Design and Access Statement

Suburban Train Shed: Movement Monitoring, King's Cross Station

Google UK Ltd

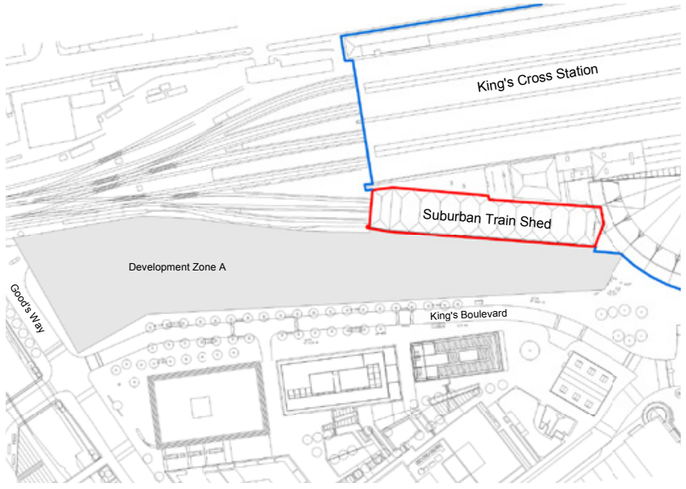
KXC-A-001-T-BDP-XX-RP001
November 2017

BDP.

Contents

Section 1.0

1.0



1.1 Introduction

In anticipation of constructing KGX1, movement monitoring equipment has been installed to Network Rail's assets adjacent to Zone A. This application refers specifically to record the assets impacted on the Suburban Train Shed. This strategy has been developed in collaboration with Network Rail and the equipment will allow the KGX1 team to understand whether any movements are experienced by Network Rail's assets as a result of KGX1 construction. In broad terms:

- The engineers assess how much movement each asset can comfortably accommodate
- The monitoring equipment is calibrated to these levels and monitoring is undertaken throughout the duration of the works
- The equipment notifies all parties if there's a risk before an issue develops
- At which point, an assessment can be made and / or mitigation measures implemented

The STS houses Platforms 9, 10 and 11 of King's Cross Station and is a Grade 1 listed building. The building is made of brick walls supporting a wrought iron roof truss.

In addition to the adjacent text, Appendix 1: 'Specification for Movement Monitoring' has been prepared by AKTII engineers which describes in more detail the scheme, monitoring locations, equipment, monitoring frequency and reporting.

Appendix 2: 'Drawings' also accompanies this application and consists of a location plan, monitoring equipment types and elevations – both existing and with proposed equipment locations.

1.2 Context

The Suburban Train Shed is situated next to the new KGX1 building occupying Zone A of the King's Cross Masterplan. A maintenance strip approximately 3m wide separates the two and will be used by Network Rail for access and maintenance to the western face of the STS. A shared access ramp is located within the new KGX1 building which will be used by both the KGX1 occupiers/tenants and Network Rail in order to access the southern shared service yard. The width of the ramp and maintenance strip adjacent to the STS is approximately 15m.

The KGX1 building runs along King's Boulevard, following the length of the railway tracks from Battle Bridge Place in the south to Goods Way in the north.

Internally, the western wall of the STS sits adjacent to railway lines with Platform 11 serving the trains to these tracks.

1.3 Design

Monitoring equipment has been fixed to the internal and external sides of the western brick wall, primarily on piers. The fixings to this wall have been located within the mortar joints in order to protect the actual brickwork.

Equipment fixed to the trusses has been by non intrusive clamps, in order to avoid damage to the actual trusses.

1.4 Access

Monitoring equipment have been fixed to the western wall and trusses of the STS in order to monitor and record horizontal and vertical displacement along this wall. Access to the equipment is from both the external maintenance strip described above and adjacent to the railway tracks at Platform 11.

2.0

Appendix 1:

Specification for Movement Monitoring

1 SCOPE

This document sets out the monitoring requirements for Network Rail's assets adjacent to the KGX1 site. The locations of the points that need to be monitored are specified as well as the frequency of the readings.

2 INTRODUCTION

The Network Rail assets that will need to be monitored are:

- Suburban Train Shed (STS)
- Gasworks Tunnels & 'Box abutment'
- Track, OHLE and signalling posts

The Suburban Train Shed (STS) houses Platforms 9, 10 and 11 of King's Cross Station. The Northern part of the STS is adjacent to the Shared Service Yard (SSY) – refer to Fig. 1. Outer brick walls incorporating integral brick buttressing support wrought iron roof trusses. From previous site investigations, it is known that the foundations are spread footings at depths below existing sloping ground levels of between approximately 1.0m (North end) and 2.0m AOD (South end). The roof cladding is composed of glazing and aluminium sheets.

Fig. 1 - Photo of the Suburban Train Shed

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The Gaswork Tunnels and 'Box Abutment' are brick structures built in the 1890s located at the north end of the plot. They both form part of a wider brick wall that retains the Goods Way with the Regent's Canal on the other side. The three tunnels serve as train passages beneath the canal. The box abutment is located just at the corner of the site, outlining an extension of the Goods Way into the NR plot. This structure shows severe damage, with a number of infilled cracks 'stitched' with steel clamps and steel channels, indicating that it was subject to remediation works in the past.

Fig. 2 - Gasworks Tunnels & 'Box Abutment'

Fig. 3 - Close-up of the 'Box Abutment'

The closest train track is the one that serves platform 11. This is approximately 7m from the plot boundary, with levels varying between +15.8m and +15.0m AOD along the site. This will be the only track that will be subject to monitoring. Adjacent to the tracks are all the associated electric equipment and signalling posts.

Fig. 4 - Tracks and Overhead Line Equipment (OHLE)

Due to the construction of a new basement along the Access Ramp and subsequent construction of the superstructure, it is considered pertinent to implement a monitoring strategy in order to assess the level of movements experienced by the different Network Rail assets.

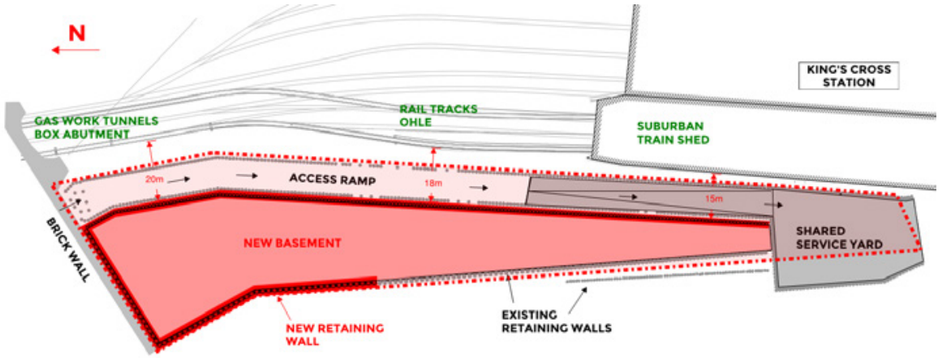

Fig. 5 - Site plan. Network Rail's Assets.

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Monitoring targets should be installed as soon as practically possible so that seasonal movements arising from temperature differentials can be benchmarked, before construction commences on site. Monitoring is to continue for at least a year after topping out and this cannot be terminated without the agreement of Network Rail. Monitoring targets are defined in section 4 of this specification.

Frequency of the readings varies and is the dependent on the importance of the works being carried out on site at the time. These are defined in section 5 of this specification.

Monitoring should be carried out by competent personnel familiar with monitoring/reporting techniques and equipment employed.

3 THE SCHEME

The new building will occupy Zone A of the Kings Cross Masterplan, being approximately 45m high, 300m long and its width varying between 22m and 64m.This will incorporate the existing structures on site which are:

- Access Ramp North (ARN)
- Access Ramp South (ARS)
- Shared Service Yard (SSY)

Fig. 6 - Kings Cross Masterplan (Zone A highlighted)

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The building will have 11 storeys at the North end of the site and steps down to 7 storeys at the South end, whilst further following the slope of Kings Boulevard. The proposed basement will have three levels: Lower Ground (LG), basement 1 (B1) and basement 2 (B2). This will be built down to level +7.9m AOD and this will be constant throughout the site. Due to the sloping nature of the Kings Boulevard, the height of ground being retained by the Western retaining will vary approximately between 17.2m (+25.1m ground level) at the North end and 10.8m (+18.7m ground level) at the South end. On the track side the ground level is relatively constant, varying between 15.0m and 15.8m AOD. The difference in retained soil between both sides of the basement will create an imbalance, which will be considered in the basement design/construction.

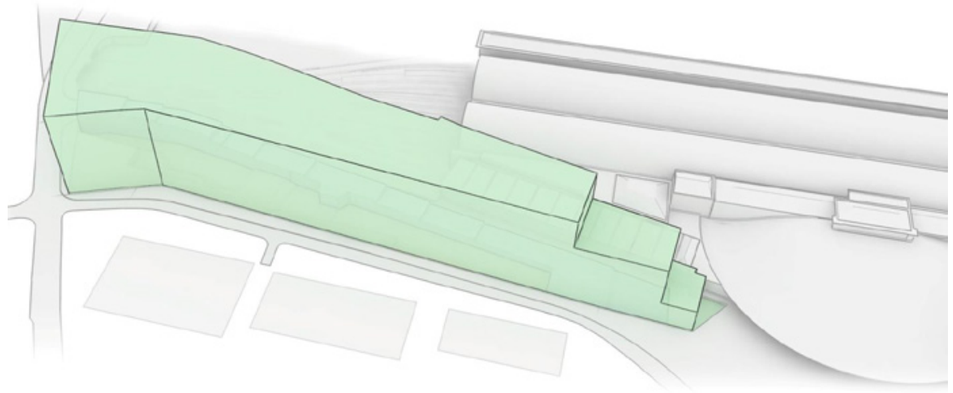

Fig. 7 - Building's massing

4 PROPOSED MONITORING LOCATIONS

The main objective of the monitoring regime is to provide and record the horizontal and vertical displacements at pre-defined locations (station-points). The recorded displacements shall be compared against a pre-determined set of trigger levels which will have to be agreed with Network Rail. All target readings shall give the x, y & z coordinates.

4.1 Suburban Train Shed

Monitoring station-points shall be placed in the main truss/hip truss alignment, unless noted otherwise, on the following elements:

- Brick wall
- Main truss
- Hip truss
- Platform 11
- Track (every 3.0m)

For the brick wall, targets will be placed on the wall so that movements can be monitored. As for the main and hip trusses, targets and strain gauges will be placed on the truss hip tie and the bottom chord of the main truss, so that the potential additional strain arising from the movements can be recorded.

Platform clearance changes shall also be monitored. For this, targets will be placed along the platform edge.

Targets shall be placed on the track every 3.0m and on both rails. This is to provide enough information in order to carry out the relevant track geometry calculations, such as cant and twist.

For the location of the station-points please refer to drawing KXC-A-001-S-AKT-10-00050 in Appendix A.

Inclinometers are to be placed on the piles of the new East retaining wall along the ramp, in zones A1 and A2. These should be placed at approximately 10m intervals. These will assist in understanding the movements on the STS and help devise mitigating procedures if any of the trigger levels is breached.

Additionally, a visual inspection will be carried out to the walls of the Suburban Train Shed and any substantial cracks identified will be recorded and monitored. The report of the inspection will be signed off by both parties (Network Rail and Google).

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4.2 Gasworks Tunnels & 'Box abutment'

Targets will be located on the gasworks tunnels and the South facing wall of the 'Box abutment' so that the movements can be easily read from outside the railway boundary.

For the location of the station-points please refer to drawings KXC-A-001-S-AKT-10-00055 and KXC-A-001-S-AKT-10-00056 in Appendix A.

4.3 Track, OHLE and signalling posts

As mentioned before in section 4.1, targets shall be placed on the track every 3.0m and be placed on both rails, continuing from the STS and extending to the entrance of the gasworks tunnels.

Targets shall also be placed on the OHLE masts and signalling posts, at the bottom and at shoulder height.

For the location of the station-points please refer to drawings KXC-A-001-S-AKT-10-00060 in Appendix A.

4.4 Access Ramp

Targets shall be placed at the top of the Access Ramp, along its East wall at 5.0m centres. For the location of the station-points please refer to drawings KXC-A-001-S-AKT-10-00061 in Appendix A.

4.5 Monitoring Instrumentation

4.5.1 Strain gauge

In order to monitor strain in the truss, Vibrating Wire Stain Gauges are to be installed in the specific locations shown on the relevant drawings. Vibrating Wire sensors are a good choice for this application as they offer a number of data acquisition options, are straightforward to install and maintain and are stable in high-voltage environments (such as that experienced close to Overhead Line Equipment).

A spot-weldable strain gauge provided the necessary fixing points and these will be orientated perpendicular to the structure in question to monitor strain along the length of the truss. Fixing can be

carried out using a suitable 2-part adhesive (such as HBM's X60 strain gauge adhesive which has been specially formulated for this specific application).

All sensors will provide both micro-strain and temperature readings.

Fig. 8 - Picture of strain gauge

4.5.2 Robotic Total Station

Movement of the prisms fixed to the brick wall and roof trusses would be monitored using a Robotic Total Station. These can be used to monitor small glass prisms fixed to the various structures and will regularly provide x, y & z coordinates to an accuracy of ±1mm.
We estimate that 307 No. prisms need to be installed to provide the scheme and these will be arranged as shown in the relevant drawings. In addition, several reference prisms will need to be installed. These will be located in suitable positions to enable reliable resection of the theodolite during each measurement cycle.

Finally, the system will provide automated quality checks on the adjustment data to ensure validity of the entire dataset and information relating to ATS performance (compensator readings, temperature, barometric pressure etc).

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Fig. 9 - Picture of RTS (Topcon MS AXII Series)

4.5.3 Target types

Data can be collected hourly and we would recommend that wherever possible, the targets are exclusively glass prisms. This provides the greatest level of accuracy and repeatability and we would utilize a combination of standard mini-prisms (such as the Leica GMP104) and 360° prisms (for use as common points). These can be quickly attached to the various structures using standard drill and fix techniques or non-intrusive Lindapter clamps. Where prisms are to be fixed to the track, a bespoke metal 'track-clip' will be used and high-visibility paint will be applied to minimise the chance of interference by other work parties

All of these fixings provide a robust, rigid and quickly deployable anchor for each of the monitoring targets and are quick to install and decommission.

The monitoring instrumentation to be used is summarised in the Table below. Also, please refer to Appendix B for their location on plan and the data sheets in Appendix C.

Equipment	Quantity	Accuracy	Resolution
Robotic Total Station (RTS)	4	±1mm	0.1mm
Strain Gauge	21	±0.5%	0.4 microstrain
Prism Targets	307	-	-
Reference Prisms	12	-	-
Prism Targets (Access Ramp)	15	-	-

Table 1 - Monitoring Instrumentation

5 PROPOSED MONITORING FREQUENCY

The monitoring frequency shall be as indicated within this section. It shall be noted that the frequency of monitoring may be increased dependent upon readings recorded during the works. This shall be subject to prior notification by the Engineer. Monitoring frequency shall not be decreased without prior agreement with Network Rail.

The periods to be considered are:

- Period 1 – Before start of construction. The monitoring should commence as soon as practical, but at least 3 months prior to the start of any works on site.
- Period 2 – Construction of the basement. This includes piling, excavation, construction of B2 and Ground floor slabs, construction of RC walls.
- Period 3 – After period 2 and until the superstructure has been completed.
- Period 4 – For a period of at least 1 year after period 3.

The monitoring frequency shall be as indicated on Table 2.

Monitoring Item	Period 1	Period 2	Period 3	Period 4
Brick Wall	Daily	Daily	Weekly	Forthnightly
Main Truss	Daily	Every 3 days	Weekly	Forthnightly
Hip Truss	Daily	Every 3 days	Weekly	Forthnightly
Track	Daily	Daily	Weekly	Forthnightly
Gasworks tunnels and 'Box Abutment'	Daily	Daily	Weekly	Forthnightly
OHLE and signalling posts	Daily	Daily	Weekly	Forthnightly
Access Ramp	Daily	Daily	-	-

Table 2 - Monitoring frequency

The inclinometers shall be read on a weekly basis unless movements on the STS warrant more frequent readings, until the completion of period 2.

The criteria for terminating the monitoring will have to be discussed and agreed with Network Rail. The monitoring of NR assets shall continue until this is done.

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6 MONITORING REPORTING

For reporting the results of the monitoring, the following rules shall be followed:

- All 'green' readings shall be tabulated and reported to Engineer and Employer a week after they have been recorded.
- All 'amber' readings shall be logged on a pre-determined internet site with automatic email notification to the key individuals within 6 hours.
- All 'red' readings shall be logged and notified immediately to the key individuals by email, with telephone notification/confirmation within 1 hour.
- The frequency and format of the reporting will have to be reviewed by Network Rail.

All key individuals are to be confirmed at a later date, but these should be members of the following organisations: structural engineers, construction manager, contractors working on the relevant packages, client and project manager.

7 MOVEMENT ACTION PLANS

The contractor shall develop a series of Movement Action Plans for consideration in the event of amber and red category readings being recorded at key construction stages.

These plans will be submitted to the Engineer and Employer prior to the commencement of works as an integral part of the Detailed Construction Method Statement.

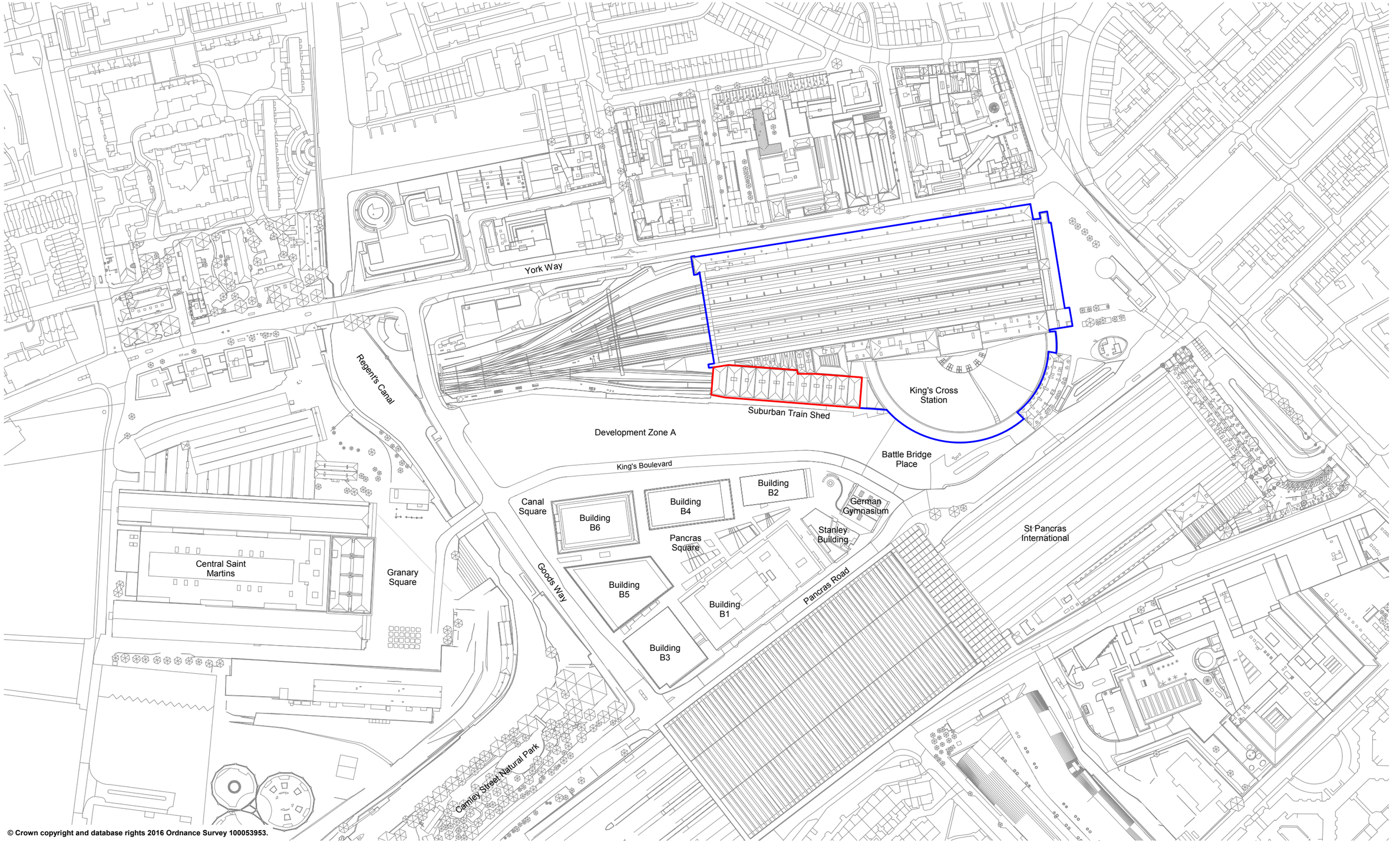
Movement Action Plans shall include the following considerations:

- Review construction sequencing and procedures
- Review pile construction method
- Consider active implementation of remedial propping regime
- Identification of key individuals within each organisation and their respective contact details and responsibilities

2.0

Appendix 2:

Drawings



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Key:

Applicant owned building

Application site

REVISION	DESCRIPTION	DRAWN	CHECKED	DATE
P01	Issued for planning	TP	EB	07.11.17

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16 Brewhouse Yard
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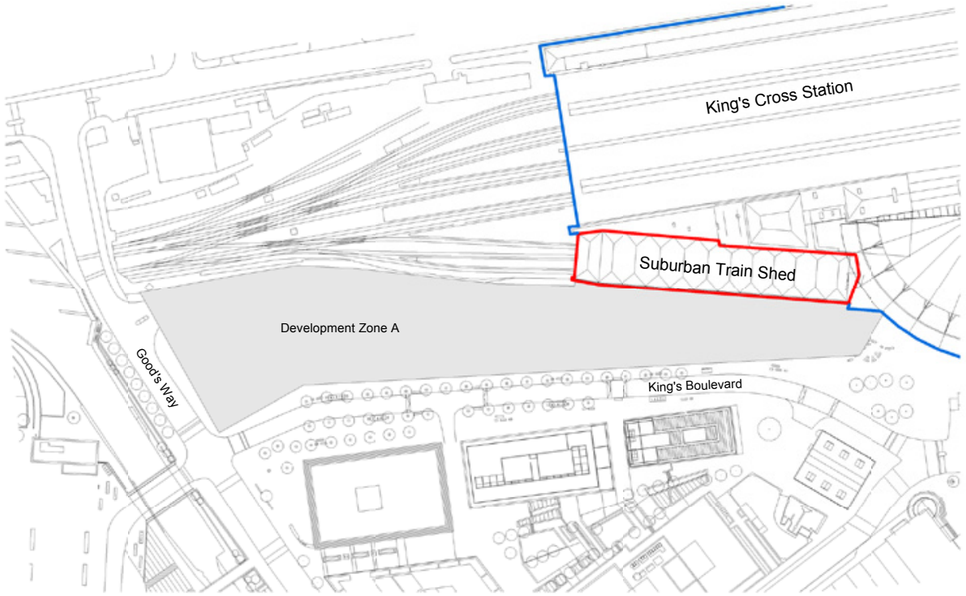
KEY PLAN

Status: FOR PLANNING

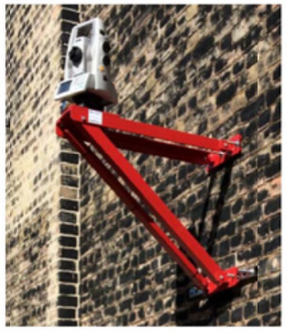
Title: Suburban Train Shed Location Plan

Date: 07/11/17
Project No: P2007133
Scale: 1 : 1250
Size: A1
Drawn: TP
Checked: EB
Drawing No: KXC-A-001-T-BDP-00-50001
Rev: P01



Suburban Train Shed - Location plan

Aerial photograph



Wall mounted total station

Wall / truss mounted prism
(all wall fixings through mortar joints)

Strain gauge
(Truss mounted)

Wall mounted electrical containment
(all fixings through mortar joints)

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- The BDP risk series of drawings
- The project CDM risk register

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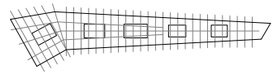
KEYPLAN



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Title: Suburban Train Shed Movement Monitoring Sheet 1

Date: 07/11/17
Project No: P2007133
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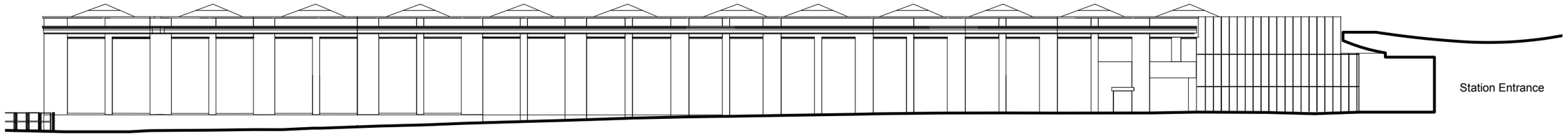
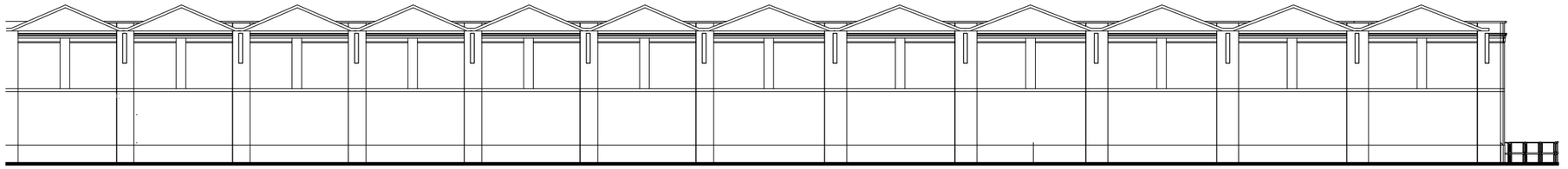
Size: A1
Drawn: TP
Checked: EB

Drawing No.: KXC-A-001-T-BDP- 00-50002

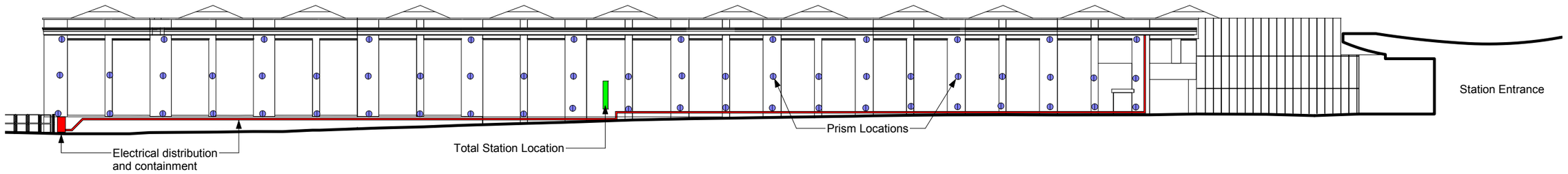
Rev: P01



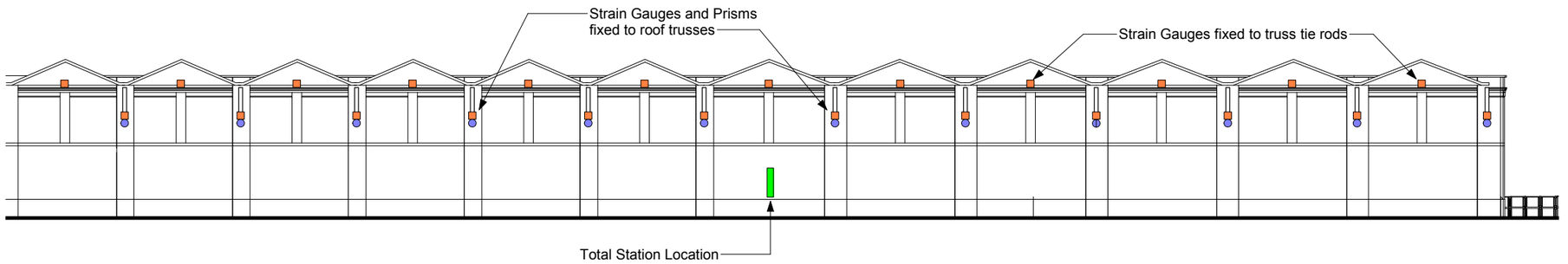
External Elevation - Existing



Internal Elevation - Existing



External Elevation - Proposed Monitoring Equipment



Internal Elevation - Proposed Monitoring Equipment

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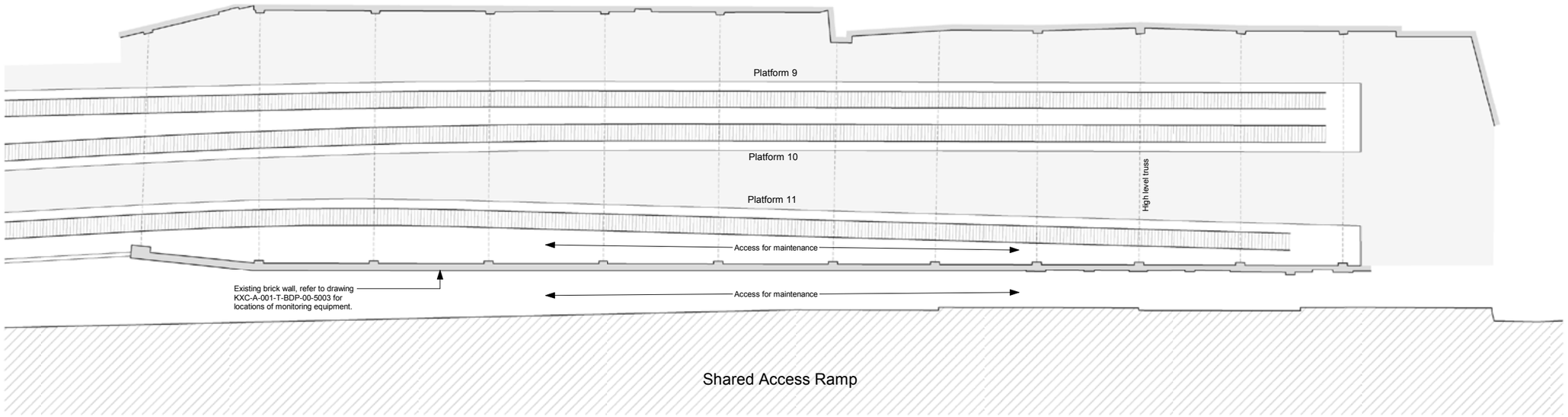
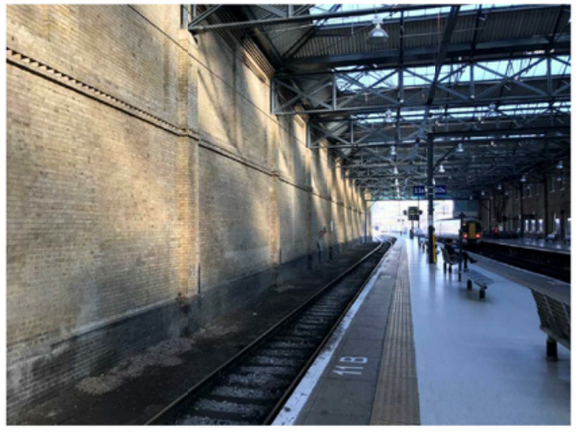
Date: 07/11/17
Project No: P2007133
Scale: 1 : 200
Size: A1
Drawn: TP
Checked: EB

Drawing No.: KXC-A-001-T-BDP-00-50003
Rev.: P01



Suburban Train Shed - Plan

External access route



Internal access route

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Project No: P2007133
Scale: 1 : 200
Size: A1
Drawn: TP
Checked: EB

Drawing No.: KXC-A-001-T-BDP- 00-50004

Rev: P01