Croxley Station - Step Free Access Project
Single Preferred Option Report

UIP3744-TWBN-ZZZ-M043-RPT-ZZ-00002

P02

TAYLOR WOODROW | bam
JOINT VENTURE
RAMBOLL
FOURWAY
fereday pollard
www.fereday-pollard.co.uk | 30 Kings Bench Street, London. SE1 0QX
fp

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Disclaimer:

Contents

List of Abbreviations

ATG – Automatic Ticket Gate
BS – British Standard
BS EN – British Standard European Norm
BS ISO – British Standard International Organisation for Standardisation
CCTV - Closed Circuit Television
CCU - Camera Control Unit
CDM – Construction (Design and Management) Regulations
CDS – Conceptual Design Statement
COP – Code of Practice
DNO – Distribution Network Operator
DVA – Digital Voice Announcement
DSfARS – Design Standards for Accessible Railway Stations
EDNE – Emergency Do Not Enter (Sign)
EVC – Emergency Voice Communications
FFL – Finished Floor Level
GLAP – Gate Line Attendant Point
GSM – Global System for Mobile Communications
HDD – Hard Disk Drive
HV – High Voltage
IP – Internet Protocol
JV – Joint Venture
LOP – Local Operation Point
LUL – London Underground Limited
LRV – Light Reflectance Value
MEPFC – Mechanical, Electrical, Plumbing, Fire and Communications
NVR – Network Video Recorder
OPO – One Person Operation
PA – Public Address
PHP – Passenger Help Point
PoE – Power over Ethernet
POM – Passenger Operated Machine
PRM – Persons with Reduced Mobility
PPRS – Passenger Place of Relative Safety
SAP – Station Announcement Point
SAP – Staff Assembly Point
SCR - Station Control Room
SCU – Station Control Unit
SFA – Step-Free Access
SMO - Station Managers Office
SMS - Station Management System
SSRA - Site Specific Risk Assessment
TfL – Transport for London
THSCU – Ticket Hall Station Control Unit
TVM – Ticket Vending Machine
TWBN – Taylor Woodrow BAM Nuttall (JV)
VE – Vitreous Enamel
VoIP - Voice over IP
WAG – Wide Aisle Gate

1.0 Aerial View

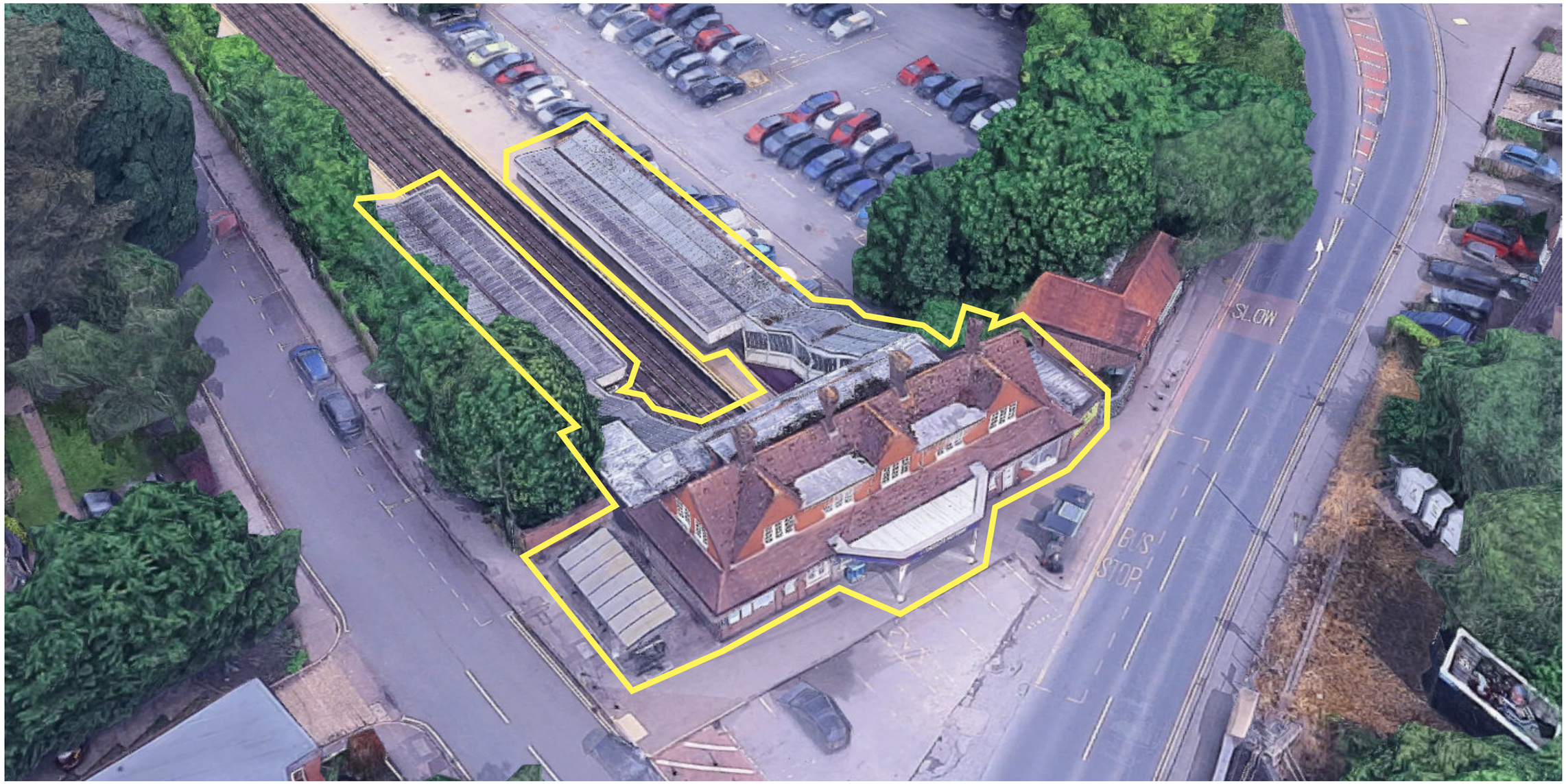


Fig 1.0-1: Aerial View of Station Entrance

1.1 Executive Summary

This report presents the single preferred option (SPO) to enable step free access (SFA) at Croxley Underground Station. The SPO was identified through a scoring process of several options that considered all aspects of the SFA solutions, from quality and operability to compliance and buildability. A full explanation of each of the options and workshops is detailed in the prior options report UIP3744-TWBN-ZZZ-M043-RPT-ZZ-00001 and briefly summarised in section 4.0. The option selected (Option 2) was chosen as it balances a high-quality customer experience with a more sustainable design.

The SPO features two "through lifts" that allow users access to both north and southbound platforms. An interesting feature of this station is the existence of an old lift shaft that has been leveraged as part of the design. The feasibility of the SPO has been studied from structural, geotechnical, civil, MEP and architectural perspectives and the design has been validated against the PAS 2080 carbon management standard. Alongside the SPO validation, this report encompasses a high-level fire strategy and overview of existing non-compliance as well as a construction methodology, cost outline, and programme plan.The report is based on information from the TFL archives and visual site inspections.

1.1.1 Conclusion of previous study

The previous reports propose the following solutions:

1. Acanthus LW study (2013):

- Southbound Platform 2: Option C principle aligned with TWBN Option 5.
- Northbound Platform 1: Reuse of the existing lift shaft (rejected in the TWBN study due to the potential small size of the lift car) or enlargement of the lift shaft as TWBM Team Option 1, 2 and 5.

2. Weston Williamson and Partners Study (2016):

- Southbound Platform 2: Principle aligned with TWBN Options 1 and 2.
- Northbound Platform 1: Creation of a completely new lift shaft beyond the station footprint. Rejected by TWBM due to offer only a single-sided lift configuration.

Option 2

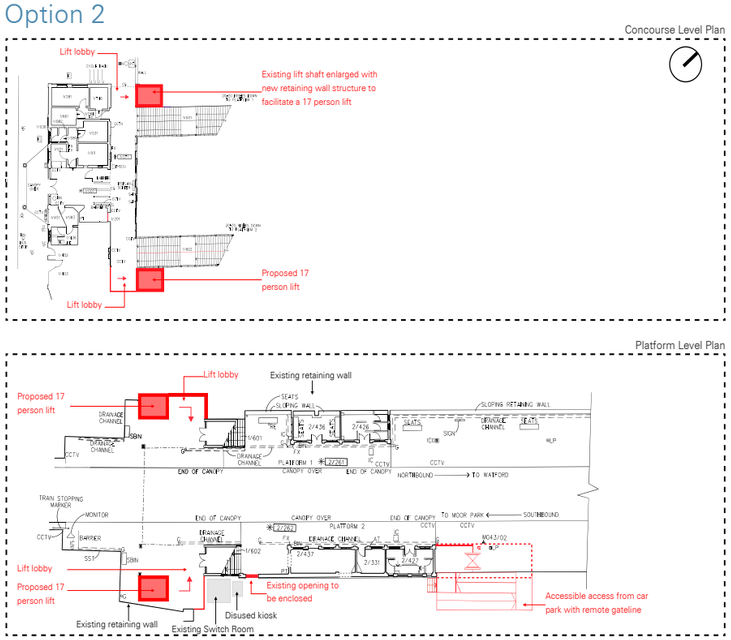


Fig 1.1-1: Single Preferred Option overview

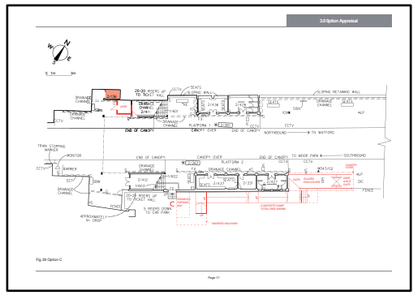
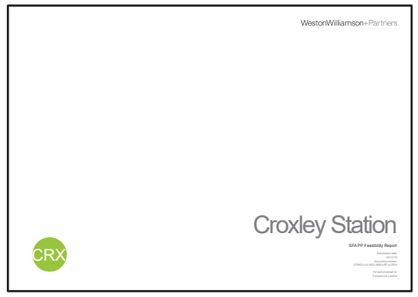


Fig 1.1.1-1: Extracts from Acanthus LW's study



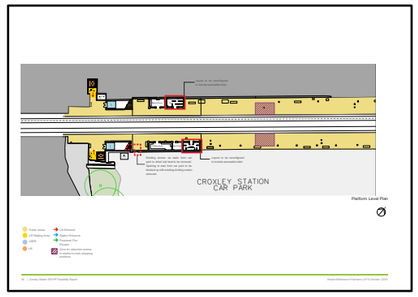


Fig 1.1.1-2: Extracts from Weston Williamson's study

2.0 Scope

This feasibility study aims to:

- Establish Project Viability: Determine the technical, operational, and financial feasibility of implementing step-free access solutions.
- Identify and Evaluate Options: Generate a range of viable options for step-free access, considering factors like:
  - Spatial constraints
  - Operational impacts
  - Cost-effectiveness
  - Assess Impacts: Evaluate the potential impacts of each option on:
    - Passenger experience
    - Station operations
    - Surrounding infrastructure
- Provide Cost Analysis: Develop detailed cost estimates for each option, including capital and whole-life costs.
- Consider Funding: Evaluate funding options and their impact on project scope.
- Inform Decision-Making: Provide a clear and concise analysis of options to support informed decision-making.
- Recommend Preferred Option(s): Identify and justify the preferred option(s) for step-free access implementation.

Fig 2.0-1: Aerial View of Croxley Station

3.0 Context

3.0.1 Local Area

Croxley Station is situated in the suburban village of Croxley Green, Hertfordshire, southwest of Watford. The immediate vicinity is primarily residential and is complemented by local shops and amenities, including convenience stores. The station benefits from its proximity to main roads, which connect it to Watford and Rickmansworth, and local bus services are available. Cycle parking is also provided at the station.

The wider Croxley Green area features the village centre, with its pubs, restaurants, and independent businesses, fostering a community atmosphere. Numerous smaller parks and green spaces contribute to the suburban character.

Croxley Station is on the Watford branch of the Metropolitan line, situated between Watford and Moor Park station. It offers a link to Central London and beyond.

3.0.2 Station Premises

The two-storey brick station features a street-level ticket hall and commercial unit, with a residential accommodation above. A canopy shelters the pavement outside the ticket hall.

The ticket hall contains ticket machines and a gateline consisting of three standard gates and one Wide Aisle Gate. To the right of the gateline, an opening provides access to the car park via a segregated route.

The ticket hall level also includes a switch room, computer room, POM room, station office, staff toilets, and mess room.

Beyond the gateline, the paid area splits into two staircases: one leads to Platform 1 Northbound, and the other offers a 2m wide stair to Platform 2 Southbound. This stair is subdivided with the remaining width providing the segregated route to the car park.

Beyond the northbound stair is a lift shaft. A side entrance with Bostwick gates is adjacent.

The only access to the two platforms is via the ticket hall at their western end.

Half of each platform is covered by canopies, and both have enclosed, heated waiting rooms and passenger toilets.

A steep bank rises approximately 6m north of the northbound platform, while the station car park is about 1m below the south of the southbound platform.

Fig 3.0.2-1: Station Entrance from Watford Road

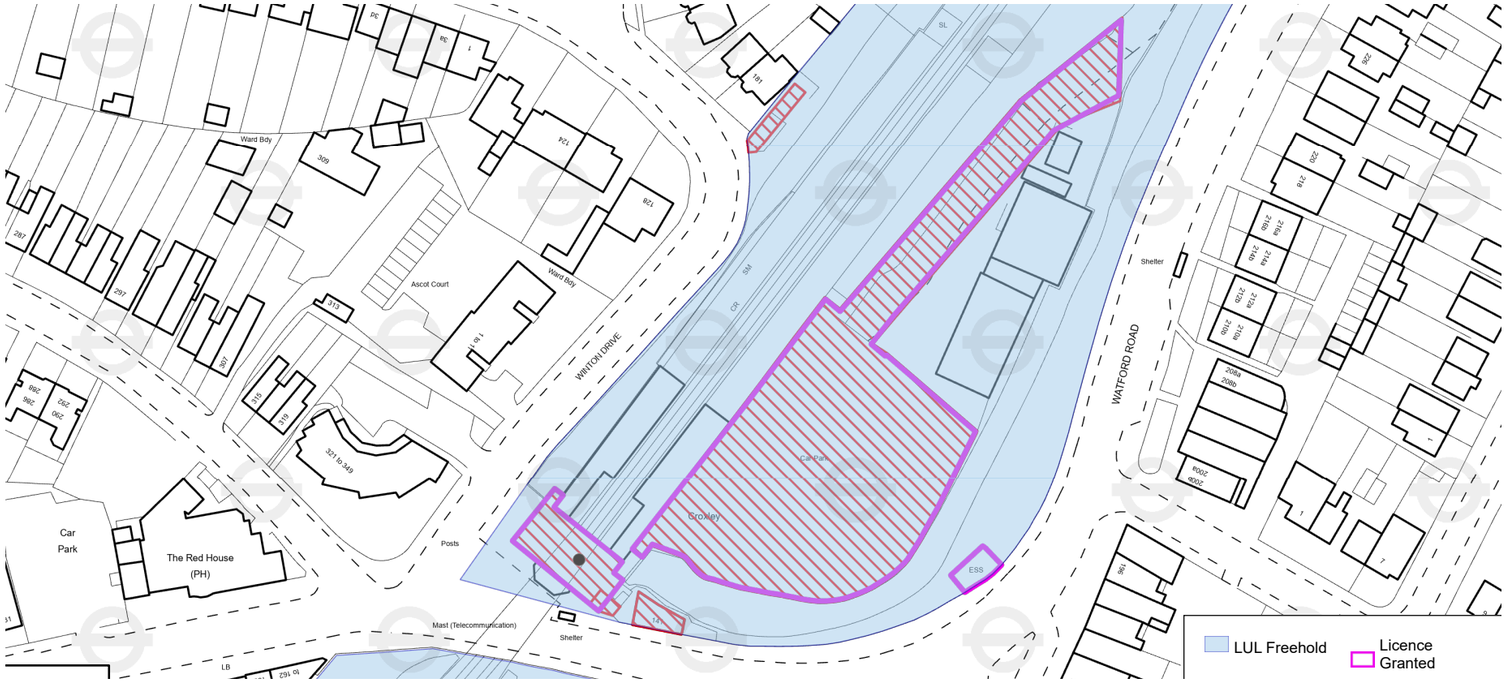
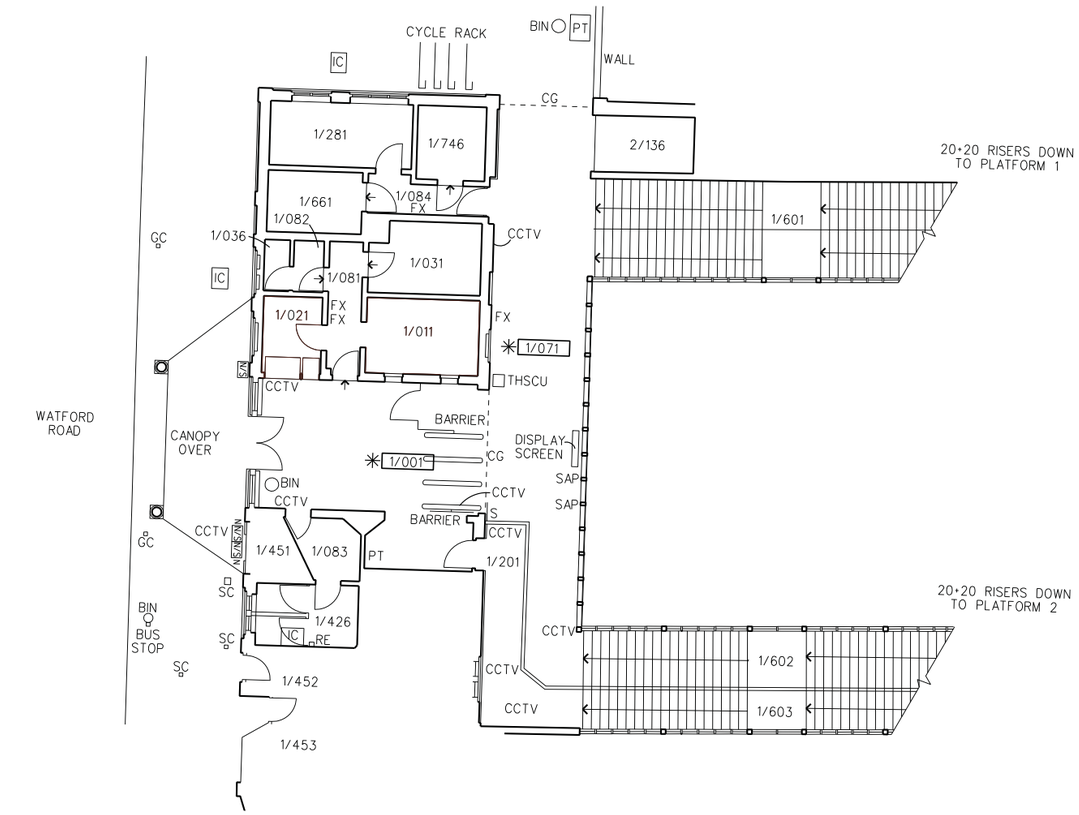


Fig 3.0.2-2: Property Line Boundary

3.1 Existing Plans

3.1.1 Concourse Level Plan

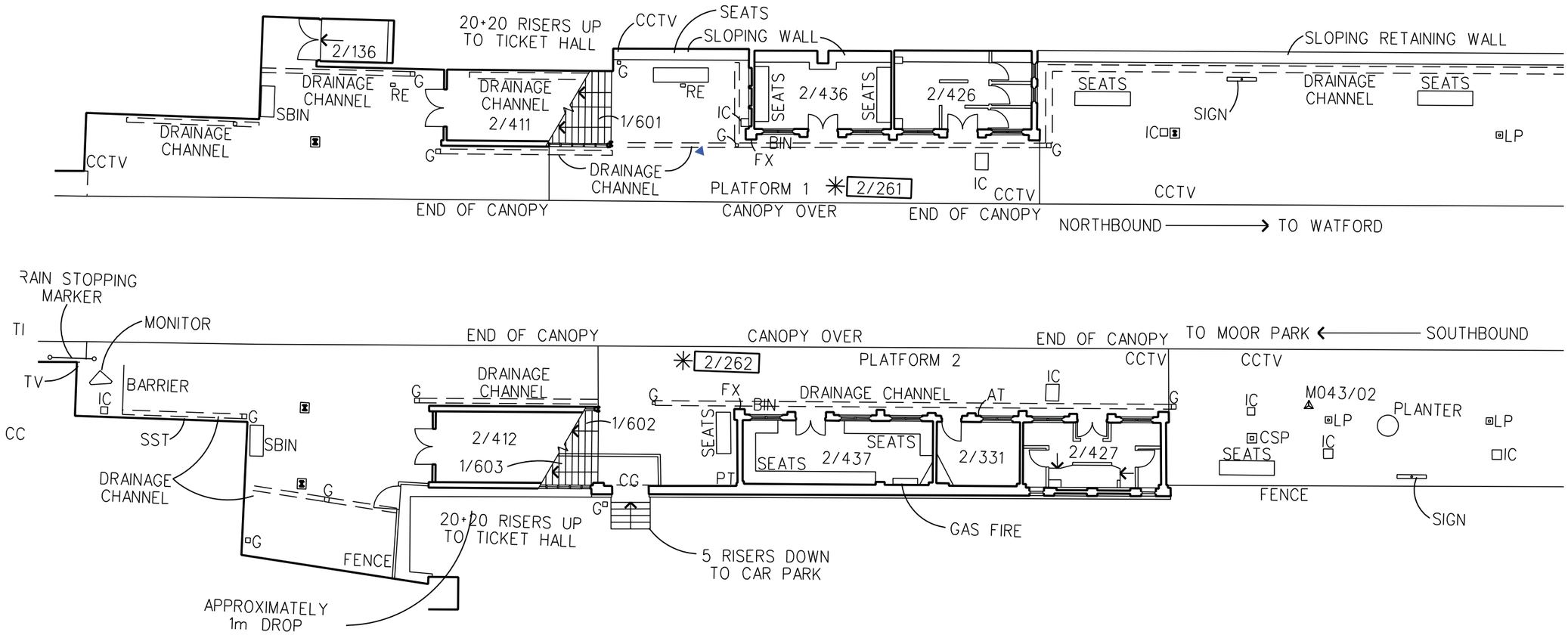


1/001	BOOKING HALL
1/011	OFFICE
1/021	POM
1/031	MESS ROOM
1/036	TOILET
1/071	CIRC. AREA
1/081	LOBBY
1/082	LOBBY
1/083	LOBBY
1/084	LOBBY
1/201	PASSAGE
1/281	OFFICE
1/426	TOILET
1/451	DISUSED
1/452	TENANCY
1/453	TENANCY
1/601	STAIRS
1/602	STAIRS
1/603	STAIRS
1/661	SWITCH ROOM
1/746	SCR
2/136	LIFT SHAFT

3.1 Existing Plans

3.1.2 Platform Level Plan

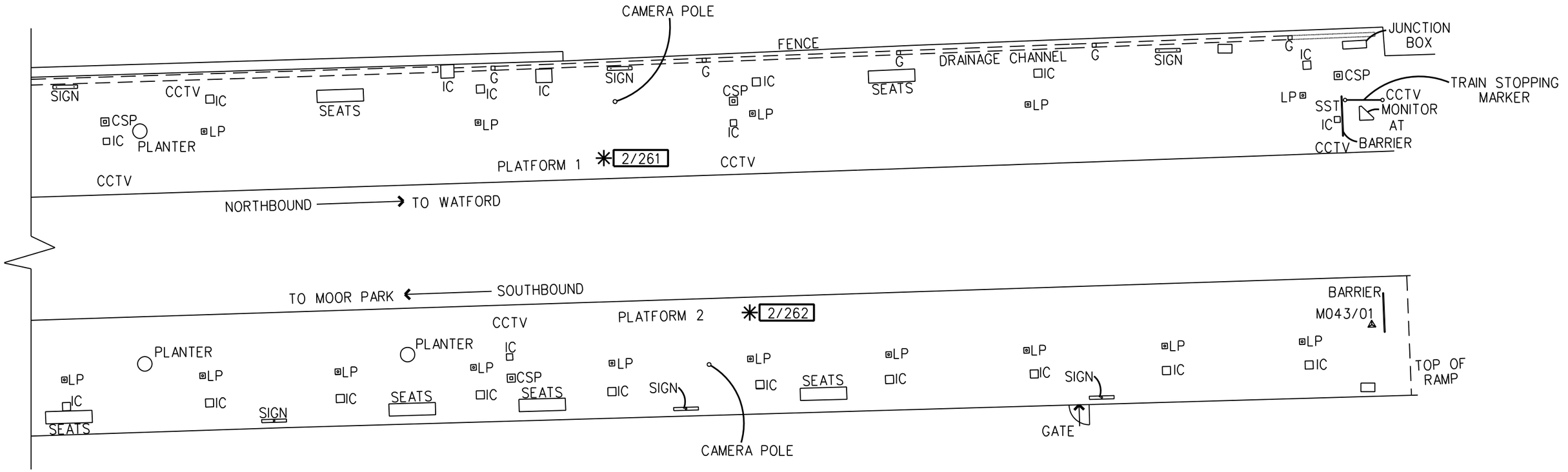
1/601	STAIRS
1/602	STAIRS
1/603	STAIRS
1/610	SWITCH ROOM
2/136	LIFT SHAFT
2/261	PLATFORM 1
2/262	PLATFORM 2
2/331	STORE ROOM
2/411	STORE
2/412	STORE
2/426	TOILET
2/427	TOILET
2/436	WAITING ROOM
2/437	WAITING ROOM



2/261	PLATFORM 1
2/262	PLATFORM 2

3.1 Existing Plans

3.1.2 Platform Level Plan



3.2 Premises Constraints

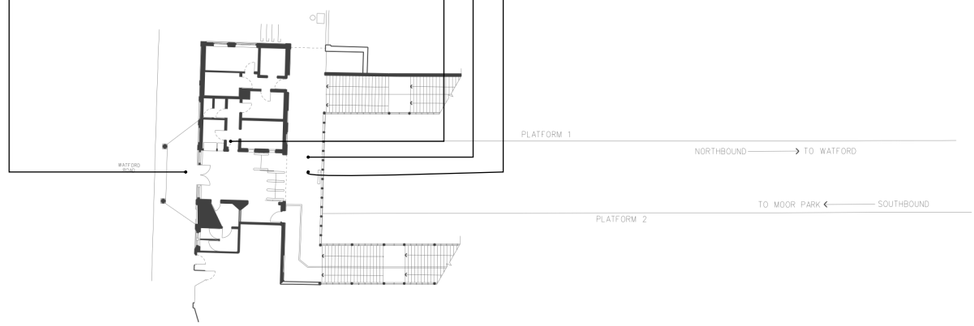
- The gateline has a single bi-directional WAG rather than the two WAGs required under Clause 3.5.13 of S1371 A8 Station Planning.
- The existing stair treads measure approximately 280 mm, which is below the 300 mm minimum specified in Building Regulations Part M.
- The existing entrance door width is 1.7 m, less than the 2.5 m minimum required by Clause 3.4.2.2 of S1371 A8 Station Planning.
- The queuing zone in front of the TVMs adjacent to the external wall is 1.2 m (due to the entrance door being held open), which is below the 4 m requirement set out in Clause 3.4.5.1 of S1371 A8 Station Planning.
- The existing gateline run-off towards the passageway is 3.2 m, which does not meet the 4 m minimum specified in Clause 3.8.2 of S1371 A8 Station Planning.
- The run-off at the bottom of the staircase serving the car park is currently 2.6 m. However, the proposed design removes the segregated route, thereby resolving this non-compliance against Clause 3.8.2 of S1371 A8 Station Planning.
- The existing staircase consists of two flights of 20 risers, which is non-compliant with S1133 – Premises: Stairways and Ramps requiring compliance with Building Regulations Part M (maximum 12 risers per flight). In addition, the handrail provision is non-compliant, as only a single handrail is provided instead of handrails on both sides.

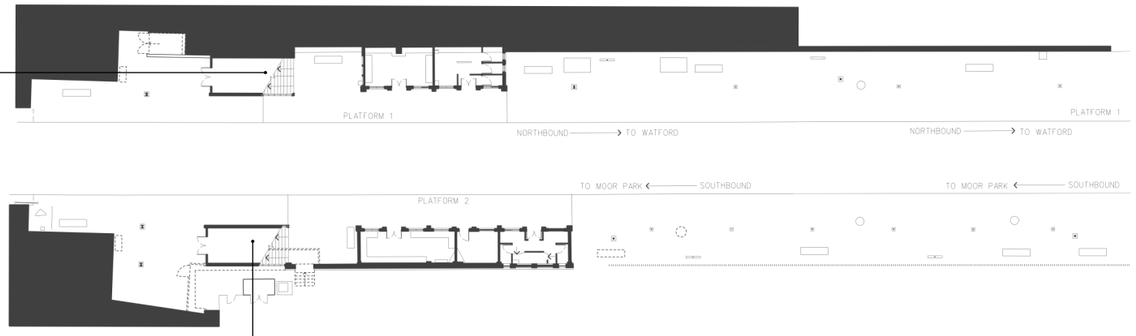
Entrance door 1.7m rather than 2.5m

TVM queuing zone too small

Existing gateline only has one WAG

Gateline run off too small





Existing staircases have 2 flights of 20 risers - against Premises - Stairways and Ramps Standard and Part M

Stair treads too narrow

3.3 Mechanical, Electrical, Communications and Public Health Constraints

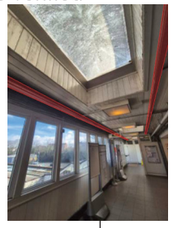
- Switchroom E1 1/661 – Limited wall space for addition lift switchgear to be installed. 100A TPN DNO Service Head load capacity is unknown.
- Concourse Passageway – 1/071 – The existing high-level condenser, which supports SCR temperature regulation, is to be relocated to enhance passenger circulation. The condenser to be repositioned in the area currently occupied by the cycle rack.
- Concourse Passageway – 1/071 – Existing LV & Communication CMS to be verified for spare capacity and structural integrity.
- Lobby 1/083 – Existing Mechanical services to be removed and enabled to facilitate the new Accessible WC.
- Existing CMS passing through the high-level Concourse to drop down the Platform 2 level – CMS to be enable out the proposed lift area.
- Platform 1 2/261 – High-level HV cable & connect services run through the dis-used lift shaft that will be re-purposed for the new passenger lift. Services are to be diverted out of the proposed lift area.
- Platform 1 (2/261) & Platform 2 (2/261) – Limited CCTV & PA in the affected SFA Area
- Switchroom E3 1/610 – Wall space available for additional switchgear for SFA works.

Wall capacity insufficient to accommodate 2no. Lift switch fuse disconnectors - E1 1/661

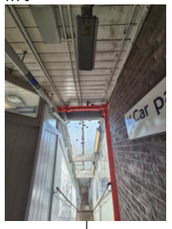
High level condenser impact passenger movement - 1/071

Existing services run down and through existing lift shaft

Existing LV and communication CMS running through concourse, capacity to be verified



Existing CMS and assets impact break through of new lift

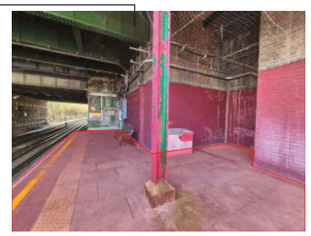


HV cable running along top of retaining wall - platform 1 2/261

SCR 1/746 - additional equipment to be added to the existing system, CMS routes to be verified

Existing HV cable runs through existing lift shaft - lobby of lift shaft 2/136

Existing connect services run through lift shaft - lobby of lift shaft 2/136



Limited number of existing luminaries, poor lighting CCTV and PA - limited coverage - platform 2/261

High level wall mounted multi-compartment CMS runs down external wall platform level - 1/601 to platform 2 2/262

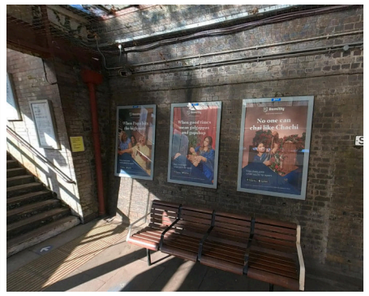
Limited number of existing luminaries, poor lighting CCTV and PA - limited coverage - platform 2 2/262

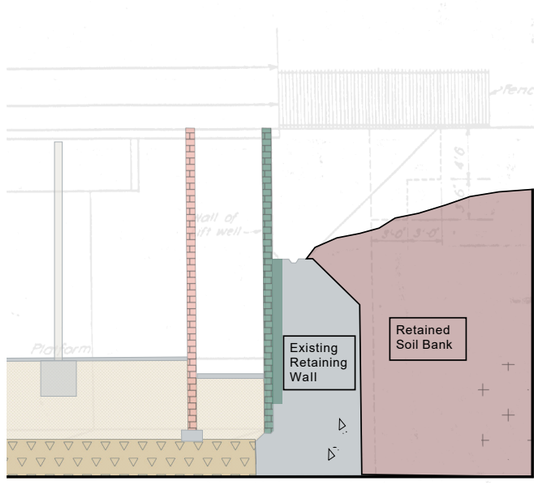
Existing switchroom has wall space for new lift supplies - E3 1/610

3.4 Engineering Constraints

3.4.1 Northbound Retaining Wall

A large gravity retaining wall supporting approximately 4m of soil runs behind the northbound platform. The gravity wall (asset number W928) is assumed to be unreinforced mass concrete and, from available archive drawings, is currently understood to be 2.2m thick. It is assumed this retaining wall was installed in the year 1920. Any modifications required to this wall would result in significant restabilising work in the temporary and permanent case. The exact dimensions of the retaining wall and its footing would need to be understood through trial pitting works.



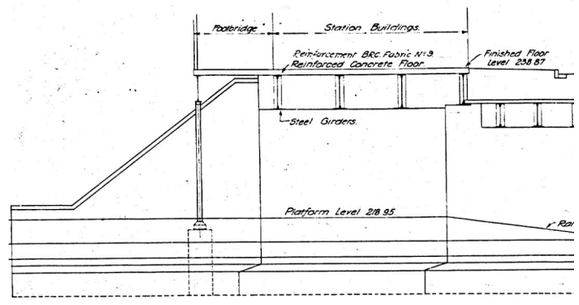


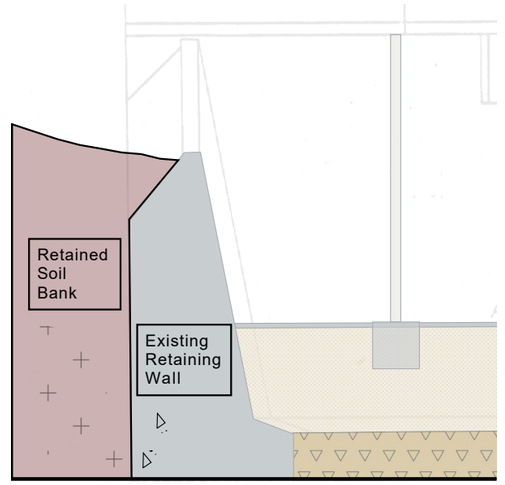
3.4.2 Disused Lift Shaft

Reusing the existing lift shaft represents a good opportunity to save cost on new structure. Its internal size is approximately 1.8m x 3.1m. Currently, it has timbers and a HV cable running through it which would need to be removed. New openings would need to be created using lintels and the current pit deepened which will impact surrounding existing structure. Depending on the size of the new lift, the existing shaft may need widening which could have an impact on the adjacent stairs width or retaining wall.

3.4.3 Southbound Retaining Wall

A large retaining wall on the southbound platform (W929) rises 8m to the height of the ticket hall. It supports a sloping bank behind and is assumed from archive drawings to have a base width of 3.5m. This retaining wall constricts where new foundations can be positioned. Any modifications required to this wall would result in significant restabilising work in the temporary and permanent case. The exact dimensions of the retaining wall and its footing would need to be understood through trial pitting works.

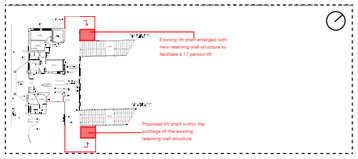




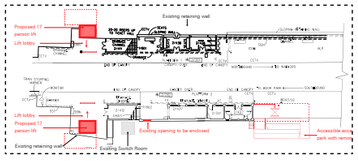
4.0 Alternative Options Considered

Option 1

Concourse Level Plan



Platform Level Plan



Pros

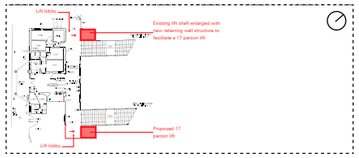
- Symmetrical arrangement.
- Existing station accommodation remains unchanged.

Cons

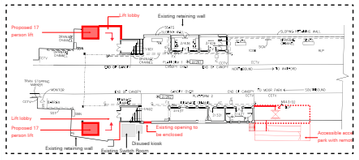
- Need for retaining wall structure for Platform 1 - Northbound lift. This is limited to the lift shaft.
- Existing HV cable within the redundant lift shaft would need to be rerouted.
- Route to lifts from gateline relies on signage.
- Lift doors are facing the platform edge. However, the platforms have sufficient width to accommodate a barrier in front of the lift lobby.

Option 2

Concourse Level Plan



Platform Level Plan



Pros

- Clear and symmetrical station layout.
- Existing station accommodation remains unchanged.
- Minor works may be required to Platform 2 - Southbound to facilitate the lift lobby.

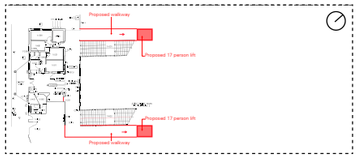
Cons

- Need for retaining wall structure for lift and lobby for the Platform 1 - Northbound.
- Existing HV cable within the redundant lift shaft would need to be rerouted.

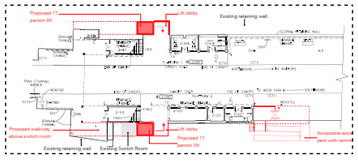
PREFERRED OPTION

Option 3

Concourse Level Plan



Platform Level Plan



Pros

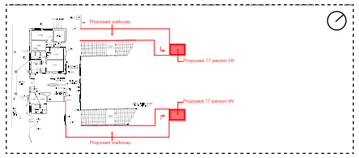
- Clear and symmetrical arrangement.
- Improved passenger experience through parity of route.
- Existing HV cable within the redundant lift shaft would not need to be relocated.

Cons

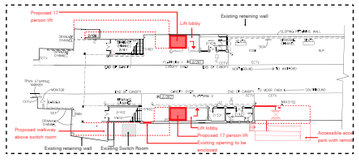
- Additional cost of walkways.
- Need for retaining wall structure for lift and lobby for the Platform 1 - Northbound lift.
- Existing cables beyond Platform 1 - Northbound (top of existing retaining wall) may need to be rerouted.
- Lift shaft structures will be more visible than options 1 and 2.

Option 4

Concourse Level Plan



Platform Level Plan



Pros

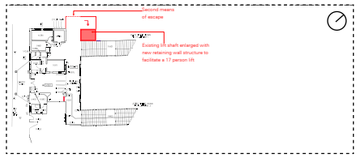
- Lifts positioned beyond retaining wall on Platform 1 - Northbound.
- Existing HV cable within the redundant lift shaft would not need to be relocated.
- Symmetrical arrangement.

Cons

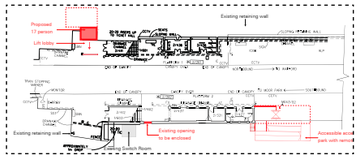
- Demolition work required to platform structures/ accommodation.
- Additional cost of walkways.
- Lift shaft structures will be more visible than options 1 and 2.

Option 5

Concourse Level Plan



Platform Level Plan



Pros

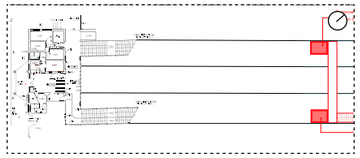
- MVP where only one lift is provided.

Cons

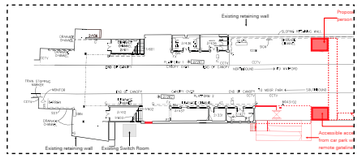
- Very long PRM route from Platform 1 - Northbound back to station car park.
- Need for retaining wall structure to form lift shaft on Platform 1 - Northbound.
- Existing HV cable within the redundant lift shaft would need to be rerouted.

Option 6

Concourse Level Plan



Platform Level Plan



Pros

- Minimal impact on existing building accommodation and infrastructure.

Cons

- No step free access from station entrance to platform (only car park).

5.0 Preferred Option Validation

5.0.1 Feasibility Premises Objectives

The objectives of the Single Preferred Option report can be summarised as follows:

- To provide step free access from pavement to platforms via 17 person through lifts.
- To provide step-free access route from the station car park to platforms.
- To develop a compact solution (Minimum Viable Product) with minimal intervention to the existing station complex.
- To provide accessible toilet(s) to the standards stated in the 'Identifying toilet provision for the LU SFA Programme 2023 Informal guidance from the Inclusive Design Team. For Croxley we are proposing a minimal provision (enlarged unisex accessible toilet with baby change facilities which is accessible from the paid side of the gateline).
- To provide an accessible and inclusive customer experience.
- To remove the segregated routes within the southbound staircase in conjunction with providing a step-free route from the car park into the station and offer an alternative staircase route between the car park and station entrance.
- To develop a clear and legible accessible route for passengers from the station entrance to and from the platforms, with a focus on accessibility, inclusivity, and customer experience.
- To offer a solution which is sympathetic to the heritage status of the station complex which currently has a local listing status by the Local Authority.

5.0.2 Preferred Option

At the option selection stage of the project, six options were considered and scored. The Pairwise scoring process by the Contractor and Client team conclude that Option 2 was the preferred option and is now the focus of the Croxley feasibility report.

This option proposes placing the lifts adjacent to the existing staircases, ensuring the lift entry point is visible from the gateline.

On the northeast side of the concourse, the lift will be partly installed within the disused lift shaft. To accommodate the 17-person through lift, the shaft will need to be enlarged, which will also require extending the concourse marginally to accommodate the lift lobby area.

On the southeast side of the concourse the lift will be located between the existing staircase and retaining wall structure. Similar to the northeast side, the concourse will need to be extended to provide a new lift lobby.

At platform level, the northwest lift lobby serving platform 1 (Northbound) will be created through providing a new retaining wall structure linked to the modified lift shaft structure.

On the southeast side, the lift lobby serving platform 2 (Southbound) will be created through marginally extending the platform to offer a more generous lift lobby.

All lift lobbies are proposed with seating, wheelchair waiting areas and Passenger Help Points. Signage / line diagram signage can be provided in the vicinity of the lift lobbies.

To enable access to the proposed southeast lift, the existing segregated route from the carpark to the station entrance is to be removed and new accessible route provided from the station carpark to the platform 2 with a remote Wide Aisle Gate. A new canopy will be built to cover this WAG in a matching style to the existing canopies. A separate staircase route is proposed linking the carpark and station entrance. In addition, 3 accessible carparking spaces are proposed to the station carpark as part of the works which will be located near to the new accessible entrance.

An enlarged unisex accessible toilet with baby changing facilities, meeting TfL's minimum provision standards (LU SFA programme 2023 requirements) is proposed at concourse level and will be accessible from the paid side of the gateline.

An early visualisation has been developed to illustrate the lift shafts in the context of the existing station. Please refer to Fig 5.0.2-1.

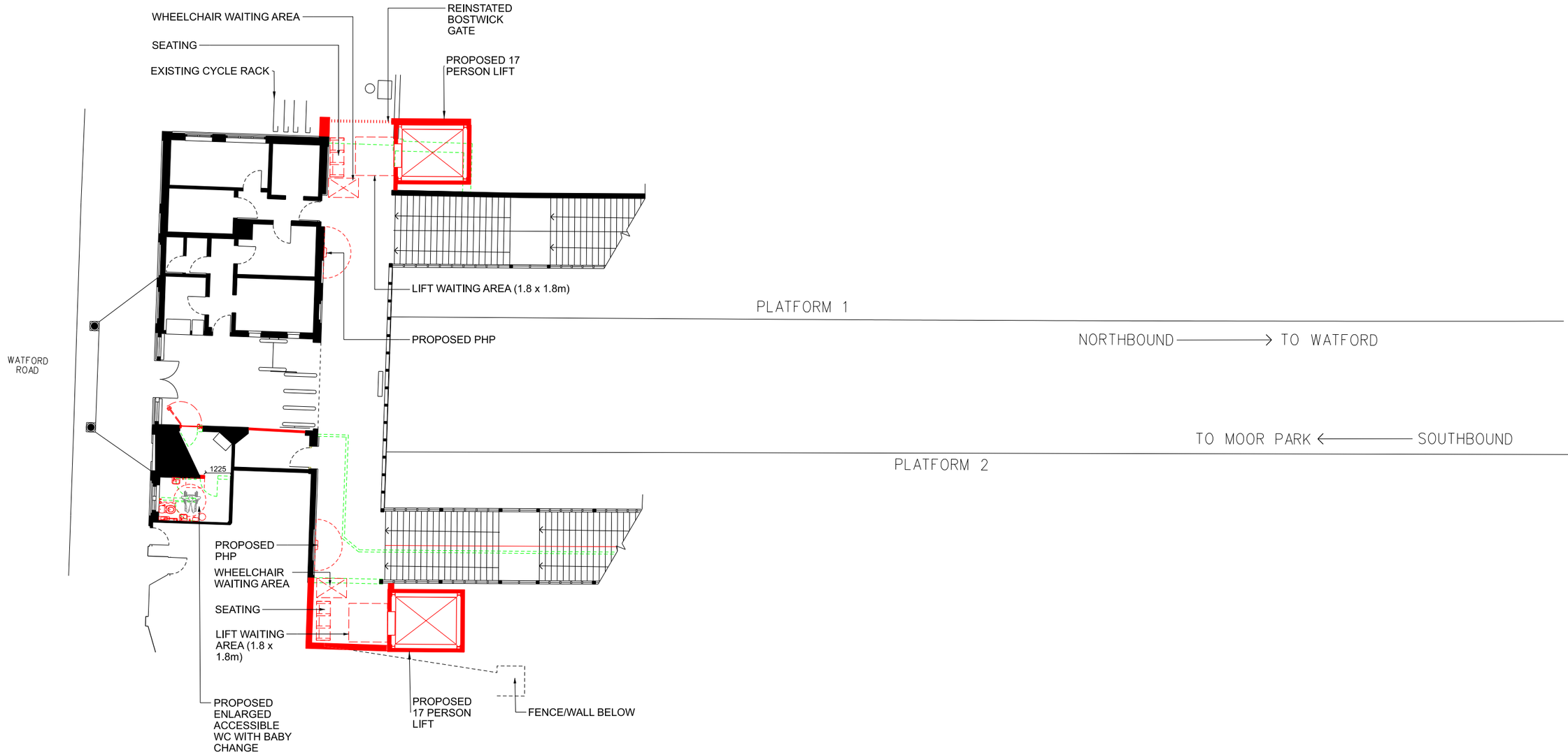
Fig 5.0.2-1: Croxley Platform CGI

1:200

Existing	
Proposed	
Demolished	

5.1 Proposed Plans

5.1.1 Concourse Level Plan



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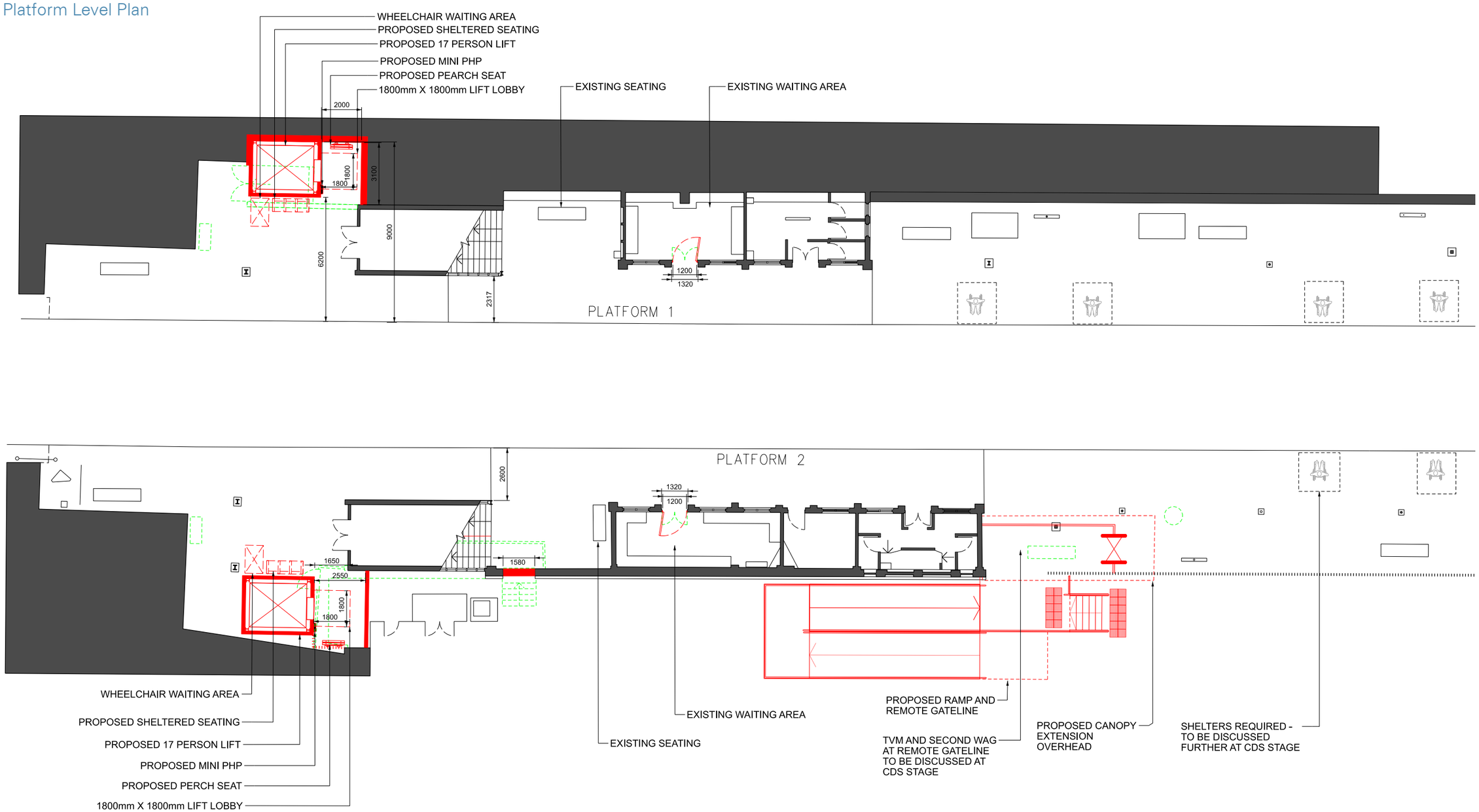
Existing	
Proposed	
Demolished	

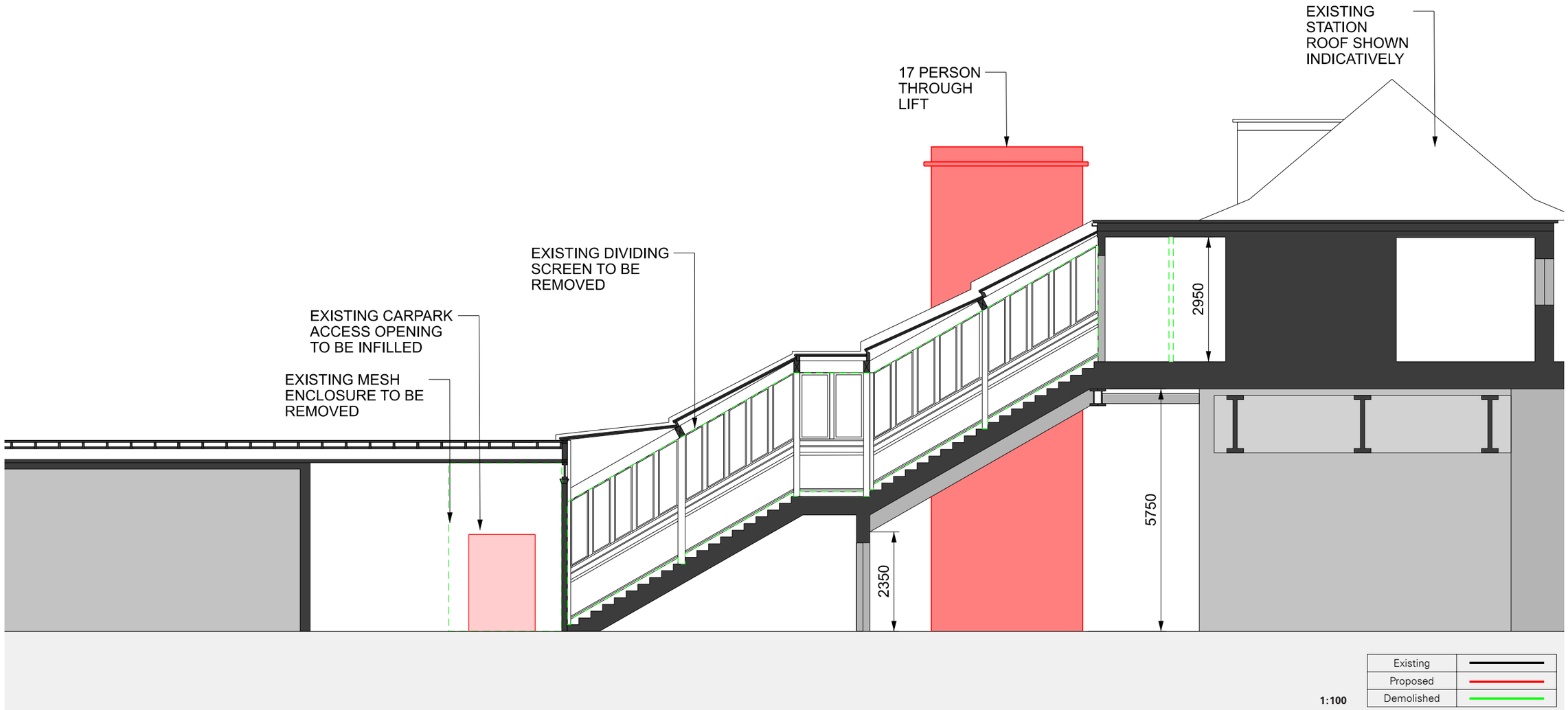
5.1 Proposed Plans

5.1.2 Platform Level Plan



5.2 Proposed Sections

5.2.1 A - A



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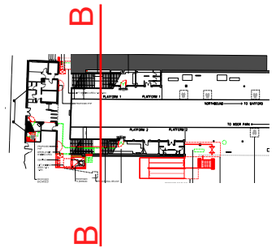
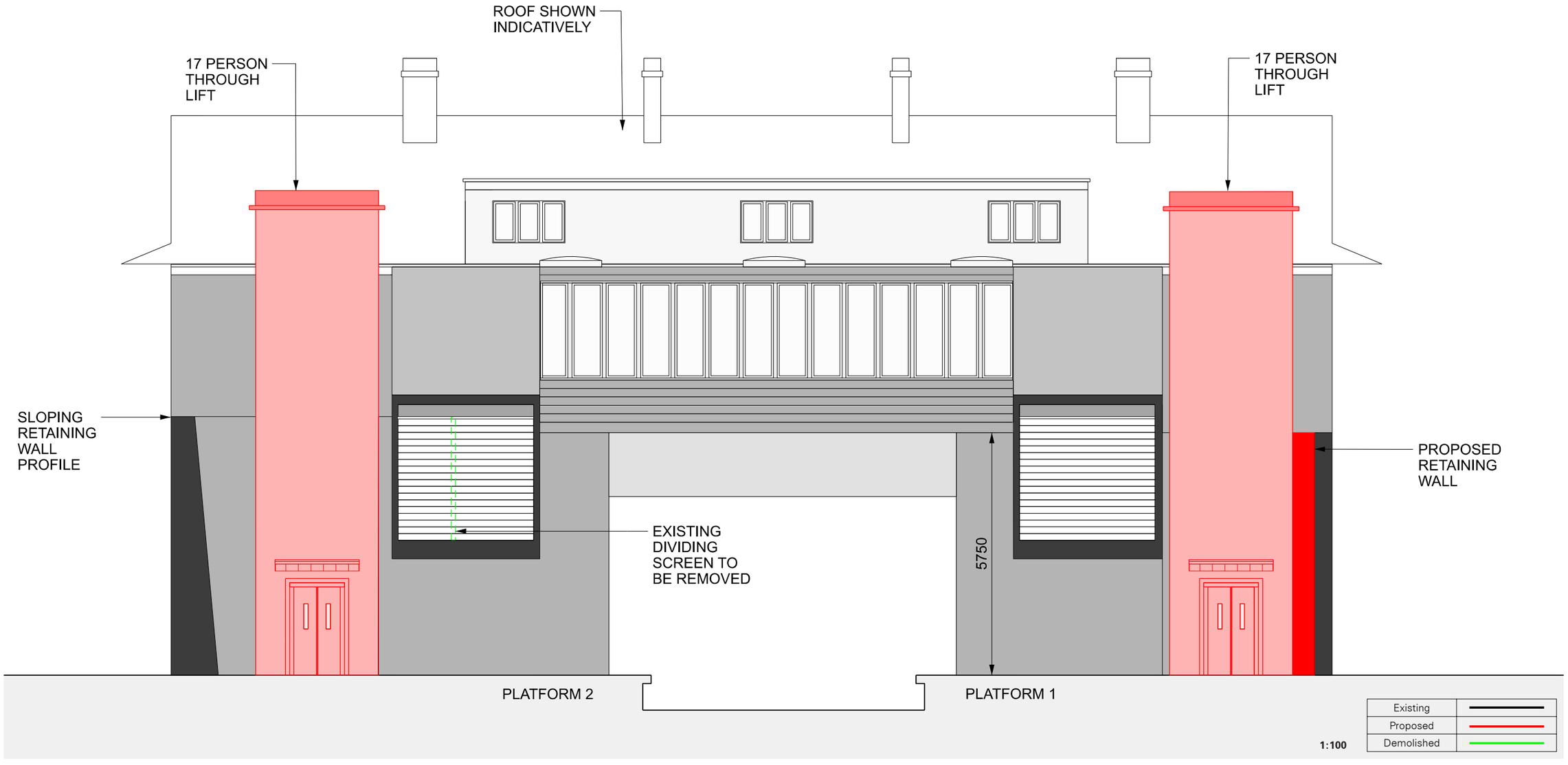
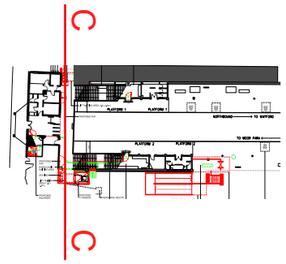


5.2 Proposed Sections

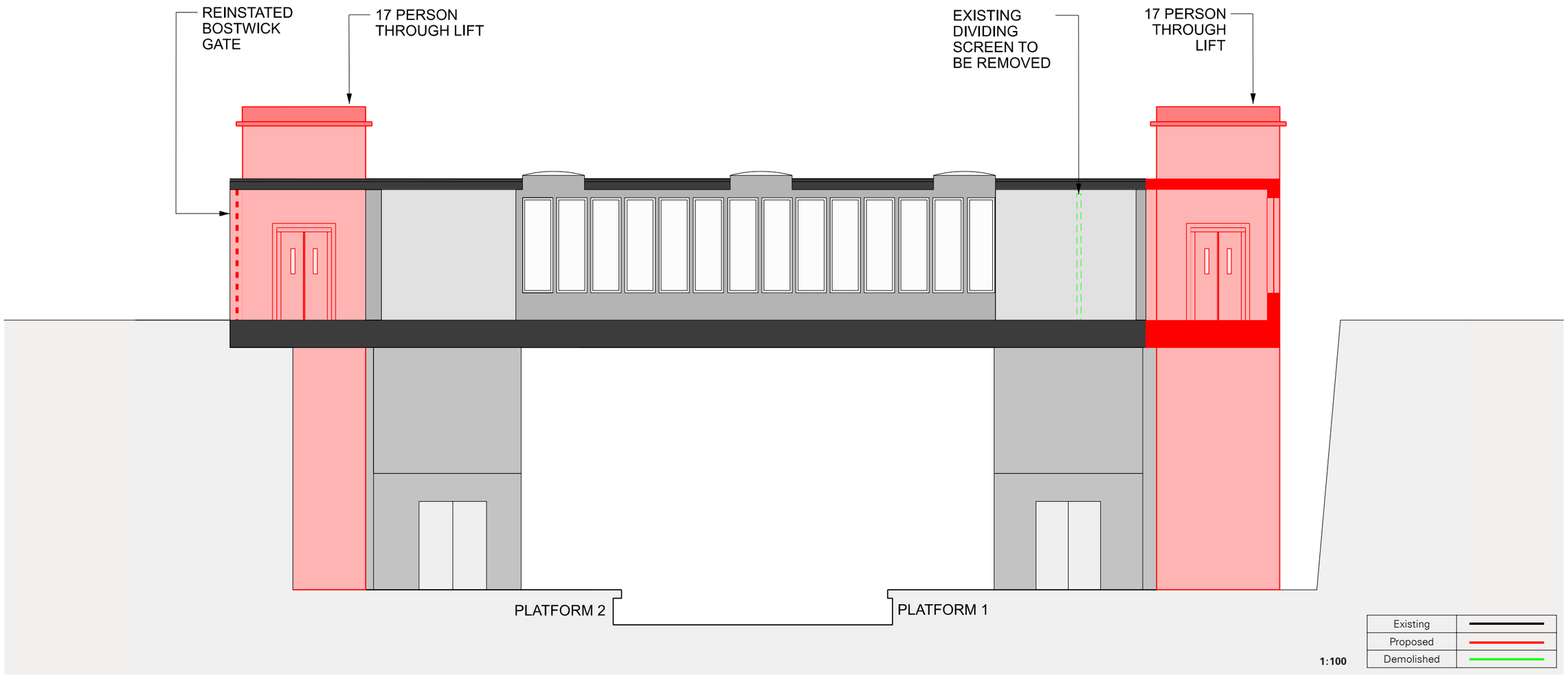
5.2.2 B - B





5.2 Proposed Sections

5.2.3 C - C



5.3 Step Free Access

The primary purpose of the selected proposal is to provide step free access from pavement to platforms. The current station complex and entrance is built over the railway. On entering the station and passing through the gateline, staircases descend to two side platforms. The station has a carpark adjacent the southbound platform and currently a segregated route is provided from the carpark back up to the main entrance via staircase.

The scheme will provide a step free route from the station entrance and carpark to both platforms.

5.3.1 Step Free Route

The approach and access to the station for a person of reduced mobility (PRM) is proposed as following:

5.3.1.1 Arriving through main station entrance (Watford Road)

- Passengers of reduced mobility can be dropped off in front of the stations main entrance (Note: there is not a designated accessible drop off space). The eastbound bus stop, which does not have level access, is located in front of the station, while the westbound bus stop, also without level access, is 110 metres from the main entrance. Cycle racks are located on the western side of the main entrance, but there is no provision for modified bikes (i.e., tricycles).
- When we visited the site, the existing station entry doors were open which would provide adequate width for wheelchair access in the future. A RFI has confirmed that these doors remaining open during traffic hours, and are only closed during engineering works. A gated side entrance past the gateline is permanently locked, which was confirmed via RFI.
- London Underground operates a Turn Up and Go (TUAG) system on their network. There is no need to pre-book the TUAG service, just turn up at the station and ask staff for assistance. The station staff are trained to give assistance to customers, including guiding visually-impaired customers by the arm and helping wheelchair users get on and off trains. This can be requested at the station office in the ticket hall or at a Passenger Help Point. A RFI has confirmed that this service is available at Croxley Station.
- If ticket purchase is required, the existing TVMs (Ticket Vending Machines) are located on the left hand side of the station entrance. Opposite the TVMs is a Passenger Help Point, the height of the Passenger Help Point will need to be verified and lowered to comply with current accessible standards.
- The WAG (wide access gate) is located at the end of the gate line, closest to the old ticket office.

Fig 5.3.1.1-1: Entrance from street level

- Once on the paid side of the gateline separate symmetrical routes give access to the platforms 1 and 2.
- The two new lifts are accessed via extended existing overbridge structure which will provide a lift lobby with seating and a Passenger Help Point in the vicinity.
- The existing disused toilets to the right of the gateline on the southern side of the concourse will be replanned to provide accessible toilet provision.
- A 17 person through lift is offered to both platforms. This could be offered as an evacuation or assisted evacuation lift depending on the requirements of the Fire Strategy to be developed at the CDS stage.
- Exiting the lift at platform level brings you onto the platform, parallel to the platform edge. Seating, signage and a Passenger Help Point will be provided at platform level.
- We understand the station will operate a help on arrival facility. If a Manual Boarding Ramp (MBR) is needed the passenger should wait for assistance from a member of station staff. Waiting at the boarding point, a member of staff will place a MBR and assist with entering the train car. At the CDS stage the boarding points are to be established with London Underground and there storage location.

5.3.1.2 Entering through car parking

- The station car park is located off Watford Road. The existing parking spaces will be replanned to provide three accessible spaces next to the proposed accessible ramp to platform 2.
- A proposed two-flight ramp will address the approximately 1-metre difference in levels from car park to platform. Additionally, a flight of stairs will be offered.
- A covered Wide Access Gate (WAG) is proposed at Platform 2 (southbound level), near the existing platform accommodation.
- For Step Free Access to Platform 1 Northbound, passengers can enter through the car park entrance and use the stairs or lifts via the overbridge.
- Access to the accessible toilet requires use of the lift to reach the concourse level, where the facility is located.

Fig 5.3.1.2-1: Entrance from car park

5.4 Proposed Lift Configuration

5.4.1 Lift Design

As previously stated, the project is proposing a 17 person through lift arrangement. The lift shaft serving the southern platform will be formed independent of existing structures and is formed in a void between the existing stair and retaining wall structure. The lift shaft severing the northern platform is formed through enlarging the original lift shaft and reducing the thickness of the existing retaining structure (refer to Civil/ Structural Engineers commentary for further information).

The project has considered the use of an AVA lift at this site. Whilst this would reduce the construction period, further investigation needs to take place to consider whether a crane with suitable loading capacity can be positioned in the vicinity of the station. Further investigation into whether the footprint of the AVA lift would be larger than the OTIS lift the design is currently based upon as both lift shafts are constrained by existing structural constraints. Furthermore, the AVA lift designed for Network Rail is based on a 16 person lift arrangement rather than a 17 person lift so may require a concession to be used.

5.4.2 Lift Sub-Options

As part of the feasibility study, we have considered two sub options for the northeast lift which may offer a cost saving over the proposed option but offer a slightly less favourable customer experience. These are a 90° lift arrangement and a through lift going North to South, as illustrated in Fig 5.4.2-1 and 5.4.2-2.

Scenario	Peak Period	Average passenger size	Lift type	Lift size	Demand ENTRY	Lift demand ENTRY	Demand EXIT	Lift demand EXIT	Required floor area of lifts	Total Capacity for given lift
2041 0800-0815 SB	AM Peak	0.60 m²	13 person	2.31 m²	131	12	27	3	0.69 m²	30%
2041 0800-0815 SB	AM Peak	0.68 m²	13 person	2.31 m²	131	12	27	3	0.77 m²	34%
2041 0800-0815 SB	AM Peak	0.60 m²	17 person	2.85 m²	131	12	27	3	0.69 m²	24%
2041 0800-0815 SB	AM Peak	0.68 m²	17 person	2.85 m²	131	12	27	3	0.77 m²	27%
2040 1700-1715 NB	PM Peak	0.60 m²	13 person	2.31 m²	3	1	62	6	0.32 m²	14%
2041 1700-1715 NB	PM Peak	0.68 m²	13 person	2.31 m²	3	1	62	6	0.37 m²	16%
2042 1700-1715 NB	PM Peak	0.60 m²	17 person	2.85 m²	3	1	62	6	0.32 m²	11%
2043 1700-1715 NB	PM Peak	0.68 m²	17 person	2.85 m²	3	1	62	6	0.37 m²	13%

5.4.1-1 : PED Flow Analysis

5.4.2.1 90° Lift Arrangement Sub Option

Advantage	Disadvantage
Visible lift entrance at concourse and platform level	90-degree lift arrangements are perceived less preferable than through lift arrangements by LU
Reduced extent of retaining wall structure	
Symmetrical lift arrangement to the station complex	

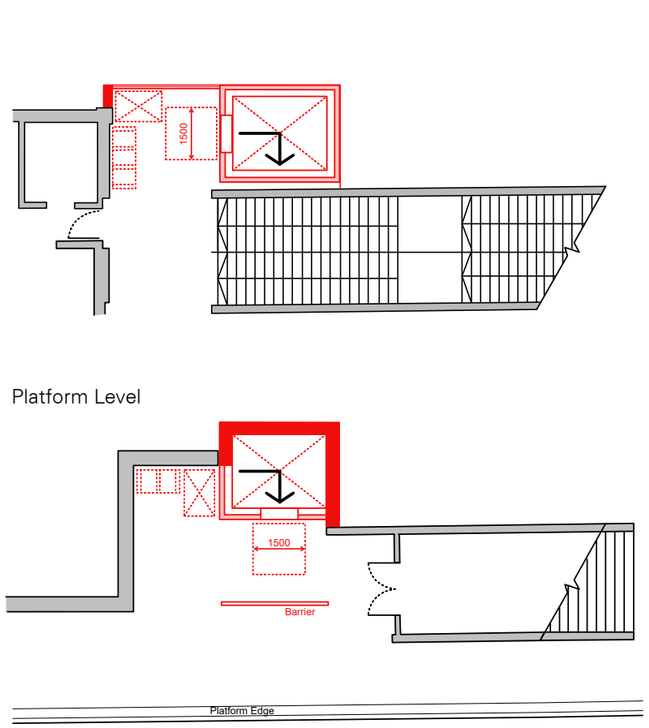


Fig 5.4.2-1: 90° lift arrangement

5.4.2.2 North – South Through Lift Arrangement Sub Option

Advantage	Disadvantage
Through lift arrangement	Lift entrance / doors at concourse level are less visible from the gateline and will rely upon signage to direct passengers.
Visible lift entrances at platform level	
Reduce extent of retaining wall structure	
Symmetrical lift arrangement to the station complex	

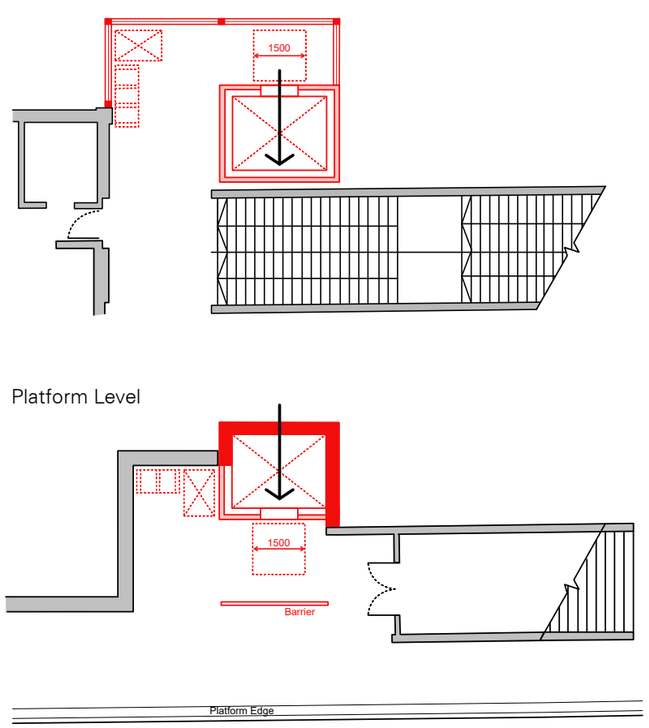


Fig 5.4.2-2: North-South through lift arrangement

5.5 Proposed Car Park

To facilitate the removal of the segregated route from carpark to the unpaid concourse, it is necessary to replan an area of the station carpark which includes:

- An accessible ramp and stair from carpark to platform level.
- Remote gateline with canopy on the southern platform.
- Re-positioning of the three accessible parking spaces adjacent to the proposed ramp access.
- The existing postal lockers are relocated.
- The opportunity for a new staircase is proposed linking the carpark and station entrance:
  - Option 1 provides a clearer route with less impact on planting to the embankment but requires the demolition of part of the commercial unit to form this route.
  - Option 2 is a dog leg arrangement, which avoid the need to demolish part of the commercial unit at street level, but a less direct route and would require more trees and vegetation clearance from the embankment.

In relation to car park provision, we have retained the 3no accessible parking spaces whilst the number of standard parking spaces is reduced by 13 to accommodate the access ramp / stair to the platform and stair access to the main station entrance. Whilst the carparking provision is reduced, the accessible parking is proposed closer to the entrance ramp and this layout segregates parking and passenger circulation to provide a much more legible and safer solution. With this layout, we have indicated some cycle parking which could be introduced.

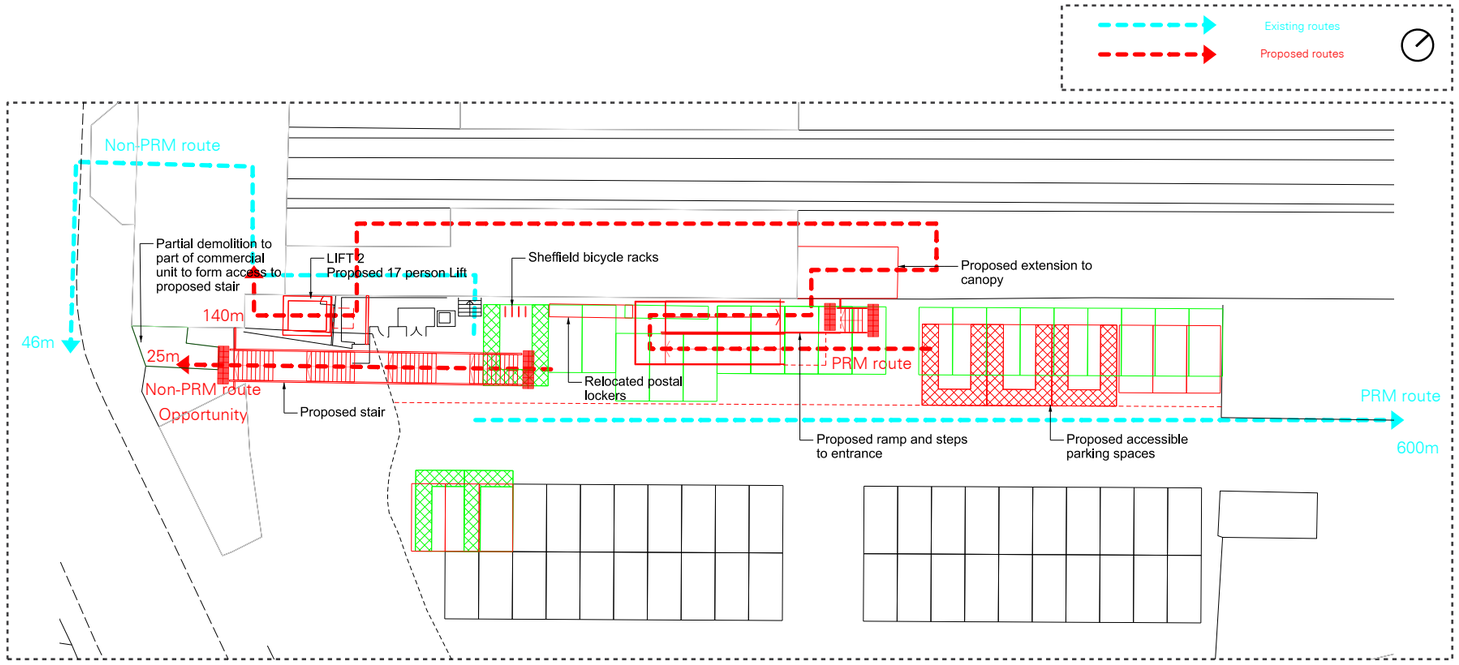


Fig 5.5 -1: Staircase from street level to car park - direct route down

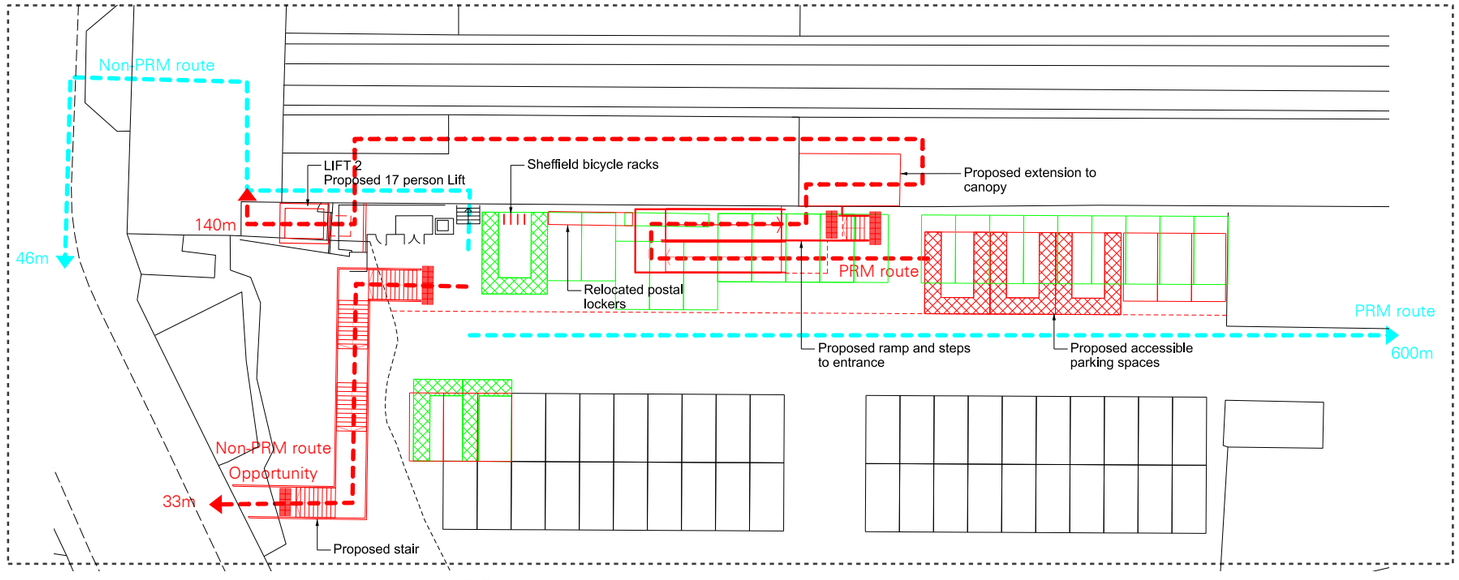


Fig 5.5-1: Staircase from street level to car park - angled route down

5.6 Proposed Accessible Toilet

The existing station has a female toilet on the unpaid side of the gateline, and two male toilets on platform level, one on either platform. We are proposing at least one accessible toilet, which may impact the existing toilets and cleaners cupboards, depending on the option chosen at Concept Design Level.

Option A:

- Concourse Female WC replaced by proposed Enlarged Accessible WC with Baby Changing Facilities
- Platform 1 Male WC retained
- Platform 2 Male WC replaced by proposed Female WC

Option B:

- Concourse Female WC retained
- Platform 1 and 2 Male WCs retained
- Platform 2 Cleaners Store replaced by proposed Enlarged Accessible WC with Baby Changing Facilities

Option C:

- Concourse Female WC replaced by proposed Enlarged Accessible WC with Baby Changing facilities
- Platform 1 and 2 Male WCs retained
- Platform 2 Cleaners Store retained

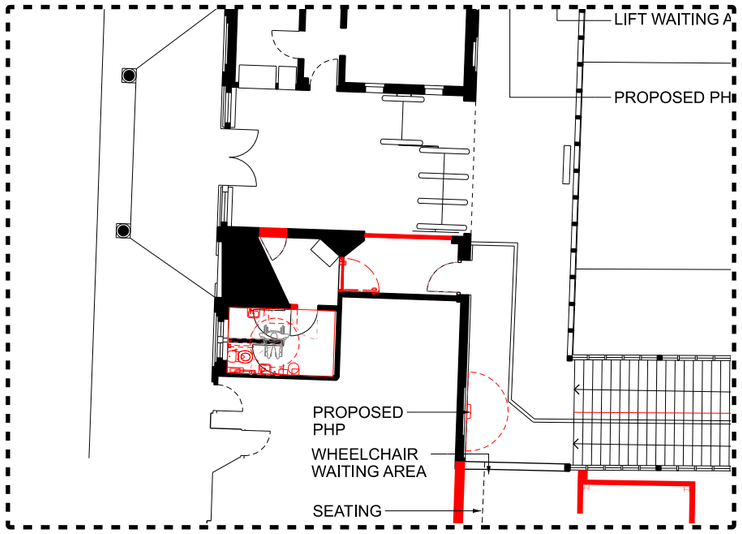


Fig 5.6-1: Option A Concourse

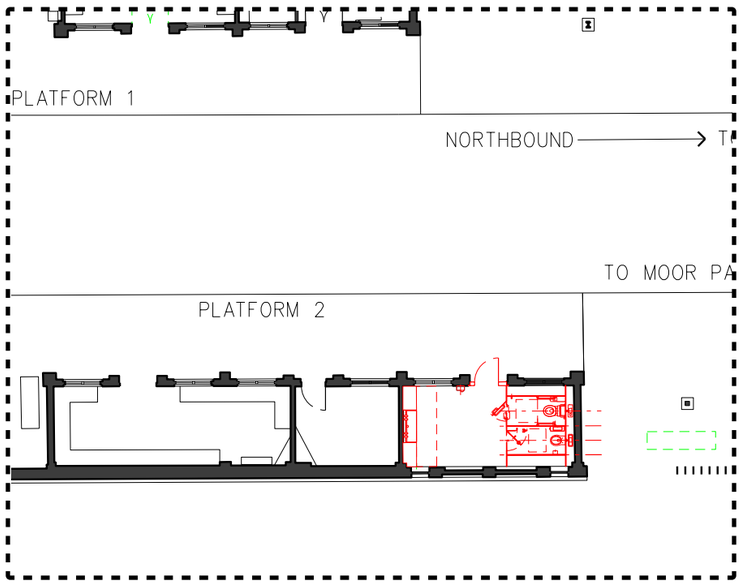


Fig 5.6-2: Option A Platform

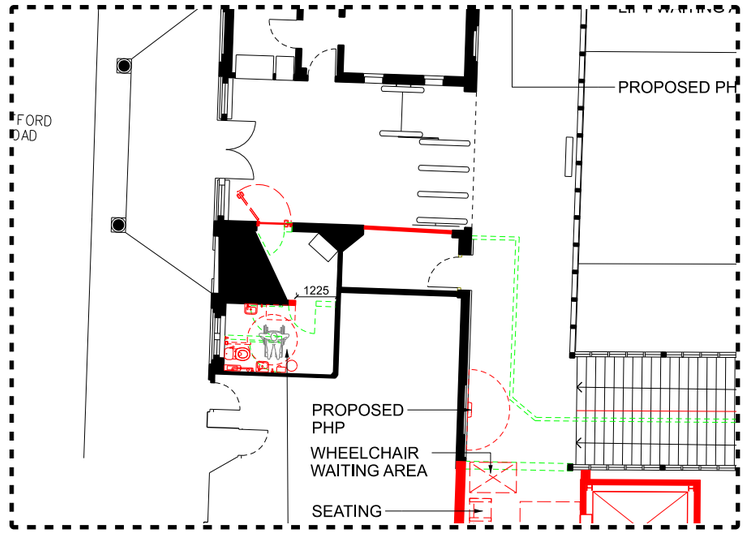


Fig 5.6-3: Option C Concourse

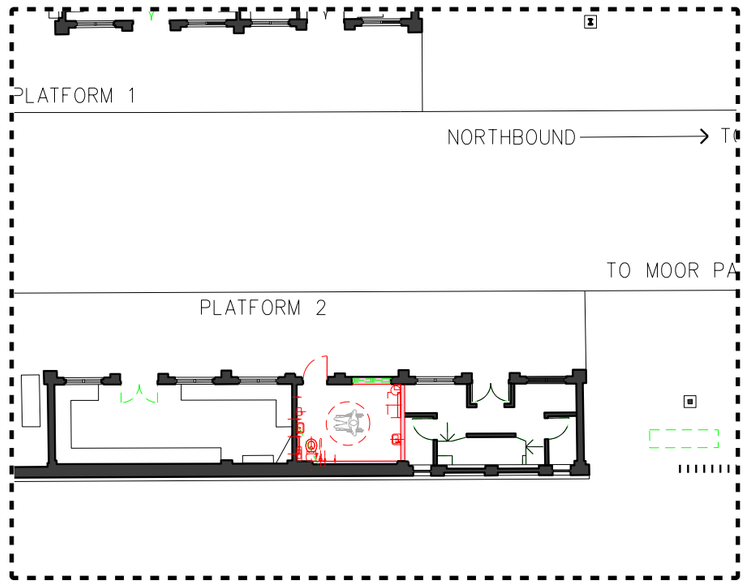


Fig 5.6-4 Option B Platform

5.7 Waiting Rooms

The existing waiting rooms have double doors within a 1200mm door frame, which is compliant for accessibility. However, double doors may not be comfortable to use as a PRM. We are proposing a single large door on either platform's waiting room, which can either be manually opened or opened via push pad. This will need to be discussed further at CDS.

There is not a step into the waiting room, however there is a drainage channel in the tiling. This will need to be replaced by a flat tile to be accessible. The remaining drainage channel(s) will still work as intended without this tile, as they have drains on either end.

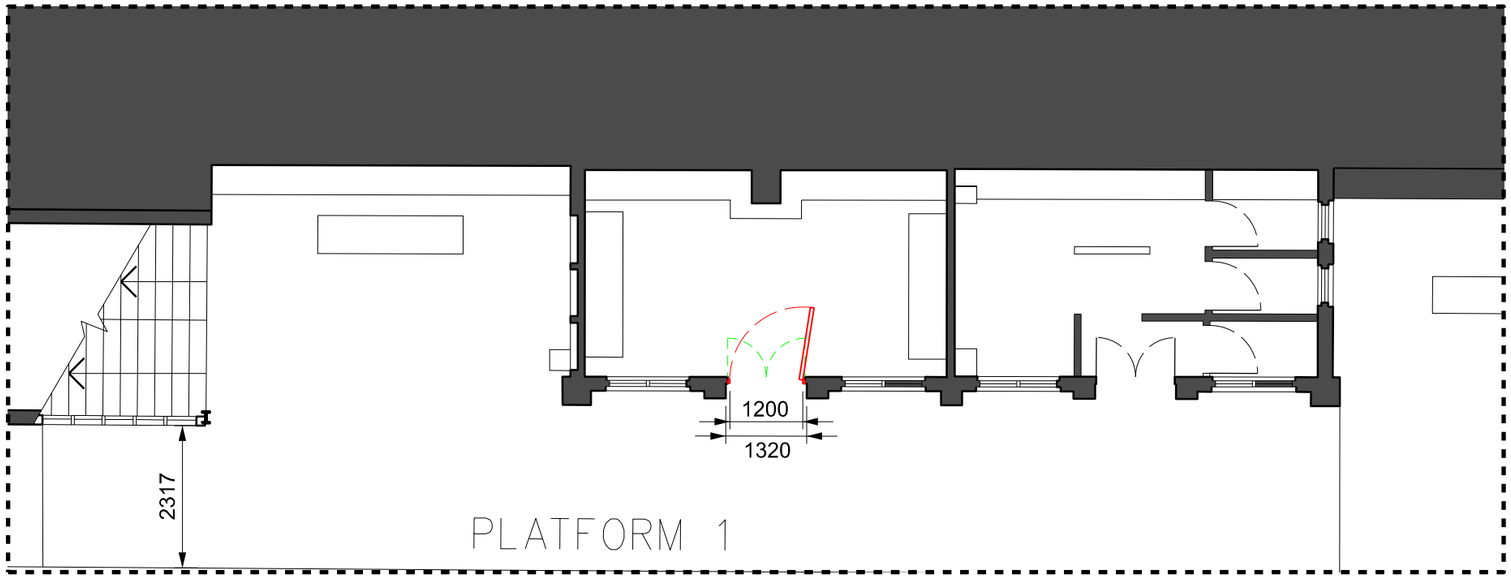


Fig 5.7-2: Proposed waiting room entrance from Platform 1

Fig 5.7-1: Existing waiting room entrance from Platform 2

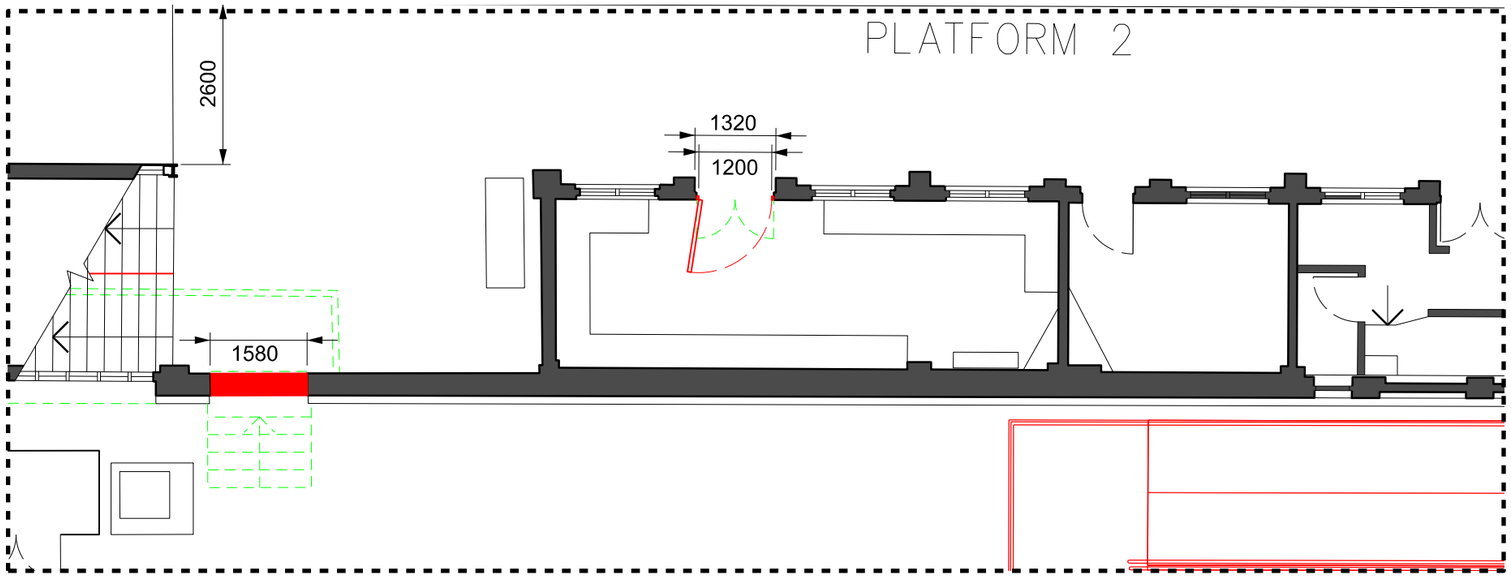


Fig 5.7-3: Proposed waiting room entrance from Platform 2

5.8 Platform Train Interface

On the Northbound platform, the step is +25mm and the gap is 70mm. On the Southbound platform, the step is +18mm and the gap is 70mm.

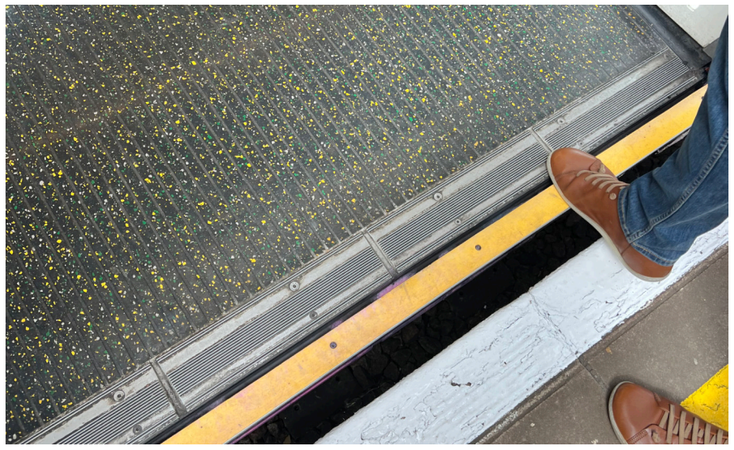
According to LU, these are classed as 'level access' in accordance with RVAR(2010) and MBRs are not required, however, mini-ramps are required in line with the Mayors Transport Strategy.

In S1374 - Customer Experience Section 3.4.12.2, it is stated that weather protection should cover designated level access boarding areas, however the existing canopy does not currently do that. Bus-stop style shelters near the accessible boarding areas can be developed at a later design stage.

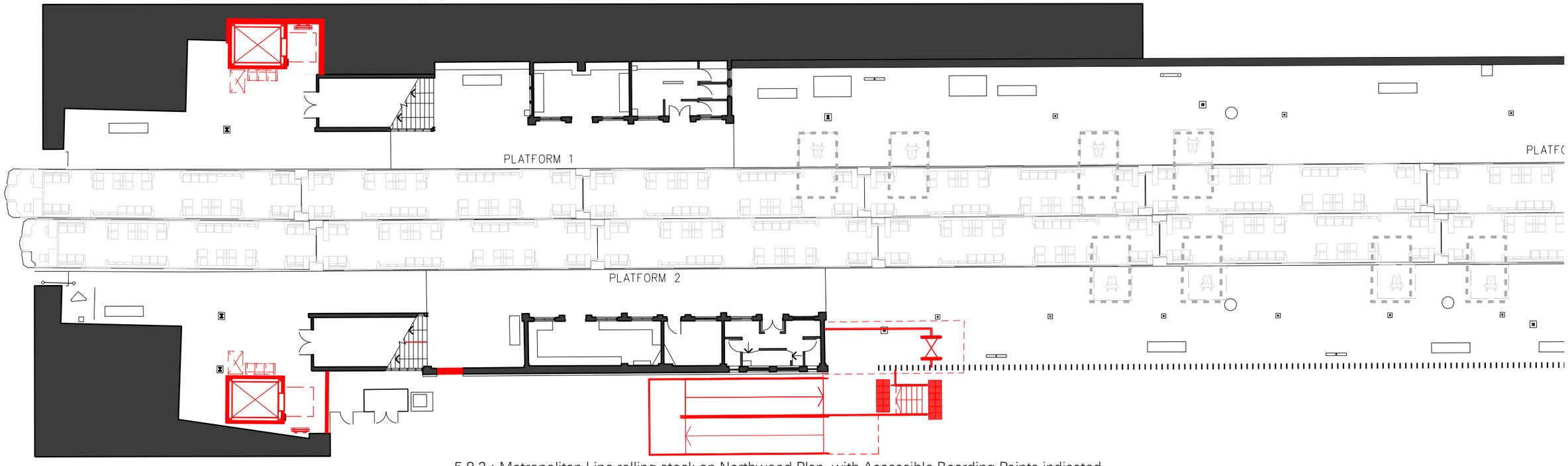
The accessible carriages are indicated on Fig 5.8-2, using information from G347 - Platform Accessibility Humps, seen below.

S Stock – 7 car (S7) [2]	Cars 3 and 4 or Cars 4 and 5 (depending on train orientation)	3rd door car 3 and 1st door car 4 or 3rd door car 4 and 1st door car 5 (depending on train orientation)	2 per car. Total 4 per train.

5.8-1 : Accessible carriages for Metropolitan Line rolling stock (taken from G347 - Platform Accessibility Humps)



5.8-1 : Typical PTI



5.8-2 : Metropolitan Line rolling stock on Northwood Plan, with Accessible Boarding Points indicated

5.9 Materials

The materials selected are to complement the existing station building without directly matching it, due to the difficulty of matching heritage and contemporary materials. All selected materials and products are durable, cost-effective and replaceable if damaged.

The 17-person through lift will be externally clad in a multi-red brickwork to complement the existing station building. The lift shaft roof would be proposed with a parapet to the three visible sides and a slopping metal profiled roof draining to the open fourth side.

Where the concourse is being extended to provide the lift lobbies, materials and colours are proposed to be sympathetic to the existing station complex.

The existing overbridge terrazzo tile is proposed to be extended into the proposed concourse lift lobbies as it is readily available and capable of achieving a high slip resistance.

Where the platform is extended to create the lift lobbies, this would be finished with concrete paving slabs to match the rest of the platforms.

Lift entrances at platform level are proposed with canopies to offer weather protection.

The remote entrance canopy will match the existing platform canopies adjacent.

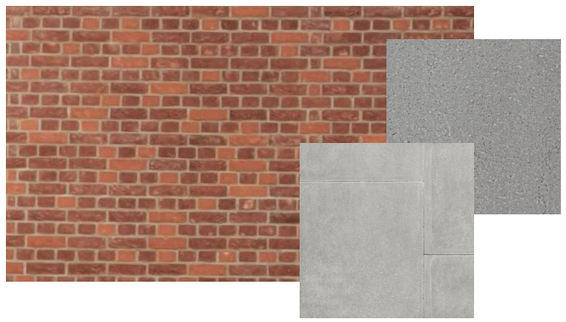


Fig 5.9-1: Proposed Material palette

5.10 Fire Strategy

Currently a fire strategy is not provided at the feasibility stage of the project, and it has been assumed this will be provided at the CDS stage of the project.

In relation to the currently feasibility design we have the following observations however this doesn't constitute a fire strategy and would need to be reviewed and verified by a Fire Engineer:

- The introduction of the proposed access route from carpark to platform 2 will reduce the dead platform distance from the northern end of the platform.
- It is assumed that a place of relative safety will be provided at the northern end of both platforms for all passengers, as other SFA schemes.
- The escape distance for passenger using the lifts from the top landing to the final exit will be similar to those using the stair.
- It is assumed the lifts could be designed as evacuation lifts or assisted evacuation lifts based on the requirements of the fire strategy.
- The existing Bostwick gate to the northwest façade could be replaced to offer a secondary means of escape if this was beneficial to the fire strategy.
- In relation to the existing station accommodation, no alterations are proposed with the exception of the repurposing of some existing toilet accommodation to an accessible WC. Therefore at this stage we do not foresee any changes to the fire compartmentation of the station.

5.11 Compliance

5.11.1 Concessions:

At this early design stage, we believe there are no concessions to consider associated with the preferred option.

Should one of the lift sub-options be developed, these should be discussed with the premises Engineer to establish if the 90-degree lift arrangement and side on lift arrangement are accessible.

5.11.2 Existing non-compliance:

Although we haven't conducted a dimensional survey, our review of station plans and site observations indicate several existing non-compliances, which are listed below.

- The gateline should have two WAGs due to it being a bidirectional rather than a single WAG.
- The existing stair treads appear to be too narrow, at approx. 280mm as opposed to the 300mm minimum requirement.
- The existing entrance door width is 1.7m as opposed to the 2.5m minimum requirement.
- The queuing zone for the TVMs next to the external wall is 1.2 m due to the entrance door being held open, as opposed to the 4 m suggested by LU standards.
- The existing gateline run off towards the passageway is 3.2m as opposed to 4m suggested by LU standards.
- The runoff of the bottom of the staircase serving the carpark is currently 2.6m, however the proposed design removes the segregated route, thereby resolving this non-compliance.
- The existing staircase has two flights of 20 risers which is non-compliant with the general requirements of the Premises – Stairways and Ramps standard, which states stairways are to comply with the building regulations and this would not conform with Part M which states a maximum of 12 risers, furthermore the current handrail design is not complaint with only a single handrail offered.

5.12 Planning Consent

Croxley Station is a locally listed building with several heritage features, as outlined in the LU heritage report, though it is not located within a conservation area, and currently none of the trees around the station are protected under tree preservation orders (TPOs).

In relation to planning history we understand that the Weston Williamson and Partners feasibility study completed in 2016 considered the redevelopment of the existing station carpark but no formal planning application was submitted. Historically, a planning application for a residential development and car park (reference 8/813/74) was submitted on 30 December 1974 but was later withdrawn on 28 May 1975.

The proposed scheme will have minimal visual impact on the station complex when viewed from the street or platform and will be developed with the proposed lift shafts positioned either side of the station building.

At the CDS stage the LU consents teams will advise on the consents process, however at this stage and considering the small amount of additional development we do not foresee a significant risk gaining planning consent or permitted development rights.

Name	Constraint Type	Description
Landscape Areas	Landscape Description	Landscape Region - Central River Valley
Locally Important Buildings	Locally Listed Building	Croxley Metropolitan Railway Station,Watford Road, Croxley Green
Denham Aerodrome (Bird Strike)	Air Safeguarding zone 3	Development forming bird strike hazards;eg.reservoirs, nature reserves,sewage disposal works;require consultation with CAA and Denham Airport Management
London Underground Zone Of Interest	London Underground Zone of Interest	Consult London Underground on planning applications
Licenced Landfill Sites 250m Buffer	Licenced Landfill Sites 250m buffer	Environment Agency consultation zone
Heathrow Airport Windfarm Consultation Zone	Air Safeguarding Direction	Heathrow Airport Windfarm Consultation Zone
Denham Aerodrome (Wind Turbine)	Air Safeguarding zone 3	Wind turbine development requires consultation with CAA and Denham Airport Management
HCC Mineral Consultation Area	HCC Mineral Consultation Area	Mineral Consultation Area (sand and gravelbelt)
RAF Northolt Safeguarding	Air Safeguarding Direction	Consultation required for all applications involving a refuse tip, a resevoir,a sewage disposal works,a nature reserve or a bird sanctuary
RAF Northolt Safeguarding	Air Safeguarding Direction	Consultation required for developments that involve flying activities including gliding, micro-light aircraft and hang-gliding sites
RAF Northolt Safeguarding	Air Safeguarding Direction	Consultation required for any building,structure works exceeding 91.4m in height above ground level

Fig 5.12-1: Constraints table extracted from Three Rivers District Council

Fig 5.12-2: OS map of site

5.13 Structural Validation

5.13.1 Structural design philosophy

Ramboll's design for SFA entails the installation of two new lift shafts, which travel between ticket hall and the existing platform level. The design reuses the existing lift shaft on the northbound platform with a new retaining structure creating the lift lobby at platform level. On the southbound platform a steel framed lift shaft will be connected to the ticket hall by a short, cantilevered walkway. The complexity of the design arises at the junctions between lift pits and the existing retaining structures.

5.13.2 Superstructure

A small, walkway cantilevers out from the southbound steel framed lift shaft connecting to the existing ticket hall. This reduces the number of columns and foundations required.

The northbound lift aims to reuse the existing lift shaft. The current pit depth and and shaft width may need enlarging depending on the dimensions of the new lift. The drawing shows a 200mm cutting back of the retaining wall and a 1100mm deep lift pit. It has been assumed that the existing wall and retaining wall will be capable of supporting the lift shaft rails and fixings however intrusive testing will be required in the concept design stage to confirm this. A new canopy will be required to form the southbound platform and will be formed of steel sections connected to the existing platform buildings.

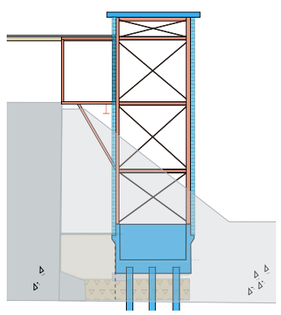


Fig 5.13.2-1: Section through southbound lift

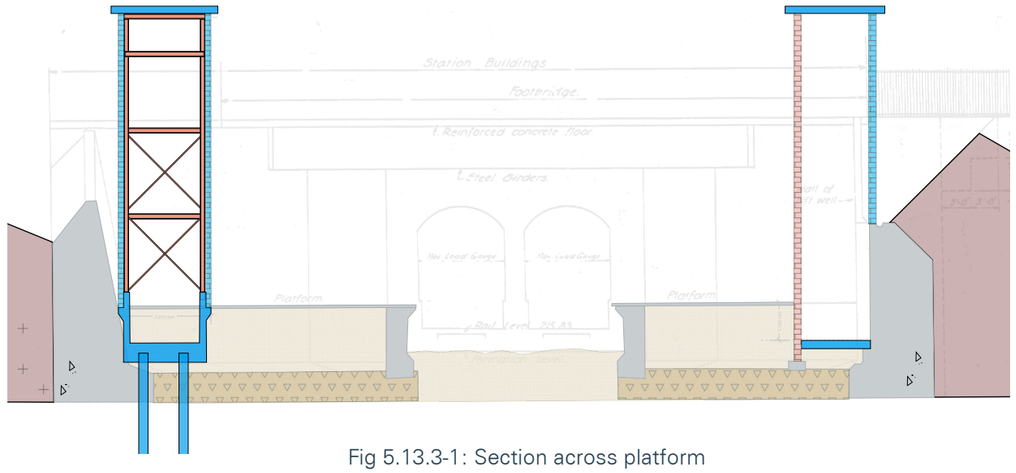


Fig 5.13.3-1: Section across platform

5.13.3 Substructure

The southbound reinforced concrete lift pit is founded on six 300mm diameter piles. A ground investigation is necessary before proceeding with the detailed design of the piled foundations and the design of the piles may need to be adjusted based on the findings of the ground investigation. Preliminary calculations suggest that the settlement of the new piled foundations will likely be minimal. However, the performance of foundations cannot be evaluated without further ground investigation, which would depend on factors such as the depth and strength of the London Clay. The lift pit may need to be designed to support the platform slab.

5.13.4 Stability

The new northbound lift system will be connected directly into the existing RC retaining wall and masonry walls on the other sides. High level calculations indicate that the additional lateral loads on these structures will be minimal. On the southbound platform the new lift pit and piled foundations will be designed to accommodate lateral loading from both lift shaft and walkway. Bracing helps to take the lateral loading down to the foundations.

5.13.5 Retaining wall

Large 5m and 8m high retaining walls currently bound the north and south platforms respectively. The northbound wall will be cut as indicated, with a new retaining wall installation to support the lift pit where the existing wall is cut. A few retaining wall options are to be considered:

- Sheet piling, with a concrete liner wall. This is an inexpensive solution, but there is the risk of deflections at the top of the sheet pile imposing high loads on the liner wall and corner of the existing retaining wall which meets the new sheet pile wall, resulting in localised failure.
- Contiguous piled wall. This wall solution would offer more lateral stability, but does not offer waterproofing. If the site has a high groundwater table, groundwater ingress may result.
- Secant piled wall. This solution offers the same stability benefit as contiguous piled walls, and additionally ensures groundwater control through the use of secondary piles, making it a more suitable choice if the groundwater table is high. However, both secant and contiguous piled walls require higher piling platforms than sheet pile and king post walls.
- King post wall. The H-Beams can be positioned to control the stiffness and subsequent deflections of the wall to satisfy deflection requirements. However, depending on the ground conditions and

5.13 Structural Validation

height of retained soil, additional support of the wall may be necessary (e.g., tie-backs).

The southbound lift pit will be adjusted to work with the existing retaining wall and preliminary calculations show that local breaking out will have minimal impact the stability of the wall.

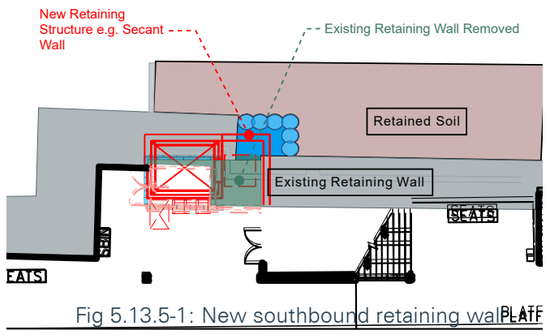


Fig 5.13.5-1: New southbound retaining wall

5.13.6 Key Interfaces

- Junction of walkway with existing ticket hall
- Junction of both lift pits and lobbies with the existing retaining walls
- New lift within existing lift shaft
- Lift pit interaction with platform slab

5.13.7 Basis of Design

5.13.7.1 Design Parameters

- Dead Loading Steelwork 0.5kN/m2
- Loading of lift car itself and associated plant 7.5kN/m2
- Walkway Imposed loading: 5kN/m2
- Wind Loading: 1.0kN/m2
- Design life 120 years
- Fire Resistance: 60 min
- Accidental Loads: No accidental loads were considered in the current design scenario as the supporting columns are located more than 4.5m away from the platform edge.

5.13.7.2 Structural Design Standards

- Eurocode 0: Basis of Structural design BS EN 1990:2002+A1:2005 and National Annex
- Eurocode 1: Actions on Structures BS EN 1991-1 to 7 and National Annex
- Eurocode 2: Design of Concrete structures BS EN 1992-1 to 3 and National Annex
- Eurocode 3: Design of Steel structures BS EN 1993-1 to 6 and National Annex
- Eurocode 4: Design of Composite Steel and Concrete structures BS EN 1994-1 to 2 and National Annex
- Eurocode 6: Design of Masonry structures BS EN 1996-1 to 3 and NA
- Eurocode 7: Geotechnical Design BS EN 1997-1 to 2 and NA

5.13.7.3 LU Standards

- S1053: Civil Engineering – Building and Station Structures
- S1050: Civil Engineering – Common Requirements
- S1051: Civil Engineering – Bridge Structures

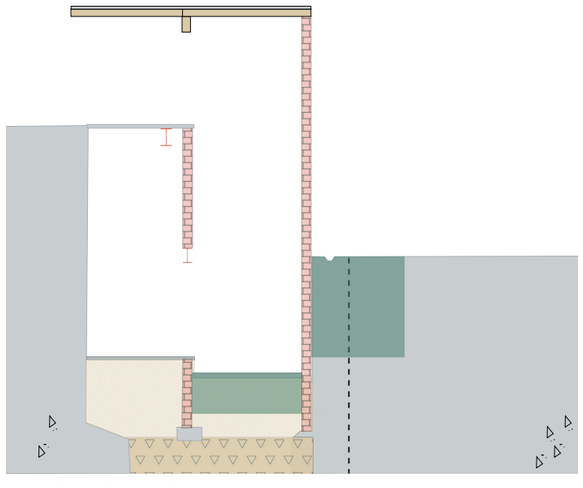


Fig 5.13.7.1-1: Before the formation of the new lift lobby

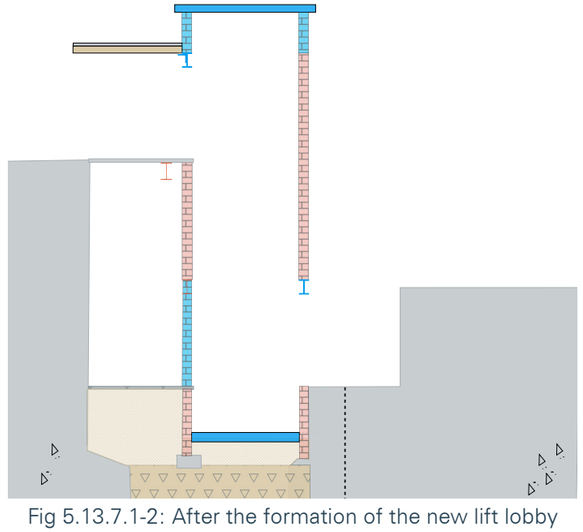


Fig 5.13.7.1-2: After the formation of the new lift lobby

5.14 Ground Conditions

5.14.1 BGS Mapping

The BGS GeoIndex Onshore map has been reviewed to determine the superficial deposits and bedrock local to the site. The geology is characterised as:

5.14.1.1 Superficial Deposits - Winter Hill Gravel

- Defined by BGS as variably clayey and sandy gravel.
- Described in local BGS logs as stiff orange brown sandy gravelly clay or orange brown clayey sandy gravel, with occasional flint cobbles and rootlets

Fig 5.14.1.1-1: BGS Superficial Deposits Map

5.14.1.2 Bedrock – Seaford Chalk and Newhaven Chalk Formation

- The Seaford Chalk is described by the BGS as consisting of hard, white chalk with seams of flint.
- The Newhaven Chalk is described by the BGS as consisting of soft to medium hard white chalk with several seams of marl and bands of flint.
- BGS logs characterise the bedrock as weak medium density white chalk, recovered as silt/slightly gravelly silt.

Fig 5.14.1.2-1: BGS Bedrock Geology Map

5.14.2 Preliminary Ground Model

The BGS GeoIndex Onshore map has been reviewed to obtain local borehole logs and develop a preliminary ground model. This should be verified by undertaking site-specific GI.

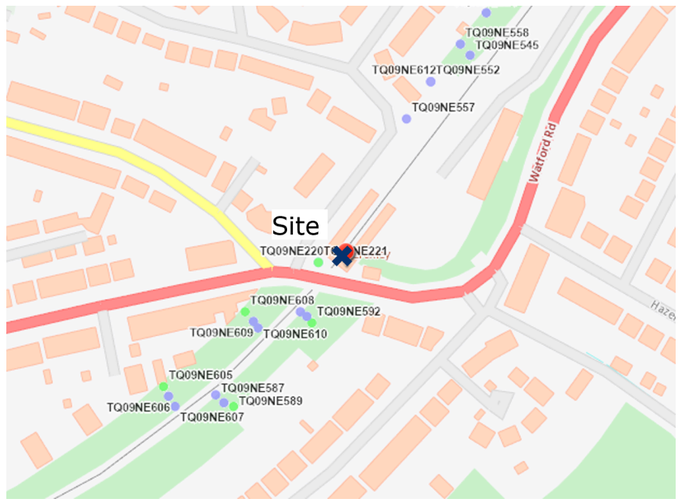


Fig 5.14.2-1: BGS Borehole Logs local to the Site.

Depths of each stratum have been interpreted and extrapolated from BGS information to produce the following preliminary ground model:

Table 5.14.2-1: Preliminary site ground model

Strata	Depth to Bottom of Strata – Range [mbgl]	Depth to Bottom of Strata – Average [mbgl]
Made Ground	0.1 to 1.0	0.4
Winter Hill Gravel	1.1 to 7.2	4.4
Seaford Chalk Formation and Newhaven Chalk Formation	Not confirmed, proven >4.6m	Not confirmed, proven >4.6m

A preliminary groundwater level of 1.45mbgl is advised, based on the highest level identified in nearby logs.

5.15 Drainage Concept Design

5.15.1 Surface Water Drainage Design

It is proposed that surface water generated by the new elements of the development will be captured by a series of rainwater downpipes which will discharge to the existing below ground surface water drainage network. Where the footprint of the new structures interact with the existing drainage, it is proposed that these drains will be diverted to avoid clashing with the new structure. All new or diverted drains will be sized to match or exceed the existing network and will be laid at a gradient to promote self-cleansing.

As the proposed options do not increase the existing hardstanding areas, there will be no increase to the generated surface water runoff. Therefore, as the runoff does not increase, it is not proposed to implement flow restrictions or attenuation features as these may prove cost prohibitive (see SUDS Design section).

5.15.2 Foul Water Drainage

The proposed options do not increase the foul water generated by the proposed development.

5.15.3 SUDS Design

In accordance with prevailing design guidance, all new developments should aim to implement flow restrictions and sustainable urban drainage systems (SUDS) to reduce surface water runoff to the existing network unless it can be demonstrated that it is impossible to implement. Due to the constrained nature of the proposed development, the opportunity to implement SUDS on this development is limited. In order to implement an efficient SUDS scheme, large land uptake and significant disruption to the existing station and below ground services would be required, which has been assessed to be cost-prohibitive to the scheme. Therefore, any drainage proposals will not include SUDS techniques.

5.15.4 Consultations

The Lead Local Flood Authority (LLFA), Hertfordshire County Council, is responsible for approving any proposed drainage schemes and should be consulted as a statutory consultee for this development.

Thames Water are responsible for the foul and surface water sewers in this area and should be consulted, through a pre-development enquiry, to determine if there is sufficient capacity in their networks to accommodate to proposals. However, as this scheme does not increase the foul or surface water runoff discharging to the public sewer, it is not necessary to submit a pre-development enquiry.

5.15.5 Basis of Design

The design of the drainage and diversions (where necessary) within the development will be in accordance with the current revisions of the relevant British Standards, Codes of Practice and Building Regulations. These include, but are not limited to, the following:

- BS EN 752 - Drain and sewer systems outside buildings.
- BS EN 12056 - Drain and sewer systems inside buildings.
- S1052 – Civil Engineering – Gravity Drainage Systems (London Underground)
- Building Regulations – Part H: Drainage and waste disposal.
- UKWIR Ltd - Civil engineering specification for the water industry.

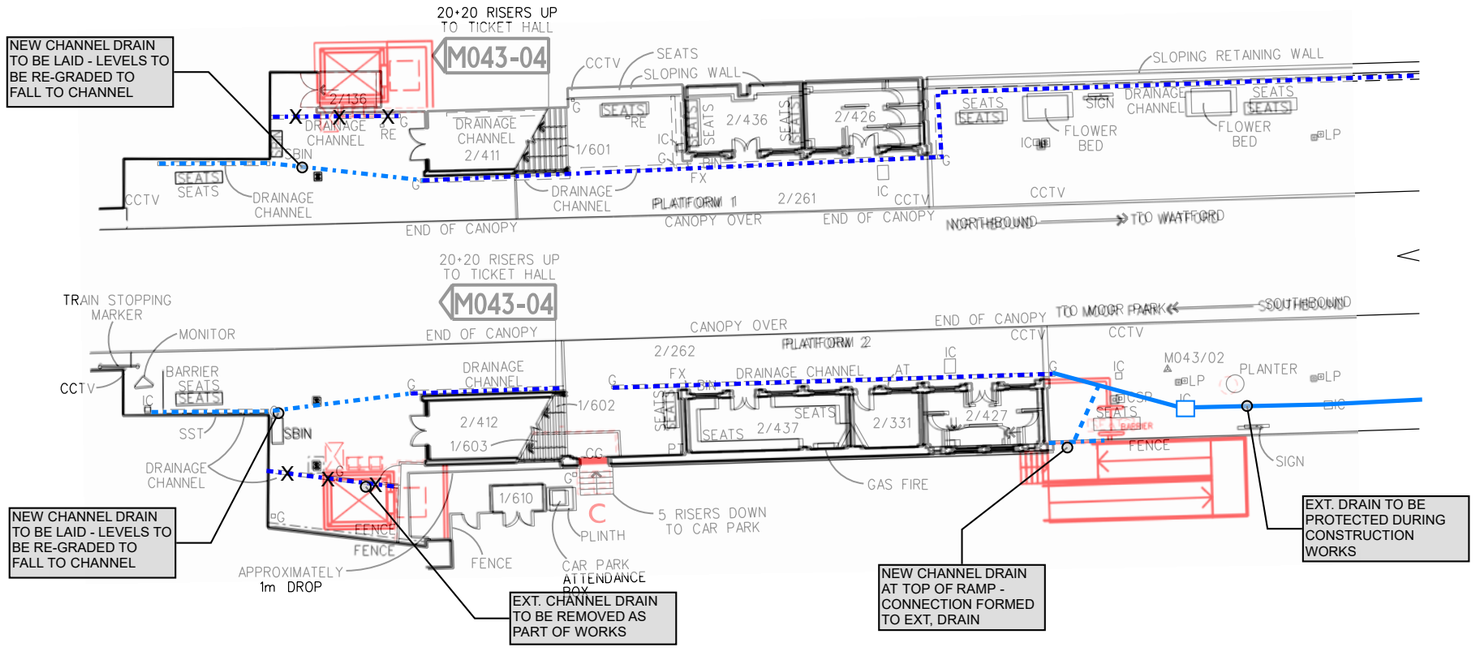


Fig 5.15-1: Proposed Drainage Design

5.16 PAS 2080 Compliance

5.16.1 Introduction

The PAS 2080 guidance is tailored for professionals across various tiers of the infrastructure project value chain. It aims to integrate robust carbon management practices through a collaboration between asset owners and managers. The goal of PAS 2080 is to reduce whole-life carbon emissions throughout the life circle of the asset, with each stage receiving comprehensive guidance.

The updated (2nd edition, March 2023) methodology introduces a macro-level perspective, urging organisations to align project objectives with broader net-zero carbon transition aspirations. This update advocates for setting net-zero targets at a systemic or network level, promoting direct carbon reduction efforts over carbon offsetting strategies. The guidance is augmented with illustrative examples that demonstrate the incorporation of carbon sequestration, land-use changes, and nature-based solutions into the project's planning phase.

The objectives of PAS 2080 encompass a series of aims dedicated to advancing carbon management across the project lifecycle and minimising carbon emissions:

1. Leadership: Championing decisive leadership at the organisational level to ensure carbon management is integrated within the culture and operations.
2. Carbon Management Process: Developing a comprehensive carbon management framework that spans the entire lifecycle of the infrastructure, from design and construction to operational and decommissioning phases.
3. Value Chain Collaboration: Encouraging a cooperative approach across the entire value chain, including clients, designers, contractors, and suppliers, to facilitate carbon emissions reduction.
4. Baseline and Target Setting: Defining an emissions baseline and establishing quantifiable carbon reduction targets.
5. Whole Life Carbon Assessment: Conducting extensive evaluations of the carbon impact throughout the project lifecycle.
6. Design for Low Carbon: Embedding low-carbon design principles from the project's inception.
7. Innovation: Stimulating innovation in materials, technologies, and methodologies.
8. Performance Measurement and Verification: Implementing robust systems to measure, manage, and verify carbon performance against predetermined targets.
9. Continuous Improvement: Promoting ongoing enhancement of carbon management practices, informed by the latest data and technological advances.
10. Transparency and Reporting: Ensuring openness in the reporting of carbon emissions and reductions to foster trust and accountability.

5.16.2 Key Components

PAS 2080 identifies five essential components integral to the Carbon Management Process:

- Target Setting: Clearly defined targets are crucial for the effective tracking of the project's KPIs, which may include capital, operational carbon, and user carbon emissions.
- Baselines: Carbon baselines should be established during early design stage to provide a baseline against which performance can be evaluated, complete with assumptions and scope.
- Quantification: A detailed whole life carbon assessment is recommended to quantify emissions in detail, supported by the report mapping out the methodology.
- Continual Development: Ensures that information is shared among value chain members throughout the project, maximising carbon reduction efforts.
- Reporting: PAS 2080 establishes the detailed reporting requirements for the wider benefit of projects, encouraging the sharing of information within the value chain and beyond, facilitating industry-wide progress towards carbon management goals.

Current progress against the key components of PAS 2080 includes actions primarily focused on carbon baselining. The formulation of a sustainability-centric brief early in the strategic planning process is advantageous, and a Life Cycle Assessment is suggested to quantify the impacts once the design reaches a more definitive stage. The iterative nature of this process is critical, with a continuous commitment to achieving tangible reductions in whole-life carbon emissions being a fundamental next step.

PAS 2080:2023 aligns with several of the United Nations Sustainable Development Goals (SDGs), specifically:

- Goal 9: Industry, Innovation, and Infrastructure, by promoting sustainable industry practices and fostering innovation in carbon management for infrastructure.
- Goal 11: Sustainable Cities and Communities, through its emphasis on creating sustainable urban environments by integrating carbon management into the planning and maintenance of buildings and infrastructure.
- Goal 12: Responsible Consumption and Production, by advocating for the responsible use of resources and reducing waste through effective carbon management throughout the lifecycle of infrastructure projects.
- Goal 13: Climate Action, by actively contributing to the reduction of carbon emissions and mitigating climate change through improved carbon management practices in infrastructure development.

Fig 5.16.3-1: SDGs aligning with PAS2080 methodology.

5.16.3 Croxley SPO PAS 2080 Compliance

A high-level qualitative sustainability assessment was undertaken during the Optioneering Stage for Croxley SFA. This assessment included commentary on the relative advantages and disadvantages of each design option in terms of environmental performance and sustainability potential.

Croxley SPO has been checked against the PAS 2080 10 No. objectives as described in previous section. Compliance with the objectives has been rated from low to moderate scale. Croxley SPO was estimated as relatively lower environmental and whole life carbon emissions compared to other options.

Recommendations and next steps have been discussed to improve PAS 2080 compliance.

5.16 PAS 2080 Compliance

1. **Leadership**
2. **Carbon Management Process**
3. **Value Chain Collaboration**

Compliance Estimate: Low

In alignment with these principles, sustainability has been considered from the early Optioneering Stage of the project. In collaboration with the design teams, a qualitative sustainability assessment was undertaken for all design options, identifying the relative advantages and disadvantages from an environmental and carbon-related perspective.

Recommendation: Carbon management should be integrated into the next stage of the project to ensure a strategic and coordinated approach to decarbonisation. This should involve:

- Carbon Resource Plan (CRP) workshops with relevant value chain members to identify challenges, discuss opportunities, and collaboratively explore low-carbon materials.

Implementing these measures will enable the project team to set clear carbon reduction targets and make informed, sustainable choices throughout the project lifecycle.

4. **Baseline and Target Setting**
5. **Whole Life Carbon Assessment**

Compliance Estimate: Low

At this early design stage, no Whole Life Cycle Carbon Assessment (WLCA) has been carried out; therefore, a carbon baseline and reduction targets have not yet been established.

Recommendation: A Whole Life Carbon Assessment should be carried out for the SPO to define the Carbon Baseline prior to Concept Stage. This should involve:

- Undertaking a Whole Life Carbon assessment in line with RICS WLC V2 requirements utilising a third party verified tool (e.g., OneClick LCA).

This baseline should then inform the development of clear and measurable carbon reduction targets.

6. **Design for Low Carbon**
7. **Innovation**

Compliance Estimate: Low

The commitment to low-carbon design has been initially embedded in the project brief. A high-level qualitative sustainability assessment was undertaken during the Optioneering Stage, providing commentary on the carbon and environmental impacts of the various design options. The SPO was estimated as relatively lower environmental and whole life carbon emissions compared to other options.

Recommendation: A set of components and material options should be explored for scheme. This should involve:

- Undertaking embodied carbon option studies on 1-2 alternative options for the most carbon intensive SFA elements as agreed upon with the relevant stakeholders.

8. **Performance Measurement and Verification**
9. **Continuous Improvement**

Compliance Estimate: Low

As discussed previously, the SPO has been rated as relatively low environmental and whole life carbon impact. Please not that his is a high-level estimate and does not fully reflect performance at this stage.

Recommendation: Whole Life Carbon Assessment should be conducted at all key design stages.

- Undertaking CRPs, WLCA and Option Studies where possible at Concept, Detailed and As-Built stages to track progress against the Baseline, and inform decision-making with measurable data through the design.

This will support performance measurement, verification, and the continuous improvement of the project, as well as future similar initiatives.

10. **Transparency and Reporting**

Compliance Estimate: Low

The high-level qualitative sustainability assessment that was conducted is insufficient for carbon reporting purposes.

Recommendation: Enhance transparency in reporting by:

- Producing a WLCA report for each design stage and facilitating independent third-party verification

5.16.4 Conclusions and Next Steps

The project currently shows low adherence to PAS 2080 standards and principles presented. Recognising the project's early design stage, there is significant potential to improve PAS 2080 compliance.

See below some suggested next steps to enhance the compliance with PAS 2080:

- CRP workshop with relevant value chain members at each key project stage to enhance collaboration and management process,
- WLCA of the SPO to establish carbon baselines and set reduction targets,
- WLCA option studies at a material/component level to support low-carbon design and foster innovative thinking,
- Demonstrate an ongoing commitment to sustainability by conducting CRPs, WLCAs and option studies at all key design stages to support performance measurement, verification, and continuous improvement,
- Produce a WLCA report for each design stage and facilitate independent third-party verification for transparency.

This approach will ensure the project's alignment with PAS 2080 and demonstrate a genuine commitment to sustainability.

5.17 Mechanical and Public Health

5.17.1 Design Summary

Design Criteria

- Repurposing the existing toilets (1/426), disused room (1/451), and lobby (1/083) at concourse level to create a new accessible toilet / baby changing facility.
- New mechanical and public health services for the two new lift shafts.

Mechanical & Public Health Standards and Regulations: The design will be carried out in accordance with all relevant law, Codes of Practice, British and LU Standards. The Mechanical and Public Health design shall comply with the relevant clauses of the latest standards, including:

- S1068 - Mechanical building services, utility provision and energy management
- CIBSE Guides
- Pressure Equipment Directive (PED) (201468/EU)
- BS EN 806 Parts 1-5 - Specification for installations inside buildings conveying water for human consumption
- BS EN 12056 Parts 1 to 5:2000 - Gravity Design Systems inside Buildings
- Water Supply (Water Fittings) Regulations 1999
- Water Regulations Guide 2010 (WRAS)

5.17.2 Mechanical & Public Health Services

Introduction: This section of the report forms part of an initial, non-intrusive assessment of the existing mechanical and public health services at Croxley. It also evaluates the new requirements arising from the chosen SFA option, Option 2.

5.17.3 Concourse Level (Public Health Services)

The step-free access proposals at concourse level include a new accessible toilet / baby changing facility, replacing the disused Room 1/451, Lobby 1/083, and Toilet 1/426. This will require modification and provision of new assets for public health services.

In addition, the provision of new lifts will require the installation of new rainwater drainage system from concourse level down to the platform level.

Toilet 1/426: All existing sanitaryware and associated public health services in Toilet 1/426, including mains water supply, hot water and drainage pipework, will be removed and replaced to accommodate the revised layout of the proposed accessible toilet / baby changing facility. Removal of the existing WCs will require strip-out of local foul drainage, which will be reinstated with new pipework configured to suit the updated design.

It is currently assumed that the mains water supply is served by a 22mm copper pipe with foil-faced lagging, and that the drainage pipework is PVC, as per LUL Standards. These assumptions are subject to confirmation through further site surveys.

Hot water to the new toilet facility will be supplied either via a local water heater or by extending the existing centralised system, subject to a survey of current hot water provision in Toilet 1/426. The survey will identify the existing source; such as a boiler or local water heater and assess system condition to determine suitability for adaptation. If deemed inadequate, a new local water heater will be installed within the new facility, and existing hot water pipework will be removed and capped at a location identified by the outcome of the survey to avoid creating deadlegs.

Disused 1/451: It is assumed that no Public Health services are within the Disused room 1/451. Further survey is required to confirm.

Lobby 1/083: It is assumed that no Public Health services are within Lobby 1/083. Further survey is required to confirm.

5.17.4 Concourse Level (Mechanical Services)

Toilet 1/426: All existing heating equipment and associated services in Toilet 1/426 shall be removed and replaced to suit the revised layout of the proposed accessible toilet / baby changing facility.

Heating will be provided either by a local electric heater or by modifying the existing centralised heating system, subject to a survey. This survey will confirm the presence and type of existing heating; i.e. a radiator or electric heater, and identify the heat source, such as a central boiler, assessing suitability for reuse. If the system is deemed inadequate, it will be decommissioned, and a new local electric heater installed. If heating is currently provided via a radiator connected to a central boiler, the radiator and associated flow and return pipework will be removed and capped at a location determined by the outcome of the survey to avoid creating deadlegs.

It is assumed that mechanical ventilation is currently provided in the existing toilet 1/426, further survey required to confirm. The existing ventilation system, including extract fan and associated equipment, shall be removed and replaced to suit the revised layout of the proposed accessible toilet / baby changing facility. Ventilation will be provided via a local extract fan with makeup air supplied through an adequate door undercut.

Disused 1/451: All existing mechanical services within Disused Room 1/451, including the radiator, associated pipework, and accessories, shall be removed.

A survey is required to confirm system operability and trace the flow and return pipework to determine the extent of removal and identify a suitable capping-off point, ensuring no dead legs are introduced. It is assumed no other mechanical services are present within or pass through the room; this shall be verified during the survey.

Lobby 1/083: It is assumed that no Mechanical services are within the lobby 1/083. Further survey is required to confirm.

5.17 Mechanical and Public Health

Circulation Area 1/071: A condenser unit serving the SCR is currently installed at high level within Circulation Area 1/071, opposite to the disused lift shaft on the Platform 1 side. The proposed lift serving Platform 1 is to be installed within the disused lift shaft 2/136, with the associated lift lobby located directly opposite the existing condenser unit. However, it is not anticipated that the condenser will require relocation, as a result of the SFA scheme.

5.17.5 Platform Level (Public Health Services)

Platform 1: It is currently assumed that no existing public health services on Platform 1 will be impacted by the proposed works, subject to confirmation by further survey. The existing drainage channel and gully near the proposed lift shaft and lobby may require modification to achieve a level surface suitable for PRM access, to be reviewed by Civils (below ground services).

A new rainwater downpipe for the lift shaft will be required, with its discharge point at platform level to be coordinated with Civils for integration into the existing drainage infrastructure.

Platform 2: It is assumed that no existing public services on Platform 2 will be affected by the proposed works, pending verification by further survey.

A rainwater downpipe located behind the proposed lift is not expected to require modification. However, the existing drainage channel and gully in this area may be impacted by the lift shaft installation and may require alteration, to be reviewed by Civils (below ground services.

A new rainwater water downpipe will be required to serve the proposed lift shaft. The discharge point at platform level shall be coordinated with Civils to integrate with the existing drainage infrastructure in the surrounding area.

5.17.6 Platform Level (Mechanical Services)

Platform 1 & 2 (Existing): It is currently assumed that no existing mechanical services will be affected by the proposed works on Platforms 1 & 2 however, further survey is required to confirm this.

Platform 1 & 2 Heating (New): An electric heater shall be provided within each lift shaft to provide frost protection for the lift equipment located inside each shaft, as per Lift Specification requirements.

Platform 1 & 2 Ventilation (New): Each lift shaft will be provided with natural ventilation. However, additional mechanical extract ventilation may be necessary to mitigate the risk of overheating within the lift shaft, as per Lift Specification requirements.

5.18 Communications Systems

5.18.1 Design Summary

Design Criteria

This section of the report contains:

- The findings of an initial, non-intrusive assessment of the existing comms systems at Croxley station.
- An evaluation of changes and impacts to the existing comms systems arising from the chosen SFA option: Option 2.

Comms Standards and Regulations

- S1140 Telecommunications Philosophy and Principles A3 / 2022
- S1142 Operational Information Systems A5 / 2023
- S1145 Wired Communication Systems A2 / 2022
- S1147 Video Surveillance and Security Systems A2 / 2023

5.18.2 Comms Services

Introduction: The project will undertake the following activities, which will impact the comms systems at the station:

1. Provide two new lifts - one for each single face platform
2. Provide a new station entrance to Platform 2 via a new ramp and stairs to car park
3. Optionally upgrade existing toilet to an accessible toilet
4. Possible PPRSs on platforms
5. Remove unpaid segregated walking route through station from Car Park to street level

5.18.3 Comms Equipment Racks

There are three existing Communications Racks at the station; one located in the POM room (1/021), one located in the SCR (1/746), and one located in the Platform 1 Waiting Room (2/436).

- The POM room Rack is 26U and houses the majority of the CCTV Central Equipment.
- The Rack in the Waiting Room contains the PA Central equipment, along with some CCTV CCUs.
- Finally, there is a CCTV Rack in the SCR, however this rack contains the OPO CCTV equipment, which does not form part of station comms (third party).

5.18.4.1 CCTV System

Existing CCTV Central System: Croxley is a hybrid CCTV system, based on a digital NVR with analogue cameras connected via Axis encoders. The NVR and encoders are housed in a CCTV rack located in the POM room (1/021), connected via a Cisco 9300 switch. The analogue cameras are connected via Sony CCUs which provide power to the cameras via the coax cables, and additional CCUs are located in a comms rack the Platform 1 Waiting Room (2/436).

Existing CCTV Long-Line Interface: There is a fibre trunk connection to the Cisco 9300 switch, but further surveying is required to determine if this forms part of an offsite WAN/LAN connection.

Existing CCTV Coverage: The CCTV system currently provides good coverage of the Ticket Hall and the overbridge leading to the stairs. The system also provides general surveillance of both platforms, although there are some blind spots in recesses.

There are OPO cameras on the platforms also although it is not yet established whether the images from these are shared with the surveillance CCTV system.

Existing CCTV User Controls: There is a CCTV keyboard in the Station Manager's Office, but no CCTV workstation or SMS. Two wall-mounted quad monitors provide eight views from station cameras.

Matters to be clarified in future surveys: Due to the limited non-intrusive nature of the surveys to date several issues still remain to be clarified regarding the CCTV system.

1. Are the images from the OPO cameras fed into the surveillance CCTV system?
2. Identifying the make/model of the NVR – what is its capacity and constraints for expansion: HDD space, licences, system limits
3. Does the CCTV system currently have long-line offsite interfaces, and if so where to?
4. Does the existing switch provide PoE power at its switch ports.

5.18.4.2 Changes required to CCTV Field Coverage

Lift Landings: General surveillance coverage will need to be provided for all four new lift landings, which will need to include recognition level coverage of the lift doors and the Passenger Help Points at the lift landings.

Lift Cars: CCTV coverage will be required inside both lift cars, which will connect via travelling cables installed by the lift contractor.

New Station Entrance from Car Park: The new access to Platform 2 from the station car park via a new gateline constitutes a new station entrance. This coverage of the new station entrance will require compliant coverage of both outbound and inbound passengers.

Furthermore, as part of the change to the car park entrance, a currently segregated unpaid route through station (car park to street level) will be lost and absorbed into the paid station area. This will give opportunities for rationalisation of existing camera coverage which currently covers the two routes separately.

Possible CCTV coverage requirement at PPRS: The Fire Strategy for the station has not yet been received so it is not known whether PPRSs will be required on the platforms. Should these be provided, recognition level coverage of Passenger Help Points will be required at these locations. More site-specific details of the requirements for CCTV coverage will be conveyed in the Site-Specific Risk Assessment (SSRA) when this is received from LUL. LUL standard S1147 mandates that all new cameras

5.18 Communications Systems

installed must be IP so these will be used to provide the additional coverage, and these will be PoE fed to reduce site cabling.

Changes required to CCTV Central System: Although, as described above, the details of the existing NVR are yet to be determined, it is assumed that the existing NVR can be expanded to host the additional IP CCTV cameras. This may require the provision of more HDD storage, and/or additional camera licences.

As described above, the details of any existing long-line offsite interfaces are yet to be determined. If present, changes will be required at the head-end systems including GUI maps to present the new cameras to the remote users.

One further matter to be resolved in a further survey stage is to determine whether the Cisco 9300 switch currently present in the comms racks is a PoE switch, if this is not the case it will need to be supplemented or replaced with a PoE model.

Changes required to CCTV User Controls: The CCTV keyboard in the Station Manager's Office functions by users tapping in the number of the camera that they want. As such it will not require any changes to allow users to select the new additional cameras.

5.18.5.1 PA System

Existing PA Central System: The PA Central equipment was not fully identified during the initial non-intrusive surveys as it is not clearly labelled, but it believed to be a Plessey rack located in the comms rack in the Platform 1 Waiting Room (2/436).

Record Information made available states that there is a Plessey PA Rack in use at the station, and this is consistent with the paging microphone and SAPs found at the station.

Existing PA Long-Line Interface: Long-line announcements were heard at the station during the site surveys undertaken. This is consistent with the identification as a Plessey rack

Existing PA System Coverage: The PA system appears to support three PA zones – Concourse, Platform 1, Platform 2.

There are speakers providing good coverage the Ticket Hall, but limited coverage currently on the overbridge.

The PA coverage on the platforms extends the full length, but limited coverage is provided under the overbridge.

Existing PA User Controls: There is a four-button paging microphone in the Station Mangers Office (1/011), used to make announcements to the station zones.

SAPs were found on the overbridge and on Platform 2, but both are old and possibly out of service.

Matters to be clarified in future surveys

1. Identification of Plessey Rack / PA Central equipment needs to be confirmed, and the condition of this rack should be assessed to determine whether it is so dilapidated that it must be replaced as part of the current project.
2. If retention of the existing Plessey rack is to be entertained as an option for the PA system going forward, then impedance measurements of the speaker chains should be made to determine what spare capacity remains in the existing amplifiers to drive any additional speakers.
3. An acoustic assessment to establish ambient noise levels at the station may be required.

5.18.5.2 Changes required to PA System

Coverage changes: Section 3.2.13 of the LUL standard S1142 A5 requires that:

The supplier of the PA system shall ensure the system complies with BS 5839–8 (for PA system connected to a fire alarm system), BS 6259, BS EN 60268-16 and BS EN 50849 to provide broadcast coverage for the following, for all operational areas of stations and depots.

Fig 5.18.5.1-1: Existing PA Central Equipment

As discussed above, the existing system provides general coverage of the station, and this SFA project will only look to ensure compliant coverage is provided in the areas affected by the project works. The affected PA areas are:

1. Lift landings on the overbridge – especially as the project is slightly extending the station demise in these areas. In practice the whole of the overbridge will have to be considered together here. The overbridge will form part of the Ticket Office Zone.
2. Platform areas in the vicinity of the two lower lift landings.
3. The modified staircase on the Platform 2 side where the segregated unpaid route is being removed.

Central System Changes: As the project progresses a key decision will be whether it is necessary to replace the existing Plessey PA rack. This decision will depend on:

5.18 Communications Systems

- The results of a dilapidation survey at the next stage
- An assessment of whether there is the required spare capacity for the additional PA load.
- The client's wishes as to whether the opportunity should be taken to replace the existing thirty year-old PA system.
- Note that if the PA system is to be replaced, the existing Voice Perfect DVA will need to be replaced as this will not be compatible with the current generation of PA systems.

5.18.6.1 Passenger Help Point System

A single Passenger Help Point was identified in the Ticket Hall; however, but no central Passenger Help Point system was found on site. The system is potentially connected via GSM, Auto circuit, or VoIP-based, but the actual connectivity was not identified as part of the non-intrusive survey. The Passenger Help Point system is utilised for providing information calls regarding train delays etc. and facilitating emergency communication with British Transport Police (BTP).

Matters to be clarified in future surveys: Further surveys will be required to be carried out to confirm:

- That there is no central system found on site
- The nature of the offsite connection (GSM, LUL Auto circuit, VoIP)

5.18.6.2 Changes required to Passenger Help Point System

Passenger Help Point coverage changes: Passenger Help Points will generally be provided at lift landings to assist stranded passengers.

Specifically, one Passenger Help Point will be required to serve each lower lift landing.

For the upper landings, either one Passenger Help Point mounted centrally on the overbridge or two mounted adjacent to each lift entrance will be required. One Passenger Help Point supported by static signage may be enough.

If the Fire Strategy specifies the provision of Passenger Places of Relative Safety (PPRS) on the platforms, a Passenger Help Point will be required at each PPRS.

New Passenger Help Point Central System: The introduction of lifts effectively creates a new use case for the Passenger Help Points at the station. This arises where stranded mobility-restricted passengers call seeking assistance. Such passengers need local assistance, and their calls will need to be routed to the SMO so that local station staff are alerted.

Furthermore, as the proposed Passenger Help Point will be equipped with an emergency button, compliance with the Emergency Voice Communication (EVC) requirements in BS 5839-9 will be required, as specified by LUL standard S1142 A5; Section 3.3.20:

" Passenger Help Point systems that provide Emergency Voice Communications (EVC, i.e. those fitted with emergency call button) compatible functions shall conform to BS 5839-9. Also, as per LUL Standard A1142 A5; Section 3.3.23 "Help Points installed at Persons with Restricted Mobility (PRM) areas shall consider small-form Help Points whilst being compliant with BS 5839-9."

Consequently, a local Passenger Help Point central system must be provided, and this system must incorporate a backup battery, fire-rated cabling to the Passenger Help Point, and fire-rated cabling to the Local Operation Panel (LOP) at which the calls are answered, as per BS 5839-9.

On earlier SFA projects we have been informed that there is an LUL requirement for the provision of a second LOP at the Rendezvous Point. However, there is an ongoing activity within the LUL SFA team seeking a derogation to this requirement, which would be onerous to implement.

There will be a requirement for sufficient rack space accommodation to house the proposed new central equipment.

5.18.7.1 SMS/DVA System

Existing SMS/DVA System: There is currently no SMS in use at the station, in place there is a Voice Perfect Digital Voice Announcement (DVA) System.

The system consists of a PC and a monitor in the SMO (1/011).

The system can only be used to play out user-recorded and pre-recorded messages via the PA system.

5.18.7.2 Changes to SMS/DVA System

If the existing Plessey PA rack is retained the existing Voice Perfect PC-DVA can also be retained.

It is possible to install the comms systems as stand-alone systems, i.e. no SMS system, however no alarm monitoring would be available and a new dedicated PA paging microphone would be required. This would require a concession to the TfL S1142 A5 Operational Information Systems standard, section 3.2.22.

This would entail significant additional costs and whether this is appropriate for the current project (were it required due to PA replacement) is a matter for further consideration.

Introducing a MICA 4 system would entail introducing a new rack mounted server and workstation in the POM room rack, connected via a KVM to a HMI located in the SMO.

5.18.8 Third Party Systems

Connect Services are supplied from Platform 1 & follow the same route through the proposed Lift 1 shaft. As with the HV cable mentioned in the Electrical section of this report, these services will need to be diverted out of the way to facilitate the construction of the lift.

OPO is provided at the station but does not form part of the station surveillance CCTV system.

5.19 Electrical and Fire

5.19.1 Introduction

This section of the report forms part of an initial, non-intrusive assessment of the existing electrical and fire services at Croxley. It also evaluates the new requirements in line with the Single Preferred Option 2

5.19.2 Option 2 Overall Project Objectives

1. Two new lifts one for each single face platform
2. New station entrance via new ramp and stairs to car park
3. Optionally upgrade existing toilet to accessible toilet
4. Possible PPRSs on platforms

5.19.3 Electrical Standards – BSEN & LU

- BS 7671:2018+A2:2022 - Requirements for Electrical Installations. IET Wiring Regulations. Eighteenth edition – Incorporating Amendment 2
- BS 5266-1:2016 - Emergency Lighting
- BS 9999 - Fire Precautions in the design, construction and use of buildings – Code of practice
- BS 9992 - Fire safety in the design, management and use of rail infrastructure – Code of practice
- S1069 - Low Voltage Electrical Installations
- S1066 - Lighting of London Underground Assets

5.19.4.1 Existing Distribution Switchrooms

E1 – 1/661: Croxley Station is served by two 100A TPN DNO service heads. The primary supply originates from the DNO service head located in Switchroom E1 (1/661), which supports the station's core infrastructure. Key services fed from this supply include:

- General lighting and small power – Supplied from C50 & Crabtree Polestar Distribution Boards
- Connect services, currently operational via a 2kVA UPS.
- 110V power supplies.
- Signalling LVAC panel (situated at Watford Junction South).
- UTS Gateline

E3 – 1/610: Switchroom E3 is situated within the station car park and is physically detached from the Platform 2 Waiting Areas. Key services fed from the supply include:

- Car park lighting
- Pump Control Panel

Further surveys to be undertaken to understand the full extent of the distribution system.

5.19.4.2 Impact on Distribution E1 & E3:

LUL have conducted Load monitoring at the primary DNO service head in switchroom E1. The maximum load measured is 42.61A on L1. With with two new lift estimated to run at 14.4A with a start up current of 21A, the existing supply capacity should be sufficient to accept the new supplies. Although further load monitoring shall be required to determine the load capacity on the DNO service head in E3.

Wall space in E1 is limited and presents a problem for new lift supplies to be install. Refer to Fig.5 below.

Fig 5.19.6-1: E1 Wall Space

Fig 5.19.6-2: E1 DNO

Existing distribution boards in Switchroom E1 comprise a mix of obsolete C50 and Crabtree Polestar models. To accommodate any new final circuits related to the SFA works, these distribution boards would require replacement or upgrade.

The 100A TPN DNO Service head in switchroom E3 appears to have sufficient capacity to facilitate installation of 2 new lifts. The electrical load is 21A TPN per lift. A detailed load monitoring exercise will be required to assess the spare capacity.

Wall space in E3 is sufficient for additional switch fuse disconnectors to be installed. Refer to Fig3.

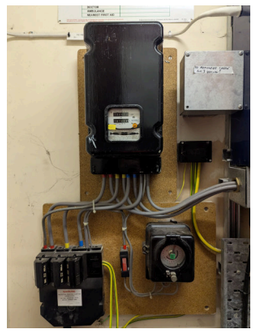


Fig 5.19.6-3: E3 Wall Space

Fig 5.19.6-4: E3 DNO

The E3 local distribution board is a Crabtree Polestar with sufficient spare capacity, but its MCBs are discontinued and unavailable. Therefore, any new final circuits for the SFA works will require the board to be replaced or upgraded.

5.19.5.1 Existing Lighting:

Lighting is provided throughout the station, but in areas affected by the proposed SFA, lighting is insufficient, key elements of the lighting are as follows:

- Platform Lighting for the proposed landing of both Lift 1 & 2 is extremely poor and shall require addition lighting.

5.19 Electrical and Fire

- Lighting is provided on the Paid and Non Paid side the stairs, 1/602 & 1/603 respectfully.
- Open Platform lighting is provided by a series of lighting columns, although these have several lamps fitted with differing colour temperature.
- The operation of the lighting is via Lighting Control system that is in 'Over-ride' as all luminaires are energised throughout the day.
- Emergency lighting is provided by integral batteries
- Detail survey will be required to capture the full extent of the Lux Lighting Levels, number of luminaires and switching operation. Surveys shall also include a Tag & Trace report detailing circuit references

5.19.5.2 Impact to Lighting

- Additional luminaires to provide lighting to the new WC and lobby in Ticket Hall
- Additional lighting to be provided to Concourse Lift Lobbies in line with London Underground Standard S0166 & BS 5266-1.
- The lighting circuits to be assessed to determine whether they can be extended or if new final circuits are required.
- Platform 1 & 2 Lift lobbies shall be supplied with additional lighting. Lux level surveys shall be conducted to assess the current condition and areas that are non-compliant.
- New luminaires will be required to provide lighting to the new Car Park to Platform 2 entrance via the ramp. Additional light will be required for the new external Gateline.
- Existing Platform lighting may not be compliant with the London Underground Standard S0166 & BS 5266-1 & the Fire Strategy. The PPRS to be identified in the Fire Strategy.

5.19.6.1 Existing Cable Management System:

CMS is provided throughout the Station and is a combination of single compartment trunking and galvanised steel conduit. The Ticket Hall and Concourse CMS are comprised of the following assets:

- Single Compartment trunking emanates from the switchroom E1 1/661 and provides the containment for the lighting & Small Power assets from the Concourse level to the Platform Levels.
- Single Compartment Trunk emanates from the CER 1/746 and provides the containment for the Communication Assets.
- Trunking runs down North to South at the Concourse Level and then down the stairs to supply Platforms 1 & 2 Canopy.
- Cable tray drops down from Concourse level to the Platform 2, external the stair core 1/602 & 1/603.
- Open Platform Assets are supplied via duct system

5.19.6.2 Impact on Cable Management System:

- Concourse CMS external to the building to be enabled out of the works area. Services to be identified through intrusive survey and assess the impact.
- Concourse CMS to be extended. Additional CMS to be provided for submains supplying Lift 1 & 2.
- Platforms 1 & 2 Canopy CMS to be extended to supply containment for new lighting & small power.
- New duct system is required to supply submains from E3 to Lift 1 & 2, which will be provided by civils

5.19.7.1 Existing Third Party Assets:

- An existing HV cable runs through the proposed lift shaft on Platform 1. It has been communicated to the project from LU Power that the cable can be relocated at the next design and will not present a problem going forward.
- UTS Gate Line in the Ticket Hall is supplied from the DNO in Switchroom E1. The Gateline is maintained by Cubic.

5.19.7.2 Impact to Third Party:

- The HV cable must be removed/diverted from the lift shaft. Further investigation with LUL will be required at concept design to coordinate the diversion of the HV cable to enable the installation of the new lift shaft.
- The Ticket Hall Gateline will not be impacted by the new works. Additional support will be required from Cubic to assess the requirements to power the new Gateline on Platform 2. It anticipated the power supply for the Gateline would be derived from switchroom E3 in the Car Park.

5.19.8 Fire

Croxley currently does not have Fire Alarm & Detection. In absence of a Fire Strategy, this will be produced at CDS stage. Following similar SFA Projects the following assumptions can be made, based on consistency with similar SFA schemes:

- The new lifts would not be used as mean of evacuation and would be grounded, in the event of a fire
- A Lift Grounding Panel will be required to facilitate the grounding of the lift
- The lift shaft will require fire detection and an interface unit
- Fire detection will be required in the existing switchroom from where the lift supplies are derived from
- Visual and Sounder Beacons will be provided in the Concourse and new Accessible Toilets

5.19.9 Electrical & Fire Key Assumptions:

- HV Cable running through the proposed Lift 1 shaft can be diverted and enabled out of the location.
- Sufficient electrical load capacity is available in both switchroom E1 & E3 for facilitate the additional electrical load.
- The existing CMS routes for Comms & LV have sufficient capacity for the additional circuit cables to be added.
- Existing lighting of the PPRS is compliant with BS & LU Standards
- A Fire Alarm system will be provided as identified above.

6.0 Construction Strategy, Programme and Cost

6.1 Compound / Site Access

The site welfare and storage facilities for the SFA works at Croxley Station will be established within the existing station car-park adjoining the station. To maximise the logistical benefits and reduce risks three further site areas will be established on the station to support construction of the new structures on Platform 1 / Platform 2 and the new access to Platform 1. The spaces will only be established on a just-in-time basis to reduce loss of revenue from the carpark.

Worksites at platform level will be accessed via a secure access route in the boundary fence on P2. Worksites on P1 will be accessed from road level.

Access route for plant / materials will be via Platform 2, during traffic/ engineering hours, this will facilitate the movement of plant / materials during the enabling / sub-structure construction. A poly-bridge will also be utilised for the works on Northbound Platform 1. Poly-bridge will be utilised for movement of plant/materials onto the Island platform.

New segregated walking routes will be established in the carpark with vehicle protection measures in place to separate members of the public

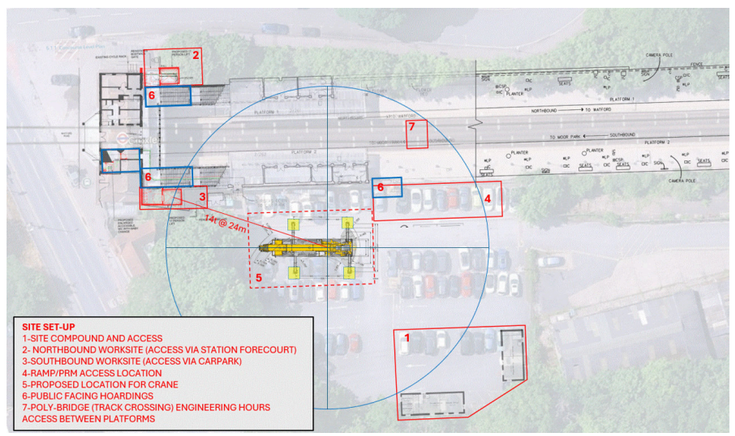


Fig 6.1-1: Site set-up

Fig 6.1-2: Typical track (poly-bridge) crossing system

from vehicles. Plant movements will be timed out of peak hours to reduce the impact / risk.

Access to / from the platform 1 during normal (traffic hours) will be via the existing Bostwick gate / adjacent to the cycle store. Cycle store will be relocated to a temporary position in the forecourt of the station during the works.

6.2 Platform Hoardings

Ground works and foundation construction will generally be undertaken behind rigid hoardings. All hoardings will be subject to temporary works design/approval, following LUL Engineering and Assurance requirements to providing safe working room for construction activities, allowing works to proceed during operational and engineering hours.

Hoardings at Croxley will be set-back to the line of the support columns for the staircases, all the foundation / construction works are to the rear of the platforms and will not impact on platform clearances/operations. Hoardings will be required to be installed at the connection points on the existing overbridge. These will be set-back adjacent to breakthrough locations minimising impact on clearance. Demolition / deconstruction works will be undertaken out of peak hours during normal or engineering hours. Noise will be reduced with manual deconstruction of the walls. Other temporary and enabling works on the station works will include:

- Removal of existing station furniture / fencing and platform features to facilitate access and installation of new works.
- Removal and demolition of the existing station elements, for lift structures
- Temporary service routes, service diversions.
- Temporary relocation of the existing drop-off points (if required) site compound / access.
- Temporary relocation of existing bike racks
- Formation of piling platform on Platform 2 for strengthening/ reconstruction of the existing retaining wall.
- Access routes for plant, including temporary track crossings, protection to covered openings.
- Installation of piling mats/structures
- Scaffolding / shoring systems for excavations.
- Scaffolding / MEWPs for high-level access.
- Temporary works registers will be developed during the concept design phase, surveys undertaken to provide design parameters and critical temporary works designs developed concurrent with the main works concept designs.

6.3 Mainworks Construction Sequence and Phasing

6.3.1 Substructure (Piling) Works

Construction works for the foundations will be undertaken in sequence, Platform 1 foundations first / then Platform 2 foundations utilising the same rig. The foundation location on Platform 1 is located adjacent to the existing retaining wall to the rear of the platform. Foundations will be excavated using a small electric excavator, with propping installed as the works progress to maintain stability of the opening. Depending on the location of existing foundation toe, underpinning maybe required to the toe of the retaining wall. Following exposure of the footings and service

6.0 Construction Strategy, Programme and Cost

checks, the foundations will be backfilled with compact 6f2 to form the piling mat. Piling will then be completed from platform level using a segmental flight auger techniques, with casings installed as necessary.

The piling works on platform 2 will be progressed once the reconstruction works has been completed on the existing retaining wall. The proposed works to the retaining wall will require the wall profile to be revised and reduced to accommodate the new shaft. Investigations / assessments will determine the extend to which the existing wall can be altered. If the wall is already at safety limit, then secondary retaining structure could be constructed to the rear of the wall, these would either secant piled wall or sheet piled wall. A different piling rig would be mobilised for the works on the embankment as this would also require temporary sheet piles to be installed to create a working platform.

The piling operations will generally be undertaken with a mini-piling rig from the range of units which have been approved for use on LUL projects, typical rigs KLEM 702, capable of mini-piles to a depth of 16-20m, diameters 350mm.

The piling rig will be tracked into position engineering hours and will be set-up complete with power pack/compressor and fuel sources. Due to limitations in the working areas and practicalities in supply and logistics for the remote platform, the piling works will be undertaken with sectional flight auger with drilling lengths limited to 1.2-2m in length. Sectional lengths will be added as the works progress with the bore retained open during excavation with temporary sleeve. If an object is structure the piling section will be removed and replaced with a drill section. If the pile cannot be progressed then a replacement pile will be required.

Pile cages will be made up in sections (length dependent on working room), stored in the site compound and transported to work areas as the project progresses, sections would then be spliced by hand or with use of an overhead lifting support with a girder trolley and manual winch. Pile sections are coupled together as required and then lowered using lifting equipment to the required depth.

in order to achieve the required output the drilling operations would be commenced during normal hours behind the hoarding. The bore would be completed during normal hours with the flight sections removed, reinforcement/concrete operations would then continue during engineering hours until the piles are complete. This approach limits the critical activities during E/H to placement of the concrete only, where track access would be required for concrete pumping. Concrete would be either batched off-site and pumped onto the station or site mixed.

Spoil /arising will be treated as contaminated waste and will be removed from the working area of the rig by a small excavator, stockpiled, then removed with a powered wheelbarrow to a skip within the main compound.

6.3.2 Lift Pit Construction

Electric Mechanical excavators will be used to form the lift pits and to complete excavation and re-grading, where scope requires existing embankments / structures to be regarded/altered.

Temporary support to the excavation will be extended as the excavation is progressed to maintain support/stability to the platform structure. These trench sheets will be progressively pushed into the excavation at 300mm increments. The trench sheets will be sacrificed as permanent external formwork for the lift pit walls, unless removal is necessary and can be practically achieved.

The excavation works will involve breaking down the concrete mini-piles by hand to the underside of the lift pit base slab. Pile testing will be carried out after the breaking down and preparation of each pile. On completion of the excavation to formation level, a blinding layer will be installed.

The steel reinforcement bars will be delivered to the site compound and transferred to the westbound platform during engineering hours.

Concrete pour will be completed in phases. The reinforced concrete (RC) pile cap/base slab will be poured first, with inclusion of sumps and drainage sections. The sides of the lift pits will then be poured. Concrete will be poured during engineering hours using mobile concrete pumps with the pump lines set-up and run across the platform poly-bridge.

On completion of the lift pit construction, the column bases will be constructed in a similar manner. However, the works may need to be undertaken outside of the hoarding lines and therefore temporarily safely covered over at the end of each shift.

6.3.3 Superstructure Installation

The proposal on platform 2 is to utilise the existing masonry shaft as part of the final structure. Assessments would be required to determine whether the masonry can take the loads from the lift equipment. If the structure isn't capable of supporting required loads, then an internal steel structure would be installed in the extended shaft with the masonry shaft then re-built as necessary and a structural cap fitted on completion of the steelwork install.

The lift shaft on platform 1 is more consistent with other sites and will be constructed from structural steel, the shaft would be constructed off site and delivered as a single unit for installation during engineering hours closure, with the landing section installed after the main tower has been fitted.

Enabling works / service diversions will be required to be completed in advance of the shaft installation, with existing services diverted below the new structure.

The lift shaft towers will be constructed in a single lift, with the steelwork placed during engineering hours, with a 250te mobile crane. The lift towers will be constructed off site and delivered in a single section to minimise noise at night when bolting together and reduce the requirement to work at height. Landing section will be lifted into place and fitted following line / levelling of the shaft.

6.0 Construction Strategy, Programme and Cost

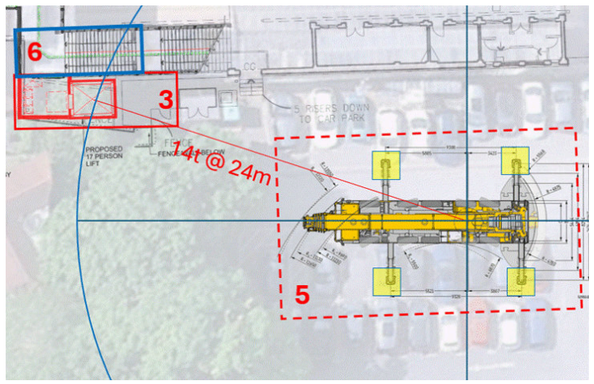


Fig 6.3.3-1: Crane proposal

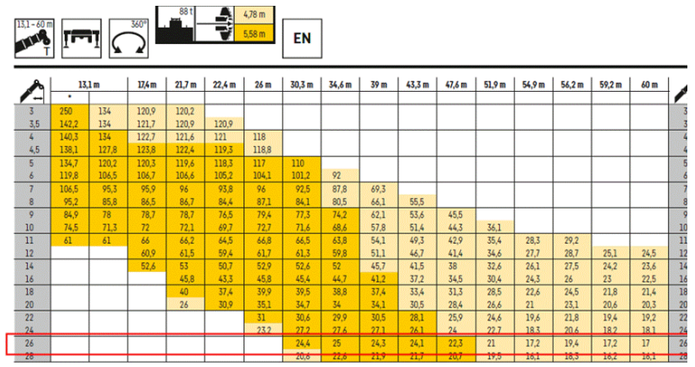
Initial planning has identified that mobile crane, capacity circa 200-250t would be adequate. This would have the capacity to lift 14t, expected weight of the shaft is around 10t-12t. The carpark would need to be closed overnight for the lifting operations, but we would expect the lifting operations to take a maximum of three shifts.

Depending on the design for the shaft on Platform 1, structural steel for the strengthened masonry shaft would be lifted from the same position or lifted from the street, with the crane located on the highway, this would require an overnight closure, which would need to be agreed with the Local residents/Local highways authority.

A combination of mobile elevated works platforms (MEWPs) and aluminium access towers will be used to provide high levels to sling the loads and complete the in-situ bolted connections. On completion of the structural steel installation, the final connection (finishing) details will be completed. These will include the mat wells and canopies.

6.3.4 Connections / Breakthrough

The proposal at Croxley is to connect the new link structure onto the existing overbridge. The connection will require removal of a section of the existing overbridge side wall. Crash decks will be installed at high level to provide a working platform, all works will be undertaken behind hoardings outside of the platform area.



	13,1 m		17,4 m	21,7 m	22,4 m	26 m	30,3 m	34,6 m	39 m	43,3 m	47,6 m	51,9 m	54,9 m	56,2 m	59,2 m	60 m	
3	250	134	120,9	120,2													3
3,5	142,2	134	121,7	120,9	120,9												3
4	140,3	134	122,7	121,6	121	118											4
4,5	138,1	127,8	123,8	122,4	119,3	118,8											4
5	134,7	120,2	120,3	119,6	118,3	117	110										5
6	119,8	106,5	106,7	106,6	105,2	104,1	101,2	92									6
7	106,5	95,3	95,9	96	93,8	96	92,5	87,8	69,3								7
8	95,2	85,8	86,5	86,7	84,4	87,1	84,1	80,5	66,1	55,5							8
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12			60,9	61,5	59,4	61,7	61,3	59,8	51,1	46,7	41,4	34,6	27,7	28,7	25,1	24,5	12
14			52,6	53	50,7	52,9	52,6	52	45,7	41,5	38	32,6	26,1	27,5	24,2	23,6	14
16				45,8	43,3	45,8	45,4	44,7	41,2	37,2	34,5	30,4	24,3	26	23	22,5	16
18				40	37,4	39,9	39,5	38,8	37,4	33,4	31,3	28,5	22,6	24,5	21,8	21,4	18
20				26	30,9	35,1	34,7	34	34,1	30,5	28,4	26,6	21	23,1	20,6	20,3	20
22						31	30,6	29,9	30,5	28,1	25,9	24,6	19,6	21,8	19,4	19,2	22
24						23,2	27,2	27,6	27,1	26,1	24	22,7	18,3	20,6	18,2	18,1	24
26							24,4	25	24,3	24,1	22,3	21	17,2	19,4	17,2	17	26
28							20,6	22,6	21,9	22,7	20,7	19,5	16,1	18,3	16,2	16,1	28

Fig 6.3.3-2: Liebherr 1250-5.1 250ft Crane set-up - Dead Loads only 80% max lift

6.3.5 Finishes and Cladding Installation

The lift shafts will be finished with full-depth brickwork. Scaffold (brick-lifts) will be installed around the steelwork allowing completion of the finishes and connections onto the concourse. Capping sections can be installed following completion using small mobile crane or using other lifting equipment.

Ready-mixed mortar tubs can be used with a retarder to provide sufficient material for the working shifts. The retarder normally allows the mix to be used for a period of 48 hrs. Debris nets/protective screens will need to be installed to protect members of the public.

Following completion of the main works station surfacing will be reinstated and hoardings removed. All works will take place behind hoarding with the hoardings removed on completion of the finishes.

Other works required on the station under the proposal include the installation of new access route from the carpark to the rear of Platform 1, re-provision of access route to the ticket hall, removal of the existing separating wall on the staircase to Platform 1 and provision of new customer facilities in the ticket hall would all be undertaken concurrent with the main works, with sections / areas brought into use in line with LUL handover and BIU requirements.

The works at the intervention points would be completed prior to handing over the lift shaft to the lift contractor to minimise interaction / impact to the lift install programme. The lift contractor would then have attendance / support during the installation phase and during stand-alone and integrated testing and commissioning.

6.3.6 MEP / Service Works

As detailed in the MEPC report, there are significant services in the location of the proposed shaft on Platform 2, existing HV cables will need to be diverted around the shaft to the north of the worksite to allow the shaft to be extended and constructed. LU HV team will be required to develop a proposal to divert the cable, this may require the cable to be jointed to provide slack to divert the cable or may require a new section of cable to be installed. If the cable diversion cannot be undertaken then the proposal to utilise the existing shaft would need to be revised and a new shaft constructed to the North of the existing with a new extended concourse and connection to platform level.

From a buildability perspective the level of impact from the M&E and Comms and power works is significantly less than the civil/ground engineering. The works will require temporary and permanent diversions and new connections all of which will require service routes to be enabled and formed.

As with other SFA sites the existing station assets will need to be upgrade concurrent with the installation, central equipment including station management systems will be updated with central equipment changed over during the main works phase, then allowing the new cameras, relocated help-points and new PA speakers to be connected to new hardware. Telent will undertake the upgrade works, ideally ahead of the SFA works to minimise risks on commissioning.

6.0 Construction Strategy, Programme and Cost

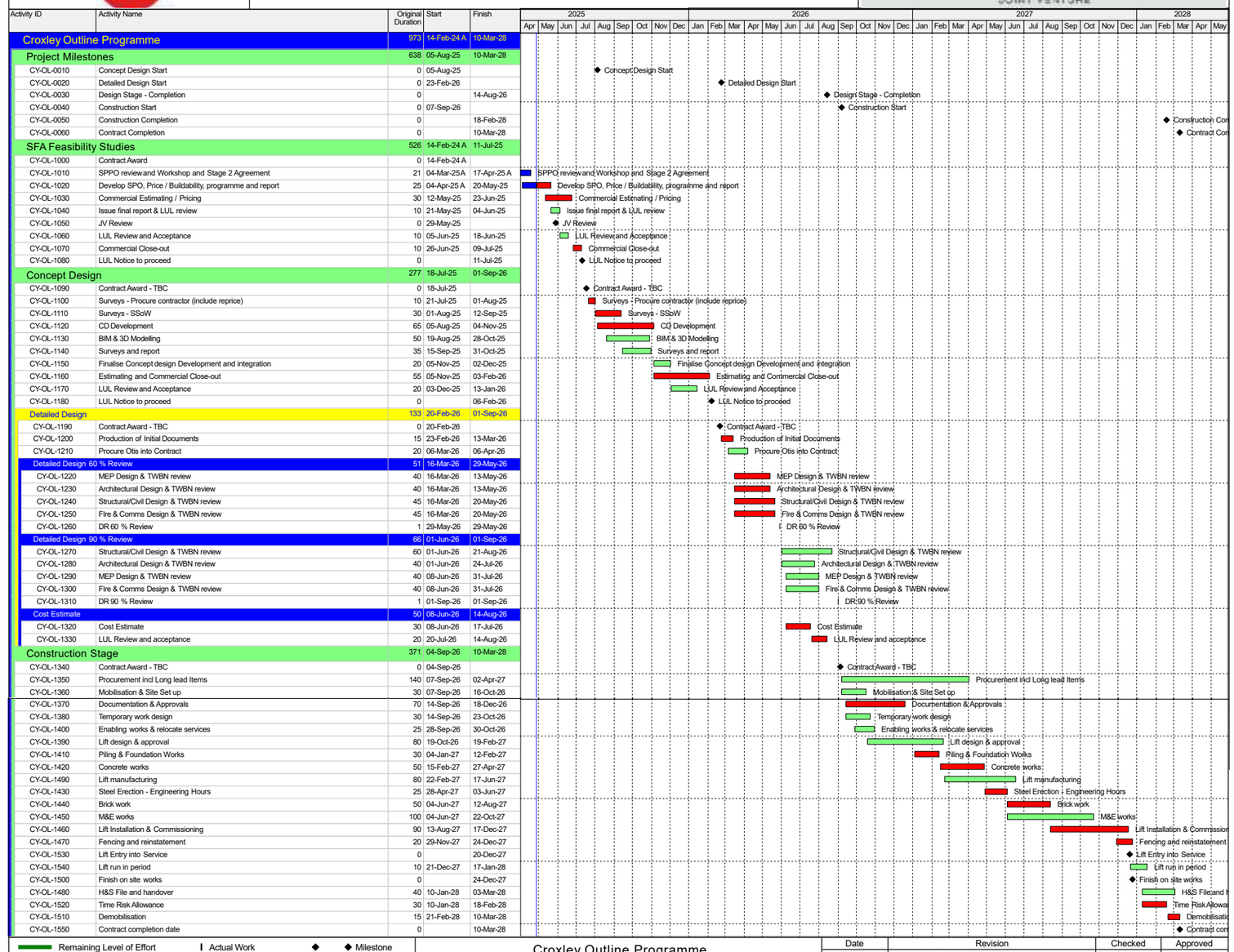
6.7 Programme

UNDERGROUND

Croxley Outline Programme

TAYLOR WOODROW | bam JOINT VENTURE

Activity ID	Activity Name	Original Duration	Start	Finish
Croxley Outline Programme		973	14-Feb-24 A	10-Mar-28
Project Milestones		638	05-Aug-25	10-Mar-28
CY-OL-0010	Concept Design Start	0	05-Aug-25	
CY-OL-0020	Detailed Design Start	0	23-Feb-26	
CY-OL-0030	Design Stage - Completion	0		14-Aug-26
CY-OL-0040	Construction Start	0	07-Sep-26	
CY-OL-0050	Construction Completion	0		18-Feb-28
CY-OL-0060	Contract Completion	0		10-Mar-28
SFA Feasibility Studies		526	14-Feb-24 A	11-Jul-25
CY-OL-1000	Contract Award	0	14-Feb-24 A	
CY-OL-1010	SPPO review and Workshop and Stage 2 Agreement	21	04-Mar-25 A	17-Apr-25 A
CY-OL-1020	Develop SPO, Price / Buildability, programme and report	25	04-Apr-25 A	20-May-25
CY-OL-1030	Commercial Estimating / Pricing	30	12-May-25	23-Jun-25
CY-OL-1040	Issue final report & LUL review	10	21-May-25	04-Jun-25
CY-OL-1050	JV Review	0	29-May-25	
CY-OL-1060	LUL Review and Acceptance	10	05-Jun-25	18-Jun-25
CY-OL-1070	Commercial Close-out	10	26-Jun-25	09-Jul-25
CY-OL-1080	LUL Notice to proceed	0		11-Jul-25
Concept Design		277	18-Jul-25	01-Sep-26
CY-OL-1090	Contract Award - TBC	0	18-Jul-25	
CY-OL-1100	Surveys - Procure contractor (include reprice)	10	21-Jul-25	01-Aug-25
CY-OL-1110	Surveys - SSoW	30	01-Aug-25	12-Sep-25
CY-OL-1120	CD Development	65	05-Aug-25	04-Nov-25
CY-OL-1130	BIM & 3D Modelling	50	19-Aug-25	28-Oct-25
CY-OL-1140	Surveys and report	35	15-Sep-25	31-Oct-25
CY-OL-1150	Finalise Concept design Development and integration	20	05-Nov-25	02-Dec-25
CY-OL-1160	Estimating and Commercial Close-out	55	05-Nov-25	03-Feb-26
CY-OL-1170	LUL Review and Acceptance	20	03-Dec-25	13-Jan-26
CY-OL-1180	LUL Notice to proceed	0		06-Feb-26
Detailed Design		133	20-Feb-26	01-Sep-26
CY-OL-1190	Contract Award - TBC	0	20-Feb-26	
CY-OL-1200	Production of Initial Documents	15	23-Feb-26	13-Mar-26
CY-OL-1210	Procure Otis into Contract	20	06-Mar-26	06-Apr-26
Detailed Design 60 % Review		51	16-Mar-26	29-May-26
CY-OL-1220	MEP Design & TWBN review	40	16-Mar-26	13-May-26
CY-OL-1230	Architectural Design & TWBN review	40	16-Mar-26	13-May-26
CY-OL-1240	Structural/Civil Design & TWBN review	45	16-Mar-26	20-May-26
CY-OL-1250	Fire & Comms Design & TWBN review	45	16-Mar-26	20-May-26
CY-OL-1260	DR 60 % Review	1	29-May-26	29-May-26
Detailed Design 90 % Review		66	01-Jun-26	01-Sep-26
CY-OL-1270	Structural/Civil Design & TWBN review	60	01-Jun-26	21-Aug-26
CY-OL-1280	Architectural Design & TWBN review	40	01-Jun-26	24-Jul-26
CY-OL-1290	MEP Design & TWBN review	40	08-Jun-26	31-Jul-26
CY-OL-1300	Fire & Comms Design & TWBN review	40	08-Jun-26	31-Jul-26
CY-OL-1310	DR 90 % Review	1	01-Sep-26	01-Sep-26
Cost Estimate		50	08-Jun-26	14-Aug-26
CY-OL-1320	Cost Estimate	30	08-Jun-26	17-Jul-26
CY-OL-1330	LUL Review and acceptance	20	20-Jul-26	14-Aug-26
Construction Stage		371	04-Sep-26	10-Mar-28
CY-OL-1340	Contract Award - TBC	0	04-Sep-26	
CY-OL-1350	Procurement incl Long lead Items	140	07-Sep-26	02-Apr-27
CY-OL-1360	Mobilisation & Site Set up	30	07-Sep-26	16-Oct-26
CY-OL-1370	Documentation & Approvals	70	14-Sep-26	18-Dec-26
CY-OL-1380	Temporary work design	30	14-Sep-26	23-Oct-26
CY-OL-1400	Enabling works & relocate services	25	28-Sep-26	30-Oct-26
CY-OL-1390	Lift design & approval	80	19-Oct-26	19-Feb-27
CY-OL-1410	Piling & Foundation Works	30	04-Jan-27	12-Feb-27
CY-OL-1420	Concrete works	50	15-Feb-27	27-Apr-27
CY-OL-1490	Lift manufacturing	80	22-Feb-27	17-Jun-27
CY-OL-1430	Steel Erection - Engineering Hours	25	28-Apr-27	03-Jun-27
CY-OL-1440	Brick work	50	04-Jun-27	12-Aug-27
CY-OL-1450	M&E works	100	04-Jun-27	22-Oct-27
CY-OL-1460	Lift Installation & Commissioning	90	13-Aug-27	17-Dec-27
CY-OL-1470	Fencing and reinstatement	20	29-Nov-27	24-Dec-27
CY-OL-1530	Lift Entry into Service	0		20-Dec-27
CY-OL-1540	Lift run in period	10	21-Dec-27	17-Jan-28
CY-OL-1500	Finish on site works	0		24-Dec-27
CY-OL-1480	H&S File and handover	40	10-Jan-28	03-Mar-28
CY-OL-1520	Time Risk Allowance	30	10-Jan-28	18-Feb-28
CY-OL-1510	Demobilisation	15	21-Feb-28	10-Mar-28
CY-OL-1550	Contract completion date	0		10-Mar-28



Remaining Level of Effort
As late As Possible
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone

Croxley Outline Programme
Page 2 of 2

Date	Revision	Checked	Approved
22-May-25	Croxley - Outline Programme	NK	NF

7.0 Project Risk and Opportunity Schedule

Discipline	Comment	Risk Considerations	Opportunities
Premises - FP		• Risk of Planning consent not being achieved. This risk seems minimal at this design stage because the proposals would have minimal impact on the existing locally listed station complex with the lift shaft positioned symmetrically beyond the extent of the existing station building. Proposed materials for the lift shaft will be sympathetic to the existing station complex.	• Proposal to modify existing lift shaft structure (serving northbound platform) which will reduce the extent of proposed retaining wall structure required • The scheme will offer direct access to the southbound platform from the car park (via a remote gateline) reducing journey time for passengers. A new staircase will link Watford Road and the car park, providing 24/7 access.
MEP - Fourway	• Existing HV cable & Connect Services penetrate the dis-used lift shaft. • Limited information on the existing station electrical load and capacity.	• After detailed surveys are conducted and RFI's raised, more information may come to light that the cable cannot be re-routed because as the downstream asset requires it to be energised permanently • After detailed site surveys and load monitoring is conducted, the project may find that the existing electrical infrastructure cannot accommodate the addition loads and therefore a new DNO supply head will be required. This would impact the space constraints in the switchroom/s	• Optimise the existing MEP infrastructure by upgrading or replacing outdated and redundant equipment to meet current standards and compliance requirements • Maximise the incoming DNO supply capacity in E3 to fully support the additional lift load requirements
Structures - Ramboll	• Southbound lift pit clashes with the existing retaining wall.	• Lift pit may need to cantilever other the existing retaining wall footing to avoid undermining it. This means that deeper/larger piles may be required.	
Geotechnical - Ramboll	• The sections showing the proposed lift pit positions in relation to the existing retaining walls are indicative, and so the intersection of the lift pits with the existing walls may be greater than anticipated. The exact location and composition of the existing retaining walls is to be confirmed through ground investigation including trial pitting. • The proposed lift pit on Platform 1 (Northbound) is anticipated to clash significantly with the existing retaining wall, creating the risk of failure of the existing retaining wall in the temporary and permanent case. The location of the existing staircase constrains the position of this lift pit.	• Ground investigation with trial pits at each of the lift pit locations is advisable to confirm the existing retaining wall footing dimensions at each location and better ascertain the extent of clashing. Coring through the walls should be carried out to determine the thickness of the brick and concrete sections. • The dimensions of the lift pit can be reduced to minimise the required breakout of existing retaining wall. Ground investigation (as detailed above) will be required, as will geotechnical modelling of the interface between the existing and proposed structures and the surrounding soil.	• Site specific ground investigation data will be required – however BGS mapping shows approx. 10no. shallow (10m) BH within 100m of the station
Civil - Ramboll	• The proposals do not increase the extent of hardstanding area on the development. Therefore, under prevailing design and statutory guidance, no flow restrictions or attenuation is required and discharge will remain as existing to the existing below ground network. This should make the drainage design for this development more straightforward. However, TFL and the LLFA may object to this strategy and may request passive SuDS methods such as rain gardens or planter boxes at platform level. These may be considered in detailed design.	• TFL / LLFA may object to any scheme that does not provide a betterment of existing runoff rates. Therefore a strong case must be put forward to ensure the proposal isn't held up during consultation stage. . Other risks include the presence of deep drainage and extensive below ground services which may require additional services diversion and non-standard construction techniques. These are to be explored at detailed design phase for any proposal.	• The opportunities for SuDS is limited on this development due to the constrained nature of the site and the presence of below ground infrastructure and proximity to a live rail line. • Rain gardens or planter boxes may be implemented but will take up space on a busy platform and carry long term maintenance requirements

7.1 Project Risk and Opportunity Schedule

Risk/Hazard	Severity Impact	Mitigation Measures
Asbestos/hazardous materials encountered during construction	Delays to project, change to design (minimal impact), health and welfare risks, short and long-terms dependent on exposure level	Review records, pre-sampling of fill materials during construction. Training / toolbox tools / site awareness of hazardous materials. SMOWs and risk controls in place during excavation.
Cable strike/service strike (unforeseen services/ground conditions)	Loss of life (dependent on cable type/power, programme impact, HSE investigation, impact to train / railway operating service, delays to project, changes to design/installation methodology.	Surveys to establish location of services and all services diverted as required prior to works commencing on site. Permit to dig process put in place, all excavations and openings managed and controlled.
Ground collapse during excavation (unprotected openings)	Loss of life/injury to personnel, HSE investigations, delays, re-design. Programme impact.	All openings require temporary works assessments and designs for shoring propping, temporary works designs prepared and accepted by client. Shoring/propping design used on site and checked prior to and during excavation.
Track / assets impacted during excavation/installation	Impact on services, programme delays, re-design.	Design to assess impact of substructure works on track, measurement and monitoring to be put in place during construction works, temporary works controls to be implemented during construction works.
Crane failure during lifting operations	Injury to operatives/damage to station and 3rd party assets, impact on railway services, delays, programme impact.	Lifting plans prepared, crane(s) sized lifting limited to 70% crane duty, tall pant lift plans prepared and issued to LUL. Survey undertaken for services, voids and ground conditions ascertained, load spreader mats used during lifting, Qualified riggers/slingers to prepare lifts/lifting points designed on structures. Mechanical fitters on standby during lifting, protection installed as required. Trial lifting in fabricators yard, weld checks on lifting points, load testing on lifting points.
Pile / Foundation failure (settlement) during works/testing	Programme delay, following design/remedial works, increased costs.	Ground surveys undertaken, boreholes / window sampling undertaken to confirm ground conditions. Foundations designed and approved. Quality assurance/quality control on site, approved Inspection and Test Plans ( ), pile load tests.
Piling / foundation construction issues/delays – resulting from poor ground conditions being encountered	Programme delay, following design/remedial works, increased costs, larger rig required to complete the works.	Ground surveys undertaken, boreholes / window sampling undertaken to confirm ground conditions. Foundations designed and approved.
Setting out/construction tolerance issues	Re-work, re-design, and programme delay.	Quality assurance/quality control on site, approved Inspection and Test Plans (ITPs)
steelwork manufacture/erection issues at connections/general fabrication/ weld failure	Re-work, re-design, and programme delay.	Approved Inspection and Test Plans (ITPs) /trial assembly off site, focus on detailing connections, independent checking and testing of welds and connections load tested.
Prohibition notices issued following environmental impacts / contraventions resulting in delays on work on site	Delay on works on site, additional controls required on site works, cost / time impact.	Environmental impacts assessment to be undertaken an environmental management plan prepared. Controls measure implemented including noise monitoring.

8.0 Conclusions and Recommendations

8.0.1 Conclusions:

This report has developed the SPO solution, (Option 2) that provides SFA from the ticket hall and carpark to both platforms via walkways and a 17-person through lift. The SPO has been studied from structural, geotechnical, civil, MEP and architectural perspectives and the design has been validated against the PAS 2080 carbon management standard. Alongside the SPO validation this report has considered fire strategy and compliances as well as a construction methodology, cost outline, and program plan.

The design intends to minimise intervention to the existing station complex, retain the existing station building and staircase, and provide an accessible toilet with baby change facilities. The design aims to provide an equitable customer experience and have clear signage.

8.0.2 Recommendations:

- Proceed with the implementation of Option 2, focusing on the design and construction of the symmetrical lift solution. Impact assessment of the existing retaining walls would be required to validate the proposed amendments
- Ensure that the final design complies with all relevant standards and regulations for step-free access.
- Aim to minimise disruption to the existing station complex during construction by focusing on modular construction techniques.
- Prioritise the development of clear and legible accessible routes, including appropriate signage and customer assistance.
- Opportunity to change through lift direction which would reduce the number of alterations required.
- Conduct further investigations and analyses, as described in the options report (UIP3744-TWBN-ZZZ-M043-MEM-ZZ-00001) to provide clarity to design assumptions and address potential engineering constraints.

8.1 Conclusions and Recommendations - Survey Requirements

System/ Area	Survey Requirement	Survey Output Required
Public Health Main Cold Water Supply (MCWS) Toilet (1/426) – Concourse Level	Intrusive survey required of the MCWS serving the existing Toilet (1/426).	As part of the intrusive survey, a detailed drawing of the toilet block shall be prepared, illustrating the pipework routing including materials, all sizes, valves and other associated components of the mains water pipework, along with all existing sanitaryware appliances. The drawing shall also include all associated valves and system components. Photographic evidence shall be provided to accompany the survey findings.
Public Health Hot Water Toilet (1/426) – Concourse Level	An intrusive survey is required for the existing toilet (1/426) to confirm the current provision and condition of the hot water supply.	A survey is required to confirm the current hot water provision within Toilet 1/426. The survey shall identify the source of the hot water supply, such as a boiler, centralised or local water heater, and assess the condition of the existing system. If the existing hot water supply is fed from a centralised system, the survey shall identify a suitable location for the pipework to be cut back to and capped off. As part of the intrusive survey, a drawing of the toilet block shall be produced, illustrating the associated hot water system's equipment within the Toilet and the source of the hot water, showing its location, the pipework routing including all sizes, valves and other associated components. Photographic evidence shall be provided to accompany the survey findings.
Public Health Foul Drainage Toilet (1/426) – Concourse Level	Intrusive survey required of the foul drainage serving the existing Toilet (1/426)	As part of the intrusive survey, a drawing of the toilet block shall be produced incorporating the discharge point, extent, size and material specification of the foul drainage pipework. All valves and components are to be included on the drawing. Photographic evidence shall be provided to accompany the survey findings.
Mechanical Heating Toilet (1/426) – Concourse Level	An intrusive survey required for the existing toilet (1/426) to confirm the current provision and condition of the heating system	A survey is required to verify the presence of a heating system; i.e., a radiator or electric heater, in the existing toilet 1/426 and the source of heating; i.e., a centralised boiler. If the current heating arrangement to the toilet, is via a radiator fed from a centralised boiler, then the existing radiator and flow and return pipework shall be removed and pipework capped off at a suitable location. The survey shall identify the appropriate location for the pipework to be cut back to and capped off. As part of the intrusive survey a drawing of the toilet block's heating system back to its source shall be produced. Photographic evidence shall be provided to accompany the survey findings.
Mechanical Heating Disused Room (1/451) – Concourse Level	Intrusive survey required to identify the source and condition of the radiator and its associated pipework and accessories serving the Disused Room (1/451).	A survey is required to confirm if the existing system is operational and if so, the survey should trace the flow and return pipework to determine the necessary extent of pipework removal and to identify the most appropriate capping-off point. As part of the intrusive survey a drawing of the Disused room's heating system back to its source shall be produced. Photographic evidence shall be provided to accompany the survey findings.
Mechanical Ventilation Toilet (1/426) - Concourse Level	Existing ventilation arrangement within the existing toilet (1/426)	A survey is required to identify the existing ventilation arrangement within toilet room 1/426. If ventilation is present, a drawing shall be produced indicating the current ventilation layout. Photographic evidence shall be provided to accompany the survey findings.

System/ Area	Survey Requirement	Survey Output Required
Public Health Disused Room (1/451) - Concourse Level	Public Health services within Disused room 1/451	A survey is required to identify the existing ventilation arrangement within toilet room 1/426. If ventilation is present, a drawing shall be produced indicating the current ventilation layout. Photographic evidence shall be provided to accompany the survey findings.
Public Health Disused Room (1/451) - Concourse Level	Public Health services within Lobby (1/083)	A survey is required to identify if any Public health services are within the Disused Room (1/451). If any public health services are present, a drawing shall be produced indicating the system and its layout or associated equipment. Photographic evidence shall be provided to accompany the survey findings.
Public Health Lobby (1/083) - Concourse Level	Mechanical services within the Disused room 1/451	A survey is required to identify if any Public health services are within the Lobby (1/083). If any public health services are present, a drawing shall be produced indicating the system and its layout or associated equipment. Photographic evidence shall be provided to accompany the survey findings.
Mechanical Disused Room (1/451) - Concourse Level	Mechanical services within the lobby 1/083	It is assumed that no other mechanical services (apart from the radiator and associated pipework and accessories) are present within the Disused Room, either serving the space or passing through it. This assumption shall be verified as part of the survey. If any other mechanical services are present, a drawing shall be produced indicating the system and its layout or associated equipment. Photographic evidence shall be provided to accompany the survey findings.
Mechanical Lobby (1/083) Concourse Level	Public Health services affected by the proposed works on Platforms 1 & 2	A survey is required to identify if any Mechanical services are within the Lobby (1/083). If any Mechanical services are present, a drawing shall be produced indicating the system and its layout or associated equipment. Photographic evidence shall be provided to accompany the survey findings.
Public Health Platform 1 & 2	Mechanical services affected by the proposed works on Platforms 1 & 2	A survey is required to identify if any Public health services are affected by the proposed works on Platforms 1 & 2 . If any public health services are likely to be affected, a drawing shall be produced indicating the system and its layout or associated equipment. Photographic evidence shall be provided to accompany the survey findings.
Mechanical Platform 1 & 2	Mechanical services affected by the proposed works on Platforms 1 & 2	An intrusive survey is required to identify if Mechanical services are affected by the proposed works on Platforms 1 & 2 . If any mechanical services are likely to be affected, a drawing shall be produced indicating the system and its layout or associated equipment. Photographic evidence shall be provided to accompany the survey findings.
Electrical Switchroom E1 & E3	Electrical Load Monitoring	7-day electrical load monitoring of the existing DNO Service Heads located in switchroom E 1/661 and E3 1/610. Load monitoring shall produce a report detailing the maximum and minimum values of the loads recorded over a seven-day period. Values shall be recorded at 1 min intervals.
Electrical Switchroom E1 & E3	Switchgear / Distribution Board	Visual & Intrusive survey of the existing switchgear and distribution boards. Distribution boards will be assessed to detail the condition, suitability and compliance for the next design stage. Photographic evidence shall be provided to accompany the survey findings.
Electrical SFA & PPRS Areas	Lux Level Survey	All areas of the station affected by the introduction of the new SFA works shall a Lux Level Survey, recording the values where lighting is non-compliant with BS & LU standards. The survey will be conducted with the luminaires in 'Normal Operation & Emergency Operation.' The survey will cover the PPRS, the location will be detailed in the LU Fire Strategy. Photographic evidence shall be provided to accompany the survey findings.
Electrical & Comms SFA & PPRS Areas	Cable Management System (CMS)	Intrusive survey of the cable management system (CMS) affected by the SFA works, providing a detailed assessment of spare capacity, system condition, and any areas of specification non-compliance. Photographic evidence & drawings shall be provided to accompany the survey findings.
Electrical & Comms SFA & PPRS Areas	Cable Tag & Trace	Intrusive survey of the cabling of the electrical & communication system. Detailing origin and destination of final circuit & comms assets affected by the SFA works. Photographic evidence & drawings shall be provided to accompany the survey findings.
Electrical Site Wide	Lightning Protection	Conduct a visual survey of the existing infrastructure, assessing the potential impact of the new SFA works on the station building's lightning protection system and associated electrical installations. Report will identify the Risks & Hazards with recommendations for Lightning Protection.

System/ Area	Survey Requirement	Survey Output Required
Telecommunications SCR (1/746), POM Room (1/021), and Platform 1 Waiting Room Cabinet (2/436)	CCTV Central Equipment in SCR / POM Room / Waiting Room Cabinet	A survey is required to identify if the images from the OPO system are fed into the CCTV system Photographic evidence of the analogue connections shall be provided to accompany the survey findings
Telecommunications POM Room (1/021)	CCTV Central Equipment in POM Room (1/021)	A survey is required to identify the make, model and specifications of the NVR. What is its capacity and constraints for expansion: HDD space, licenses, system limits Does the CCTV system currently have long-line offsite interfaces, and if so where to? Photographic evidence shall be provided to accompany the survey findings.
Telecommunications POM Room (1/021)	CCTV Central Equipment in POM Room (1/021)	A survey is required to identify if the existing switch provides PoE power at its switch ports. Photographic evidence shall be provided to accompany the survey findings.
Telecommunications Platform 1 Waiting Room (2/436)	PA Central equipment in Waiting Room Cabinet (2/436)	Identification of Plessey Rack / PA Central equipment needs to be confirmed. The condition of this rack should be assessed to determine whether it is so dilapidated that it must be replaced as part of the current project. Photographic evidence shall be provided to accompany the survey findings
Telecommunications Platform 1 Waiting Room (2/436)	PA Central equipment in Waiting Room Cabinet (2/436)	A survey is required to determine if retention of the existing Plessey rack is to be entertained as an option for the PA system going forward Impedance measurements of the speaker chains should be made to determine what spare capacity remains in the existing amplifiers to drive any additional speakers. Photographic evidence shall be provided to accompany the survey findings.
Telecommunications Platforms 1 & 2	PA Field Equipment on the platforms	An acoustic assessment to establish ambient noise levels at the station. SPL Readings in the affected areas are to be taken and photographic evidence of the readings is to be provided
Telecommunications Platforms 1 & 2	PA Field Equipment on the platforms	Pre-checks of the PA circuit(s) will be undertaken prior to undertaking these works. A copy of the configuration will be taken and recorded before commencing with any system configuration works. Speaker lines will be injected with audio to test functionality of speakers before and after works. Results will be recorded before and after. SPL readings (broadcast and ambient) will be taken using a calibrated SPL meter for the zones that are affected by the works.
Telecommunications Sitewide	PHP Central Equipment	A survey is required to confirm that there is no PHP central equipment found on site If equipment is located, photographic evidence is to be provided
Telecommunications Sitewide	PHP Central / Field Equipment	A survey is required to determine the nature of the offsite connection (GSM, LUL Auto circuit, VoIP) If equipment is located, photographic evidence is to be provided