

Science & Industry Museum Viaduct

Viaduct
Design and Access Statement
September 2023

Version history

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Project number: 9488
Client: Science & Industry Museum, Manchester

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1	September 2023	ISSUE	Emily Green I Architect	PLANNING

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1.0

Introduction

1.0 Introduction

1.1 Executive Summary

1.1.1 The statement has been prepared by Buttress Architects Ltd on behalf of the Science & Industry Museum. It explains our response to the work that is required to repair and waterproof the Viaduct to prevent water ingress in the future. It has been prepared in line with the guidance document ‘Design and Access Statements: How to Write, Read and Use Them,’ published by CABE.

1.2 Background

1.2.1 Buttress Architects have been commissioned by the Science Museum Group (SMG) to deliver the **Viaduct waterproofing**. The viaduct is sandwiched between the 1830s Warehouse to the north and the Station Building, both Grade I Listed.

1.2.2 This report is concerned with the area of viaduct which extends from the west boundary, extending east, abutting the concrete spans and bridge, passageway. There are 11 arches in total. However, the current issues do extend beyond the confines of the viaduct with the effects of water ingress visible from within the Station Building.

- 1.2.3 The application covers the following:
- Waterproofing of the concrete slab and troughs
 - Interfacing and abutment with buildings and assets

1.3 Purpose

1.3.1 Buttress Architects have prepared this Design & Access statement to support a Planning and Listed Building application for the Viaduct waterproofing.

1.4 Authorship

1.4.1 The report has been prepared by Emily Green, Architect, BA (Hons), MArch under the direction of Alex Scrimshaw Associate Technologist BSc (Hons), MCIAT, CIAT-Accredited Conservationist with Buttress Architects Ltd.

1.5 Limitations

1.5.1 Existing survey information has been used to produce

the drawings. The content of this report is based upon inspections carried out by Buttress Architects undertaken by Alex Scrimshaw Associate Technologist BSc (Hons), MCIAT, CIAT-Accredited Conservationist, Emily Green Architect, BA (Hons), MArch and Peter Levers BSc, completed firstly on the 30th November 2022 and subsequent visits have been undertaken on an ad-hoc basic.

1.5.2 The report is based on inspections made from ground level, floor levels and other accessible safe vantage points. Unless otherwise stated the inspection(s) were purely visual and no enclosed spaces or inaccessible parts have been opened up for inspection. Therefore, the arrangement and interfacing illustrated across details and GA’s are purely indicative / approximate only. The accuracy of the survey data is graphically presented cannot be confirmed. The report indicates the current condition of the building/ asset at the time of survey. It does not report to be wholly comprehensive but to indicate the principal areas of concern. It is a report on the condition and the findings and recommendations contained herein are subject to reappraisal once appropriate safe access has been facilitated.

1.6 Exclusions

1.6.1 This report excludes any internal / external works across the Station Building and 1830s Warehouse unless otherwise directed.

1.7 Other Specialist Reports

1.7.1 Buro Happold have been appointed to carry out a Structural, MEP and Civils reports, developing through RIBA Stages. The RIBA Stage 3 reports can be found appended to this document, alongside cctv surveys.

1.8 Drawings and Other Documents

1.8.1 The drawings contained within this report and used during the surveys are based on information provided by the client and/or sourced from archival resources.

1.8.2 Any diagrams and illustrations provided are for information only and may not be wholly accurate or too scale.

1.9 Acknowledgements

1.9.1 Buttress gratefully acknowledges the assistance provided by the Science and Industry Museum site staff.

1.9.2 The drawings provided are for Planning and Listed Building consent purposes only.



SIM Capital Projects

- SIM Ownership Boundary
- New Warehouse roof & fabric repairs
- Upper Yard conservation repairs
- Gantry restoration
- Special Exhibitions Gallery (SEG)
- 1830's Viaduct Waterproofing
- Site entrance bollards & barriers

1.10 Application and Project Team

Science and Industry Museum

Applicant and Client

Buttress

Lead Consultant, Architects, Heritage Consultants

Buro Happold

Structural, Mechanical, Electrical and Civil Engineers

Appleyard & Trew

Quantity Surveyors

Deloitte

Planning Consultant

Keelagher Okey Klein

Principal Designer

SCIENCE+
INDUSTRY
MUSEUM

Buttress

BURO HAPPOLD

Appleyard
& Trew

Deloitte.

KEELAGHER
OKEY
KLEIN

2.0

Background & Context

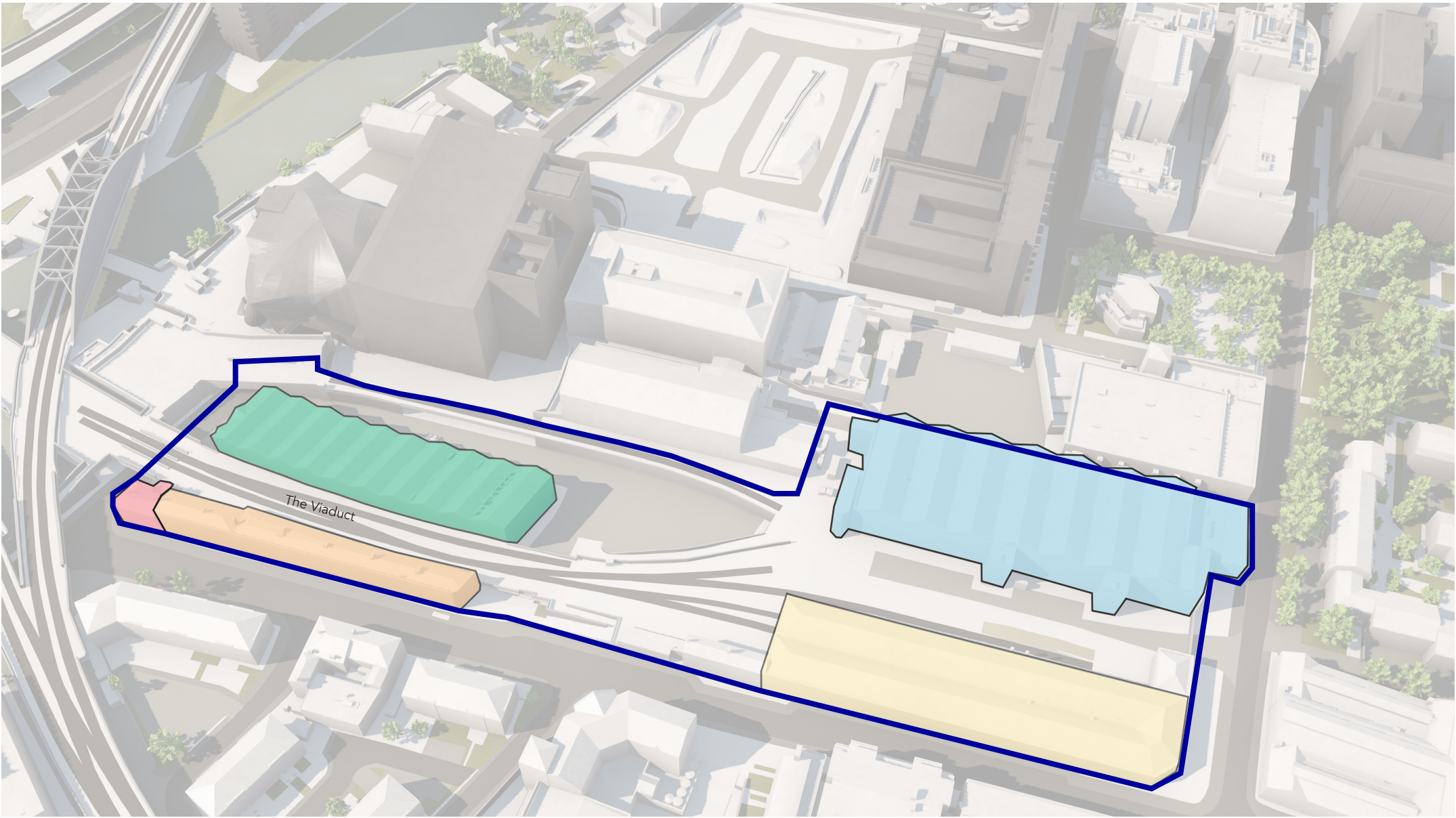
2.0 Context

2.1 Location

- 2.1.1
- The Science and Industry Museum is located to the north-west of central Manchester, to the east of the River Irwell and within the Castlefield Conservation Area and Castlefield Urban Heritage Park. The Science and Industry Museum includes a number of Grade I and II listed buildings and structures.
- 2.1.2
- This report focuses on the 1830's Viaduct Waterproofing Only.
- 2.1.3
- The site is within close proximity to Deansgate, Spinningfields and the Castlefield Basin. The site is well connected with Deansgate train station and Metrolink approximately 550m away.
- 2.1.4
- The Viaduct is situated to the west of the site, nestled in-between the 1830's Warehouse, the Liverpool Road 1830's Station Building and Station Masters House. It is not separately listed but within the curtilage of two Grade I Listed Buildings and in close proximity to other assets.

Key

- SIM Ownership Boundary
- 1830's Warehouse
- The Liverpool Road 1830's Station Building
- The Station Masters House
- The New Warehouse
- The Power Hall



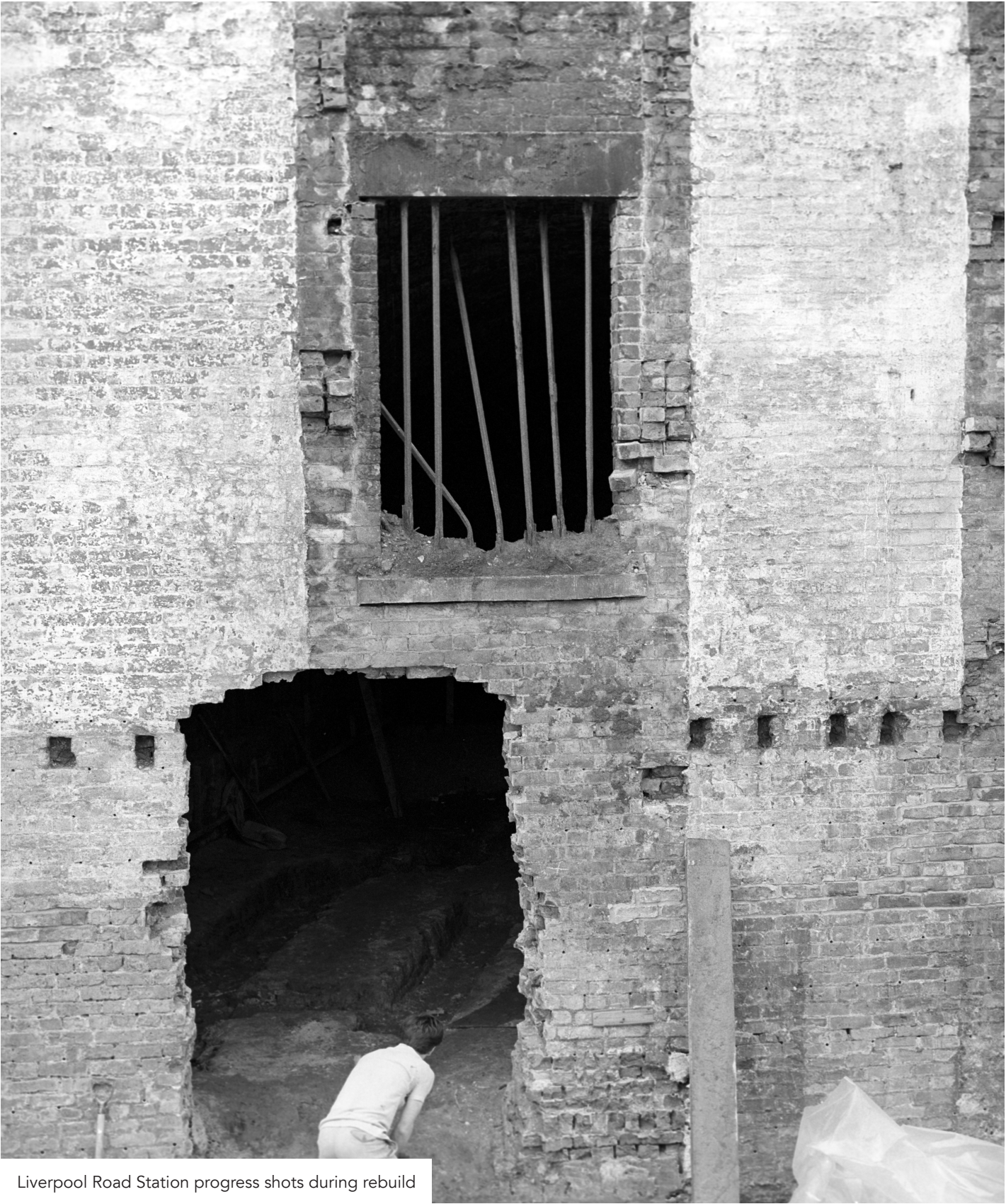
2.2 Heritage & History

2.2.1 The Liverpool Road 1830’s Station Building

- 2.2.1.1 Liverpool Road Station is the oldest passenger rail terminal in the world. It was first opened on 15th September 1830. Trains that ran from the station linked Liverpool with Manchester. The station functioned both as a passenger and freight terminal until it closed to public use on 4th May 1844. The elegant, Grade I listed building was built in the style of the late Georgian period and is now under ownership of the Science Museum Group.
- 2.2.1.2 The Passenger Station (or Coach Offices) was built in 1830 and comprised the first and second class booking offices on street level and separate waiting rooms, accessed by separate staircases, on first floor or platform level. It was intended for departures only, with arrivals descending from the other side of the track to Water Street, until a separate arrivals station was built on the other side of Water Street in 1837. The building was extended eastward in two stages; these are covered in the following section. When passenger services terminated in 1844, the building was used for goods offices. In 1982, the Station was restored and turned into museum usage and the first class booking hall fittings reconstructed. The staircase to the second class booking hall had been removed prior to 1975.
- 2.2.1.3 At platform level, to the rear of the building, doors open on to the platform from each waiting room. Initially the space was left uncovered; a roof was added in 1834. As of January 2019, the building was being used as offices. Most recently the spaces have undergone a refurbishment to become the Science Academy, now known as the Carriage Works, for the Science and Industry Museum. This project was successfully completed in the summer 2022.
- 2.2.2 The 1830’s Warehouse
- 2.2.2.1 The warehouse was built to provide warehousing facilities for the railway. The company originally advertised for five separate warehouses, which was executed as a single warehouse with five double bays. David Bellhouse Junior was awarded the work in April 1830, for completion by 15 August. Each bay was designed to operate independently for vertical movement of goods and to accommodate goods being delivered both by rail (by turntable and transshipment between the

transshipment between.

- 2.2.2.2 The building was altered in 1831, with the insertion of a mezzanine floor in the three bays nearest Water Street. An engine house was built between the warehouse and Water Street in 1831, with power being transmitted to the building via a vertical shaft up the west façade and from there across the building. A water tank was also added to the top floor of the east end. Various goods were stored over the following years, including spirits, requiring the addition of bars at the windows. With the conversion to museum usage glass lifts and staircases were introduced in the 1990s, as well as modern glazing and automatic doors and other facilities. The eastern bay was more extensively adapted, including the addition of a steel and concrete frame in the Electricity Gallery.
- 2.2.3 The 1830’s Viaduct
- 2.2.3.1 The 1830 Viaduct was built by George Stephenson in his capacity as Chief Engineer of the Liverpool & Manchester Railway Company.
- 2.2.3.2 The skewed River Irwell and Water Street bridges dictate the shallow curve of the viaduct on the Station site, which, together with the massive brick arches, characterises the structure. The floor level of most arches is at the level of the 1830 Warehouse and Station Building basements. A raised floor permitted access between the Lower Yard and Liverpool Road through two of the arches. Originally the upper level extended straight into the Shipping Shed. In about 1867 an extension with a curved brick outer wall was added to its northern face, supporting rail tracks leading to the north side of the Upper Yard. This blocked off some of the eastern arches. Since 1982 the western arches have been incorporated into the exhibition space and provide a connection between the 1830 Warehouse and the Station Building.

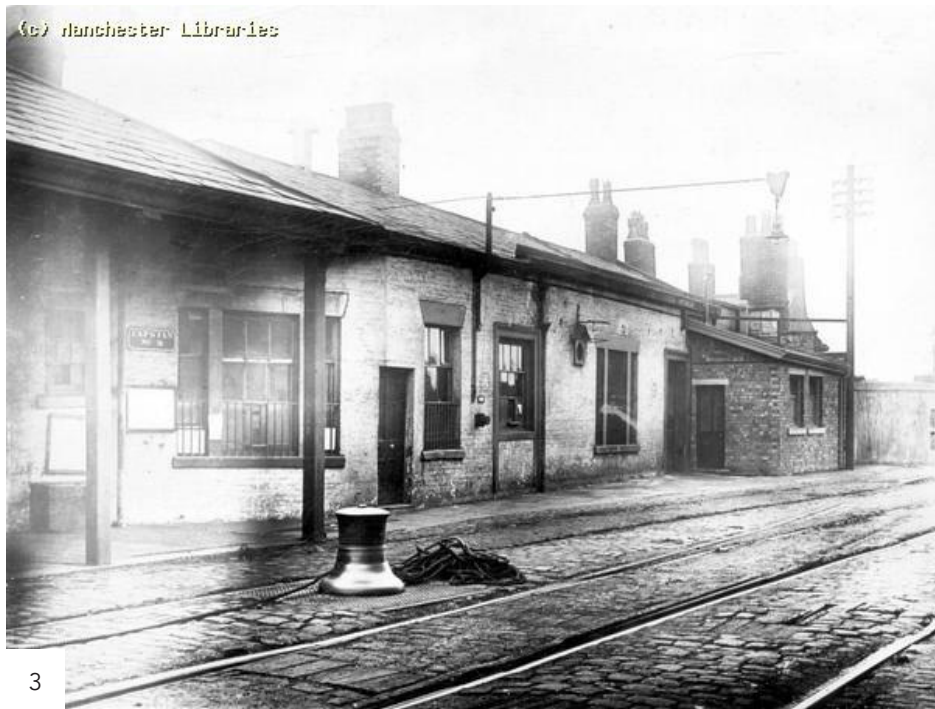


Liverpool Road Station progress shots during rebuild





(c) Manchester Libraries



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4



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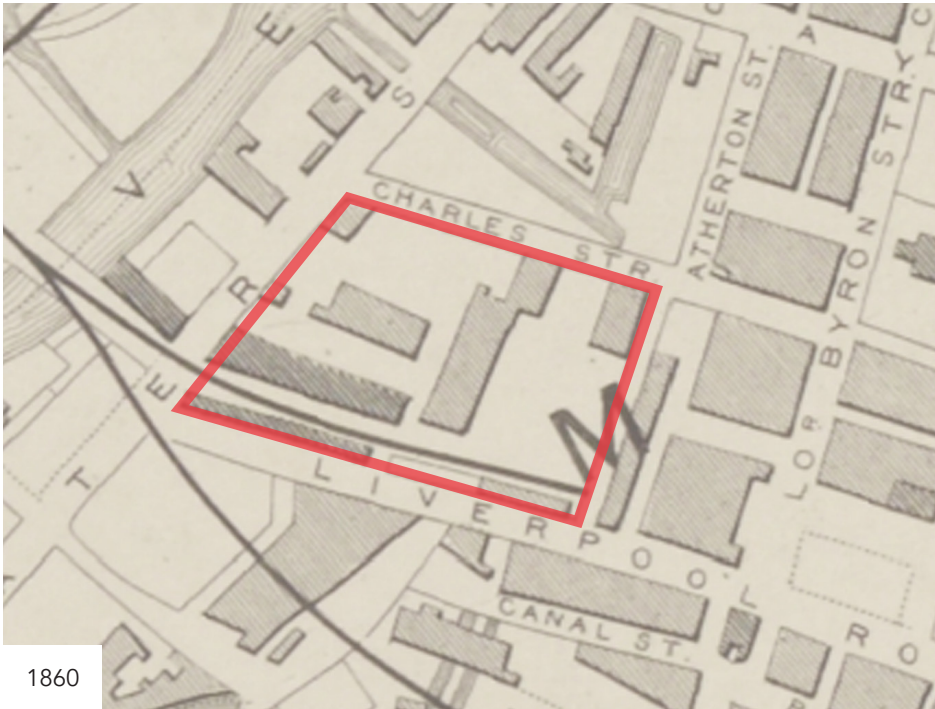
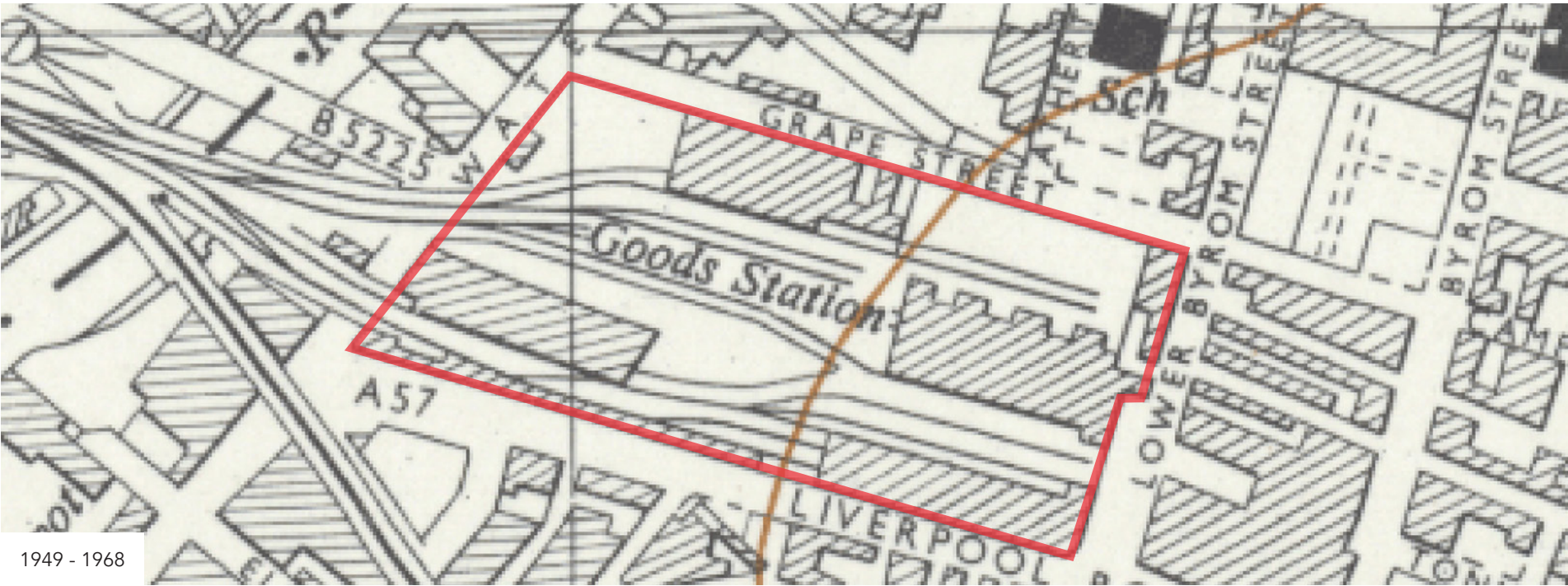


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1. Liverpool Road Platform 1978
2. Liverpool Road Platform circa 1980's
3. Liverpool Road Platform 1895
4. The Carriage Sheds and Shops circa 1985
5. Area surrounding the Platform May 1980
6. Station Building Platform 1956
7. Viaduct Capping works circa mid1980's
8. Station Building Platform 1955

2.4 Historical Maps

- 2.4.1 In 1824, much of the site between Liverpool Street and Charles Street lay empty up until the development of Liverpool Road Station in 1830. The 1808 Station Master's House is the only building that can be seen to the left of the highlighted image.
- 2.4.2 In 1860, the site of the Science & Industry Museum was now occupied by Liverpool Road Station and the 1830 goods warehouse. In the right image, the New Warehouse has a different position to its current day, and the Shipping Shed was a new addition.



2.5 Listing Descriptions

Official list entry

Heritage Category: Listed Building

Grade: I

List Entry Number: 1291477

Date first listed: 18-Dec-1963

Statutory Address 1: FORMER LIVERPOOL ROAD RAILWAY STATION, LIVERPOOL ROAD

Statutory Address 2: STATION MASTERS HOUSE, LIVERPOOL ROAD

Location

Statutory Address: FORMER LIVERPOOL ROAD RAILWAY STATION, LIVERPOOL ROAD

Statutory Address: STATION MASTERS HOUSE, LIVERPOOL ROAD

The building or site itself may lie within the boundary of more than one authority.

District: Manchester (Metropolitan Authority)

Parish: Non Civil Parish

National Grid Reference: SJ 82952 97867

Details

MANCHESTER

SJ8297 LIVERPOOL ROAD 698-1/18/213 (North side) 18/12/63 Former Liverpool Road Railway Station, and Station Master’s House

GV I

Also known as: Museum of Science and Industry, Liverpool Road Station LOWER BYROM STREET. Passenger railway station at terminus of Liverpool and Manchester Railway, now part of museum complex. 1830, by George Stephenson for the Liverpool and Manchester Railway Company, with attached house of 1808, formerly occupied by station agent; altered. Red brick, the booking offices faced with sandstone

ashlar and stucco; hipped slate roofs. Rectangular plan parallel to street, with house to left and added range of former shops to right. Classical style. The BOOKING OFFICES, which back onto an embankment carrying the railway line at 1st floor level to the rear, have a 2-storey 4-bay facade (2:1:2:1 windows), symmetrical except for the 4th bay, with channelled rustication to the ground floor, panelled pilasters to the upper floor, a moulded cornice and high parapet with cornice and blocking course. The 2nd bay (the centre of the symmetrical portion, containing the entrance to the 1st Class booking hall) breaks forward slightly, has a large square-headed doorway with an architrave of coupled pilasters, moulded cornice and blocking course surmounted by a vase-pedestal sundial, and a recessed panelled door with rectangular overlight; and at 1st floor a tripartite sashed window with a cornice. The flanking bays have 15-pane sashed windows at ground floor flanked by wide segmental-headed tripartite sashed windows with glazing bars, and 12-pane sashes at 1st floor with moulded architraves. The 4th bay, containing the entrance to the 2nd Class booking hall, has a doorway at ground floor similar to the other but with single pilasters, and a 12-pane sash above like the others. Interior: separate booking halls and staircases leading to platform. Rear: 2 doorways to the platform with moulded stone surrounds, a tripartite sashed window to the left of the 1st Class doorway and a one-light sash to the left of the other. To the east, an added hipped-roof platform canopy on slender iron columns (C20 offices with glazed screen wall inserted under this roof). The former HOUSE to the left of the booking offices, 3 storeys and 3 bays to the same height, symmetrical, has a doorway with pedimented stone architrave, sashed windows of 16 panes at ground and 1st floors and 12 panes at 2nd floor, all with raised sills and flat-arched heads, and modillioned eaves; and a double-splayed left corner to the return wall, with sashed and blind windows. To the right of the booking offices is a long 9-bay range, recently rebuilt or restored, formerly with shops at ground floor and a train shed above, which is stuccoed at ground floor, has coupled pilasters, 1st-floor sill-band, moulded cornice and high brick parapet (carried across from the booking offices), and most bays with symmetrical openings including a round-headed doorway at ground floor flanked by windows in segmental-headed blank arches, and 2 windows above. HISTORY: oldest surviving passenger railway station in the world; ceased to handle passenger traffic in 1844 (when Hunt’s Bank station was opened, now Victoria Station, q.v.), but continued in use as goods station until 1975. Forms group with Old Warehouse on opposite side of railway track (q.v.).

Listing NGR: SJ8295297867Official list entry

Heritage Category: Listed Building

Grade: I

List Entry Number: 1282991

Date first listed: 08-May-1973

Statutory Address 1: OLD WAREHOUSE TO NORTH OF FORMER

LIVERPOOL ROAD RAILWAY STATION, LIVERPOOL ROAD

Location

Statutory Address: OLD WAREHOUSE TO NORTH OF FORMER LIVERPOOL ROAD RAILWAY STATION, LIVERPOOL ROAD

The building or site itself may lie within the boundary of more than one authority.

District: Manchester (Metropolitan Authority)

Parish: Non Civil Parish

National Grid Reference: SJ 82990 97886

Details

MANCHESTER

SJ8297 LIVERPOOL ROAD 698-1/18/208 (North side) 08/05/73 Old Warehouse to north of former Liverpool Road Railway Station

GV I

Railway warehouse. c.1830, together with Liverpool Road Railway Station (q.v.), by George Stephenson and his son Robert; altered. Red brick in Flemish bond, with sandstone dressings and slate roofs. Long slightly curved plan, convex to the railway line and concave to the rear. Three storeys but presenting only 2 storeys to the raised level of the track, 10 individually gabled bays arranged in pairs, with slotted pilasters between each pair and at both ends, a moulded stone cornice (carried round the whole), a small lunette on the cornice in the centre of each bay, and stone gable copings linked by short flats. In each pair of bays (except the 5th pair, at the right-hand end), one bay has a segmental-headed wagon archway with stone surround, 3 small segmental-headed barred windows above the archway with linked sills and wedge lintels (except the 4th bay where the wagon entrance has been raised so as to leave only the heads of the windows) and one 2-stage loading slot to left or right, and the other bay has 2 loading slots. The last pair of bays both have the wagon-archway form. The right-hand loading slot in the 3rd bay has a hoist pulley over the lintel, and apparently altered brickwork over the other loading slots suggests that all were formerly equipped with similar hoists. The left hand return wall has (inter alia) a small pediment to the centre, with an oculus; the 3-storey 6-window right-hand return wall has a doorway with stone surround at the left end of the ground floor, 2 segmental-headed doorways at 1st floor level, and narrow rectangular windows diminishing in the height. The 3-storey rear, with cornice and lunettes like the front, and pilasters which have small windows, has 3-stage loading slots arranged singly or in pairs corresponding to those at the front, with hoists over all except one at the west end and 2 at the east end, doorways with stone surrounds next to the single slots, and small rectangular barred windows with wedge lintels. Interior: timber construction visible.

Listing NGR: SJ8299097886

2.6 Heritage Assessment

2.6.1 Conclusion and Justification Statement

2.6.1.1 The below is an extract from the Heritage Assessment by Buttress Architects Heritage Consultancy Team, the full document is included within the application:

2.6.1.2 *The proposals will result in a significant enhancement to the status and condition of the 1830 Warehouse, 1930 Viaduct, and the Station Building, serving to provide essential upgrades and fabric repairs, securing its future for years to come.*

2.6.1.3 *The scheme will respond appropriately and sensitively to the character and fabric of the Grade I listed assets with minimal visual impact to the museum estate, whilst also providing numerous benefits to the buildings and structures.*

2.6.1.4 *Where negligible harm may occur, this will be outweighed by the following benefits, in accordance with Para 202 of Chapter 16 of the NPPF:*

- *Removal of existing, unsympathetic and inappropriate details and fittings.*
- *Protect and secure heritage asset for years to come. Building fabric repaired including structural enhancements.*
- *Appropriate ventilation requirements provided*
- *where necessary.*
- *Increased performance of surface water management system.*
- *Replacement of inferior / poor quality weathering’s, flashings, and coverings with more suitable and robust products.*
- *Leadwork installed to appropriate standards.*
- *Improved detailing and interfacing.*

2.7 Planning Context

2.7.1 1803’s Warehouse

- 2.7.1.1 035767 | FOR DETERMINATION BY THE CENTRAL MANCHESTER DEVELOPMENT CORPORATION Demolition of building and environmental improvements prior to restoration of 1830 warehouse
- 2.7.1.2 035768 | FOR DETERMINATION BY THE CENTRAL MANCHESTER DEVELOPMENT CORPORATION/LISTED BUILDING CONSENT Demolition of building prior to restoration of 1830 warehouse.
- 2.7.1.3 040766 | DETERMINATION BY THE CENTRAL MANCHESTER DEVELOPMENT CORPORATION/LISTED BUILDING CONSENT Internal and external alterations in connection with proposed use as a museum
- 2.7.1.4 040764 | DETERMINATION BY THE CENTRAL MANCHESTER DEVELOPMENT CORPORATION Restoration and change of use of 1830 warehouse to a museum with associated external yard
- 2.7.1.5 045699/DL/CMDC/94 | LISTED BUILDING CONSENT Demolition of 8 No. barrel drops and retention and refurbishment of 4 No. drops in association with approved works on building
- 2.7.1.6 046822/DF/CMDC/94 | Large scale photographic work to be affixed to Water Street elevation.
- 2.7.1.7 046824/DL/CMDC/94 | LISTED BUILDING CONSENT Large scale photographic work to be affixed to Water Street elevation.
- 2.7.1.8 113752/FO/2016 | Removal of existing wall and railings to Liverpool Road , removal of existing 1980s ramp and railing entrance to the 1830 Warehouse, conversion of existing Viaduct into a new excavated entrance hall including accessible entrance to the Lower Yard and new frontage to Liverpool Road, associated access ramp, hard landscaping, lighting and other associated works.
- 2.7.1.9 121835/LO/2018 | LISTED BUILDING CONSENT for the removal of the existing ‘1830 Warehouse’ fixed sign, and replacement with ‘1830 Warehouse’ fixed sign

- 2.7.1.10 122660/LO/2019 | LISTED BUILDING CONSENT for 3 Trial pits in the basement of the 1830 warehouse
- 2.7.1.11 123052/LO/2019 | LISTED BUILDING CONSENT for the installation and upgrade of the fire alarm systems throughout the 1830 Warehouse Building and former Liverpool Road Station Building of the Manchester Museum complex.
- 2.7.1.12 124068/LO/2019 | LISTED BUILDING CONSENT for urgent repair works to the 1830 Warehouse, required to prevent weather ingress and deterioration of the building fabric, including external facade works and internal works.
- 2.7.1.13 124163/LO/2019 | LISTED BUILDING CONSENT for the provision of safe access to the roof through the adaptation of existing roof hatches, new retractable ladders, new walkway platforms within the valleys, stepped access, and mansafe system, and minimal guardrails.
- 2.7.1.14 129394/LO/2021 | LISTED BUILDING CONSENT for provision of safe access to the roof through the adaptation of existing roof access, new fixed and retractable ladders.
- 2.7.1.15 130172/LO/2021 | LISTED BUILDING CONSENT for alterations to the Grade I Listed 1830 Warehouse for the creation of openings and the installation of pipework plus the introduction of a services trench and borehole cover within its curtilage.
- 2.7.1.16 136466/FO/2023 | Replacement of structural glazing and repairs to masonry, timber and metalwork.
- 2.7.1.17 136467/LO/2023 | Listed Building Consent for the replacement of structural glazing and repairs to masonry, timber and metalwork.
- 2.7.1.18 136747/LO/2023 | Listed Building Consent for reprofiling of valley gutters, repairs to roof trusses and replacement of torching to Bay 4 within the 1830 Warehouse roof.
- 2.7.1.19 137070/LO/2023 | Listed Building Consent for fire protection remediating works in the 1830 Warehouse including works to stud walls and fire doors.
- 2.7.2 Liverpool Road Station
- 2.7.2.1 F12862/LA | G.M.C. DEVELOPMENT Change of Use from railway goods yard and buildings to railway and science Museum.
- 2.7.2.2 F15121/LA | G.M.C. DEVELOPMENT Change of use from railway goods yard to railway and Science Museum and extension and alterations to goods shed.

- 2.7.2.3 F15153/LA/LB | G.M.C. DEVELOPMENT Alterations to station masters house and station buildings.
- 2.7.2.4 F15154/LA/LB | LISTED BUILDING CONSENT Alterations to station master house and station buildings.
- 2.7.2.5 019724 | GMC DEVELOPMENT Change of use to museum of science and industry of Lower Byrom Street warehouse and the provision of a car park and picnic area at upper level
- 2.7.2.6 020895 | Illuminated double sided box sign and logo fixed between cast iron column feature
- 2.7.2.7 022689 | LISTED BUILDING CONSENT Proposed works to the eastern end of station building including the dismantling, reinstatement and stabilisation of the front elevation and upgrading of the floors to suit museum loading requirements and adaption to buildings for m
- 2.7.2.8 022690 | Proposed works to the eastern end of station building including the dismantling, reinstatement and stabilisation of the front elevation and upgrading of the floors to suit museum loading requirements and adaption to buildings for use as museum
- 2.7.2.9 040115 | DETERMINATION BY THE CENTRAL MANCHESTER DEVELOPMENT CORPORATION / LISTED BUILDING CONSENT Addition of vehicle ramp between the upper and lower yard to allow car parking in the lower yard
- 2.7.2.10 103617/LO/2013/C1 | Works to viaduct comprising demolition of brick vaults and construction of new concrete vaults and buttress wall to provide support. Installation of buffer stops and fencing. Fabric repairs and ancillary works.
- 2.7.2.11 103616/LO/2013/C1 | Works to viaduct, comprising removal of sections of parapet, platform, and infil material to brick vault Termination of MoSI tracks and installation of fencing and buffer stops. Fabric repairs and ancillary works.
- 2.7.2.12 105575/LO/2014/C1 | Core holes and brick mortar testing to listed structures.
- 2.7.2.13 107645/LO/2014/C1 | LISTED BUILDING CONSENT for structural investigation works, involving trial pits/opening up works and material samples
- 2.7.2.14 107649/LO/2014/C1 | LISTED BUILDING CONSENT for structural investigation works, involving trial pits/opening up works and sample areas of cleaning.
- 2.7.2.15 111830/JO/2016/C1 | Minor Non Material Change to Vary Deemed Planning Permissions and 103617/LO/2013. Alterations to design of south abutment of proposed

- Network Arch bridge next to Hampson Street
- 2.7.2.16 117084/LO/2017 | LISTED BUILDING CONSENT for stucco render repairs and associated works to Liverpool Road elevation of MOSI Station Building
- 2.7.2.17 120038/LO/2018 | LISTED BUILDING CONSENT Undertaking a programme of core hole analysis to listed structure.
- 2.7.2.18 123052/LO/2019 | LISTED BUILDING CONSENT for the installation and upgrade of the fire alarm systems throughout the 1830 Warehouse Building and former Liverpool Road Station Building of the Manchester Museum complex.
- 2.7.2.19 129385/LO/2021 | Listed Building Consent for 2No. barriers at roof level, rainwater goods, roof repairs and associated works at Station Building.

2.8 Building Form

2.8.1 Description of Structure

- 2.8.2 The Viaduct is built with varying skew along its length with a shallow curve on plan, nestled between the 1830s Warehouse and Station Building.
- 2.8.3 The floor level of most of the arches matches those of the adjacent buildings, with a link formed centrally, providing access between the 1830s Warehouse and Station Building.
- 2.8.4 The Viaduct for the purpose of this report extends from Water Street, progressing eastwards, up until the western wall of the storage arch.
- 2.8.5 There are 11 masonry skew arches. Most of the interior spaces are not used, or used sporadically for storage. The arch to the west is open to both the north and south elevations, with access from the Station master's House rear yard.
- 2.8.6 The interior masonry skew arches are visible across most arches.
- 2.8.7 The masonry skew arches have been capped with a concrete slab with drainage channels / troughs to the north and south at the abutment with masonry assets, understood to have been implemented during the mid-1980s. The concrete slab extends from the most western arch across to the west wall of the storage arch. The undercroft / east viaduct is understood to not be capped or waterproofed as existing.
- 2.8.8 The main concrete slab is laid to fall into the drainage channels, through cast insitu land drains.
- 2.8.9 At platform level, the railway tracks sit upon a mix of timber and concrete sleepers with ballast infill from platform to slab level.
- 2.8.10 The north drainage channel is capped with exposed concrete covers.
- 2.8.11 The transverse and south drainage channels are not visible at ground level, concealed by external surface finishes, which consist of macadam, stone pavers / cobbles, and modern timber planks.
- 2.8.12 The tracks are separated from the platform via a metal balustrade, which runs the entire length of the platform.
- 2.8.13 Rainwater from the 1830s Warehouse and Station Building are discharged into the drainage channels across the viaduct slab.

- 2.8.14 It is understood that the viaduct slab discharges into a single rainwater outlet, which in turn connects into the public sewer.



View onto the Viaduct from the 1830's Warehouse

2.9 Key External Views



- 1. 1830's Viaduct at track level - concrete revealed beneath ballast
- 2. View onto the tracks and 1830's Warehouse from the platform
- 3. View east along the tracks
- 4. 1830's Warehouse, tracks and station platform
- 5. North trough along the 1830's warehouse
- 6. 1830's Station Building Platform
- 7. Concrete slab exposed beneath the ballast

2.10 Key Internal Views



1. Water ingress - junction between the Viaduct & Station Building
2. Damp issue - Plant room - Station Building
3. Link between the Station Building & 1830's Warehouse
4. Water ingress - LG-Station Building
5. Water ingress GF - Station Building
6. Water catchment pools GF -Station Building
7. Paint and plaster defects - junction between the Station Building & Viaduct
8. Evidence of water ingress into the stair well
9. Example of water ingress issues into the Viaduct Arches

3.0

Identification & Referencing

3.0 Identification and Referencing

3.1 Identification

- 3.1.1 The Museum have provided room references however, for simplicity the viaduct arches have been renumbered numerically, starting from east to west and those references are referred to within this report. Museum referencing may be specifically referred to within localised areas only.

3.2 Reference material

- 3.2.1 The water ingress issues have been studied and reported upon for some time, the most extensive report completed back in 2017, when detailed analysis was undertaken across the viaduct. This was due to the interior spaces being identified as a potential location to house the new Special Exhibitions Gallery (SEG). The SEG area was subsequently installed within the Lower Ground level of the New Warehouse, due to the water ingress issues within the Viaduct.-

3.3 Ground Floor Viaduct Arch Plan



3.4 Lower Ground Floor
Viaduct Arch Plan



4.0

Summary of Findings

4.0 Summary of Findings

4.1 Viaduct and Station Building

- 4.1.1 For the purposes of this document, the following have been inspected and reported upon only:
- Exterior hard landscaped surfaces
 - Concrete slab / capping (where visible)
 - Drainage channels / troughs (where visible)
 - Rainwater pipes (in relation to water ingress issues only)
 - Interior of the Viaduct arches
 - Interior of the Station Building (water ingress only)

4.2 Current Issues

- 4.2.1 Current issues can be attributed to the following:
- Poor original detailing
 - Poor sequencing of works
 - Poor retrospective / temporary repairs
 - Vegetation / silt and detritus
 - Leaking / defective rainwater, drainage goods
 - Access limitations, areas in accessible
 - Failing, aging materials, finishes and flashings, beyond service life
 - General fabric repairs

4.3 Defects Observed

- 4.3.1 The information here on in is based upon inspections made from ground level, floor levels and/or other accessible vantage points.
- 4.3.2 Unless otherwise stated, the inspections have been purely visual, and no enclosed spaces or inaccessible parts have been opened / exposed for inspection.
- 4.3.3 The external waterproofing features have been broken down into elements.
- 4.3.4 A table has been provided across the following pages and lists each of the elements and components.
- 4.3.5 Refer to ‘defects observed’ tables.

4.3.6 Defects Observed Table

Item	Element	Description	Defects observed	Potential additional defects to consider
1	Slab	Slab poured insitu during the 1980s, suspected to have been at some point during 1984, the slab has a camber running down the centre and discharges to the north and south, dispersing north and south into troughs. It is likely that land drains and connected into the south side of the trough from the slab. The slab as observed may be a protective layer against the ballast, with waterproofing measures and further slab below. The full extent, coverage of the slab is unknown.	A very small area of the slab has been exposed. No defects visible.	<ul style="list-style-type: none">▪ Seepage through fissures.▪ Defective / spalled concrete.▪ Low spots, dishd surface, allowing for ponding water.▪ The slab is not designed for the capacity required.▪ Land drains may be blocked.▪ Settlement.
2	Slab day / movement joints across slab	A mix of kerbed and flush abutments noted. Exact quantities / centres are unknown.	Brittle, defective, loose mastic. A very small area % of the external face of the slab has been exposed.	<ul style="list-style-type: none">• Mastic may be missing in areas.• Joints may have been widened.• Defective / spalled concrete.• Settlement.
3	Original waterproofing	Likely to have been either puddle clay or poured pitch, discharging into hopper / sump.	Not exposed	Water may be migrating between the defective waterproofing measures and the concrete slab
4	Vault extrados	Skew masonry	Not exposed	<ul style="list-style-type: none">▪ Open mortar joints.▪ Spalled / defective masonry.
5	North trough	Concrete cast insitu with concrete lids. Appears to only be a single system, not tiered. The trough takes rainwater from the 1830s Warehouse downpipes and circa 50% of slab over viaduct. The trough appears to discharge through a large diameter below ground drainage pipe towards the west end of the run, which then penetrates and discharges into a hopper and external downpipe to the north external elevation of Arch 11.	Heavy buildup of silt, detritus and standing water masking internal faces of trough.	<ul style="list-style-type: none">▪ Defective abutment / day joints.▪ Outlet(s) are not appropriately sized for capacity / flow rates.▪ Outlet(s) may be blocked by debris, silt.▪ Defective drainage.▪ May operate on a single outlet.▪ Defective spalled uneven concrete surfaces.
6	South trough	Dual layered concrete cast insitu trough. Removable timber planks provide access into first top layer. A series of manholes provide access into bays of lower trough, roughly aligning with metal columns to Station Building roof which double up as rainwater pipes. The trough takes rainwater from the Station Building roof, station platform and circa 50% of the slab over the viaduct. Land drains are visible within the lower trough, presumably taking ground water from the slab over the viaduct. The trough appears to discharge at the end of the west run, penetrating the west wall, sandwiched between the Station Masters House and Arch 11. Discharging into a large diameter pipe with various changes of direction, then running vertically and discharging into a manhole chamber within the rear yard of the Station Masters House.	<ul style="list-style-type: none">▪ Heavy buildup of silt, detritus and standing water.▪ Unventilated concealed upper and lower troughs.▪ Rotten planks to underside, due to lack of ventilation.▪ services penetrations	<ul style="list-style-type: none">▪ Defective abutment / day joints.▪ Outlet(s) are not appropriately sized for capacity / flow rates.▪ Outlet(s) may be blocked by debris, silt.▪ Defective drainage.▪ May operate on a single outlet.▪ Defective spalled uneven concrete surfaces.
7	North interface	The north concrete trough abuts the 1830s Warehouse external masonry wall with a flashing which extends circa 100mm up the face of the wall.	Asphalt flashing is defective and brittle in areas.	
8	East interface	Interface with undercroft viaduct capping is unknown. The exact interfacing detail with the adjacent Storage Arch / Undercroft is unknown as this has not been exposed, however it is likely that the edge includes a concrete upstand / toe.	Not known.	How is this linked with the viaduct waterproofing measures?
9	South interface	The south concrete trough abuts the Station Building north elevation at platform level with no waterproofing interface or weathering.	There was no evidence of weep holes or outlets noted which connect into the trough.	Water may be migrating vertically between interfaces with the glazed screens. Water is trapped behind the brick header border with the platform.
10	West interface	Interface with Water Street viaduct / bridge is unknown.	Not known.	How is this linked with the viaduct waterproofing measures?
11	Station Building hard landscaped areas	Randomly sized stone paving slabs and macadam.	<ul style="list-style-type: none">▪ Cracked slabs.▪ Vegetation.▪ Open mortar joints.	No waterproofing measures or interface detailing with the trough / viaduct.
12	Covered Station Building platform	Covered external platform within the Station Building. Timber planks to floor, fixed onto battens and tapered asphalt on top of concrete planks which form the first-floor level (platform level)	<ul style="list-style-type: none">▪ There are no water proofing measures between the platform floor, glazed room or external faces of masonry. Water migrates underneath glazed screen into the ‘internal’ Carriage Works.▪ Vegetation visible.▪ Rotten planks.▪ Rotten battens.▪ Soiled / saturated planks.▪ Unventilated.▪ Water trapped behind concrete upstand with platform.	Water migrates through the interface
13	Above ground drainage – Station Building	There are two variants of rainwater downpipes, the first is a series of iron columns which double up as internal downpipes, these discharge into the lower south trough. The second are traditional cast iron downpipes which discharge direct into below ground sealed system.	Outlet to columns reduces to circa 50mm diameter, discharging into difficult to access lower-level trough. Outlets added retrospectively.	
14	Above ground drainage – 1830s Warehouse	Large diameter downpipes discharge into the north trough.	Finishes flaking, blistered with localised areas of corrosion noted.	
15	Below ground drainage	Likely pipe networks connecting troughs into external hopper / downpipes.	Not exposed	Blocked, cracked, dislodged pipework.
15	Services	Below ground services penetrations and distribution.	Not exposed	Services may have penetrated ‘waterproof’ layers.
16	Railway tracks	Railway tracks over the viaduct, fixed onto timber / concrete railway sleepers.	Corrosion / defects noted across railway tracks.	Concealed, hidden defects.
17	Interior of arch	Largely exposed skew masonry arches and walls with cast insitu floor slabs. A couple of areas have been internally tanked with a supposed waterproof render.	<ul style="list-style-type: none">• Water is seeping through a number of locations across the viaduct area.▪ Washing out of mortar joints.▪ Friable, spalled masonry.▪ Ponding water across stairs and floor finishes.▪ Water working its way down into lower basement areas.▪ Stalactites.▪ Efflorescence, salt crusting.	
18	Interior of Station Building	Internally finished areas of Museum spaces.	<ul style="list-style-type: none">▪ Water is seeping through t&g ceilings.	Embedded, concealed steelwork may be corroded



- Water is being held within the ceiling voids, due to the presence of insulation roll absorbing water.
- End of viaduct arches are saturated.
- Washing out mortar joints.
- Friable, spalled masonry.



4.4 Water Ingress Locations

- 4.4.1

The plan diagrams provided across the following pages illustrate the areas observed internally where there are high moisture levels and evidence of ongoing water ingress.
- 4.4.2

For the purposes of this report a Red, Amber, Green (RAG) system has been adopted as a means to graphically represent the condition and level of moisture/saturation observed internally.

4.4.3 Lower Ground Floor Water Ingress Locations



4.4.4 Ground Floor Water Ingress Locations

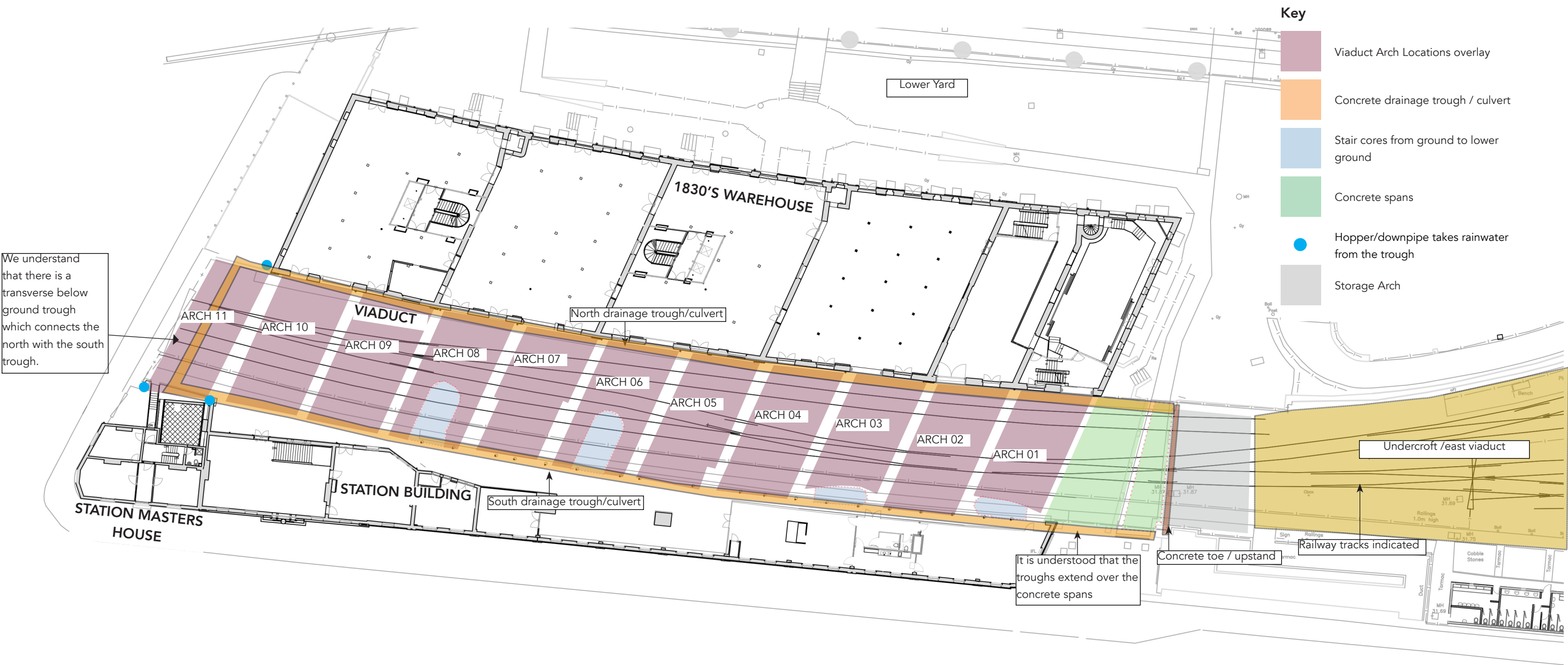


4.5 Key Findings and Observations

- 4.5.1 The following observations can be considered as the primary issues found to date across the assets.
- 4.5.2 There are 11 arches across the Viaduct, with Arch 11 being the only one which has not been enclosed and is open to the elements to the north and south elevation with Water Street to the west.
- 4.5.3 Water ingress is at its most prominent internally within Arches 6,10 and 11.
- 4.5.4 All of the arches show signs of damp, moisture to some degree. The arches are typically sealed units with no signs of cross ventilation or means to heat the spaces. If heating provisions are insitu, they are not currently monitored or controlled.



Arch 6 - Plant Room



4.5.6 Internally

4.5.6.1 Arch 10 – Storage

4.5.6.2 Lower Ground Floor

4.5.6.3 There were signs of ongoing water ingress issues found, which appeared to be isolated towards the south western corner of the arch.

4.5.6.4 The masonry was visibly saturated, spalled, friable with open mortar joints.

4.5.6.5 Efforts have been made in the past by the client, as an attempt to control the extent of water across the floor slab.

4.5.6.6 Arch 6 – Plant Room

4.5.6.7 Lower Ground Floor

4.5.6.8 Arch 6 at lower ground level houses plant and equipment and has most recently been upgraded under a separate contract. Due to the presence and issues with water ingress, a steel lined, and framed canopy has been erected to protect equipment internally from water ingress.

4.5.6.9 Arch 6 – Stair core

4.5.6.10 Lower Ground Floor

4.5.6.11 The stair core within Arch 6 which provides access from Station Building ground level, to the lower ground levels of the Viaduct and Station Building is heavily saturated and regularly floods.

4.5.6.12 Arch 6 – Stair core

4.5.6.13 Lower Ground Floor

4.5.6.14 The stair core within Arch 6 which provides access from the Station Building ground level, to the lower ground levels of the Viaduct and Station Building is heavily saturated and regularly floods.

4.5.6.15 The masonry walls are heavily soiled, with spalled bricks, open mortar joints and efflorescence.

4.5.6.16 This not only has a massive impact on the degradation of the structure, but also poses a health and safety risk, given that this stair core forms part of the means of escape strategy.



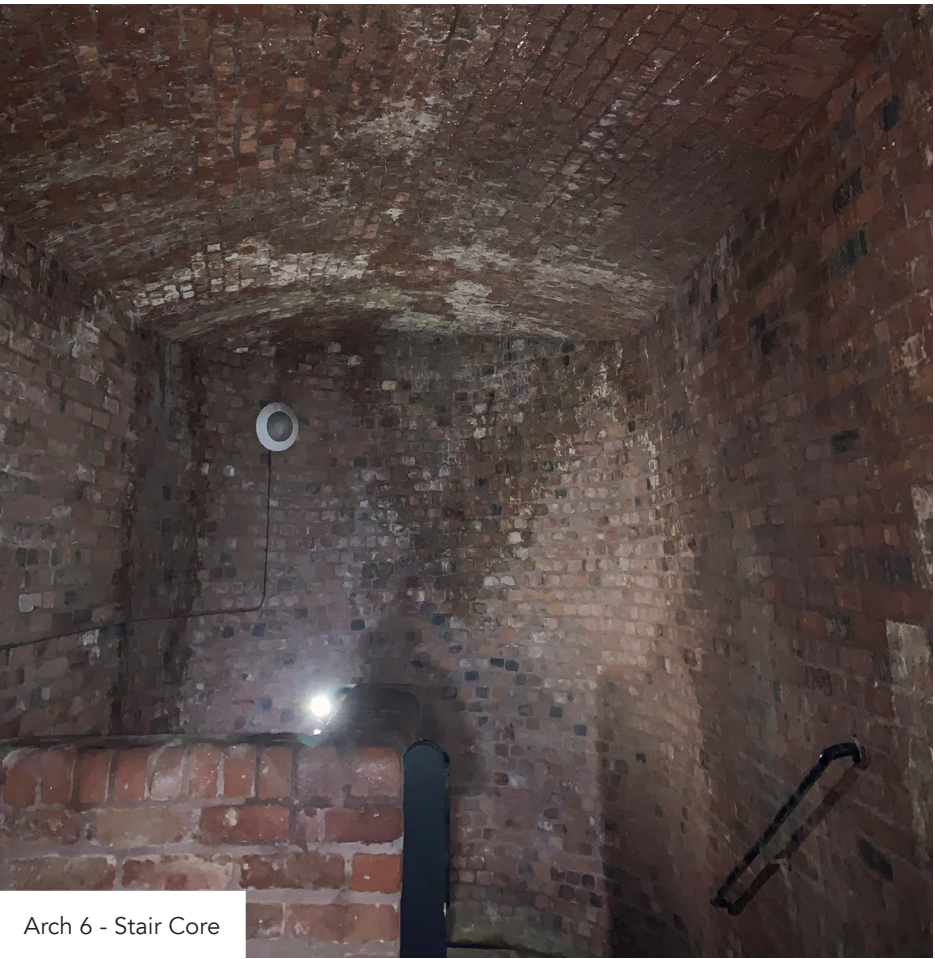
Arch 10 - Storage



Arch 6 - Plant Room



Arch 6 - Stair Core



Arch 6 - Stair Core

4.5.6.17 Station Building – Room SB LG05A – Adjacent Arch 6

4.5.6.18 Lower Ground Floor

4.5.6.19 An area of T&G boarded ceiling shows signs of moisture, water ingress within corridor space. The boards show signs of decay with finishes blistered.

4.5.6.20 The client has provided video footage in the past within this area, evidencing extreme water ingress down into this sub-level during heavy and prolonged rainfall.

4.5.6.21 Station Building – Room SB G05 – Adjacent Arch 6

4.5.6.22 Ground Floor

4.5.6.23 There are major water ingress issues currently observed within room SB G05 within the Station Building, directly accessed from the stair core from Arch 6.

4.5.6.24 The museum team have constructed a waterproofed tub, to allow for catchment of water ingress from the ceiling above.

4.5.6.25 The T&G boarded ceiling is visibly saturated and heavily soiled with localised decay.

4.5.6.26 Station Building – Room SB G05 – Adjacent Arches 4-5

4.5.6.27 Ground Floor

4.5.6.28 To the east of Arch 6 within the Station Building, there are two arches where the south elevations have been opened up, allowing for connections into the Viaduct and 1830s Warehouse beyond.

4.5.6.29 The exposed masonry is heavily saturated, with spalled and friable masonry.

4.5.6.30 The timber boxing out directly above also shows signs of moisture and is heavily soiled within localised locations along its length. It is believed that a steel frame exists beyond. The detail and condition of which is currently unknown.

4.5.6.31 Carriage Works

4.5.6.32 Water migrates from the covered platform and underneath the exterior glazed screens, with evidence of ponding water internally, below the timber floor boards and battens.



Station Building – Room SB LG05A – Adjacent Arch 6



Station Building – Room SB G05 – Adjacent Arches 4-5



Station Building – Room SB G05 – Adjacent Arch 6



Carriage works interior - water ponding under floor boards

4.5.7 Externally

4.5.7.1 Northern trough (drainage channel)

4.5.7.2 The northern concrete trough runs the full length of the 1830s Warehouse to the south elevation and appears to take ground water from circa 50% of the viaduct slab, whilst also taking water from the rainwater pipes to the south elevation. It is likely that the downpipes take circa 50% of the roofscape across the warehouse. It is unknown what area of the warehouse roofscape the downpipes take. It is likely that there are a series of land drain connections from the viaduct slab, which discharge into the trough, though none were observed at the time of the survey. The flashing upstand was brittle, defective in areas.

4.5.7.3 The trough appears to be a single chamber and is connected into a concrete transverse drainage channel which in turn is connected to the southern trough. At this time, it is reported in archival material to discharge into a large diameter vertical downpipe, which disperses into the highway sewer. In addition, there is an outlet an hopper to the west end of the northern trough which may also be connected to the trough or perhaps used as an overflow or entirely unrelated. The trough is concealed by large format concrete lids. There was standing water within the base and a large build-up of silt and detritus.

4.5.7.4 It is not clear at this time exactly which downpipes the troughs and slab drain to, Fig A-B show a hopper and downpipe to the west end of the Viaduct (north wall) which maybe connected or used as an overflow and Fig C-D show large diameter downpipes to the southwest corner of the Viaduct, to the north of the Station Masters House, which disperse into the main sewer.

4.5.7.5 Upon closer inspection, the hopper and downpipe appeared to be blocked with silt, vegetation growths. Given the extent of well establish vegetation, it is reasonable to suggest that there is a high moisture content within this location. Suggesting potentially defective below ground drainage pipework.

4.5.7.6 Southern trough (drainage channel)

4.5.7.7 The southern trough runs the length of the station platform, from east to west and follows the arc of the tracks and building. The trough has two chambers, an upper and a lower. The upper chamber is hidden by timber planks which can be lifted to gain access. The planks show signs of minor decay and condensation to the underside caused by sweating due to lack of appropriate ventilation.



Northern Trough



Fig A



Fig B



Southern Trough and Station Platform



Fig C



Fig D

4.5.7.8 The internal rainwater pipes within the columns to the station roof, discharge into the lower chamber. Access is difficult into the lower chamber with manholes offering views into the chamber typically where downpipes are located.

4.5.7.9 The lower trough holds water and is full of silt and detritus, including unknown obstructions at the east and west of the run which likely effect the flow.

4.5.7.10 There are several land drain connections with the viaduct slab to the north elevation of the trough. It is understood that round water from the slab, disperses into the lower chamber.

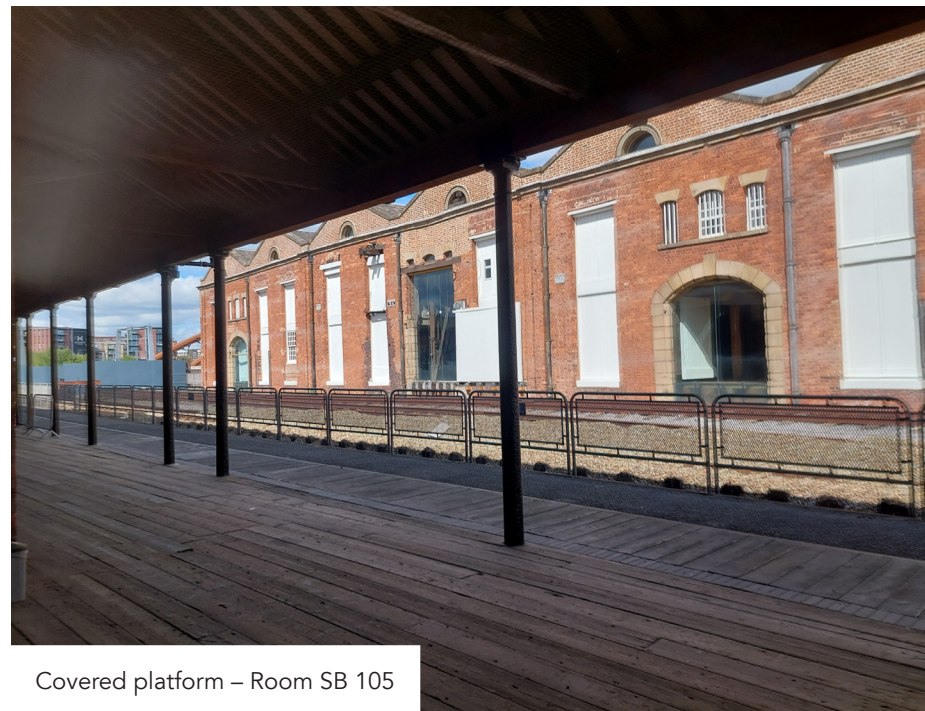
4.5.7.11 The trough appears to discharge towards the west end of the run, into a visible surface fixed large diameter sealed downpipe. The pipe discharges into a manhole located within the yard of the Station Masters House. (Fig C)

4.5.7.12 Covered platform – Room SB 105

4.5.7.13 The external covered area within the Station Building platform is open to the elements. A high percentage of the planks are visibly saturated, with localised vegetation noted.

4.5.7.14 The planks abut tight and there appears to be no cross ventilation offered to the underside, concealed voids

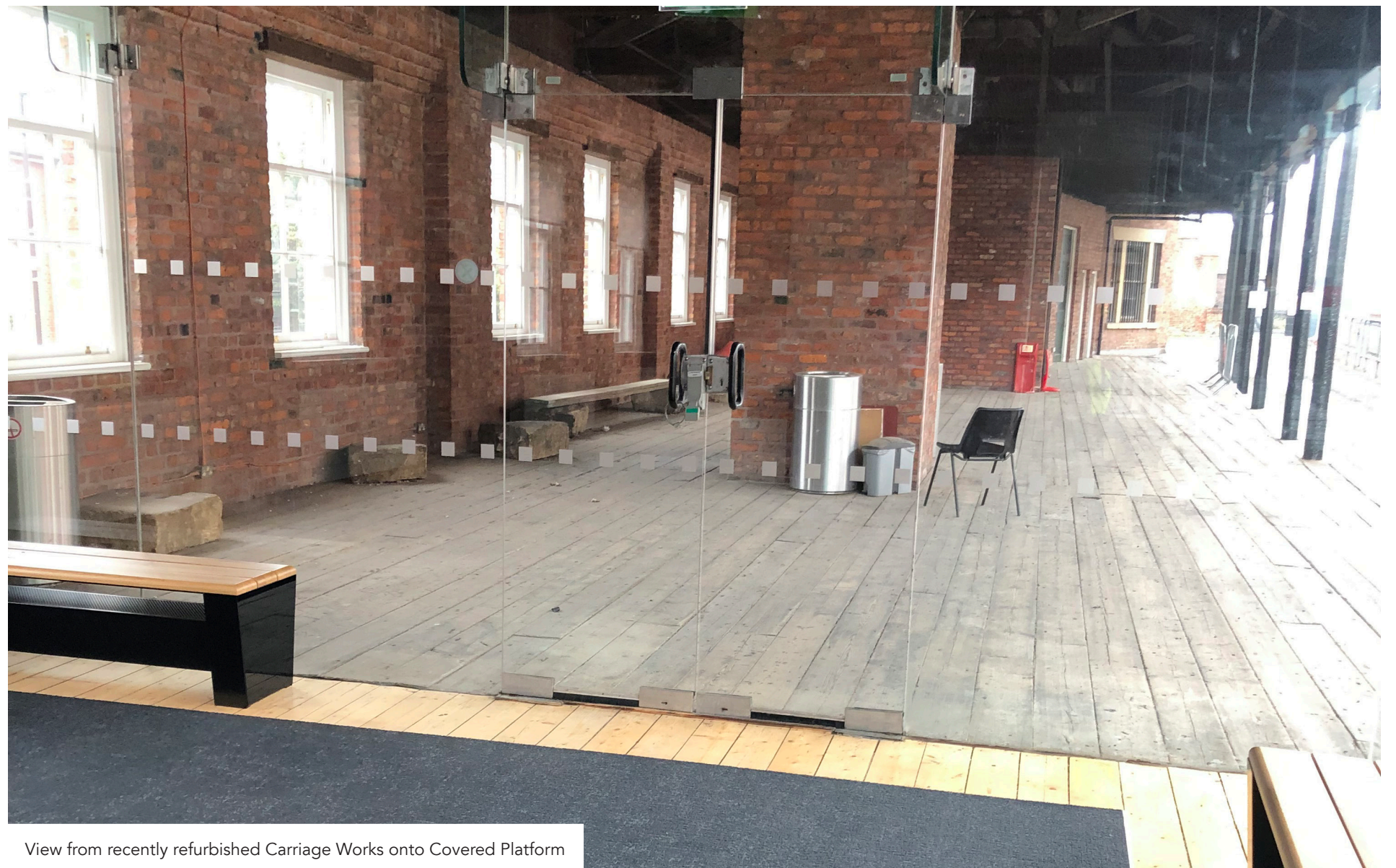
4.5.7.15 There was no evidence of any flashings or weathering's at the interface or abutment of the external walls or glazed screens



Covered platform – Room SB 105



Covered platform – Room SB 105



View from recently refurbished Carriage Works onto Covered Platform

5.0

Archival Analysis

5.0 Archival Analysis

5.1 Historic Sequencing

5.1.1 Key dates of significant alterations across assets:

5.1.1.1 The Grade II listed Viaduct was built in 1829-30, sandwiched between the Station Building and 1830s Warehouse.

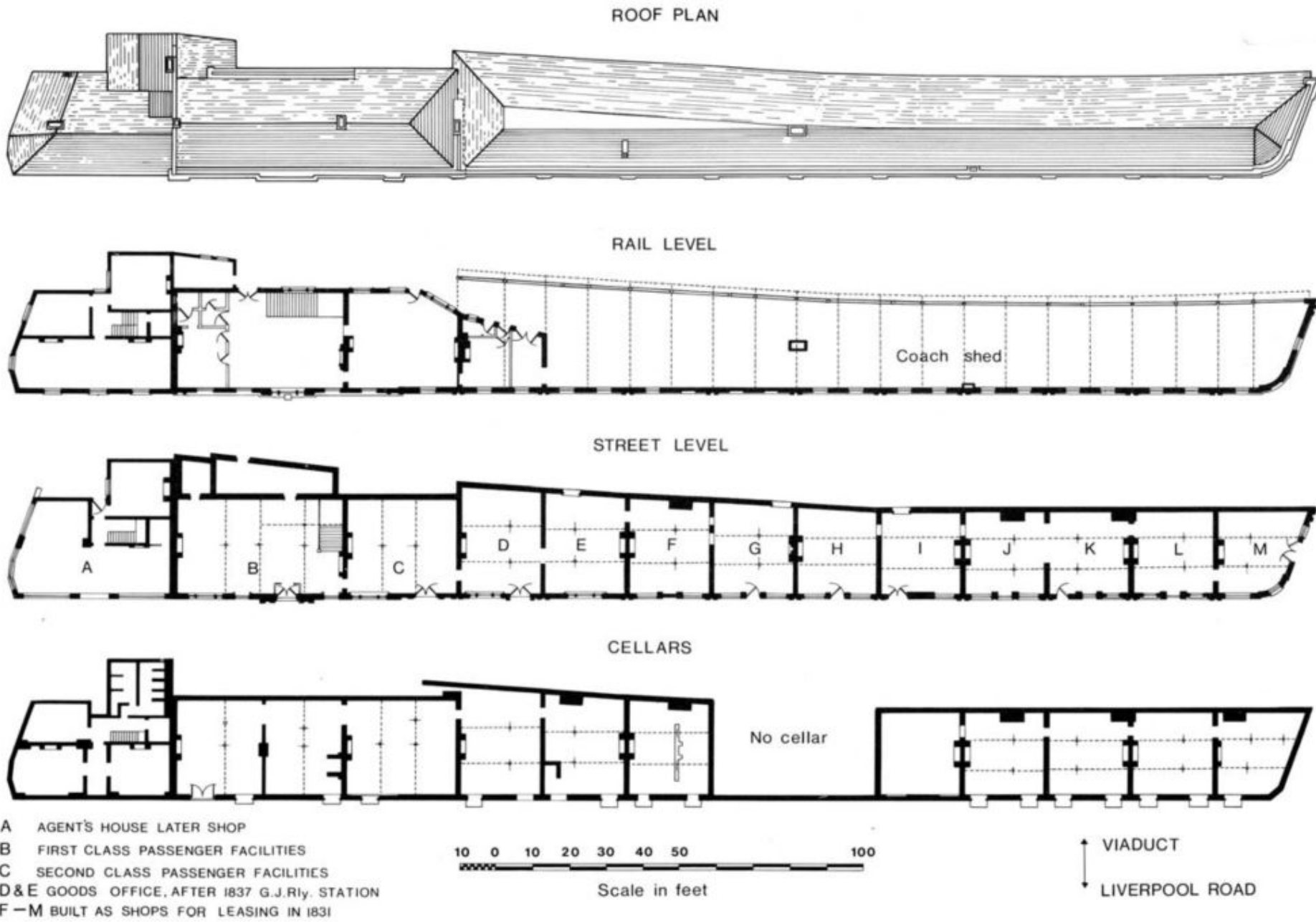
5.1.1.2 The Grade I listed 1830s Warehouse was built and completed in 1830. In 1831 the building was altered, with a mezzanine floor introduced. The building went through various alterations up until around 1961, when the warehouse was used as a tyre store. In 1985-86, the easternmost bay was altered by the replacement of the internal timber frame with a steel frame supporting reinforced concrete floors. In 1992-96, the building was restored by repairing the timber frame, followed by the installation of two lift and staircase cores to allow for the conversion to a museum space.

5.1.1.3 The Grade I listed Station Building is essentially split into two distinct areas, the first being the Passenger Station towards the west which included the booking halls and waiting rooms. Construction began on the Passenger Station in 1830.

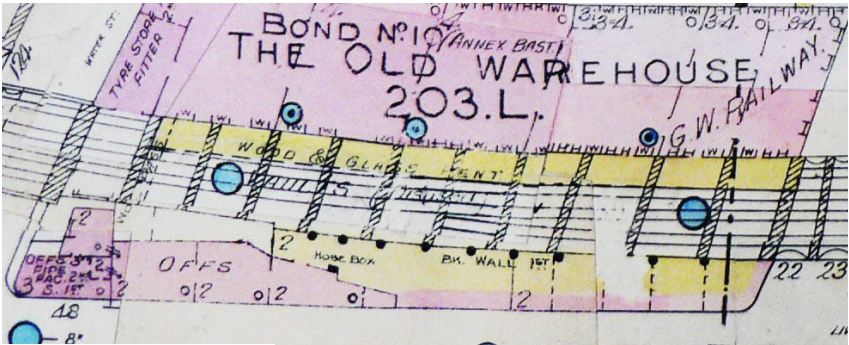
5.1.1.4 The second and larger area of the Station Building, was completed in 1830 for use as the Carriers Offices, Carriage Shed and Shops. The platform area under the canopy appears to have been partially enclosed with a masonry wall by 1881 and fully enclosed by 1913.

5.1.1.5 In 1982, the former passenger station was restored for museum use as gallery space.

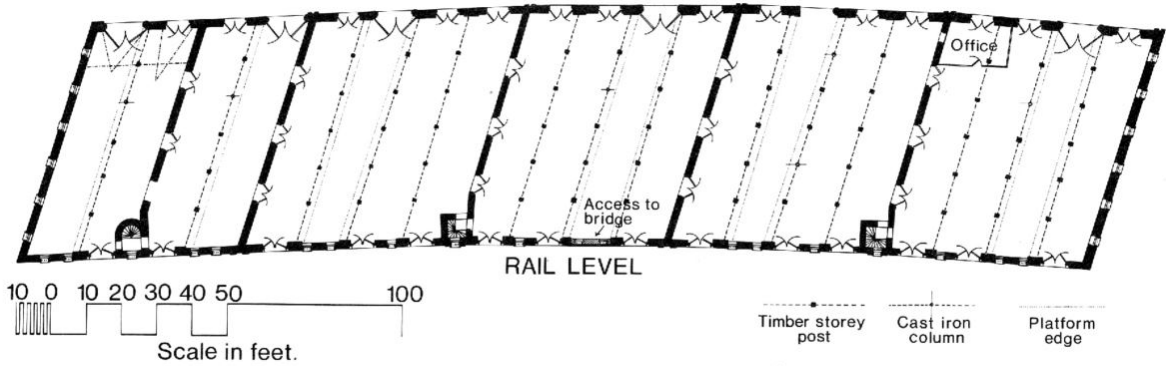
5.1.1.6 In 1986-87, extensive and invasive works were undertaken across the former carriers' offices and shop extension which was dismantled, taken down to the foundations and rebuilt to its original external configuration, this was due to the south elevation leaning outwards, towards Liverpool Road. This included the addition of a glass walled studio at the eastern end of the former carriage shed, using modern construction techniques. In 1988, two galleries were installed in the basement and ground floor.



Plan of Passenger Station and Carriers Office and Carriage Sheds, as in 1831



Viaduct Plan as in 1961



Historic 1830's Plan



The junction between the Station Building and Viaduct during construction mid 1980's



Junction between the Station Building and Viaduct within room SB G05

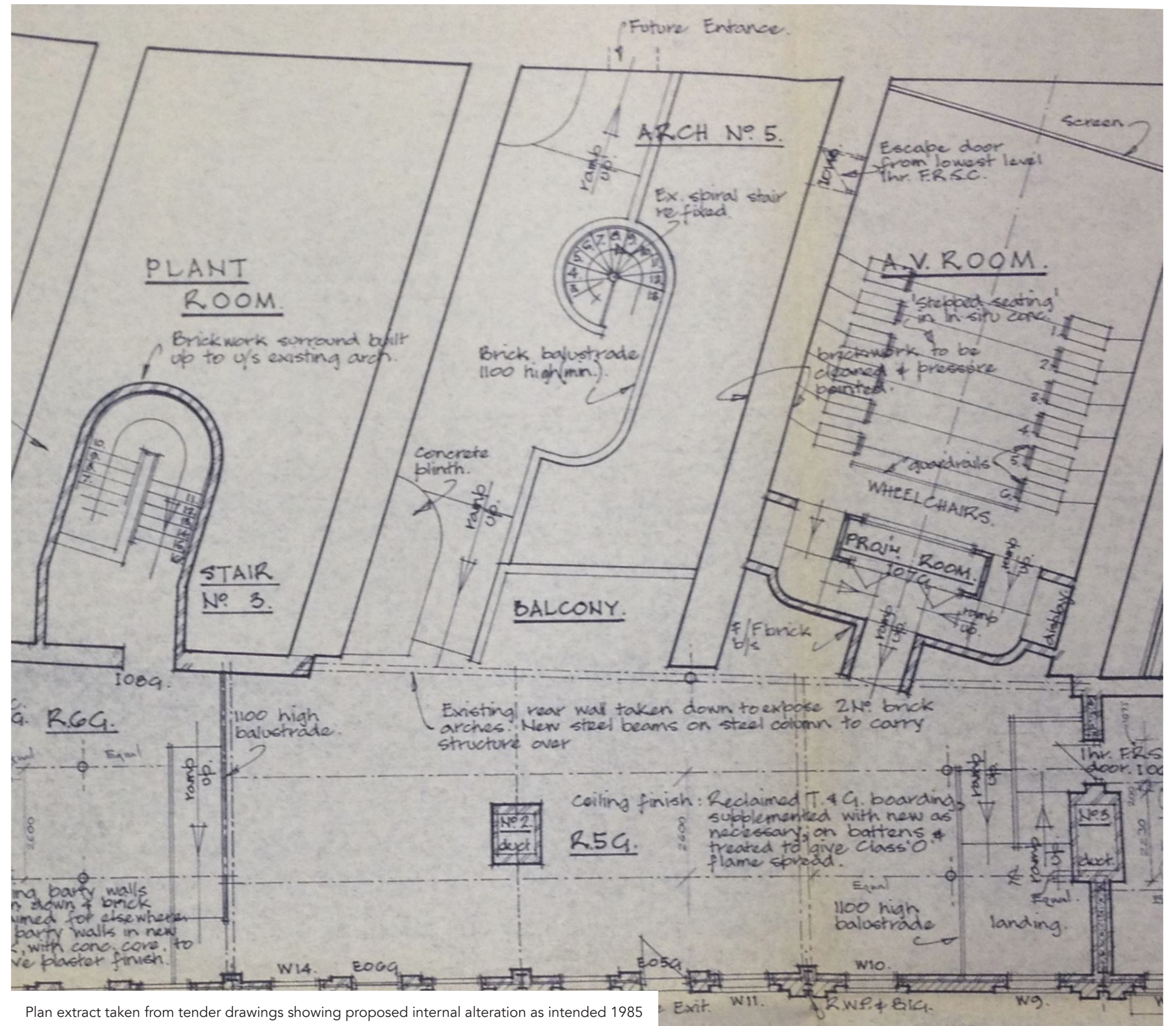


Junction between the Station Building and Viaduct within room SB G05



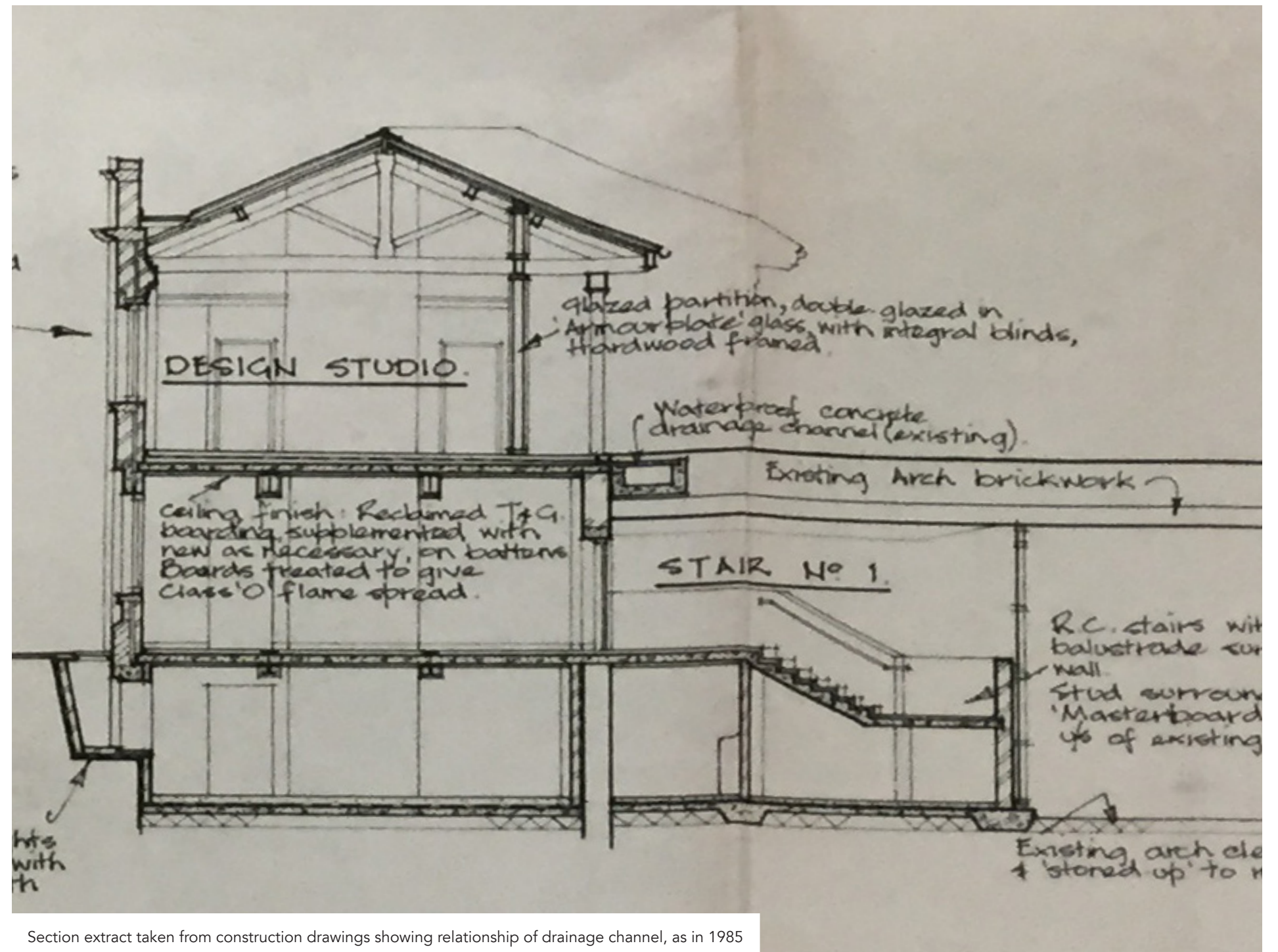
Setting out and formwork for the concrete slab above the Viaduct during construction

- 5.1.2 In addition to rebuilding the extension, the building was heavily modified internally by inserting doorways through the internal walls, as well as the removal of internal walls to allow an east-west visitor flow and to open up the central space at ground level. The most extensive alterations carried out were at the abutment with the southern wall of the viaduct, where some of the arches were reopened to provide horizontal public access between the Station Building, 1830s Warehouse and the viaduct. A series of stair cores were also introduced to provide improved access, whilst also providing increased means of escape, the stairs were housed within the viaducts with access into the Station Building.
- 5.1.3 Centrally, the alterations required the removal of a length of masonry wall to expose two brick arches (nr. 4 & 5) and the installation of steel beams bearing down onto a steel column. This provided the access route through the viaduct, whilst also providing access into a newly proposed auditorium.
- 5.1.4 As part of the fire escape strategy, a series of stair cores were located within the viaduct arches, providing access from ground to lower ground levels across the Station Building with additional access into the arches themselves. The staircases were formed with a masonry surround and concrete cast insitu flights, retaining the visual aesthetic of the masonry skew arches above.



Plan extract taken from tender drawings showing proposed internal alteration as intended 1985

- 5.1.5 The masonry walls between the Viaduct and Station Building are understood to have been cleaned, repointed, and then irrigated with a preservative fluid, the specification and extent of which is unknown.
- 5.1.6 The first-floor plate across the Station Building platform was reconstructed. The build-up is believed to consist of reclaimed timber planks fixed onto battens, with insulation between on asphalt, on top of a screed laid to fall, finally onto 150mm thick concrete planks to provide a 1-hour fire rating.
- 5.1.7 The original intention appears to have been that any trapped water ingress upon the covered platform, would discharge via gravity into the concrete trough, which runs the length of the platform. The current orientation of battens below, precludes the flow of water.
- 5.1.8 The 1985 tender drawings appear to suggest that the concrete drainage channel / trough predates the 1986-87 alteration works, note its reference as being 'existing'. Tender drawings have been sourced for the concrete slab and drainage troughs, dated early 1984. It is assumed that the installation of the concrete slab and troughs was therefore introduced at some point towards the middle of 1984.



Section extract taken from construction drawings showing relationship of drainage channel, as in 1985

- 5.1.9 The existing 1985 section does not appear to align with current survey data or analysis. Instead of a single chamber, there are in fact an upper and lower chamber. The lower chamber was originally 'accessible' to a degree, with loose concrete covers capping the chamber with ballast over. The retrospective introduction of the upper chamber and concrete kerbs made the lower chamber inaccessible with no access points to allow for rodding of the rainwater outlets, only recently has there been a series of manhole covers provided to allow for routine maintenance to be completed. The introduction of the upper chamber was likely as a result of increased external floor levels or the design intent of platform finishes.
- 5.1.10 The historic photograph (Fig 1) adjacent shows the installation of the concrete slab and southern drainage trough, along with the concrete spreader beams that span between the end of the Viaduct and sit upon the west wall of the Storage Arch, which then proceeds into the Undercroft. The Station Building appears to have not yet gone through the 1986-87 alternations as the masonry wall which encloses the platform is visible and is not yet glazed or representative of the 1985 drawings.
- 5.1.11 Further review of the photograph shows us the presence of what looks to be a single chamber, which aligns with the 1985 proposed section. The rainwater pipes to the Station Building also appear to discharge direct into the trough, they have yet to be relocated within the columns as we know this is now the current arrangement likely introduced as part of the Station Building rebuilding project.
- 5.1.12 The current southern drainage trough has removable visible timber planks, allowing for access into the upper chamber. The drainage channel follows the arc of the track and varies in width across its length, though its depth appears to be consistent, however review of recently obtained archival information, suggests that the trough base is laid to fall.
- 5.1.13 The current arrangement would suggest that the brick header course, concrete upstand, and upper chamber to the trough, were introduced either during the 1986 works or post 1987. The current abutment detail between the covered platform weathering's and the upper trough currently traps any moisture across the platform floor plate. Upon localised invasive inspection, there were no signs of weepholes or outlets which connected the external floor plate to the drainage trough.
- 5.1.14 It is unknown as to why the upper chamber was introduced. It is likely that external ground levels have been increased, thus necessitating the need to increase the trough depth and surrounding areas. The reasoning for the additional void



Fig 1

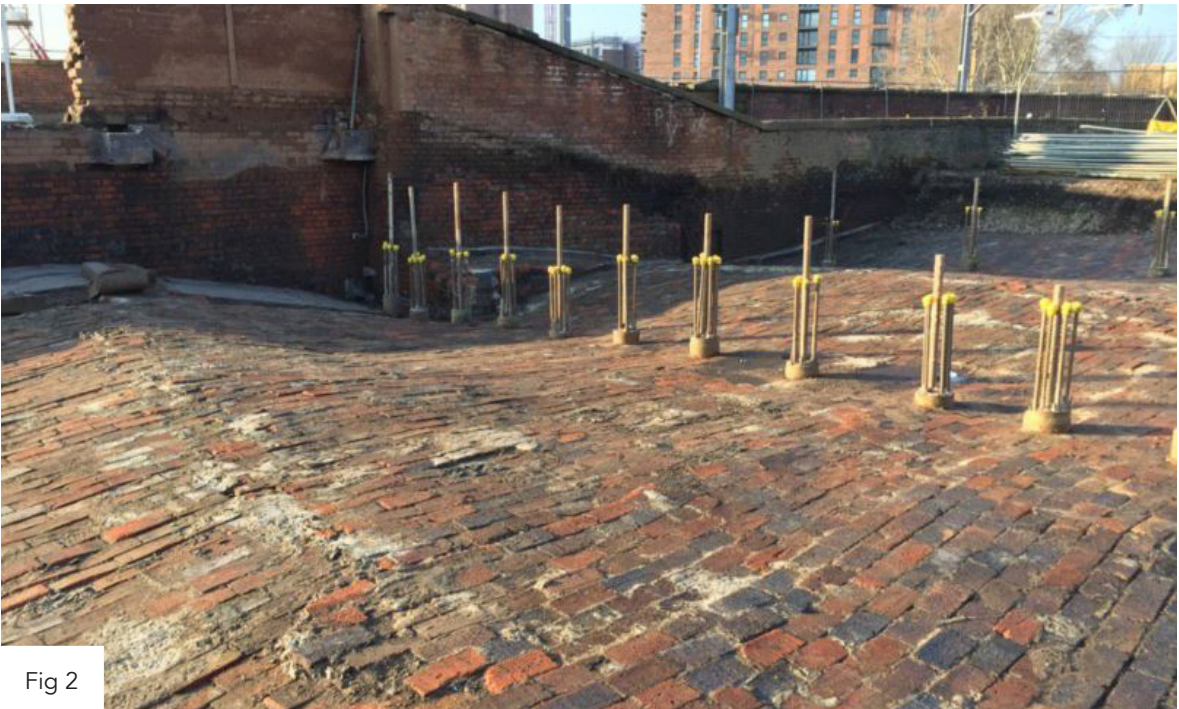
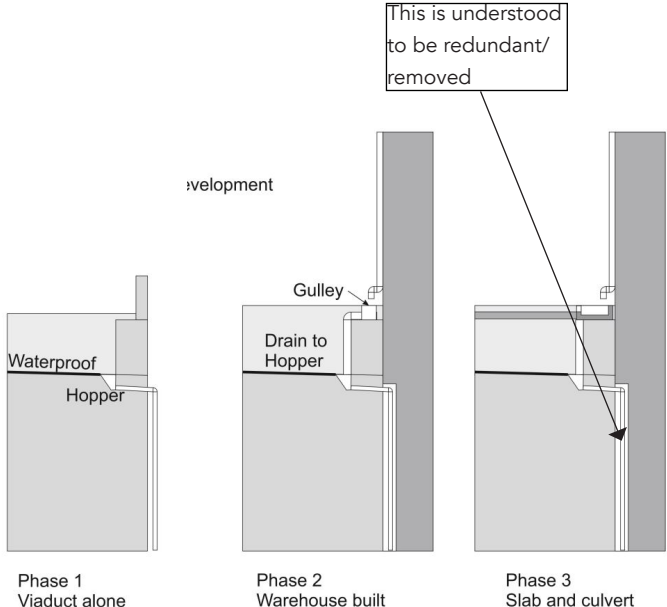


Fig 2

- 5.1.15 The abutment with the 1830s Warehouses differs to the Station Building and appears to be a more robust detail. The precast concrete lids are exposed.
- 5.1.16 The exact makeup of the original viaduct waterproofing measures is unknown, review of archival material suggests that the concrete slab and troughs were cast over the viaduct masonry skew arches, separating by an ash fill. Fig 2 (not SIM site) shows the build up observed during excavating works to the West end of Water Street during construction of the Ordsall Chord, which shows an example of the extrados to the viaduct which may be similar over the SIM viaduct.
- 5.1.17 The diagram adjacent illustrates the likely phasing and evolution of the viaduct drainage at the abutment with the 1830's warehouse.
- 5.1.18 The current theory is that there were three phases across the viaduct waterproofing measures.

- 5.1.19 Phase 1 was the viaduct alone, with the skew arches waterproofed traditionally with a camber and fall to the capping, which discharged into a series of hoppers / sumps to the North, then into rainwater downpipes.
- 5.1.20 Phase 2, the capping was then further modified during the construction of the 1830s Warehouse when downpipes from the Warehouse were discharged into a gulley at track level, which then connected below ground into the original hopper.
- 5.1.21 The latest and current Phase 3 example includes the construction of the concrete capping atop of the viaduct, which is likely to have been carried out in the 80s, with the introduction of concrete troughs to the North, South and transverse as well as the slab. It is likely, though unconfirmed that the original waterproofing measures were made redundant and encapsulated, blocked.



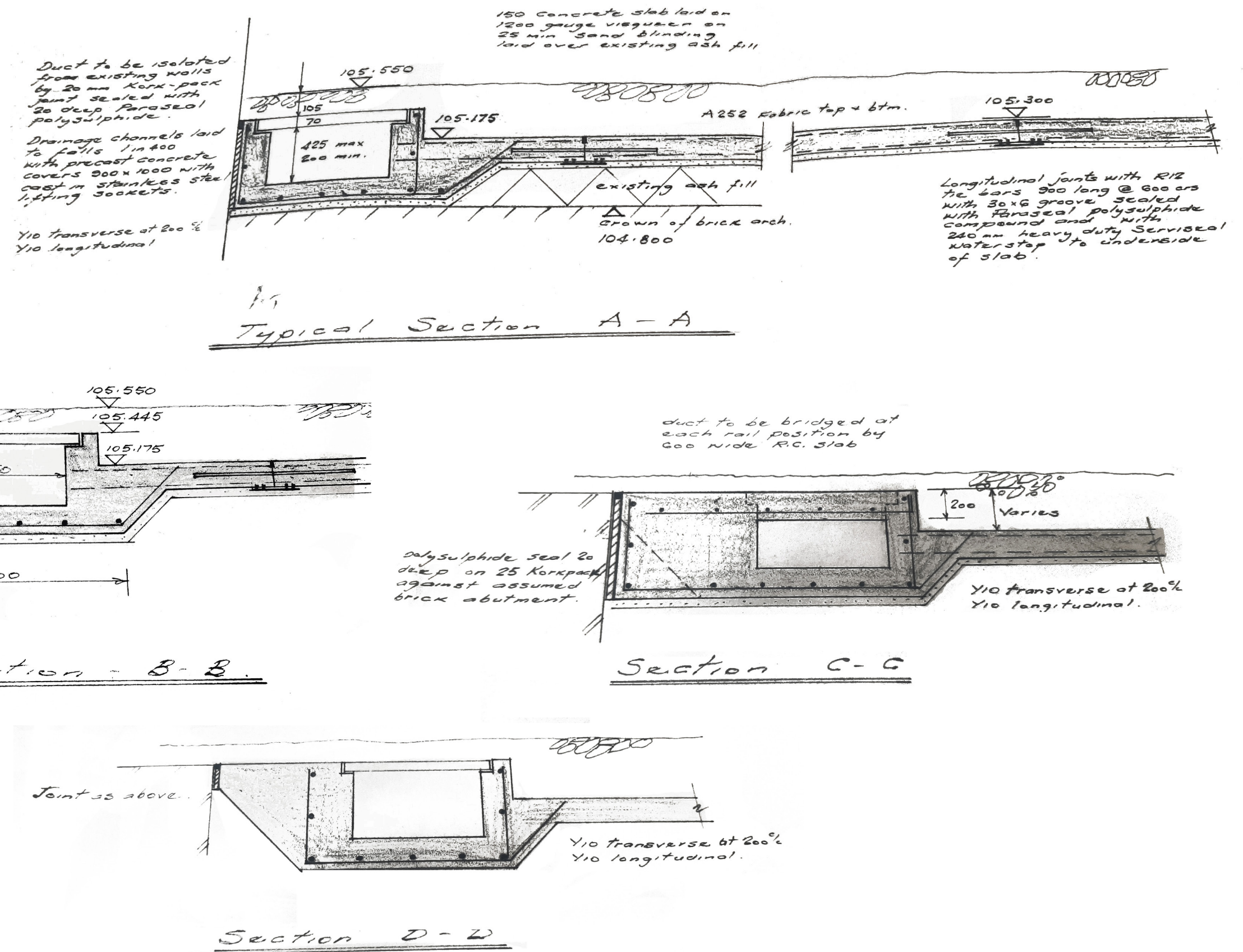
1830 Viaduct Drainage Development Diagram - Phases 1-3

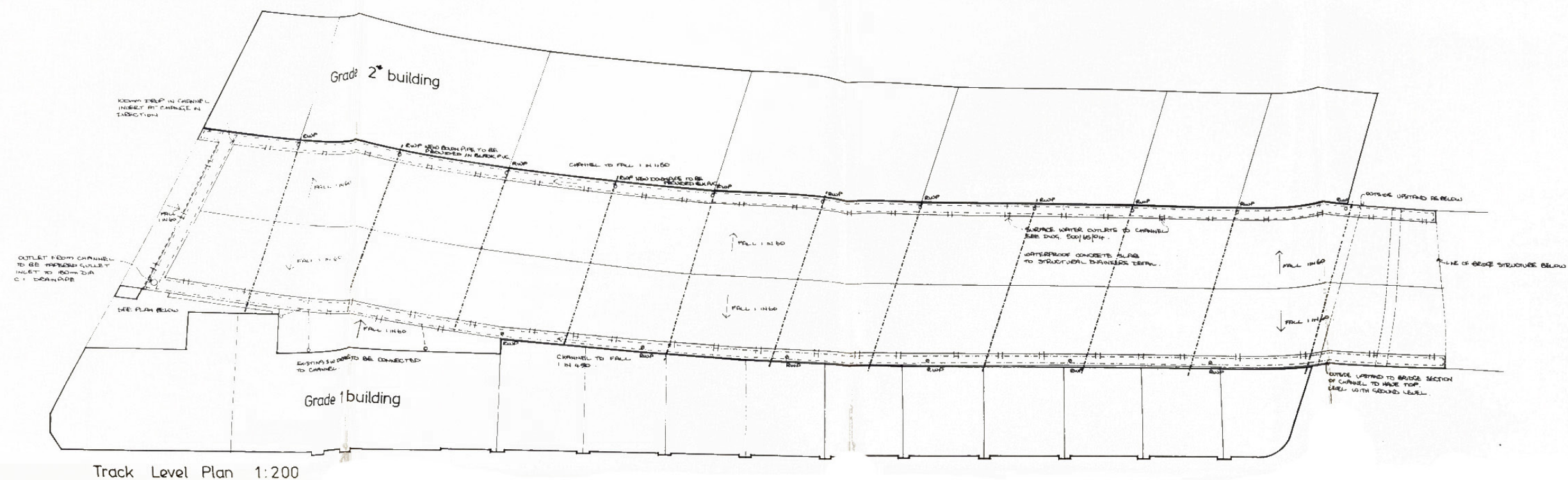
5.2 **Current External Finishes**

- 5.2.1 The external areas, finishes, elements and components extend over the Viaduct and into the Station Building platform and first floor plate of the covered platform.
- 5.2.2 Externally, the zones can be broken down as follows:
 - Ballast, railway tracks and sleepers (timber and concrete)
 - North trough with concrete lids
 - South trough with timber planks
 - Paved area
 - Timber planks to covered platform
- 5.2.3 The full extent of the concrete slab is unknown, though it is expected to fill the area currently infilled and hidden, concealed by the ballast over the full extent of the Viaduct, abutting the west wall of the storage arch There is potential that the slab and existing waterproofing measures also exists under the paved area to the north of the ticketing hall, though this has not been confirmed.
- 5.2.4 The area within the covered area of the Station Building platform at first floor, is understood to to have concrete planks with a screed and waterproofing membrane on top to the substrate with timber planks fixed on top.

5.4 Archival typical details showing original design intent

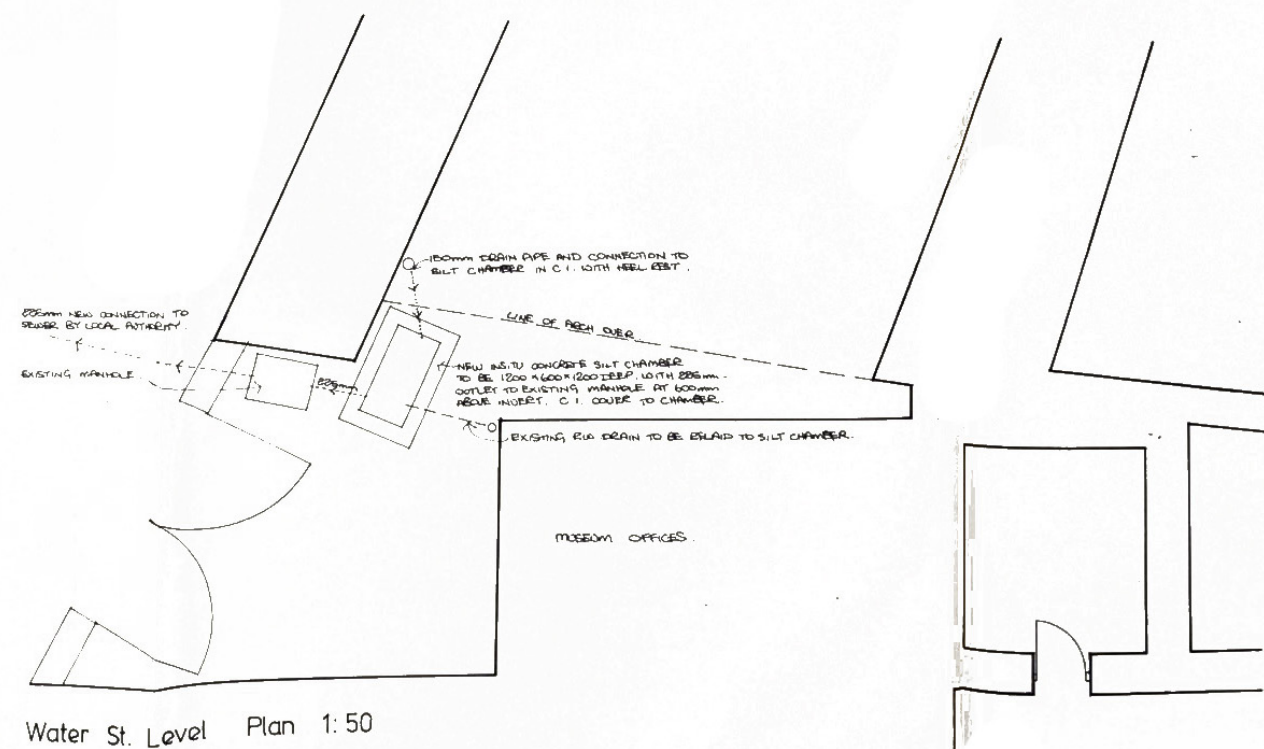
5.4.1 A selection of tender drawings have been sourced, which illustrate the original 'design intent' for the concrete slab and drainage channels.





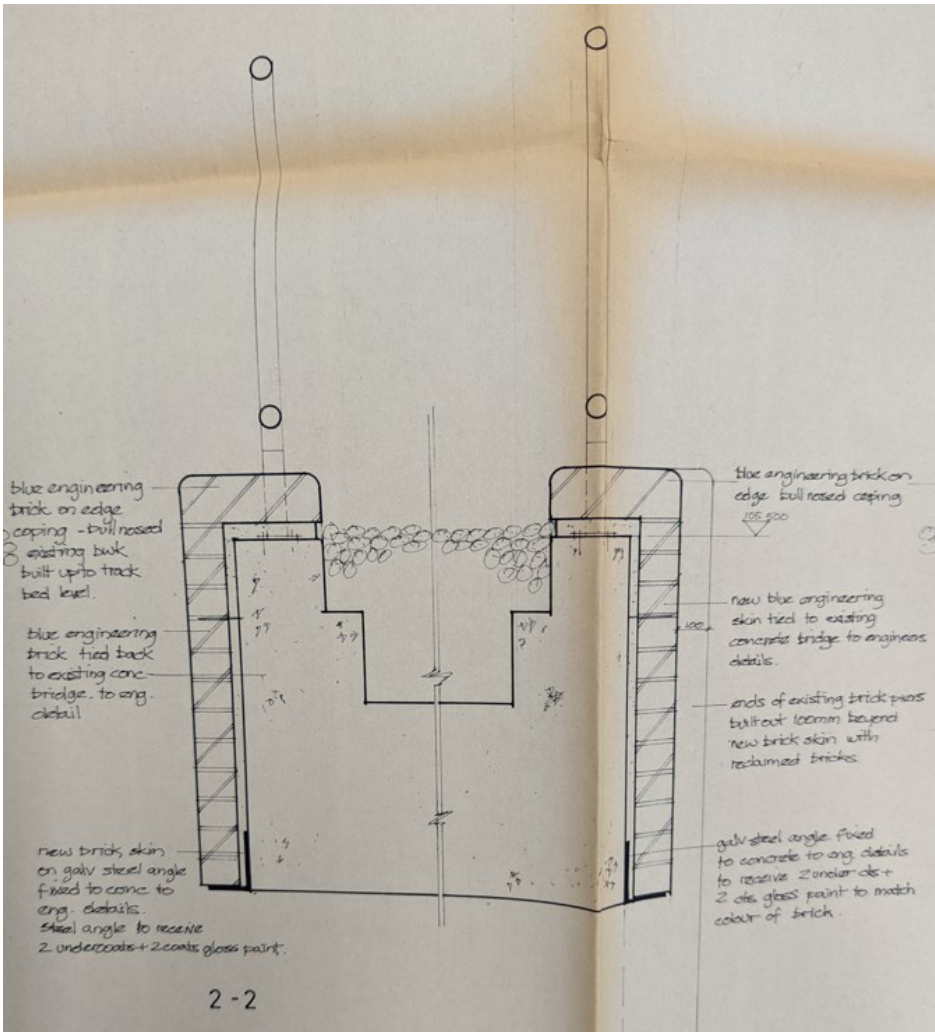
5.5 Archival GA showing original design intent at slab level

- 5.5.1 The general arrangement plan at slab level illustrates that the concrete slab extends east to west and abuts the north and south drainage channels (troughs), which directly interface with the 1830s Warehouse and Station Building. The channels are connected via a transverse trough with a rainwater outlet identified to the southwest corner.

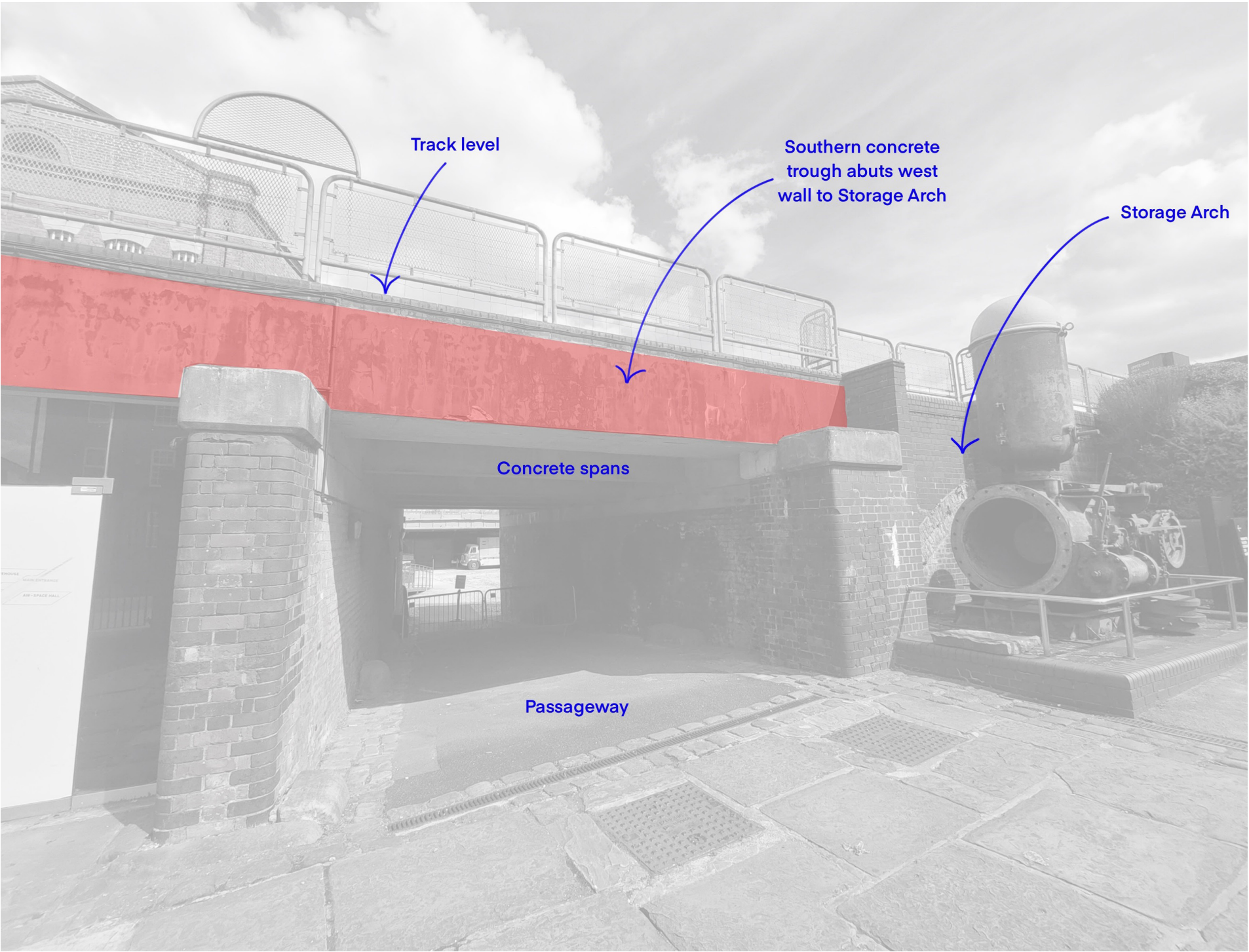


5.6 Concrete Spans

- 5.6.1 The marked-up photograph illustrates the location of the southern drainage trough, as it extends beyond the Station Building and abuts the west wall of the Storage Arch. This area is also referred to as the concrete spans, which provides a passageway between the Lower Yard, the Station Building as well as providing access to track level via a ramp to the east.
- 5.6.2 Photograph taken from the east end of the Station Building, looking north through the passageway with the pedestrian ramp to the right hand side which provides access from the Lower Yard up to track level.



‘Design intent’ for the south trough which extends across the concrete spans



6.0

Investigative Surveys

6.0 Investigative Surveys

6.1 Surveys

- 6.1.1 As part of the initial inspection works, a series of additional surveys have been commissioned to help ascertain material build-ups / arrangements / interfacing, as well as uncovering areas which are hidden and/or concealed.
- 6.1.2 The various survey techniques included both invasive and non-invasive survey types.
- 6.1.3 The surveys included the following:
 - Focused opening up works across the station platform
 - Focused opening up works across the interior of the Station Building
 - Commissioning of a timber and damp survey across the Station Building
 - Commissioning of a drainage CCTV survey
 - Flood and dye testing across areas of the drainage channels and slab
 - Lifting of timber planks across the station platform and covered areas
 - Removal of brick header course / border to platform
 - Exposure of concrete slab
- 6.1.4 The output of these various surveys included written reports of findings and recommendations, as well as general photographs and sketch details.
- 6.1.5 The purpose of the investigative works was to provide up-to-date imagery across the concrete slab and troughs to be able to report upon the current condition, in addition it provided the opportunity to inspect the various substrates across the station platform and Station Building interior to understand the various layers and arrangements.
- 6.1.6 It should be noted that the surveys carried out were limited and focused only within a few select locations, to limit any future defects or cause any further issues or harm, than those already exhibited onsite, therefore there can be no guarantee or certainty that the areas exposed are fully representative of the substrates across the entire footprint. Further survey works will undoubtedly be required in the future once appropriate safe access has been provided and the substrates exposed.

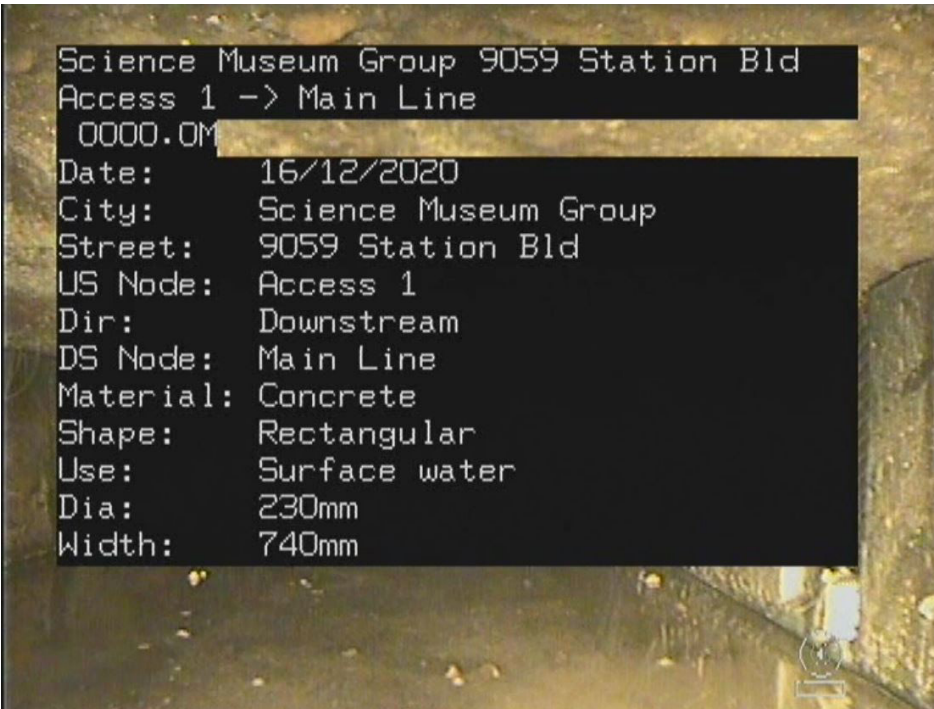
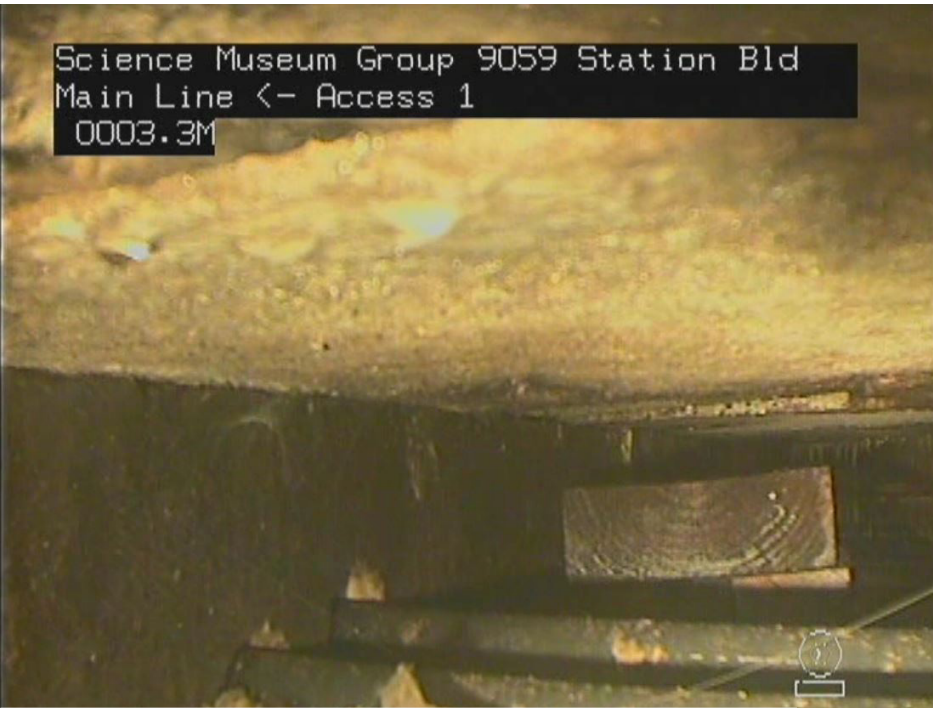


Image from CCTV inspection.



CCTV inspection showing 50mm pipe, suspected to be connected to internal rainwater downpipe which connects into the north cast iron gutter



CCTV inspection showing pipes / cables penetrating concrete trough, debris to background.

6.2 Opening up / survey techniques adopted to date

- 6.2.1 During the Station Building re-roofing project completed in April 2022, there was an opportunity to carry out several localised inspections across the assets to try to identify the cause of the leaks within the Station Building and interlinked Viaduct spaces, predominantly confined to the central area off room SB G05 and rooms, stairs and circulation areas in the surrounding area.
- 6.2.2 Further inspections were carried out in August 2022, involving the temporary removal of localised areas of ballast across the slab, to expose the concrete slab.
- 6.2.3 This included the following:
- a. Localised lifting of covered platform planks, to inspect substrate below.
 - b. Localised lifting of covered platform planks at abutment with Learning Platform, to inspect substrate below and interface with glazed screen.
 - c. Removal of brick header course / border at platform level, to inspect interface with the southern trough.
 - d. Lifting of timber planks to the southern trough.
 - e. CCTV drainage survey within the lower chamber of the southern trough.
 - f. Dye flood test across accessible areas of the lower chamber of the southern trough.
 - g. Focused dye flood test across a localised area of the viaduct slab, across day / movement joints.
 - h. Cutting out of saturated T&G ceiling boards in room SB G05 within the Station Building.
 - i. for exposure of conc slab, refer to note on pg 36. Temporary removal of ballast fill within a focused area.

6.2.4 a. Lifting of covered planks

The timber planks within the covered platform are fixed tightly with traditional nails, abutting adjacent planks. The planks sit upon timber battens directly upon the sloped substrate beneath. The boards lifted were typically saturated to the underside with signs of wet rot, decay. The battens were also found to be severely decayed. There was no evidence of cross ventilation.

- 6.2.5 The lifting of the planks allowed for review of the substrate which appeared to have an asphalt finish typically, although it had been retrospectively repaired within localised areas with a mix of a liquid and membrane applied system.
- 6.2.6 The substrate did not appear to be linked to the southern trough. From the areas inspected, it appeared that any moisture within these locations to the underside of the boards, would be trapped. There was evidence of localised soft vegetation in areas, suggesting that there was a constant source of moisture available.
- 6.2.7 b. Lifting of covered planks at abutment with glazed screen
- 6.2.8 Similarly to item (a), the build-up and condition was found to be similar. However, there was no weathering or flashing detail at the abutment / interface with the platform glazed screen.
- 6.2.9 Any trapped moisture which had penetrated the planks was simply allowed to migrate under the glazed screen to the internal space. The water has nowhere else to go as there were no visible connections or outlets evident with the southern trough.
- 6.2.10 c. Brick header course
- 6.2.11 The brick header course extends along the length of the covered platform, between columns. Used as an interface between changes in finishes.
- 6.2.12 Several bricks were carefully removed to better understand the levels, waterproofing and connections with the southern trough.
- 6.2.13 Following the removal, it was found that the screeded substrate to the covered platform simply abuts a concrete upstand / kerb, which appears to have been formed during the creation of the upper chamber of the southern trough.
- 6.2.14 There was no evidence to suggest that the covered platform substrate connects to the southern trough to discharge any trapped rainwater.
- 6.2.15 d. Lifting of timber planks to platform
- 6.2.16 Several timber planks were lifted along the length of the platform to allow for investigation of the southern upper trough chamber.
- 6.2.17 The underside of the planks were found to be sweating / moist, likely due to the fact that the void below is unventilated with stagnant air. It is understood that the

planks were replaced along their entire length in 2016.

To improve access and facilitate future, a series of manhole covers were added during the 2021-22 Station Building re-roofing works to allow for routine maintenance to be carried out across the internal rainwater piped outlets. This also allowed for localised inspection of the lower chamber and were used as access points to carry out a flood / dye test within the lower chamber.



Typical outlet from Station Building



Upper chamber visible following temp removal of timber planks

6.3.20 e. CCTV southern trough drainage survey

6.3.21 Following the formation of manhole covers providing access into the lower chamber, a drainage CCTV survey was commissioned. The survey extended from the east end of the trough, working towards the west. The survey was abandoned in both directions due to obstructions found within the trough.

The survey confirmed the following:

- There are a number of land drains to the north internal face of the lower chamber, presumably taking ground water from the viaduct slab. There appears to be a metal grillage with what appears to be ballast beyond.
- The outlets from the columns / internal downpipes appear to be circa 50mm in diameter.
- There was standing water noted within the lower chamber with silt and detritus evident.
- There were a handful of holes / mesh covers which presumably allowed for any water within the upper chamber to migrate into the lower chamber.

6.3.22 f. Dye test across southern trough

6.3.23 A dye / flood test was carried out across the accessible length of the lower chamber to the southern trough.

6.3.24 The lower chambers were tested in sections and then filled as one.

6.3.25 Following the dye test there was no evidence found of any coloured dye within the interior of the viaduct or Station Building.

6.3.26 g. Dye test across viaduct slab

6.3.27 Localised areas of the Viaduct ballast were stripped back to expose the concrete slab below. A number of mastic day / movement joints were exposed.

6.3.28 The mastic appeared to be brittle / loose in areas.

6.3.29 These joints and the slab were flood dye tested.

6.3.30 Following the dye test, there was no evidence of any of the coloured dye migrating through the slab into the interior spaces. Though the dye did work its way into the lower chamber of the southern trough, confirming that there are land drains, connections from the slab into the southern trough.

6.3.31 h. Cutting out of T&G boarding to ceiling

6.3.32 A section of the T&G boarding ceiling was removed to allow

for inspection of the void, substrate beyond. This was within the location of room SB G05 where ongoing water ingress issues had been persistent for some time, resulting in the client team building a permanent catchment tub internally.

6.3.33 The timber boards were visibly saturated and heavily soiled.

6.3.34 Following removal of the boarding, a layer of mineral wool was found packed between timber battens and counter battens, with what appeared to be the concrete planked floor structure above. The void appeared to be circa 50-75mm in depth.

6.3.35 The insulation was soddened, the timber visibly wet and soiled with evidence of moisture being held to the underside of the planks. Suggesting issues potentially linked with condensation and water migrating through the slab.

6.3.36 The area above here is an externally covered space. The voids within the ceiling appear to be unventilated with no air space.

6.3.37 i. Exposure of concrete slab

6.3.38 Following the completion of previous survey inspections, the existing concrete slab was exposed, involving the temporary removal of compacted ballast between the outer edge of the most southern tracks and the balustrading to the platform edge.

6.3.39 The removal of the ballast allowed for closer inspection of the top surface of the slab, including a number of north-south axis joints being made visible. The localized section of exposed slab was found to be relatively smooth and even.

6.3.40 The two joints exposed included a general day joint and an expansion joint. The expansive joint projected from the surface by approximately 50mm with chamfered edges with a mastic sealant fill to the centre.

6.3.41 Potential routes / causes of water ingress

6.3.42 The root cause of the issues observed both internally and externally is still unknown, though likely to be a multitude of defects as opposed to a single underlying issue.

The potential causes of water ingress are noted below:

- Water is migrating through day joints in the slab, concrete elements.
- Water is migrating through the concrete troughs, slab, through fissures, open joints.
- Services penetrations, distribution have been subsequently installed and have disturbed and broken

previously impervious finishes and waterproofing measures.

- Ground water is migrating between the original viaduct capping and the concrete slab.
- There is defective, broken below ground drainage.
- The slab and outlets cannot cope with the capacity imposed.



Exposed slab to the south side



Typical expansion joint



CCTV southern trough drainage survey



Dye test across southern trough



Dye test across viaduct slab



Cutting out of T&G boarding to ceiling



Lifting of covered planks



Lifting of covered planks at abutment with glazing



Brick header course interface with south trough



Lifting of timber planks to platform

6.3 Specialist Surveys and Inspections

6.3.1 The design team site inspections have been further supplemented by the commissioning of both a drainage CCTV survey and a timber and damp survey.

6.3.2 The full reports have been appended to this report but can be summarised as follows:

6.3.3 Drainage CCTV survey

6.3.3.1 A drainage CCTV survey was commissioned and focused on the below ground concrete formed drainage trough which runs perpendicular to the Station Platform and was introduced during the mid-1980s reconstruction building works.

6.3.3.2 It is understood that the concrete formed rectangular drainage trough takes surface water drainage from the Station Building rainwater goods which serve the north elevation.

6.3.3.3 Observations:

- Two CCTV survey inspections were undertaken, and both were abandoned due to the presence of obstacles.
- The trough length is approximately 69.60m in length.
- Internally the trough is rectangular and measures (H) 230mm x (W) 740mm.
- Water level within the trough, 5% vertical dimension.
- The size of the rainwater connection pipes into the trough were circa 50mm dia.
- There was a general build-up of silt (settled deposits) and debris contained within the trough base.
- Pipe or cabled (obstacle) connection visible from 4 o'clock to 8 o'clock.
- The trough may also take surface water from the 1830s Viaduct adjacent.

6.3.4 Timber and Damp Survey

6.3.4.1 A timber and damp survey was commissioned to be undertaken across the Station Building both internally and externally. This document excludes all roofed elements as these were included within an earlier survey and report. See H+R 'Detailed timber condition survey of roof structure' dated 9th November 2020 for further information.

6.3.5 Observations:

6.3.6 Exteriors

6.3.6.1 North elevation and platform

6.3.6.2 Platform timber deck:

6.3.6.3 To the south of the tarmac filled 'track-bed', square-edge boards measuring 1250 (l) x 220 (w) x 70mm (d) form an external timber deck. Timber species identified as Sitka spruce (*Picea sitchensis*). The boards were tightly abutting and there were no physical fixings.

6.3.6.4 Where accessible, the underside of the boards were superficially decayed with moisture content in excess of 40%. The 'damp' was largely attributed to continuous condensation cycles within the unventilated void.

6.3.7 Brick:

6.3.7.1 Localised areas warranted repointing.

6.3.7.2 External hardstanding has been laid directly up to the external wall and had encouraged rainwater to 'splashback' against the foot of the building and the brickwork was visibly wet. This issue was exacerbated by overtopping of the blocked rainwater gutter above.

6.3.8 Stone:

6.3.8.1 The door openings were framed by original decorative limestone architraves and windows included limestone



Vegetation growth between platform boarding



Wet rot decay to timber battens and boarding to platform boarding



Moisture content reading being taken within the lower ground floor

	arches, sills and mullions.				
6.3.8.2	Many of the stones had suffered from mechanical damage, erosion, and delamination. In addition, corrosion of the embedded metal railings had resulted in cracking through the stone.	<ul style="list-style-type: none"> A board to the north west corner was heavily decayed by wet rot, this was lifted and revealed the underlying batten, measuring ~40 x 45mm. Internally, there is a significant risk that the timber battens may be partially decayed. Ground - floor 		<ul style="list-style-type: none"> Lightwells were spanned by concrete lintels encased in timber. No significant decay was detected. 	
6.3.9	South elevation:			6.3.19	Walls:
6.3.9.1	Liverpool Road elevation: <ul style="list-style-type: none"> The external wall dates from the 1980s reconstruction and consists of a half brick thick inner leaf constructed of red brick laid in faux Flemish bond (incorporating snapped headers). Behind the inner leaf, a ~50mm wide cavity is filled with a ‘blown’ mineral fibre insulation. At first floor the external leaf appears to be a single brick thick. The original drawings show that the ground floor external leaf is constructed of medium density concrete block with a ‘sika’ type waterproof render and ashlar detailing. 	6.3.13	Water penetration: <ul style="list-style-type: none"> Significant water ingress noted to north wall. The brick arches in these areas were saturated and internal finishes were damp and had deteriorated. 	<ul style="list-style-type: none"> The void behind the inner leaf of brick was inspected using a boroscope. The Sika type ‘waterproof’ render to the backside of the blockwork was visible as there was no mineral wool insulation within the cavity at this level. The full timber and damp report provided by Hutton and Rostron can be found appended to this document and includes a set of marked up key plans. 	
6.3.10	First floor				
6.3.11	Windows: <ul style="list-style-type: none"> All windows to the south and east elevation were of softwood single glazed sliding sash construction and appeared to largely date from the 1980s reconstruction. Sills, bottom rails and lower elements of the first - floor windows were generally partially decayed by wet rot. Window openings were generally spanned by concrete lintels concealed with stained softwood timber boards within the reconstructed portion of the asset. Windows to the former first- and second-class ticketing hall were spanned by timber lintels, concealed behind softwood linings. No decay was detected but were at risk of damp and decay in areas of ongoing water penetration. 	6.3.14	Ceiling: <ul style="list-style-type: none"> Softwood tongue and groove (t&g) boards conceal the underside of the concrete first floor and the projecting steel RSJs were boxed-in with boards. The t&g boards appeared to be fixed to timber battens suspended from the concrete floor and formed a void of circa ~250mm above. Timbers were generally free from significant decay. However, in the areas of water ingress, the timbers were damp and partially decayed with surface moisture content in excess of 35%. 		
		6.3.15	Windows and doors: <ul style="list-style-type: none"> Ground floor window construction was as per first floor. 		
		6.3.16	Floor: <ul style="list-style-type: none"> Tongue and groove floorboards measuring ~160 x 30mm were nailed to timber battens which sat atop a solid concrete floor. Boroscope investigation revealed the spacing between the batten was filled with insulation. Surface moisture was typically elevated in areas of ongoing water ingress, though no significant decay at this time. There is a significant risk that the timber battens may be partially decayed where water has penetrated and pooled above the concrete floor. Lower - ground floor 		
6.3.12	Platform / first floor: <ul style="list-style-type: none"> Square edge boards measuring ~230 x 80mm were nailed to underlying battens at ~ 450mm cts with mineral wool insulation between. Timber species identified as Norway spruce (Picea abies). Timbers at the northern extremity were wet and partially decayed in localised areas, generally corresponding with leaks from the defective rainwater goods. Debris and vegetation build-up was noted to have accumulated within the gaps between the boards and had reduced subfloor ventilation and exacerbated damp and decay. 	6.3.17	Ceiling: <ul style="list-style-type: none"> The ceiling was as described at ground floor level. The paint finishes were in very poor condition and this is attributed to shrinkage of the timbers due to the overheating of the lower ground floor spaces. No significant decay was detected, and moisture contents were generally low. A small number of isolated areas highlighted an increase in surface moisture content and were elevated up to 18%. This generally corresponded with the location of the former lightwells to the south elevations. 		
		6.3.18	Window openings:		

7.0

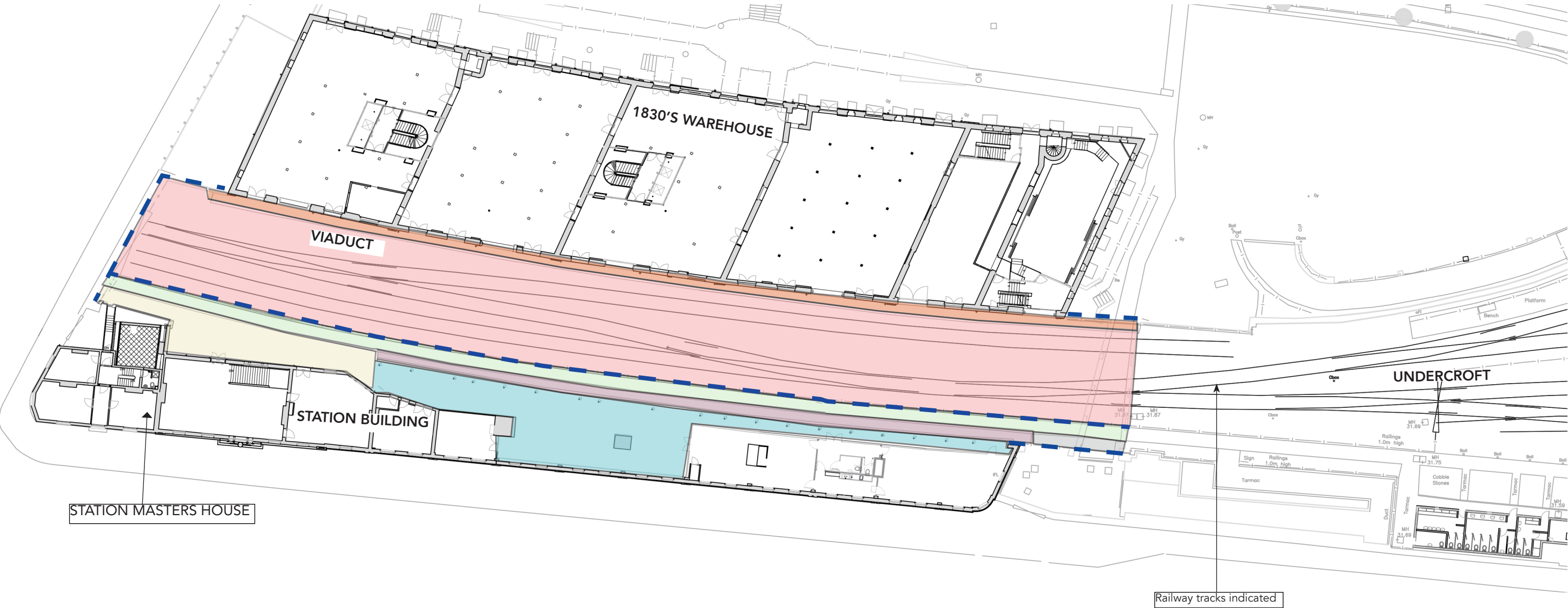
Current Design & Arrangement

7.0 Current Design & Arrangement

7.1 External Finishes Key Plan

Key

- Ballast and railway tracks with concrete slab beneath
- Macadam
- Random Stone Pavers
- Modern timber planks
- Timber planks within covered external area
- Concrete lids to trough
- Metal Balustrading



7.2 Current slab level general arrangement plan

- 7.2.1

The general arrangement plan, provided on the following page illustrates the interpreted layout of the below ground surface water drainage system which extends across the full length of the Viaduct based upon obtained archival material and focused opening up / investigative works. The graphic is not to scale.
- 7.2.2

The ballast and track have been omitted for presentation purposes.
- 7.2.3

The troughs / drainage channels are highlighted with a pink fill with the primary troughs abutting the 1830s Warehouse to the north and the Station Building to the south, connected via a transverse channel to the west. The main slab highlighted in purple has a high point to the centre and falls towards each of the troughs. The slab abuts the troughs to three sides with a small kerbed, concrete toe to the east end.
- 7.2.4

The area of land to the west within the orange fill is laid to fall into the troughs on both sides.
- 7.2.5

The zone within the covered platform with brown fill is understood to be laid to fall into the trough.

WATER STREET

LOWER YARD

Concrete slab
laid to falls

Concrete toe /
upstand

1830s WAREHOUSE

North trough

Transverse
trough

Outlet from channel to be
tapered gulley inlet to 150mm
Ø cast iron drain pipe

Concrete planks
and screed

Line of bridge
structure below

South trough

LIVERPOOL ROAD STATION

Covered
platform

Concrete slab & drainage trough layout Plan as Existing

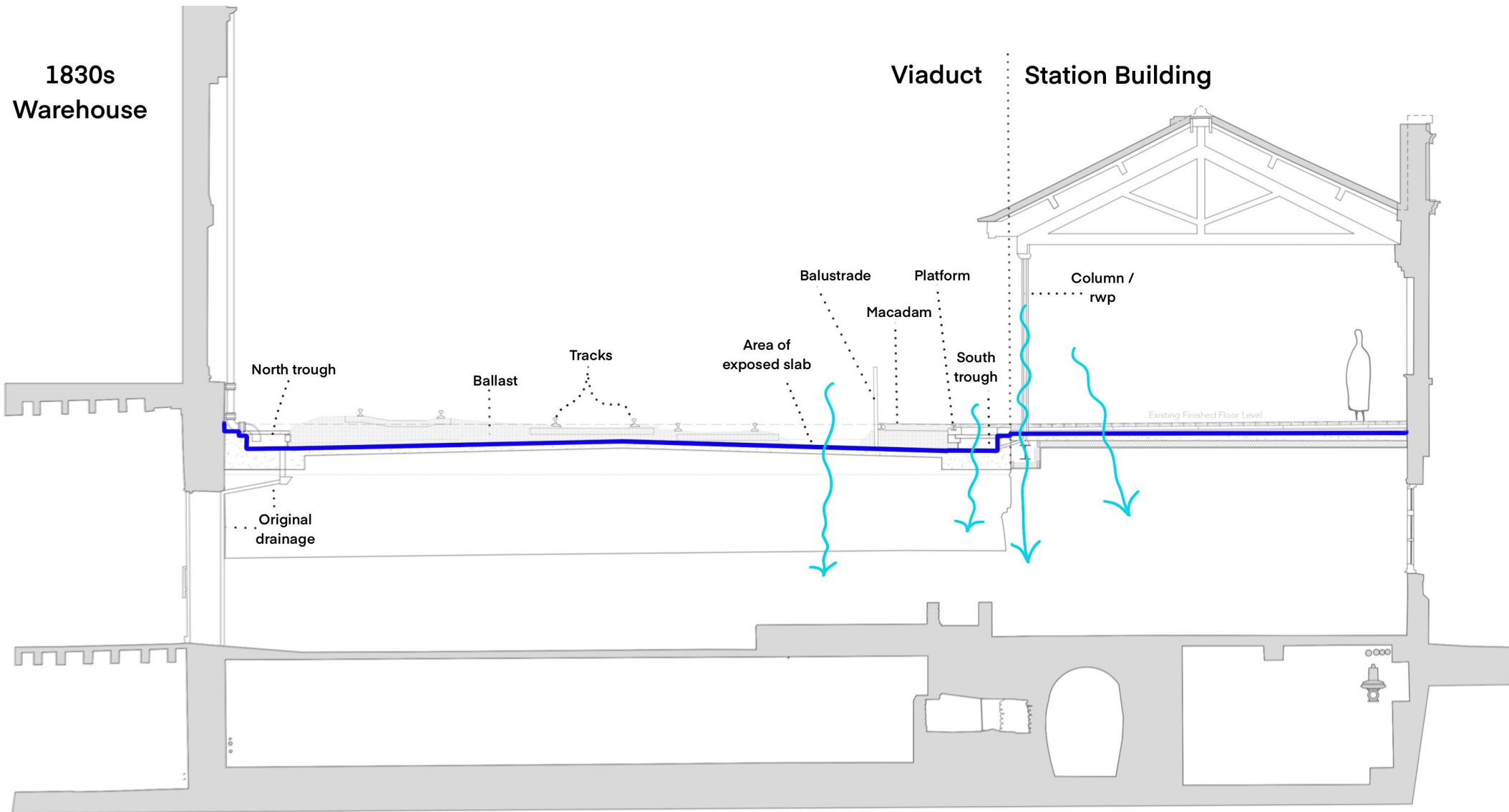
Concrete slab
laid to falls

LIVERPOOL ROAD

7.3 Cross Section

7.3.1 Cross section review

- 7.3.1.1 To aid with understanding the relationship between the three assets, a working cross section has been developed for illustrative purposes, it is by no means meant to fully interpret the below ground make-up but to identify changes in level and the intricacies of the potential waterproofing interfaces.
- 7.3.1.2 The standard GA section has been provided by an external surveyor, however the below ground drainage, waterproofing and levels are purely indicative representative of isolated follow-up dimensional surveys only, following package of opening up and investigative works.
- 7.3.1.3 The slab is laid to 1:60 falls from the centre, dispersing into the north and south troughs.
- 7.3.1.4 As reported earlier, we believe that the original drainage system is redundant, though we have illustrated where this may have existed at the abutment with the warehouse.
- 7.3.1.5 We understand that the troughs are laid to a 1:450 fall towards the west, with the north and south troughs connected via a transverse trough. Archival research suggests that water then discharges into a single downpipe to the southwest corner, to the north of the Station Masters House.
- 7.3.1.6 Having reviewed the section and all available information to date, it is highly likely that the interface with the southern trough and covered platform is poor, non-existent.
- 7.3.1.7 There are many potential areas where water may be migrating such as:
- poor detailing / interface with columns / outlets
 - ret
 - rospective works
 - services penetrations
 - movement / expansion joints
 - defective finishes

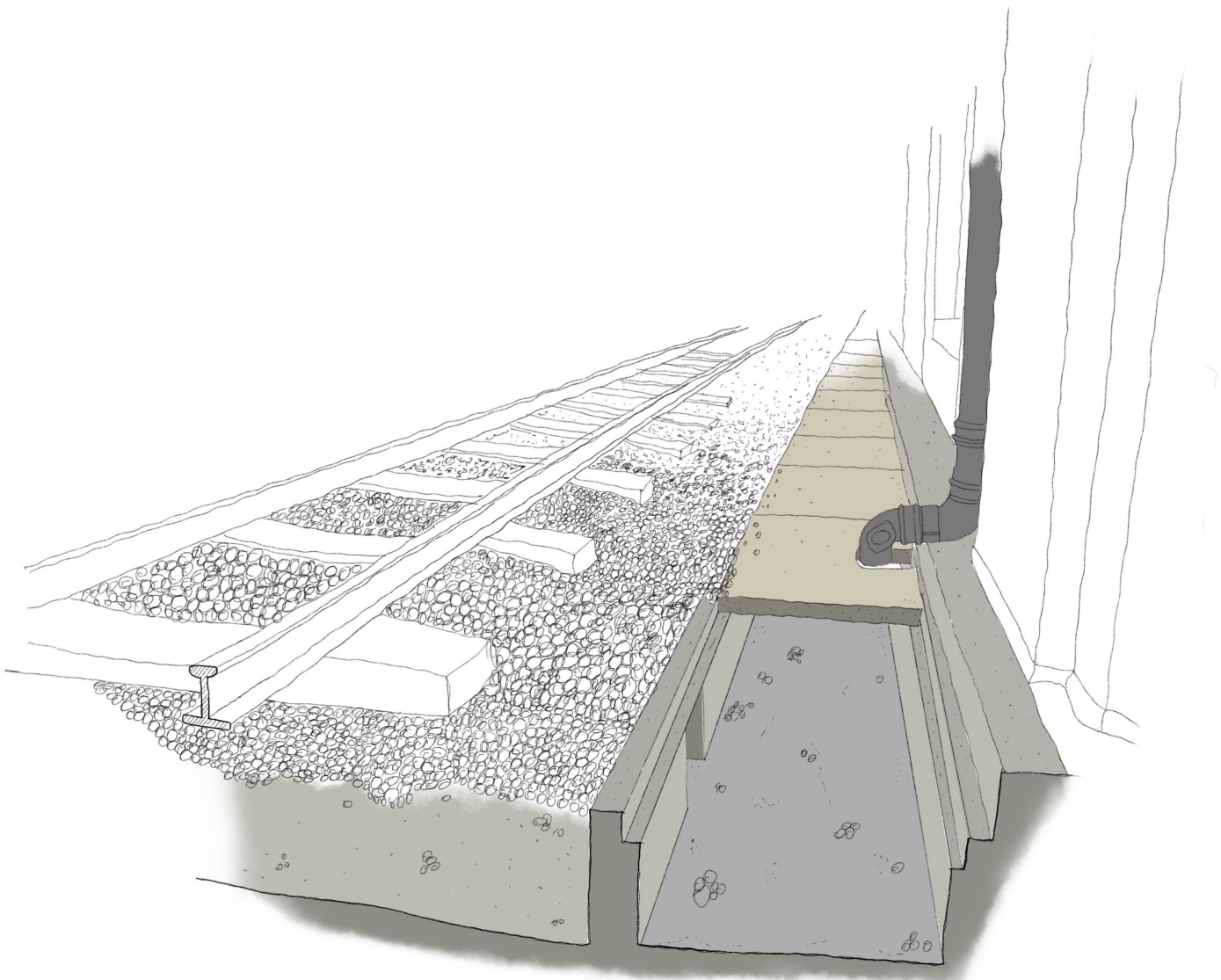


7.4 Drainage Channels / Troughs Design

7.4.1 Northern Trough

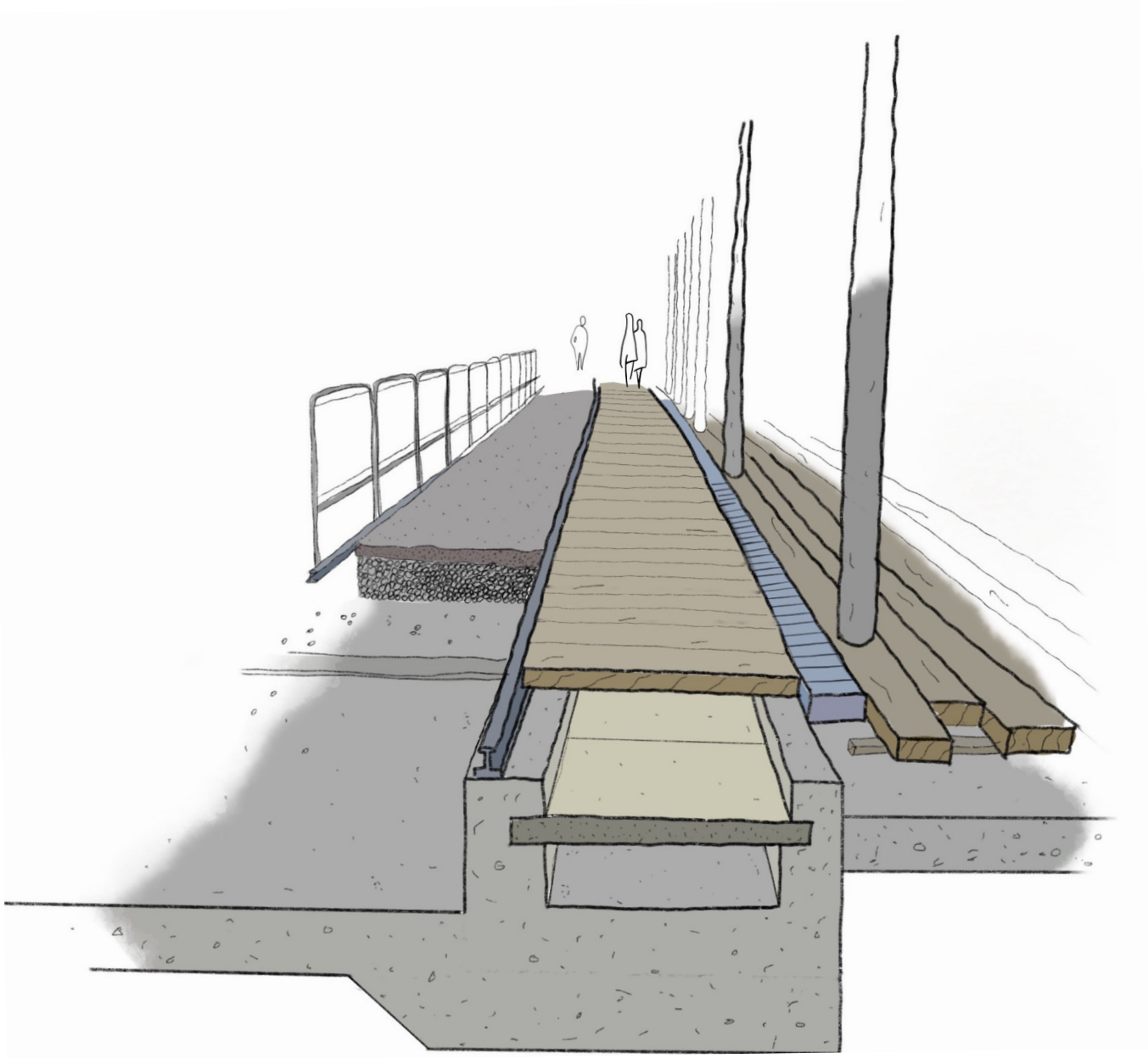
- 7.4.1.1 The north trough runs perpendicular to the 1830s Warehouse and extends beyond the end elevations in both directions. The end of the east channel stops just after it passes over the top of the concrete spans, just before the Storage Arch.
- 7.4.1.2 It is a single chamber and understood to be laid to fall towards the west, where the surface water transfers to the transverse drainage channel, which in turn connects into the south trough.
- 7.4.1.3 The channel is capped by huge precast concrete covers, that are set within a rebated edge detail. The lids are tightly abutted in localized areas but typically have gaps between each unit. There are several defective lids with fissures evident. The lids are uneven, likely due to the presence of ballast in between the underside of the lid and edge rebate.
- 7.4.1.4 The covers have been locally broken out to allow for the rainwater downpipes from the 1830s Warehouse to discharge into the drainage channel.
- 7.4.1.5 The trough abuts the south elevation of the warehouse with a deep ledge (concrete screed) with a shallow upstand, which is flashed and taken into the first mortar joint.

- 7.4.1.6 The interior of the chamber is full of ballast which has worked its way through from track level, detritus and standing water observed, including well established vegetation growth in areas.
- 7.4.1.7 The adjacent graphic illustrates the current arrangement of the northern trough and its relationship with the 1830s Warehouse and railway tracks. A section of concrete covers has been removed to illustrate the profile and arrangement of the interior of the drainage channel. You can see the large diameter rainwater downpipes from the warehouse discharge directly into the channel.



7.4.2 Southern Trough

- 7.4.2.1 The south trough follows the arc of the Station Building and railway tracks, extending north to south, matching the extent and length of the northern trough.
- 7.4.2.2 The channel has a single chamber predominantly with an upper chamber which was added retrospectively in order to make up external ground levels and allow for the installation and detail of recessed timber planks, which run the entire length of the Station Building roof, this has resulted in a two-tiered arrangement.
- 7.4.2.3 The adjacent graphic illustrates the current arrangement of the southern trough and its relationship with the Station Building and platform. The trough is masked by timber planks which encapsulate the upper chamber, with a macadam finish to the north with balustrading and original timber planks to the covered platform to the south.
- 7.4.2.4 The channel then extends beyond the last plank to the west and is concealed and capped by stone paving stones of random lengths and width, with stone cobbles to the east.
- 7.4.2.5 The rainwater pipes to the Station Building penetrate the lower chamber and discharge directly into the trough.
- 7.4.2.6 It is understood that the trough is laid to fall towards the west of the site and discharges into a large 150mm diameter external vertical downpipe. The exact connection and arrangement of this detail is unknown.
- 7.4.2.7 The interior of the chamber is largely inaccessible, having only recently seen a series of manholes formed and installed at rainwater outlet locations to aid maintenance. The channel has standing water, silt and debris. Services penetrations have been observed on a north-south axis, running through the channel. The full extent of penetrations or defects across the concealed drainage channels are unknown.

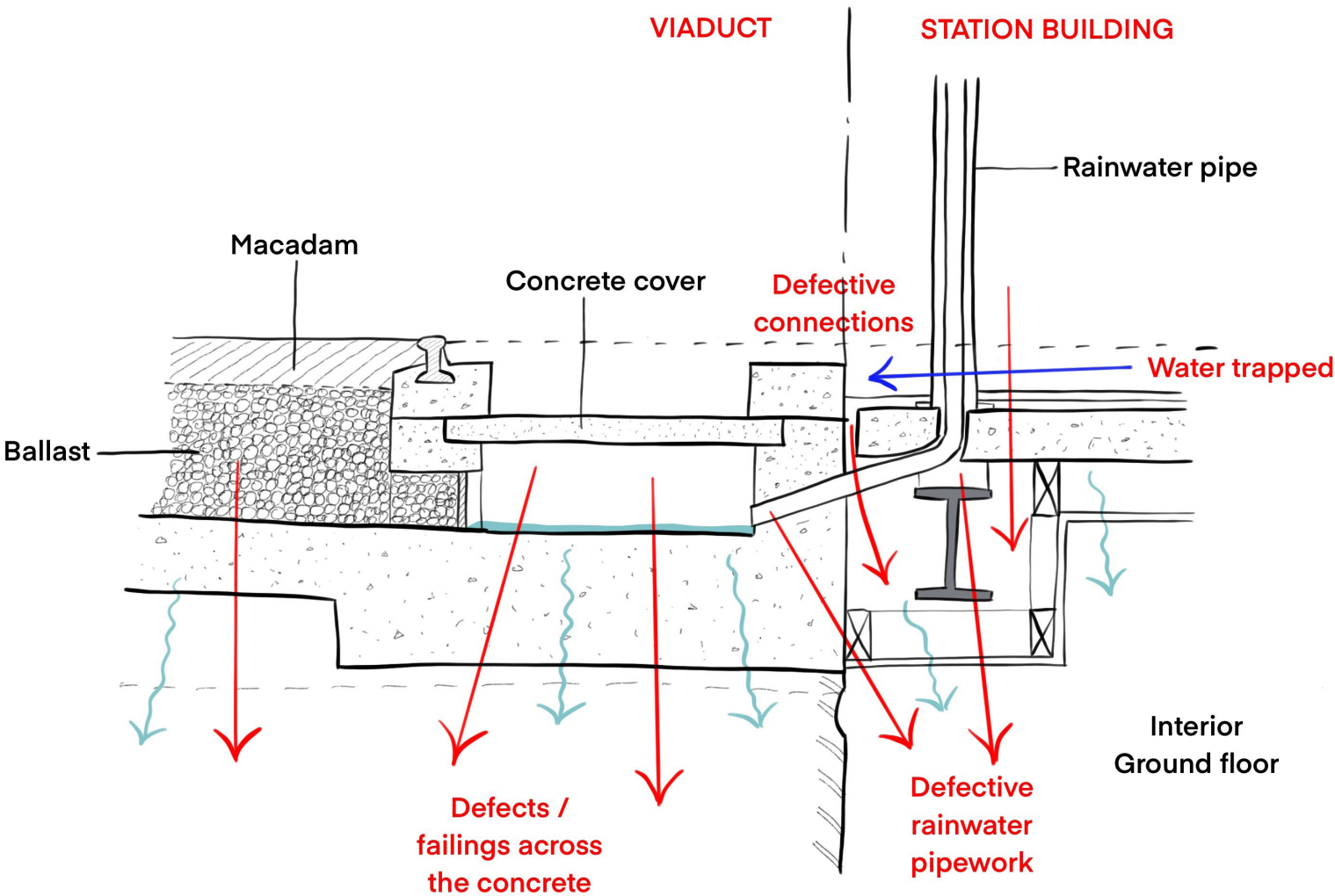


7.4.3 Transverse Trough

- 7.4.3.1 Until recently, the potential existence of this trough was not known, review of additionally sourced archival material suggests that the northern trough is connected into the southern channel via a separate trough on a north-south axis.
- 7.4.3.2 The trough or lids are not visible at track level and if they do exist, are buried, and concealed by the ballast and tracks over.

7.5 Design Constraints

- 7.5.1 The original intention is likely to have allowed for the concrete screed over the concrete planks to the Station Building to be laid to a fall, to disperse towards the concrete covers. However, at some point in time post Station Building rebuilding, a brick header border was added, and then subsequently timber planks have been introduced, inset to be laid flush with surrounding finishes. This involved the introduction of the cast insitu concrete kerb.
- 7.5.2 The introduction of this then restricted the passage of trapped water from the covered platform, into the drainage channel. In addition, and already noted in detail, a series of rainwater outlets were retrospectively introduced with penetrations formed through the side cheek of the trough.
- 7.5.3 The adjacent diagram illustrates an interpretation of the likely interfacing conflicts and highlights potential areas of water ingress. This detail is at the junction between the Viaduct, southern trough and the Station Building. The arrangement is purely indicative with timber planks hidden for graphical purposes.



7.6 Irregularities and Discrepancies

7.6.1 Further review between the recently sourced archival material, which is recorded as being at tender status and the as built (present day) construction onsite has highlighted a number of discrepancies and variations to the original design intent.

7.6.2 A number of localised investigative works, a mix of invasive and non-invasive have been carried out within the last 12 months as a means to try to confirm the condition and make-up of the slab and drainage troughs.

7.6.3 a. Station Building rainwater pipes

7.6.4 Review of the archival material suggests that the original intention was that the rainwater pipes from the Station Building would be surface fixed to the elevation and discharge, directly through the concrete covers. This may have been the case when the project was completed, however the subsequent major restoration and rebuilding project carried out in 1985 changed this intent, with the existing platform columns understood to have been sleeved to allow for the transfer of rainwater from the gutter, down through the pipe, through the base of the column, and lastly discharging into the lower chamber via a transfer pipe. The material, waterproofing measures and connection detailing are unknown, however review and analysis of drainage CCTV footage, confirms the inclusion of outlets which align with the columns and appear to have been formed retrospectively through the side wall of the trough, to take a 50mm diameter transfer pipe. The outlets observed vary in terms of detail and projection.

7.6.5 b. South trough upper chamber

7.6.6 At some point between 1985 and present day, modern timber planks were introduced, running the entire length of the Station platform. The timber planks are set flush with surrounding hard landscaping finishes. The planks sit upon a cast insitu concrete kerb, which provides a ledge for the timber to sit on, with the planks unsupported to the centre. It is assumed that the void, upper chamber was designed and detailed in such a way as to encourage cross ventilation to the underside of the timber planks. However, the planks are tightly abutted, and ventilation is restricted, resulting in the underside of the timber being incredibly moist and saturated. The void has created a stagnant zone, which has resulted in localised wood rot.

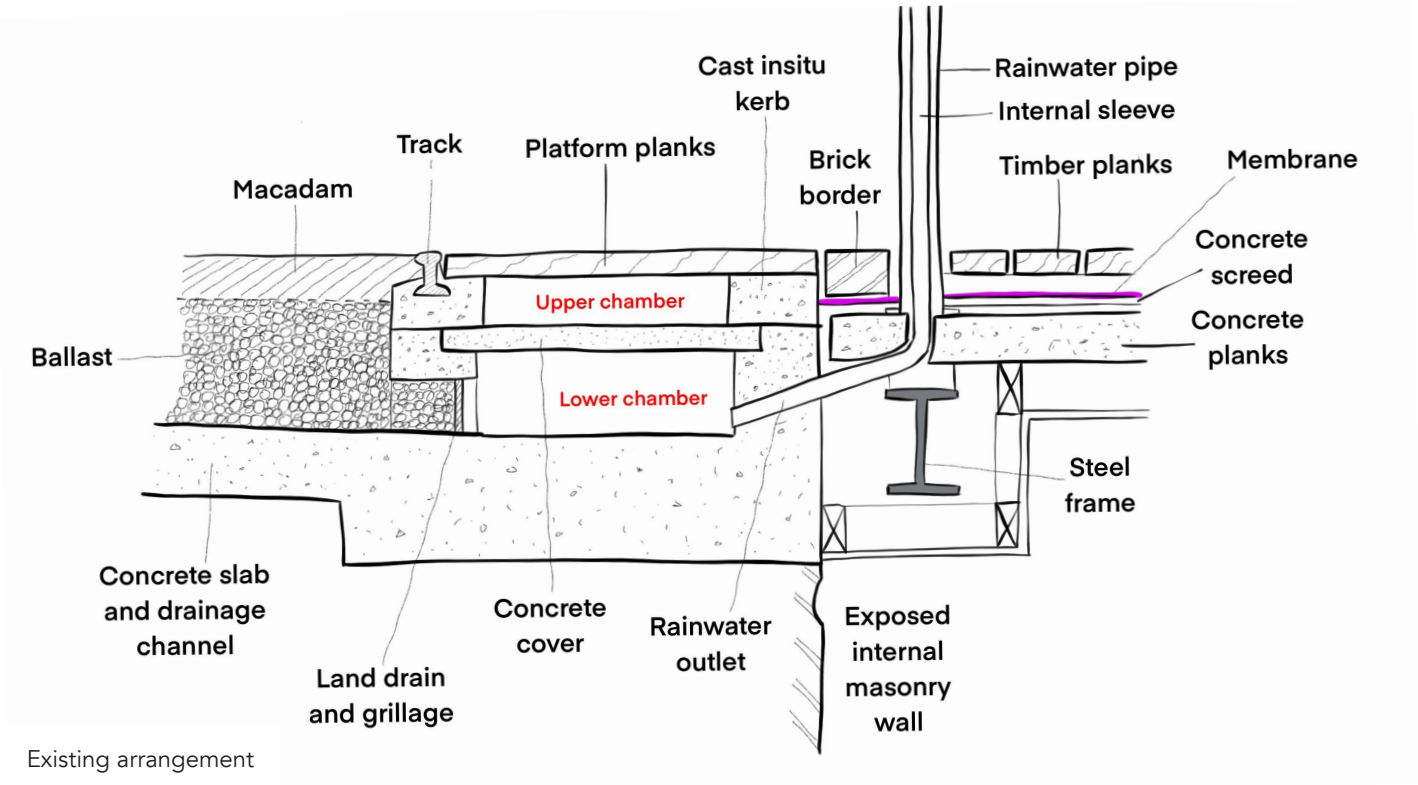
7.6.7 In addition, the introduction of the concrete kerbs/upstands to support the timber planks has resulted in the covered platform being unable to appropriately disperse water

from its substrate. A physical barrier has been formed with no consideration for removing any trapped moisture from behind. This has resulted in increased and sustained saturation of water to the underside of the original timber planks, which has encouraged the growth of soft vegetation as well as resulting in wet rot outbreaks.

7.6.8 The adjacent diagram provides an interpretation of the likely interfacing layout. The detail is taken through the southern trough at the abutment with the Station Building. The arrangement is purely indicative.

7.6.9 c. Trough outlets

7.6.10 According to the recently sourced archival material, both of the north and south troughs are connected via a transverse trough running on a north-south axis to the west end of the Viaduct. There is a single vertical outlet to the most southwestern corner, which is then subsequently connected into the main highway sewer. However, a second large diameter pipe is located to the north of the Station Masters House. It has yet to be proved but this may be a secondary outlet pipe to the below ground slab drainage network. Equally, there is a hopper and outlet to the west of the 1830s Warehouse, just north of the northern trough, which may also be connected to the below ground drainage network, potentially offering an overflow arrangement, however this has not been confirmed.



8.0

Proposals

8.0 Proposals

8.1 Introduction

8.1.1 The document sections up until this point will have provided the reader with a detailed and clear understanding of the Viaduct and its relationship with the 1830s Warehouse and Station Building but most notably, the content has highlighted the extensive issues that currently exist which are adversely impacting the Viaduct.

8.2 Proposals

- 8.2.1 The primary objective for this project is to expose the concrete slab, surfaces and drainage channels which extend across the Viaduct and interface with the 1830s Warehouse and Station Building, this will involve the temporary removal of all existing surfaces, elements, and components, including but not limited to ballast, railway tracks, hard surfaces, fixtures, and fittings.
- 8.2.2 The proposal will then include full detailed inspection across all concrete substrates and surfaces, to identify and schedule all necessary remediation works, to carry out localised improvement works to enhance and secure the assets future for years to come and then finally, to install a new waterproofing system, carefully interfaced with the surrounding heritage assets to provide a watertight external envelope.
- 8.2.3 Following this, all external surfaces, elements, components, fixtures, and fittings will be reinstated, except where stipulated otherwise, where minor enhancements have been incorporated.

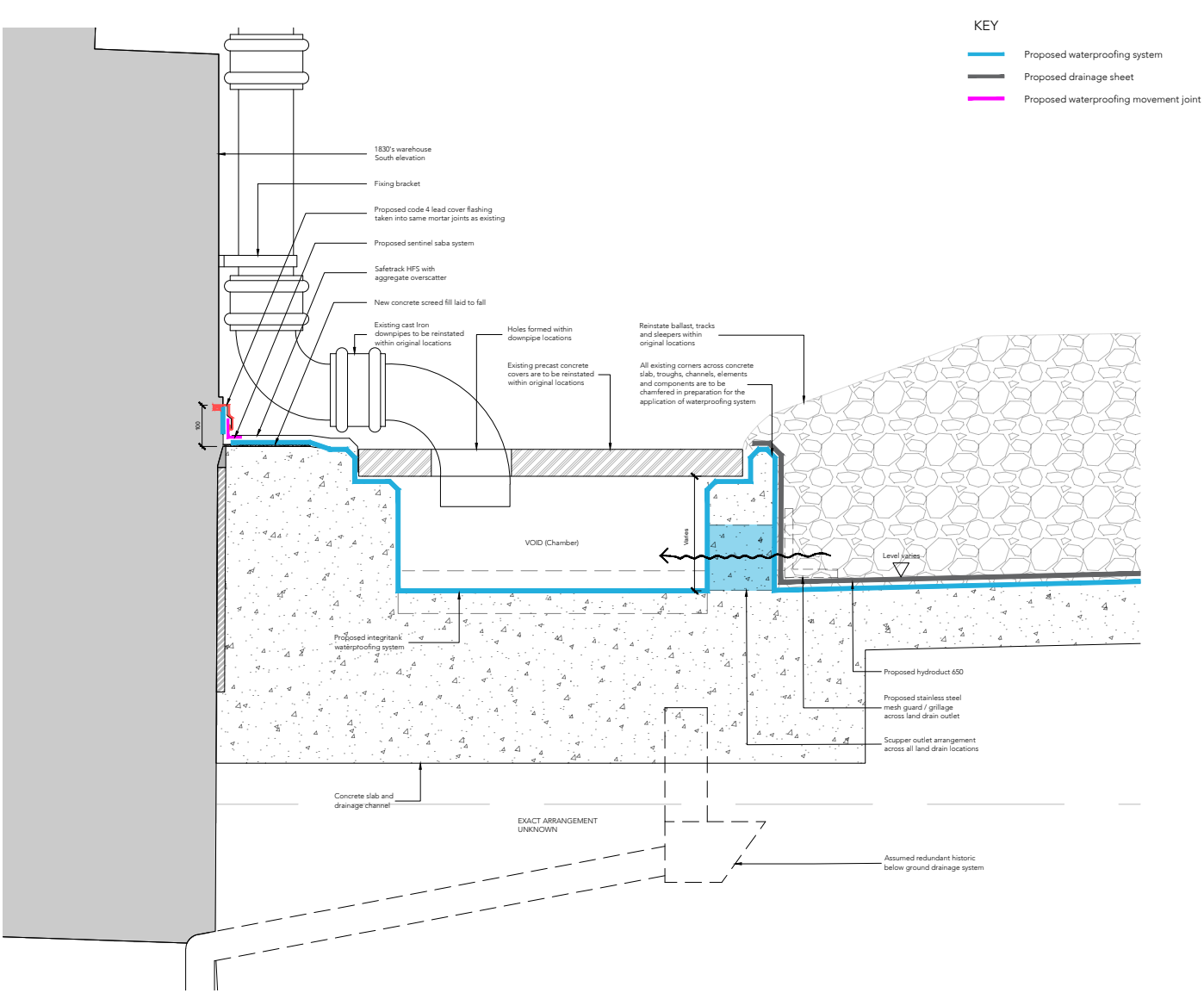
8.3 Technical Studies

8.3.1 Typical Details

- 8.3.1.1 The inspection and assessment of the existing fabric has informed the development of the proposals.
- 8.3.2 Interface / Abutment with the 1830s Warehouse – North Trough
- 8.3.2.1 Due to the retainment of the existing north drainage channel, the general arrangement and interface with

the warehouse will not dramatically alter from its current situation. The asphalt upstand as existing will be replaced with the new waterproofing system with the finish masked by the inclusion of a lead cover flashing, taken into and coursed across the existing mortar joints.

- 8.3.2.2 The concrete screed as existing, which forms a deep ledge, connecting the drainage channel to the warehouse will be replaced on a like-for-like basis, masked by the new waterproofing system. The finish of the waterproofing system will be masked by an adhered aggregate scatter coating, to be more in-keeping with the current exposed concrete finish.
- 8.3.2.3 The concrete covers which provide access into the drainage channel will be reinstated, including backfilling of ballast fill and track bed.
- 8.3.2.4 The lower portions of the downpipes which serve the warehouse will be reinstated, redecorated locally.



North Chamber Land Drain Detail as Proposed

8.3.3 Interface / abutment with structural glass – North Trough

8.3.3.1 The proposed arrangement will not be that dissimilar to the current arrangement, the proposed waterproofing system in this instance will be visible and extend vertically, up the face of the structural glass, lining though with the height of the upstand as existing.

8.3.3.2 A metal termination trim will be installed and suitably sealed with mastic at the interface.

8.3.3.3 The waterproofing layer will be masked and concealed by the application of an aggregate scatter coat, as current proposal across the deep ledge interface, between the trough and masonry wall.

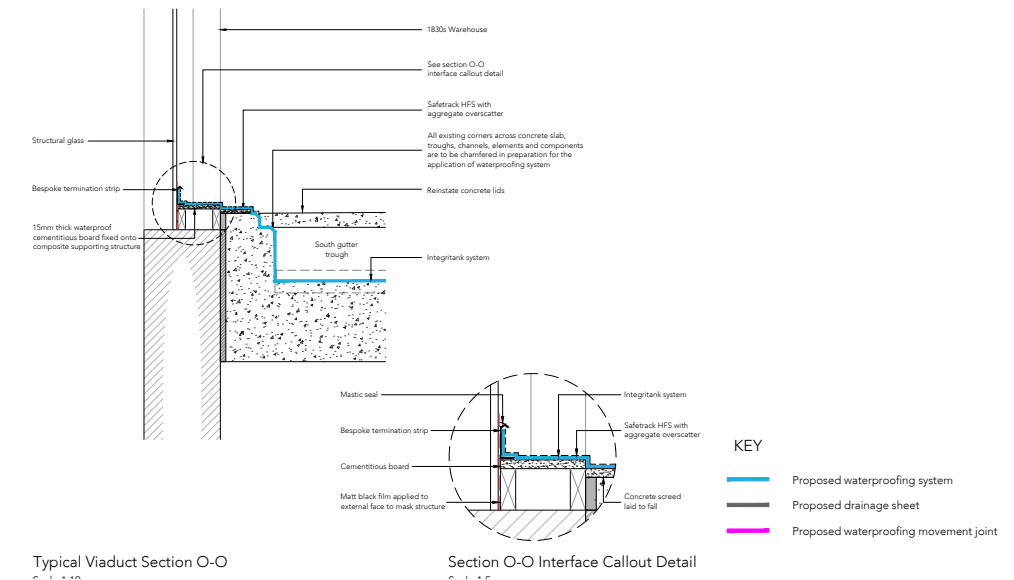
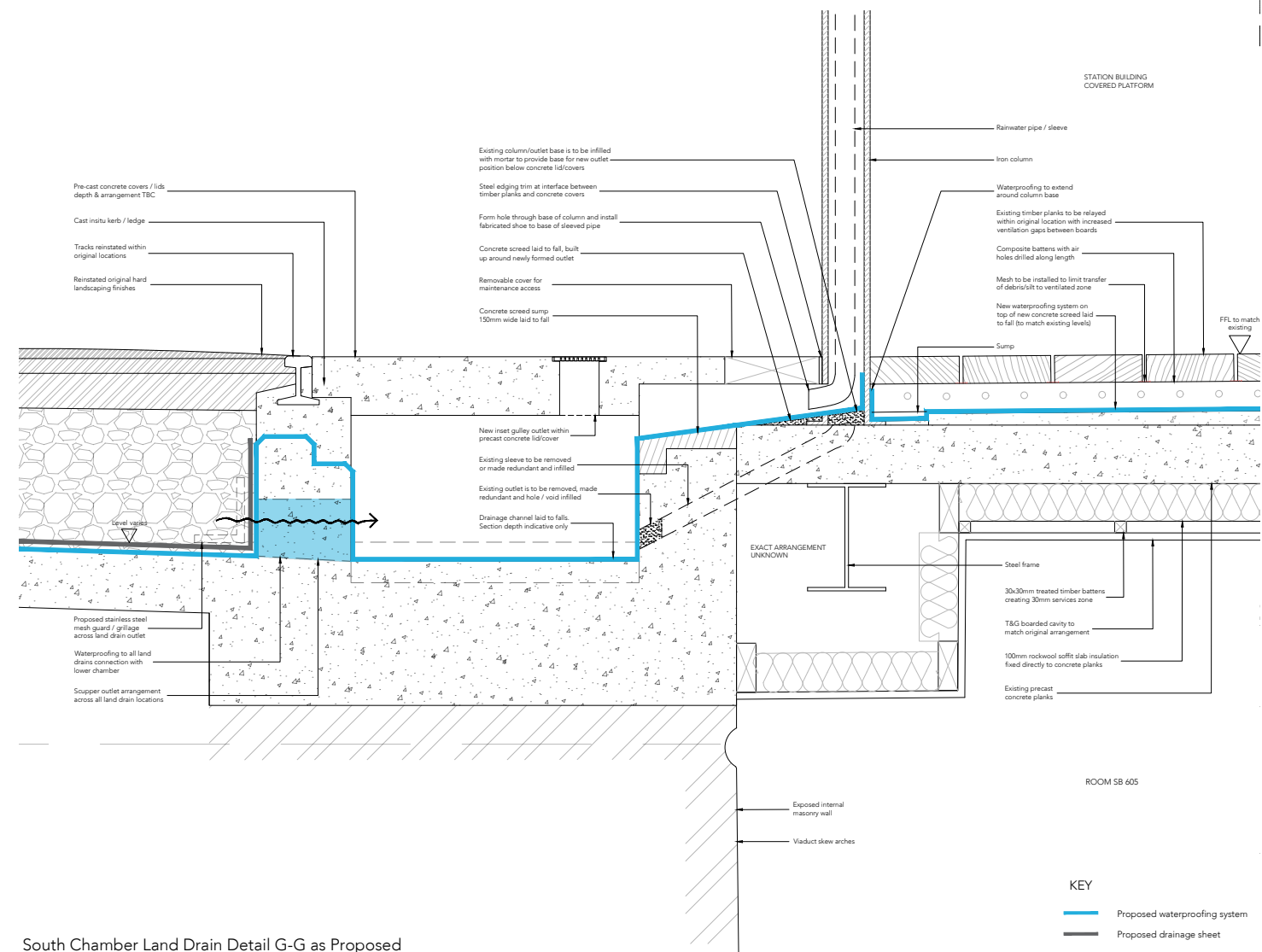
8.3.4 Interface / abutment with the Station Building – South Trough

8.3.4.1 The new waterproofing system will be installed across the exposed surface of the concrete, up and over the slab and concrete trough, traversing horizontally across the covered platform to create a watertight impervious surface.

8.3.4.2 The existing modern timber planks to the platform will be replaced with exposed reinforced pre-cast concrete covers (incorporating lifting eyes), which will extend across the entire length of the station platform, separated from the covered platform via a metal edge boarder. The covers will provide a safe contrasting surface for pedestrians as well as being capable of trafficking small MEWP type vehicles, in addition, the removable covers will provide direct access to the trough, allowing for the completion of routine maintenance tasks, dramatically improving accessibility.

8.3.4.3 The existing downpipes which disperse through the ferrous columns will remain but will no longer be connected to the trough via the current convoluted route. Instead, a hole will be carefully formed below original timber planks, allowing for the internal rainwater pipe to eject directly onto the waterproofing layer, removing the highly inaccessible internal connection pipe.

8.3.4.4 All existing finishes, elements, and components across the platform at the abutment with the ballast will be reinstated to match the current arrangement, including recessed tracks.



8.3.5 Plan interface – South Trough

Key



Ballast



Macadam



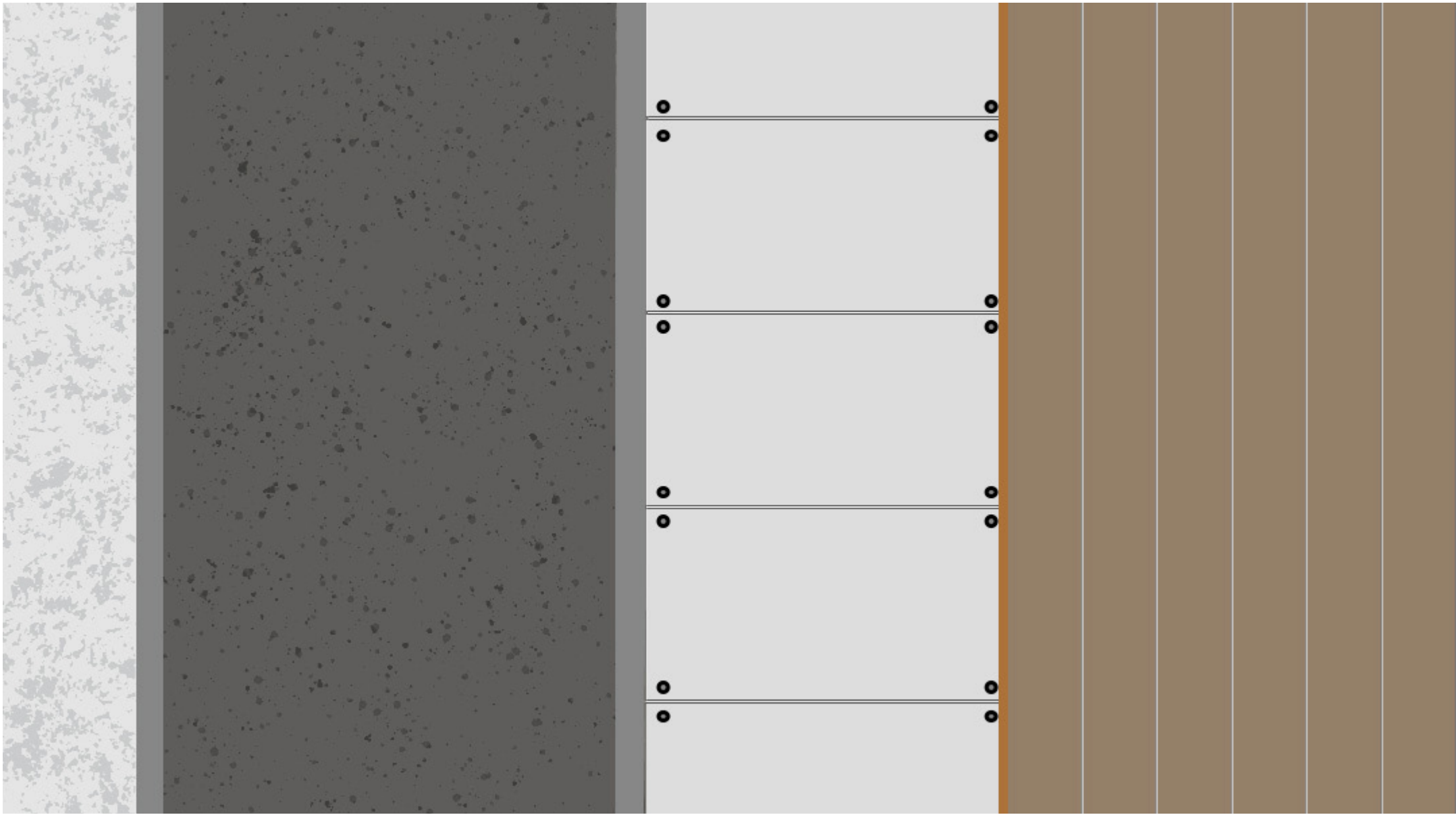
Reinforced Pre-Cast Paving Flags



Metal edge strip



Existing timber planks

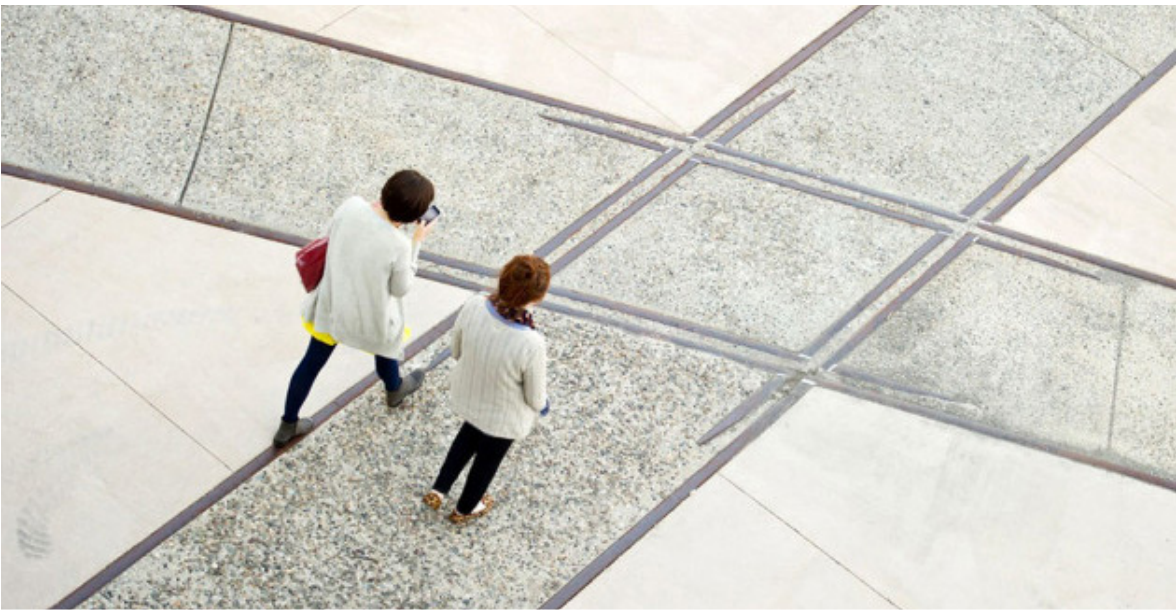


8.3.6 Materials

- 8.3.6.1 All existing surface treatments are to be reinstated, following successful insertion of waterproofing system, with the exception of the modern timber planks which exist along the station platform.
- 8.3.6.2 It is proposed to replace the modern timber planks, which are susceptible to rot and not appropriate for light vehicular traffic with exposed concrete covers, to closely match the current exposed arrangement at the abutment with the 1830s Warehouse.
- 8.3.6.3 Product: Large format slab
- 8.3.6.4 Material: Reinforced precast concrete
- 8.3.6.5 Size: Varied length (to match arc of platform) x 600 x depth (tbc by engineer)
- 8.3.6.6 Colour: crème
- 8.3.6.7 Finish: acid etched, heavy
- 8.3.6.8 Accessories: to include lifting eyes and smaller access lids



Current arrangement with exposed concrete covers at the interface with the 1830's Warehouse



Examples of railway tracks set flush with surrounding hard surfaces, in this case a mix of acid etched concrete surface treatments at Urban Outfitters HQ (LHS) and Martin Luther King Park (RHS).

8.3.7 Interface with glazed screens within covered platform

8.3.7.1 The original timber planks will be lifted to expose the concrete screed below at the interface with the perimeter of the glazed screens. The concrete screed will be replaced, and a new waterproofing system installed. The system will include for an upstand at the interface with the glazed screen, to restrict the migration of water underneath the screen, the upstand will remain just below the platform finished floor level, to retain the current aesthetic.

8.3.7.2 Composite battens with air holes will be adhered to the waterproofing layer, allowing for the re-fixing of timber planks across the covered platform. The original timber planks will be repositioned within their original locations, however they will be planed to the edges, to incorporate an appropriate ventilation gap. The entire substrate to the underside will be cross ventilated.

8.3.7.3 Any trapped moisture to the underside of the planks will be able to escape, and be dispersed into the drainage channel, via the introduction of a drainage layer, below the concrete plank ledge.

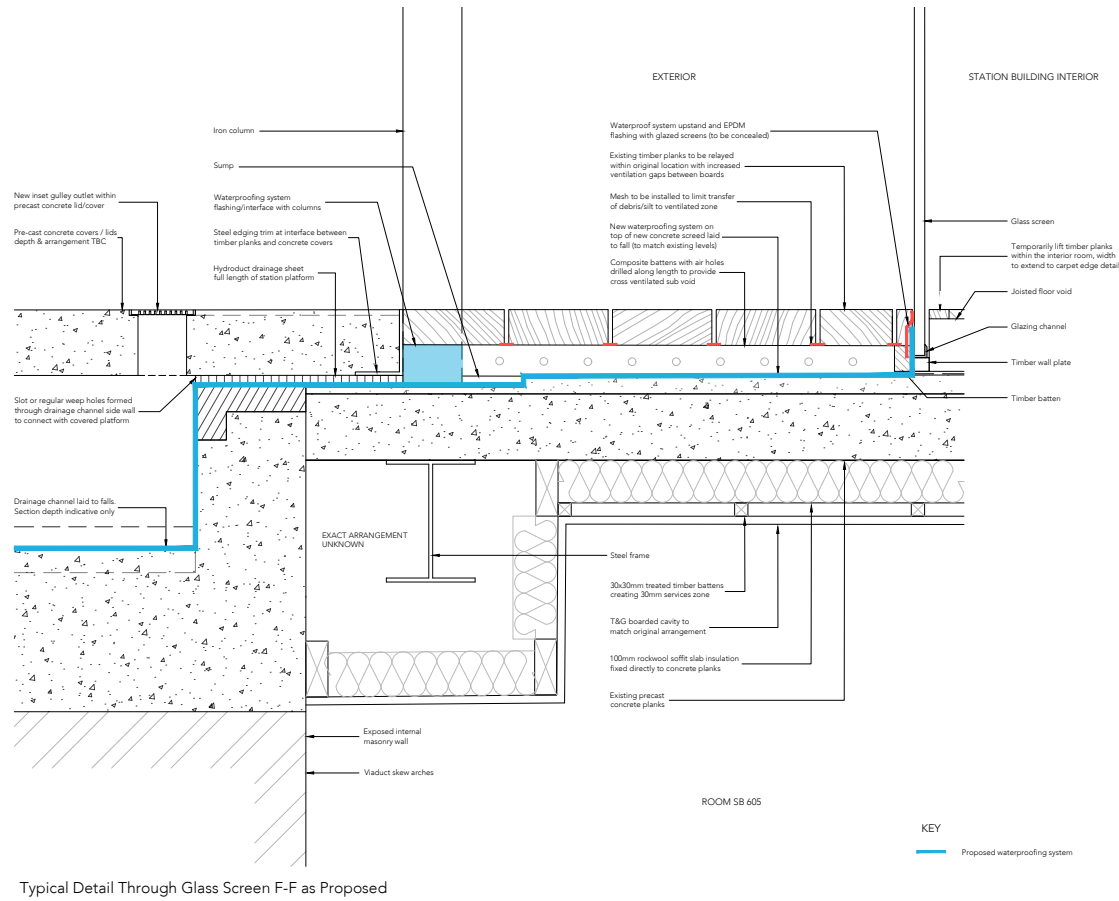
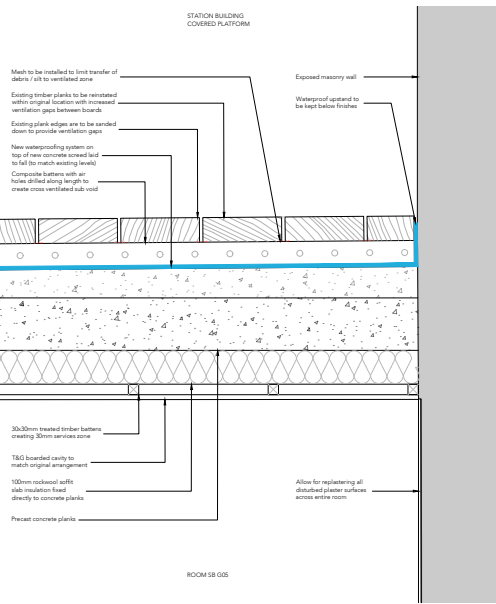
8.3.8 Interface with masonry within covered platform

8.3.8.1 Similar to that of the proposal at the interface with the glazed screens, the abutment at the interface with the exposed masonry wall within the covered platform will remain concealed, below the finished floor level.

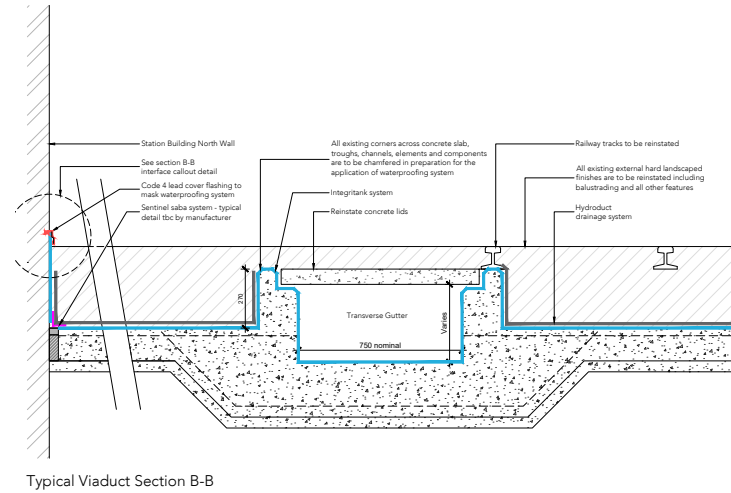
8.3.9 Interface with masonry wall across platform

8.3.9.1 The proposed arrangement will not differ greatly from the current situation. Currently, the asphalt flashing upstand is exposed above finished floor level. The proposal will mimic the height of the upstand with the waterproofing system taken up the face of the wall but will be masked via the inclusion of a lead cover flashing, taken into the mortar joint.

8.3.9.2 Existing hard landscaping surfaces will be reinstated to match the current arrangement.



Station House External Wall/Floor Junction Detail as Proposed
Scale 1:10



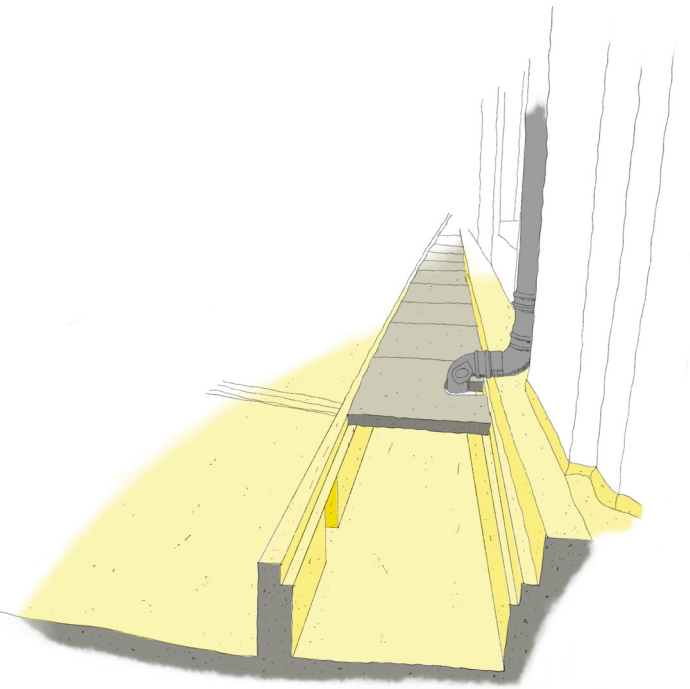
8.4 Waterproofing System

8.4.1 Introduction

- 8.4.1.1 Butress have been in dialogue with a specialist waterproofing contractor who will supply and install the waterproofing system. There are a few options available, much will be dependant on the condition of the concrete surfaces.
- 8.4.1.2 There are variety of spray and membrane solutions available.
- 8.4.1.3 The spray systems require the concrete surfaces to be smooth with no imperfections. If the concrete surface is found to not be suitable, the surface may require a mix of concrete repairs or screeds.
- 8.4.1.4 If a spray solution is found to not be suitable due to significant issues with the existing concrete finish, a membrane solution would minimise the amount of surface preparation required.
- 8.4.1.5 Due to the construction and current arrangement across the viaduct capping, it will not be possible to assess the wholesale condition and detailing interfaces of the existing concrete surfaces, as the concrete is predominantly hidden and concealed, buried deep below hard landscaping.
- 8.4.1.6 The true extent of potential defects and remediation works across the concrete surface will not be fully understood until all hard landscaping surfaces, substrates and features have been temporarily removed.
- 8.4.1.7 Localised investigations have been undertaken within focused areas. The areas of concrete exposed appear to be in a reasonable condition and generally smooth. However, this only provides a snapshot across a very small percentage of the total surface area of the slab.
- 8.4.1.8 CCTV surveys have been undertaken within the southern trough, which were unfortunately abandoned due to debris blocking access routes. However, it was clear from reviewing this sample footage that the concrete is in a poorer condition within the drainage channels.
- 8.4.1.9 It is therefore likely that the proposed waterproofing system will be a hybrid approach, a mix of both spray membrane layers.
- 8.4.1.10 The waterproofing system will be further protected by a geotextile membrane which will incorporate a drainage layer, providing a clear zone from the ballast and waterproofed surfaces.

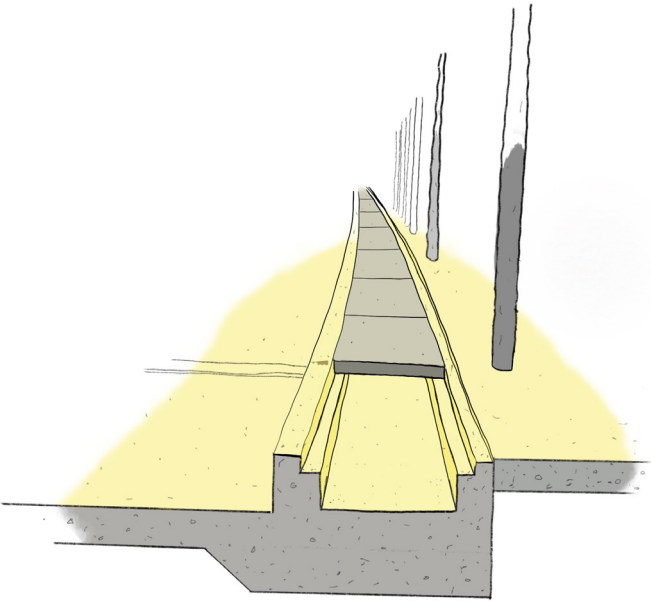
8.4.2 Preparation and Installation

- 8.4.2.1 All of the concrete slabs / surfaces, concrete drainage troughs / channels and features are to be fully exposed, allowing for thorough review and appraisal by the CA, structural and civil engineers, contractors and sub-contractors.
- 8.4.2.2 A package of remediation works will then be implemented across all areas, with the surface appropriately prepared to meet the manufactures requirements.
- 8.4.2.3 Any required modifications and alterations will be carried out, which may include improving existing interfacing details, improving surface water flow, introduction additional outlets, forming of new below ground drainage infrastructure etc.
- 8.4.2.4 The graphic below shows the northern trough, stripped back of ballast and railway tracks, to expose the concrete surface. The concrete covers will be temporarily removed.



- 8.4.2.5 The waterproofing system will then be applied / installed, show on the graphic in yellow.

- 8.4.2.6 The graphic below shows the southern trough, stripped back of ballast, railway tracks, timber planks as well as the concrete kerbs / upstands which supported the planks, to expose the concrete surfaces and allow suitable access to temporarily remove the concrete covers over the channel.



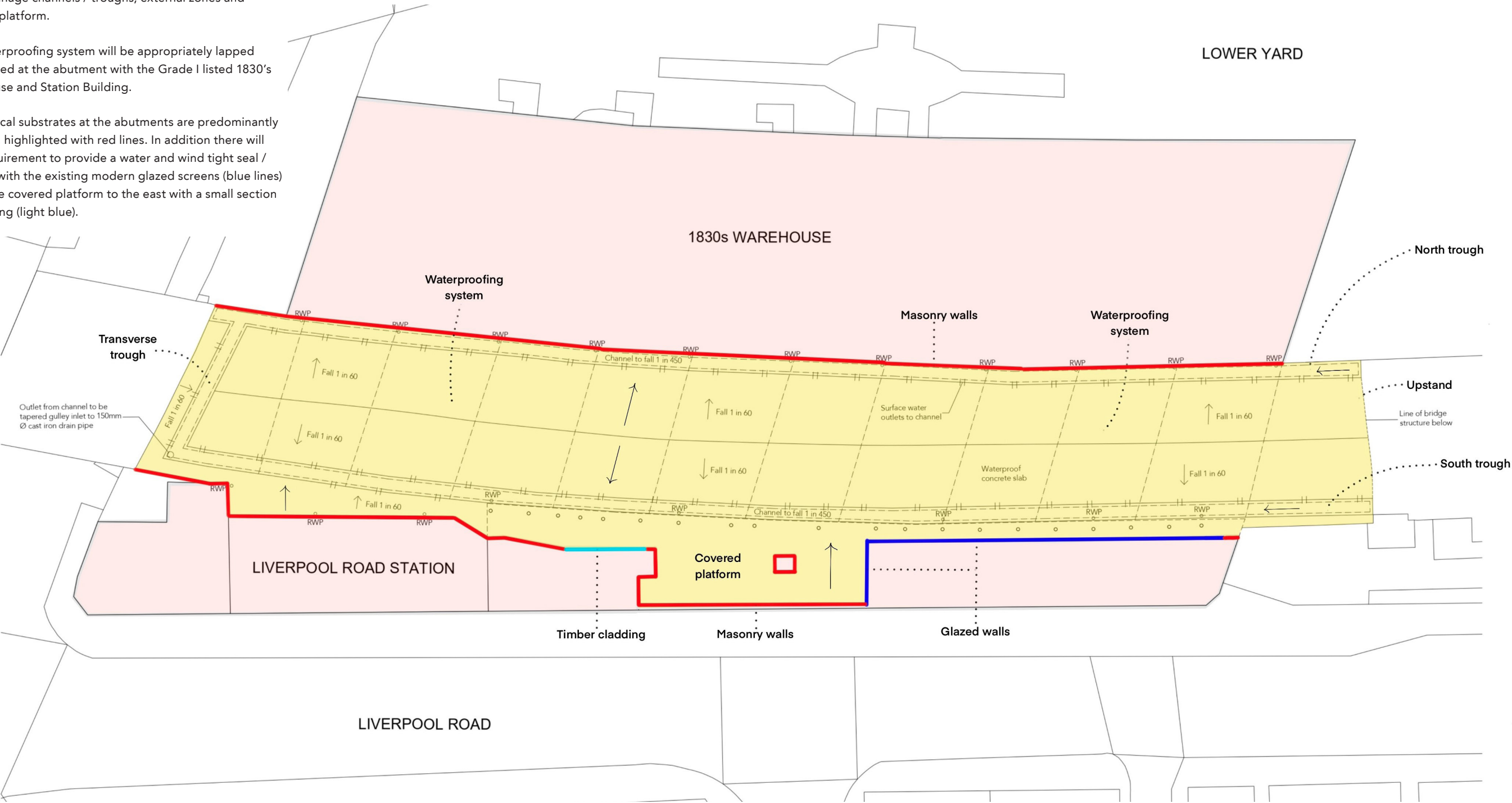
- 8.4.2.7 It is important to note that the final proposal and interfacing arrangement may differ from those presented. The purpose of the graphics is to illustrate a general philosophy.
- 8.4.2.8 The final arrangement will need to incorporate proposals from both the Landscape Architect, M&E, Structures and Civil Engineer.

8.4.3 Proposed slab level general arrangement plan

8.4.3.1 The proposed general arrangement plan illustrates the extent of the proposed waterproofing system highlighted with yellow fill, which is to extend across the entire concrete slab, drainage channels / troughs, external zones and covered platform.

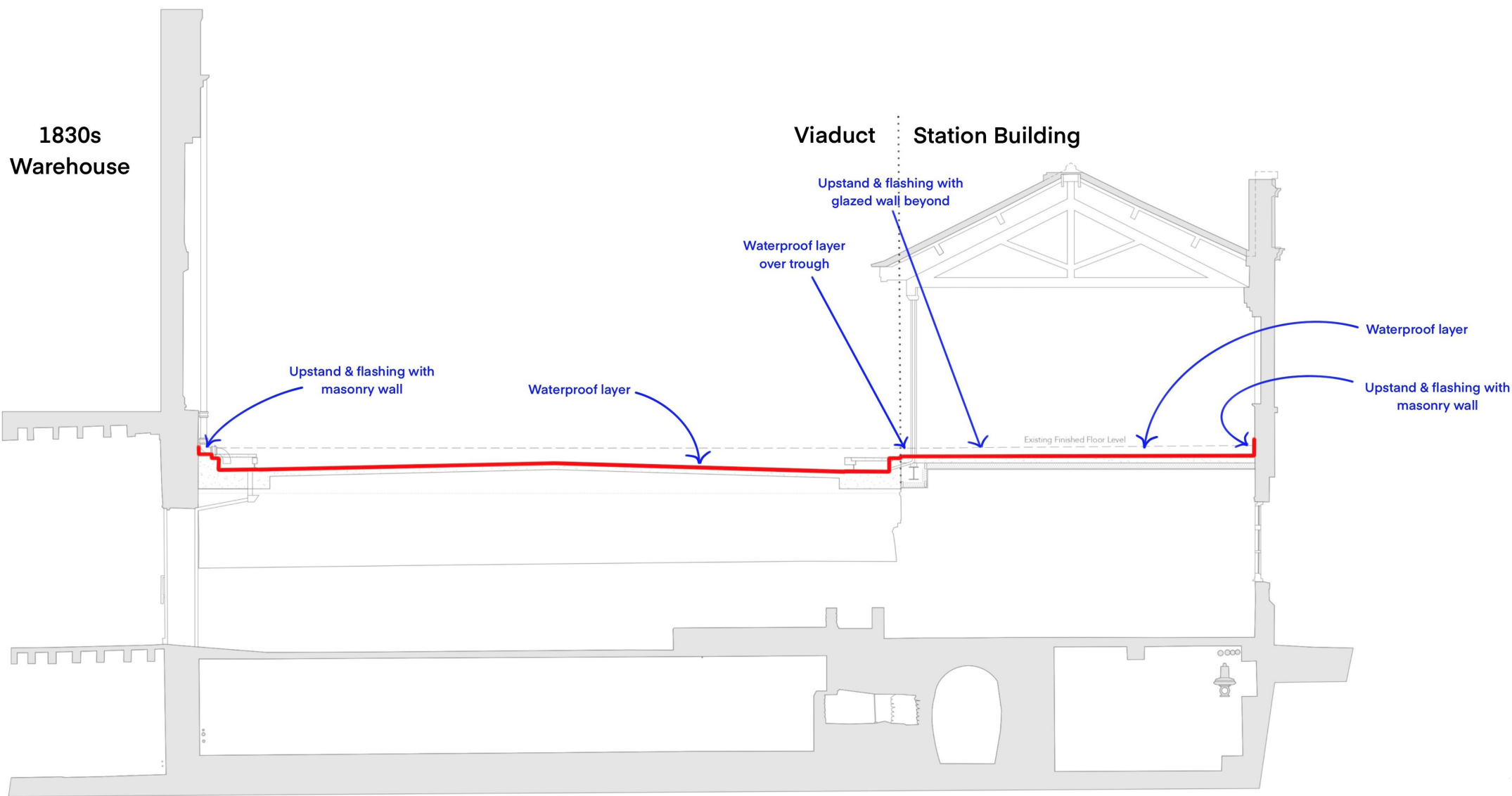
8.4.3.2 The waterproofing system will be appropriately lapped and flashed at the abutment with the Grade I listed 1830's Warehouse and Station Building.

8.4.3.3 The vertical substrates at the abutments are predominantly masonry, highlighted with red lines. In addition there will be a requirement to provide a water and wind tight seal / flashing with the existing modern glazed screens (blue lines) under the covered platform to the east with a small section of cladding (light blue).



8.5 Cross Section:

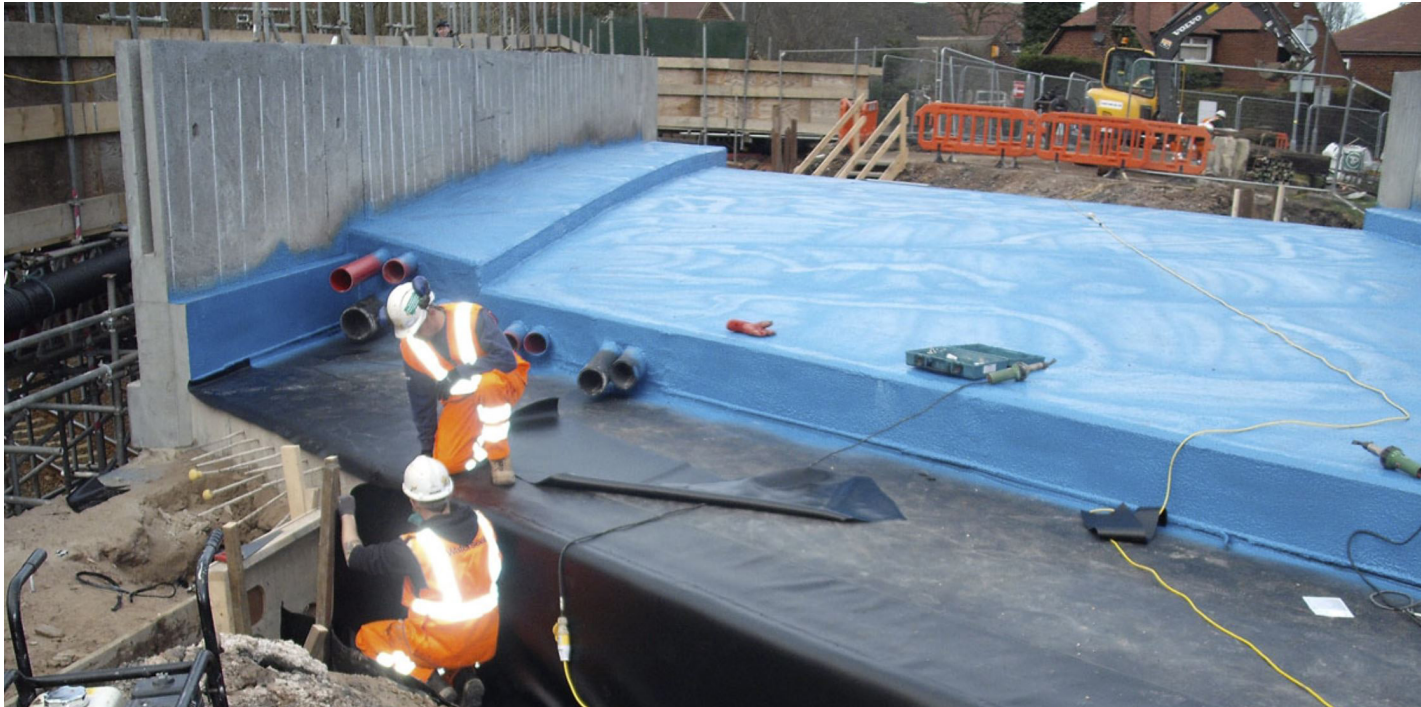
- 8.5.1 The adjacent section illustrates the extent of the proposed waterproofing system.
- 8.5.2 Hard surfaces and finishes have been hidden for graphical purposes.



8.6 Access

- 8.6.1 The proposals included within this report will improve access requirements down the full length of the Station platform as the concrete covers will be robust and capable to take the imposed loadings of MEWPs and/or other small access equipment. Access provisions across the ballasted area will be returned to match the existing arrangement.

8.7 Waterproofing Systems in use

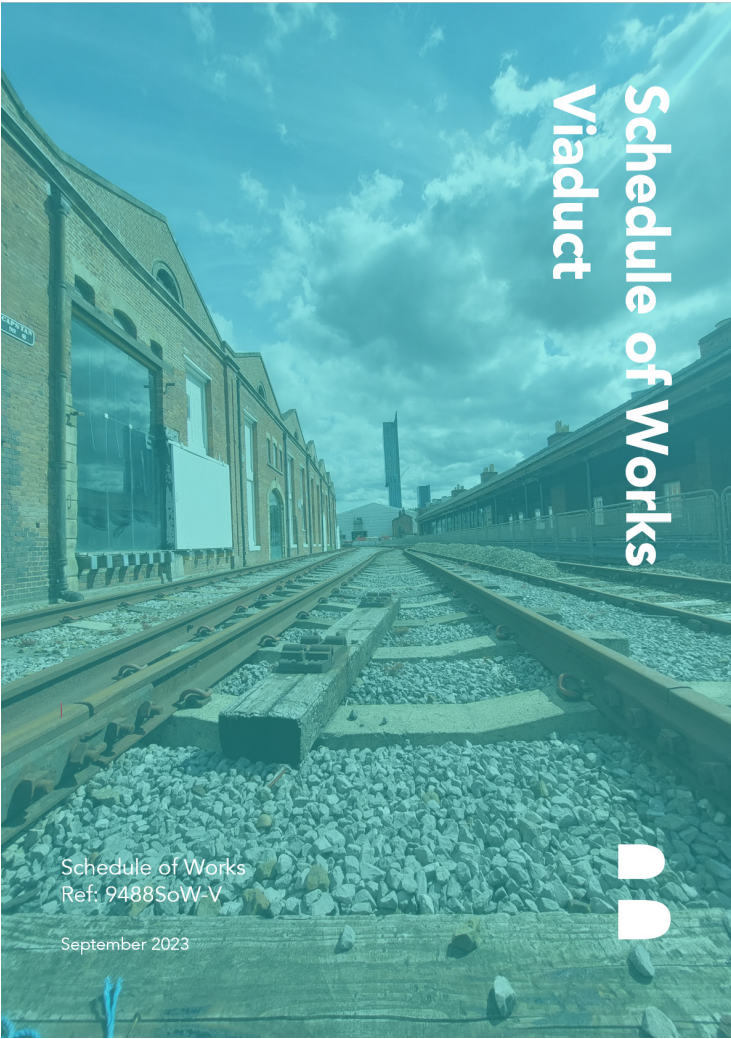


8.8 Schedule of Works

8.8.1 General

8.8.2 A separate schedule of works document is included in the appendices and outlines all the envisaged work items across the Viaduct. The schedule also refers to the accompanying Architectural Restoration specification.

8.8.3 All specifications, schedules, reports, and drawings must be read in conjunction with this Design and Access Statement.



9.0

Summary

9.0 Summary

9.1 Summary of proposals

- 9.1.1
- The mid-1980s saw radical alterations implemented across the Viaduct, Station Building and 1830s Warehouse as well as extensive construction works across the remaining areas of the site, as the land and buildings transferred to the Museums ownership.
- 9.1.2
- As part of the mid 1980s improvement works, a major project was implemented across the viaduct capping, which saw the introduction and formation of a reinforced concrete slab and associated drainage channels and external finishes, to provide a watertight envelope in 1984.
- 9.1.3
- Not long after the completion of the viaduct capping works, the Station Building then underwent a major renovation scheme, as the building was dismantled down to lower ground level and rebuilt due to the south elevation dramatically leaning out towards Liverpool Road. This provided an opportunity for the Museum to carry out a major overhaul.
- 9.1.4
- All three assets were linked centrally, allowing for horizontal public access. This involved opening up of the central vault at the North and South elevations, to provide circulation across all three assets, as well as the opportunity to introduce increased vertical access and open up spaces to offer improved flexibility.
- 9.1.5
- The capping and waterproofing systems introduced in the mid-1980s have now subsequently failed, well beyond retrospective repair and extensive remediation is now required to protect these heritage assets.
- 9.1.6
- If the current water ingress issues are left unresolved across the Viaduct and Station Building, the building fabric will continue to decay with further loss of building fabric inevitable.

- 9.1.7
- Not only will it be detrimental to the building fabric but there are obvious health issues with respect to spores, fungal and damp atmospheres within confined, unventilated, spaces internally.
- 9.1.8
- There are additional health and safety risks with free-flowing water throughout the structure, within visible and non-visible areas, concealed and hidden voids. All of which could have potential issues with mechanical, electrical, and plumbing elements.
- 9.1.9
- There are areas of extensive water ingress issues located within primary escape routes with large areas of ponding water, potentially leading to slips, trips, and falls.
- 9.1.10
- The current proposal, will represent a significant improvement across the status and condition of the Viaduct and Station Building, serving to provide a watertight external envelope which would protect the Viaduct and Station Building structures and there interior within, as well as incorporating essential improvements and fabric repair works, securing their future for years to come.

9.2 Limitations and Further Considerations

- 9.2.1
- Percentages and quantities reported are based upon information received or access provided to date and as such cannot be deemed as being wholly accurate or representative.
- 9.2.2
- The true condition and arrangement of the hidden and concealed substrate below the ballast and hard finishes is unknown, though we do have a reasonable understanding based upon archival research.
- 9.2.3
- At this stage, only a handful of focused areas have been opened up / inspected using a mix of both invasive and non-invasive survey techniques.
- 9.2.4
- Further survey techniques and methods are likely to be necessary, once works start to progress onsite.

9.3 Benefits

- 9.3.1
- The scheme would sensitively respond to the heritage asset

with minimal visual impact to the museum estate, whilst also providing numerous benefits to the building, including:

- A watertight external envelope, restricting further degradation.
- Enhanced heritage.
- Protect and secure heritage assets for years to come
- Building fabric repaired.
- Improvements made across rainwater goods outlets
- Aesthetic enhancements across the external appearance of the Viaduct, Station Building and 1830 Warehouse
- Increased performance of surface water management system.
- Introduction of access / rodding points across rainwater goods and outlets to improve routine maintenance tasks
- Replacement of inferior / poor quality weathering's, flashings, and coverings with more suitable and robust products.
- Leadwork installed to appropriate standards.
- Improved detailing and interfacing.
- Provision of thermal enhancements.

Buttress

Architects | Masterplanners | Heritage Consultants