underpin wall [GI24 - 25+]. Backfill to existing basement level.

(5) Temporarily support existing column [G/25+] and associated steelwork at 1 16.600ATD level. Underpin existing masonry foundation. (Allow for grouting rubble masonry infill prior to underpinning).

(6) Underpin northern wall [26/G-L]

(7) Support existing stanchion 5/25 on temporary cross support steelwork spanning 8m at Wl basement between underpinned walls [G/24-25+] and [L/24-25+]. Expose existing steel grillage foundation. Undertake alteration to base of existing column including site welding. Excavate for and construct new foundation. Install and commission flat jacks.

(8) Partially underpin existing crosswall [24/G-MI] against wall of Old Parcels Tunnel. Cut back existing corbelled foundations.

(9) Needle existing ground floor wall [15/24-25] and support existing ground floor [J-L/24-251] with temporary steel beams spanning 8m at h/l basement between underpinned walls [G/24-25+] and [L/24-25+]. Demolish ground floor slab [G-J/24+-251]. Excavate and shore/prop for lift pit E (approx. 3.75m below existing basement level. Construct foundation/ lift pit to 111.850ATD.

(10) Needle existing ground floor wall [J/25+] and support existing ground floor [J-L/25+] with temporary steel beams spanning 8m at h/l basement between underpinned walls [G/25+] and [L/25+]. Demolish ground floor slab [G-J/25+].

(11) Reduce basement level approximately 1.75m to approx. 111.850ATD. Construct new basement level slab.

(12) Construct lift shaft E and associated walling to ground floor 116.600ATD, including pinning new construction up to existing masonry over and incorporating [J/24] grillage foundation into lift shaft construction. Remove temporary support beams.

(13) Construct staircase from 112.150 - 116.500ATD

(14) Install new ground floor steel beams and ground floor reinforced concrete slabs.

(15) Prop Old Parcels Tunnel roof slab locally around [24/J-L]. Enlarge opening into Link basement and install new lintels in sequence to ensure construction over is continuously supported.

(16) Install new ground - 1st floor stanchions proppinglaligning with existing 1st floor steelwork. Dismantle temporary steelwork (see (13) above)

(17) Demolish timber 1st floor construction to area [G-5124-24+]

(18) Install new E lift shaft steelwork to 1st floor.

(19) Construct new reinforced concrete 1st floor slab and ground-1" floor staircase.

(20) Remove timber 2nd floor [G-J/24+-25+] and prop and trim timber to [G-J 124-24+].

(21) Remove timber floor to mezzanine and 3rd floor areas [G-J /24+-25+] and form opening in h/l 3rd floor ceiling [G-J/24+-25+].

(22) Erect shaft steelwork, and where applicable new floor beams, and lift E (1" - 2nd)

(23) Construct reinforced concrete slabs and stairs to 2nd floor [G-J/24 -25+] and mezzanine, and 3rd floor high level [G-J/25+].

(24) Prop and strengthen timber floors [L-W24- 261], form openings, install new steelwork and trim timber to 1st, 2nd 3rd floors.

18.6.2 Platform 8 Service Duct

18.6.2.1 General

This section covers the outline sequence of construction for forming a service duct under Platform 8, linking the Central Block and southern spur of the Old Parcels Tunnel. The tunnel replaces that section of the western service tunnel (the 'rat- run'), which is demolished as part of the 'Bomb Gap' works.

The tunnel occupies part of the redundant Gentleman's Toilets, which were originally constructed in the 1930's; and the remaining section of the original lightwell to the basement areas of the eastern façade of the Western range.

It is assumed that platform construction to the north of the Gentleman's Toilet block is original, comprising York Stone slabs on arched sleeper walls.

The tunnel breaks out from the northern end of the redundant toilet end wall and undermines the foundations of the station over bridge and access stairs; and will provide new support to both when completed. The tunnel will break into the 1.2m thick concrete splayed side wall of the southern spur of the Old Parcels Tunnel.

The level of the original lightwell floor will be maintained to avoid undermining the adjacent Main Train Shed flank wall; and thus the need to underpin the foundations solely to accommodate the duct.

It is assumed that the existing overbridge is closed and removed, and foundations to the new overbridge installed prior to the commencement of the works.

The new Gentleman's toilet in the Northern Building are to be completed and opened prior to work commencing on the alteration of the existing Toilet Block.

The sequence assumes that provision is made for access to the suburban train shed externally prior to the restriction of the platform width to the east; and that the impact of closing the footbridge on the King's Cross Emergency Plan (particularly the Eastern and Western Ranges) is assessed and accommodated.

Outline Sequence of Construction.

(1) Erect platform hoarding.

(2) Locally break out western area of platform behind the line of the contiguous piled wall, breakdown existing arch, construct new mass concrete piers and associated platform slab for use of a piling platform.

(3) Install contiguous mini piled wall between grids 23 and 19.

(4) Backfill between piles and plinth. [See (j)]

(5) Progressively open up existing platform construction southwards from grid line +23 to 22- in approximately 2m sections; at each stage undertaking the works in (6) below

(6) Install twin horizontal props between the main flank wall and the contiguous piled wall at approximately 115.800 level.

- Demolish arched sleeper wall
- Excavate made ground adjacent to existing flank wall and construct concrete back blinding to new strip foundation
- Construct reinforced concrete strip foundation1 retaining wall and slab at 114.150 ATD, including installation of reinforcement couplers for extension to next section

(7) Repeat (4) between grids 20 and 1 9.

(8) Complete excavation, blind and construct 113.140 ATD slab and kicker to lining wall between grids 22 - 21 and 20 - 19; including contiguous pile capping beam and incorporating cross beam bearing pockets.

(9) Install remaining steel framework grids 23 - 19.

(10) Progressively break through 1.2m concrete splay wall to Old Parcels Tunnel spur, installing lintels. Make good reveals.

(11) Excavate and construct staircase and ramps to northern end of tunnel

(12) Construct new insitu concrete platform slab between grids 21 and 19. Remove temporary horizontal props.

(13) Reopen platform between grid 23 and 19 over full width.

(14) Close eastern half of Platform 8 over roof of Gentleman's Toilets between grid 19 and 13. Erect hoarding, maintaining 3 .0m clearance to the platform edge.

(15) Remove existing platform construction to western section of platform between grids 19 and 13.

(16) Prop existing cross beams supporting platform over redundant Toilet Block and demolish existing piered brick walling.

(17) Excavate made ground adjacent to existing flank wall and construct concrete back blinding to new strip foundation and constructing reinforced concrete strip foundation/ retaining wall and slab at 114.150 ATD. Reinstate 113.140 ground slab and construct ramp.

(18) Install new steel frame, including insitu connections to existing platform beams. Remove props.

(19) Breakthrough basement main flank wall grid 13-14, and install lintels to form entrance into service tunnel.

(20) Reinstate platform using precast concrete slabs; construct non-loadbearing wall.

(21) Remove hoarding and reinstate platform finishes as part of the Platform Renewals works.

18.6.3 Suburban Station & North West Building Strengthening

18.6.3.1 General

This section covers the general sequence in which the works should be undertaken to ensure that the stability of the North West Building, Link Building and Suburban Station is maintained during the works.

The stiffening portal provides stability to the southern end of the suburban shed following the demolition of the entrance wall, and resists in-plane transverse loading applied at gridline 24, by the southern section of the North West Building and northern area of the Link Building; and residual thrusts from the adjacent areas.

The proposal to demolish the end wall and two southern bays of the suburban shed, and to provide a new flat roof which extends into and replaces the roof over the Old Parcels Yard, aligns the retained open end of the retained station with the southern end of the North West Building.

It is proposed that a new stiff portal to stabilise the southern end of the retained section of the suburban shed is provided under the Suburban Station Renewal works.

18.6.3.2 North West Building Strengthening

The general requirements and proposals for strengthening works to the North West Building have been assessed under stability load effects; particularly those arising from the main train shed roof arch thrusts.

The significance of the original southern party wall with the Link building on grid line 24 in providing, (in conjunction with the three relatively unaltered crosswalls on grids 28,29,and 30 to the north), transverse resistance to lateral loads.

The historic alterations to the southern end of the North West Building and Link building to provide an open parcels yard have substantially reduced the stiffness of the remaining southern ground floor walling in the area of grid 24; although some contribution to stability is provided by the steel frames installed on gridlines 24 and 25 as part of the alteration works.

It is likely that a significant proportion of lateral loads, particularly those applied by the main train shed at the North West Building roof truss support level, (and to a lesser extent at second floor level) are transferred via the upper level crosswalls, parcels yard canopy and diaphragm action of the southern end of the suburban shed roof, directly to the stiff southern walling of the suburban station.

The demolition of the southern end of the suburban station reduces the lateral resistance of the southern area of the North West and Link Buildings; and compensatory horizontal and vertical stiffening has been introduced.

The horizontal floor bracing, would be supplemented by additional members to enable lateral loads, applied to the central area of the North West Building, to be distributed to the gridline 24 stability portals and to the substantial crosswalls and staircore to the northern bays (grids 28 to 30).

It is assumed that the North West Building and Link Building are stabilised before any demolition of the parcels yard canopy roof structure and southern end of the suburban shed is commenced. These stabilisation works will include the installation of the permanent strengthening steelwork to the North West Building.

If the overall programme includes the demolition of the Southern Section of the Suburban Shed prior to the implementation of strengthening works to the North West and Link Buildings, the Main Train Shed arches in the vicinity of these buildings must be tied before work to the suburban shed is commenced.

Filename:	206_final.doc
Directory:	Y:\08-Reports\8-03-Reports_Issued\Report 206 - Structural Impact
Template:	C:\Program Files\Oasys\OvaWord\Reports\ArupRep4p.dot
Title:	Report
Subject:	Impact on Existing Structures
Author:	Jim McCarthy
Keywords:	
Comments:	
Creation Date:	8/18/2006 2:46:00 PM
Change Number:	3
Last Saved On:	8/18/2006 2:52:00 PM
Last Saved By:	jim mccarthy
Total Editing Time:	8 Minutes
Last Printed On:	8/18/2006 2:53:00 PM

As of Last Complete Printing

Number of Pages:	44
Number of Words:	17,699 (approx.)
Number of Characters:	93,099 (approx.)

for accurate layouts and level of floors

York Way

Euston Road

Kings Cross Station

Platform
Platform 1
Platform 2
Platform 3
Platform 4
Platform 5
Platform 6
Platform 7

TOC Facilities if required

King's Cross Station Main Shed

Bus Set-Down & Pick-Up

Southern Square

TOC Facilities if required

LUL Entrance & Fire Escape Stair

Southern square

LUL Stair and Lift subject to agreement with LUL

Dashed line shows outline of canopy. Vents and above taxi pick-up point. Design for temporary canopy underlighting. Stair and Lift development and subject to separate consent.

Access to LUL Fire

North West Building

Western Range Link Building

North Wing

Bomb Gap

Old Booking Hall

Southern Wing

Sub-Urban Train Shed

NR Western Concourse
FFL 116.800

Western Concourse

Taxi Pick up

Great Northern Hotel

Taxi Pick up

Pancras Road

Network Rail Planning Application Boundary

Taxi and Private Drop-off

PLOT / BLOCK A1

Northern Square

Taxi Set-Down

Station Square

Taxi drop off

Proposed Argent St. George Development

ARUP

Building Definitions - For information only
Ground Level. **17th July 2006**

St Pancras Station

Kings Cross Station

North West Building

Western Range Link Building

North Wing

Bomb Gap

Old Booking Hall

Southern Wing

Sub-Urban Train Shed

Northern Ticket Hall

Great Northern Hotel
Basement of
Great Northern Hotel
by Kings Cross Central

Shared Service Yard

NR Plant Room

Void above Loading Bays

Proposed Basements to
Argent St George Development.
Layout tbc.

Proposed Link to
Argent St George
Development

German Gymnasium over

Services Zone ground
Pancras Road

Escape Stair to Platform 10

OBS Tunnel
FFL 112.150

OBS Lift

OBS Preparation Area

Core Line

Access to Deep Tube Lines

Gate Line

LUL Tube Ticket Hall
FFL 112.920

LUL stair and
lift subject to
agreement with
LUL

Hotel Curve

Passageway
closed by LUL

FFL 114.748

FFL 113.700

FFL 113.450

FFL 113.100

FFL 112.795

FFL 111.800

Link to Thameslink

Fleet Sewer

LUL Fire Strip

NR Stair & Escalators

NR MIP
Lift 11

NR Lift
Machine
Room

Area safeguarded for
LUL utilities entries

ARUP

Building Definitions - For information only
Basement Level. 10th April 2006