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Crossrail Ltd

Woolwich Station

Site-Specific Archaeological Written Scheme of Investigation

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1 Executive Summary

1.1.1 This version of the WSI has been revised from the May 2011 GRIP 4 Outline Design, and with the preliminary results of the Package 37 Ground Investigations.

1.1.2 The site contains standing non-listed historic buildings from the Royal Arsenal (which have already been recorded in advance of demolition), and has a high potential for below-ground remains of further Arsenal buildings and structures dating from the 18th to the early 20th centuries. In addition there is a moderate potential for Roman and prehistoric remains. The western end of the site has already been partially archaeologically excavated, up to 1.5m depth, as part of previous remediation works. Geotechnical boreholes also suggest the presence of natural palaeochannels extending below the formation level of the preparatory ground reduction (105m ATD).

1.1.3 The proposed works comprise the construction of a station box and associated enabling works, including service diversions. Impacts on potential archaeological remains across the majority of the site, arise from ground reduction in preparation for the piling mat and excavations for the station box. The main change to the affect on archaeology arising from the GRIP 4 Outline Design is that the area of initial ground reduction has been increased to the south of the station box (including a construction area to be used subsequently for over-station development [OSD]), but reduced slightly to the east. In addition, there are potential impacts from service diversions, in particular shafts for a sewer.

1.1.4 Accordingly, a mitigation strategy of preservation by record will be conducted during the Enabling Works phase, as follows:

- general watching brief on the service diversions (sewer shafts, and any utilities trenches more than *c* 1m deep).
- targeted watching brief ('strip, map, and record excavation') integrated in a rolling programme from sub-area to sub-area with the preparatory ground reduction to 105m ATD.

1.1.5 The targeted watching brief will take the form of archaeological monitoring and supervision of the Groundworks Contractor's excavations ground reduction, via a series of sequential sub-areas across the site. Within each sub-area, the Groundworks Contractor will:

- Remove up to c 1m of over modern overburden to expose former Arsenal buildings, under archaeological monitoring and supervision. Make final clean and remove any localised deeper areas of modern fill, using a smaller machine, if required.
- Archaeologists then hand clean, investigate and record local features, to a targeted sample-based approach.
- The above method is repeated, in approximately 1m horizons until the 105m ATD formation level is reached.
- At the 105m ATD formation level, further selective archaeological investigation of any atypically deep features may need to be carried out. Palaeochannels may be sample investigated below 105m ATD using trial trenches and/or geoarchaeological boreholes.

1.1.6 Following fieldwork, the programme of off-site assessment, analysis, and reporting will be commensurate with the significance of the results. The mitigation strategy of preservation by record will be completed by publication of the results and deposition of the archive.

2 Project Background

2.1 Introduction

2.1.1 The overall framework within which archaeological work will be undertaken is set out in the Environmental Minimum Requirements (EMR) for Crossrail (www.crossrail.co.uk/the-railway/getting-approval/parliamentary-bill/environmental-minimum-requirements-including-crossrail-construction-code). The requirements being progressed follow the principles of Planning Policy Guidance Note 16 on archaeology and planning (1990). Accordingly the nominated undertaker or any contractors will be required to implement certain control measures in relation to archaeology before construction work begins.

2.1.2 The strategy for archaeological works has been set out in the Crossrail Generic Written Scheme of Investigation (WSI) and Archaeology Specification for Evaluation and Mitigation (doc. Ref. CR-PN-LWS-EN-SY-00001). These documents present the strategy for archaeology design, evaluation, mitigation, analysis, dissemination and archive deposition that will be adopted for the design and construction of Crossrail and provide a general statement of objectives, standards and structure for the planning and implementation of archaeological works.

2.1.3 This site-specific WSI addresses the archaeological and built heritage works required to mitigate the impacts resulting from the construction of Woolwich Station.

2.2 Site Description

2.2.1 The Woolwich Station site is located immediately north of Plumstead Road and extends in an east west direction across Arsenal Way, in the London Borough of Greenwich (Fig 1). The area is crossed by Arsenal Way and Cornwallis Road and includes remains of the Woolwich Arsenal, which is currently in the process of regeneration.

2.2.2 The site is located 220m north of the existing Woolwich Arsenal Station, which is located on the Southeastern mainline service to Gravesend and Dartford; and on the Docklands Light Railway (DLR) service from Woolwich Arsenal to Bank. The site is located *c* 400m south of the River Thames.

2.2.3 Historically the site has been in a military area since the 16th-century, armaments manufacture and associated logistical facilities had extended onto the site by the early 18th-century and the first barracks were built in 1719. By the 19th-century the site had been entirely covered by military and industrial buildings associated with the Royal Arsenal. The former Royal Arsenal is now being regenerated with housing and other amenities.

2.2.4 The proposals comprise a station box (approximately 14–16m deep x 22–27m wide and 256m long internally) and shafts at both ends to ground level. The station box will be constructed using diaphragm walls and piling. Significant ground reduction adjacent to the box and dewatering of the site will be required in order to enable the construction works to proceed. Gunnery Terrace is to be demolished as part of the development.

2.3 Summary of Previous Crossrail Studies

2.3.1 The archaeological potential in the area of the Crossrail worksites for Woolwich Station is described in the following documents:

- Crossrail, 2005, *Assessment of Archaeological Impacts, Technical Report*, Part 4 of 6, Central Section, Report Number 1E0318-E2E00-00001

- MOLA 2009, *Woolwich Station: Detailed desk-based assessment.* Unpub report (author H Dawson)

2.4 Geology and Topography

2.4.1 Woolwich lies on a promontory of bedrock (Thanet Beds) protruding into the floodplain (alluvium). This higher and dryer ground would have made the area attractive for settlement throughout prehistoric and historic times. The site is located *c* 400m south of the River Thames. Ground level slopes very gently down from 108.8m Above Tunnel Datum (ATD) in the west to 107.5m ATD in the east.

2.4.2 Geotechnical boreholes monitored in 2006 by MoLAS (now MOLA) and tabulated in the DDBA (MOLA 2009, Table 1), showed natural subsoil to be natural gravels and Thanet Beds. The natural deposits vary in depth, but are generally at a depth of *c* 1.5–2m below ground level (m bGL). The DDBA Fig 3 and Fig 4 show the locations of the boreholes and the geological ground model respectively. Subsequent geotechnical investigations by Soil Mechanics in 2007 and 2008 have been tabulated in the DDBA (MOLA 2009, Appendix 6.1: Table 6 and Table 7). More recent and intensive boreholes forming GI Package 37 were conducted on the site in April and May 2011 by Soil Mechanics for Capita Symonds/Crossrail, and selected boreholes were monitored by MOLA. The preliminary results of these new boreholes, plus older data, have been interpreted and used by MOLA to produce an archaeological transect across the site (Fig 8 & Fig 9).

2.4.3 The transects and GI data show the following deposits on the site:

- **Modern made ground**: generally *c* 0.4–1.5m thick and mostly of modern origin;
- **Archaeological made ground**: generally *c* 0.5–2.5m thick, and containing 18th–early-20th century material in some locations – eg foundation walls;
- No prehistoric, Roman, or medieval man-made features have yet been found within the site, but the surrounding sites indicate potential for such features, most likely at/close to the base of the archaeological made ground.
- **Alluvium and palaeochannels**: observed in four of the boreholes (WP123, WP142R, B587 and WP97R).

  The boreholes indicate that two palaeochannels are present on the site, cut into the Thanet sands and Upnor formation. The channels are filled with alluvium in the base of the western channel, above which, and in all of the eastern channel, they are filled with deposits of archaeological/historic potential (ie 'archaeological made ground'). The channels run approximately north–south. The western channel is represented in Boreholes WP123, WP142R, and B587; this appears to be the ancestor of a much smaller stream channel seen on a map of 1717 (Fig 2). The eastern channel is represented in Boreholes WP96, WP136, and WP134.
- **Natural river terrace gravels and soliflucted slope deposits**: occurring at 0.40m bGL in the central part of the site (BS46, WP131) and extending to depths of more than 10m in the palaeochannels. These probably represent the Head deposits mapped by the BGS (BGS map 271, not reproduced), but discounted in previous interpretations of the site geoarchaeology.
- **Lambeth Group/Upnor Formation**: occurring between *c* 1.20 and 5.20m bGL. The Lambeth group comprises gravels (the 'Woolwich and Reading Beds') deposited above the Thanet Beds during the Tertiary period. They therefore have no archaeological interest, pre-dating human occupation, but are the base upon which the Holocene and later archaeological deposits developed (eg WP96); and

- Thanet Beds: occurring at depths of *c* 2m bGL to 16–17m bGL. The Thanet Beds are approximately 60 million years of age and therefore have no archaeological interest – they form a promontory on which Woolwich developed.

2.5 Past archaeological investigations on the site

2.5.1 Previous investigations at the site have been quite extensive and included excavation in association with the ground remediation, detailed archaeological excavation adjacent to the site and site investigation works comprising test pits, trial trenches, observation pits, observation trenches and boreholes. The relevant results from these investigations are summarised here.

2.5.2 A scheme of remediation and the installation of new infrastructure were carried out during 1999 and 2000. These works were monitored by Oxford Archaeology (OA) (including watching brief, evaluation, strip and record, and area excavation) (OA 2004, 9). Zones 4 and 5 of OA's investigations are located within the site (Fig 6): Zone 4 was remediated to 1.5m bGL (with all archaeological remains removed to this depth), while Zone 5 was not remediated. The excavation on Zones 4 and 5 revealed widely differing heights in the gravels and sand, resulting from three centuries of development at the site (OA 2005). Road 9, which bisects the site in a north–south direction, was remediated to 0.75m bGL.

2.5.3 The excavations at the Dial Arch (1999–2001) (corresponding to OA's Zone 2) revealed some 158 Roman inhumations (oriented north–south) and nine cremations. One inhumation and several cremations were recorded within the site and removed during the excavation works, but other parts of the site have never been investigated.

2.5.4 Pre-Construct Archaeology (PCA) monitored the insertion of shallow service runs within parts of the site; however, this report was not available at the time of writing (Mark Stevenson, GLAAS pers. comm. 09-11-09).

2.5.5 In November and December 2004 and April 2005, Oxford Archaeology completed an evaluation at the Royal Arsenal (Oxford Archaeology 2005). This evaluation included a number of investigations in the western half of the site. These investigations are shown on Fig 7, and the results are summarised below. It should be noted that in accordance with Crossrail practice the Tunnel Datum (TD) for heights is OD plus 100. 1m Ordnance Datum (OD) is therefore equivalent to 101m above Tunnel Datum (ATD). In total 15 investigations were undertaken within site, with additional investigations outside. These 15 investigations comprised;

- 9 Test Pits (TP) varied from 1.2x0.9m to 4.3x 0.6m
- 3 Trial Trenches (TT) varied from 2.1x0.4m to 4x1.5m
- 3 Observation Trenches (OT) varied from 3.1x0.6m to 3.0x2.5m

2.5.6 The Building numbers referred to in the summary relate to numbers assigned to the buildings by Oxford Archaeology. The relevant Building numbers are shown on DDBA Figs 16–24.

AA625/TP1

The pit contained demolition rubble from an 18th century building and construction levels for more recent ground surfaces.

AA627/TT6

In situ Thanet Beds was recorded at 105.4m ATD, overlain by a 1.2m thick layer of loam with former ground surfaces (tarmac and concrete) and demolition rubble above.

AA628/TP26

In situ Thanet Beds was recorded at 105.74m ATD, overlain by 0.6m of *in situ* natural river terrace gravel. The natural deposits were overlain by two former tarmac ground surfaces with associated bedding layers.

AA638/TT7

In situ natural river terrace gravel was recorded at 105.29m ATD under interleaved make-up layers, demolition material and degraded former surfaces.

AA640/TP22

A possible *in situ* or deposited layer of Thanet Beds was recorded at 103.92m ATD. A 2.5m deep wall foundation associated with Building 10a (dated 1802–3) was recorded with a maximum height of 106.32m ATD. The foundation was overlain by a bedding layer below a concrete surface.

AA645/TP29

In situ Thanet Beds was recorded at 105.95m ATD, with 1.3m of *in situ* natural river terrace gravels above it. A 0.9m deep wall foundation associated with Building 86 (extant by 1818), was recorded with a maximum height of 107.25m ATD. The pit also contained a darker soil deposit and bedding layer for the car park surface.

AA646/TP28

In situ natural river terrace gravel was recorded at 106.94m ATD, truncated by a service trench, overlain by make-up and bedding layers for past and present tarmac ground surfaces.

AA647/TP25

This pit contained a foundation cut 0.7m deep to the base of the trench, with a maximum height of 105.81m ATD. It contained an orange-red brick foundation for an unmarked building between Building 10a and Building 92. The trench also contained a storm drain and layers of levelling and make up for the present car park surface.

AA652/OT6

A red-brick flat topped flue was recorded at a maximum height of 105.76m ATD, probably part of a gas emission system for Block 2 and Building 81 of *c* 1818. This was overlain by ground raising levels and bedding for the existing car park. The trench was abandoned at 1.4m deep due to live services.

AA653/OT8

In situ natural river terrace gravel was recorded at 105.42m ATD, overlain by a red-brick Stretcher Bond wall (dated *c* 1916–1931) 0.5m deep with a maximum recorded height of 105.92m OD. Above the wall was a layer of sterile material introduced after previous ground remediation with landscaping above.

AA654/OT6a

This trench contained a sequence of banded layers, identified as 19th- to 20th-century make up. They included demolition layers and make up and bedding for the current car park surface.

AA662/TT4

In situ Thanet Beds was recorded at 106.05m ATD, overlain by a demolition layer. A layer of 'Teram' lay above this deposit with layers of make up, drainage and landscaping above. The layer of 'Teram' indicates the extent of past ground remediation here.

AA663/TP21

This pit contained a light yellow brick, Flemish bond wall foundation of Building 10a (dated 1802–3 Carriage Works rebuild). It was 1.3m deep and extended to a maximum height of 106.6m ATD. It was overlain by a contemporary ground raising deposit below a concrete layer.

AA669/TP22a

In situ Thanet Beds was recorded at 105.27m ATD, overlain by a 0.34m thick layer of either *in situ* natural river terrace gravels or a make up associated with Building 10a. A 0.34m thick layer of construction debris associated with Building 88 (dated to 1818 to 1860) was overlain by make up and preparation for the modern car park. A cast iron gas pipe (of the 1860s) associated with Building 10a and Building 88 was also present in the pit.

AA670/TPA

This pit was in the basement of Building 11 and no level information is available from the report. The pit contained a 0.85m deep red brick English garden wall bond foundation, below a levelling deposit and make up for the original roughly cut, unmortared slabs of the basement floor.

2.5.7 Overall the evaluation recorded no evidence of any remains prior to the construction of the Arsenal, although it does indicate that remains may be present beneath the level of past ground remediation. The highest natural river terrace gravels was recorded at 107.25m ATD, and the highest Thanet Beds at 106.05m ATD. A number of trenches and test pits contained the remains of foundations from previous phases of the Arsenal. These foundations were located at 105.76–107.25m ATD. Demolition and construction deposits and occasional historic services were also recorded.

2.6 Archaeological and Historical Development of the Site

2.6.1 A more detailed description of the archaeological and historical development of the site can be found in the DDBA (MOLA 2009 section 4.3) Archaeological features referred to in the text can be seen on Fig 6 of this WSI. Arsenal buildings identified from the historic maps have been located on the site plan and are shown in Figs 16–24 of the DDBA (MOLA 2009), selected ones of which are includes in this document as Fig **2** to Fig **5**. It should be noted that due to the distortions present in early maps (and those resulting from the copying processes) the locations of these buildings are only approximate.

2.6.2 Located on the edge of the higher ground of the Woolwich promontory and the marshy floodplain the site would have been attractive to prehistoric people (*c* 700,000 BC –AD 43). Prehistoric pottery sherds of uncertain date have been found within the site and antiquarian finds of preserved Bronze Age wood and weapons are recorded from the vicinity of the Arsenal. Two Iron Age ditches and evidence of occupation have been recorded to the west of the site during excavations at the former Woolwich Power Station and the 'Teardrop Site' (TDP07) respectively. This complex has been interpreted as an Iron Age *oppidum* (a hillfort or fortified town), with some later Roman activity.

2.6.3 During the Roman period (AD 43–410), a road may have run east–west along the higher ground on the edge of the river terrace, perhaps along the course of the Plumstead Road or to the north, possibly within the site. The road has not been observed archaeologically, but is likely to have been the focus for a Roman cemetery, found during excavations at Dial Arch, to the north of (outside) the site. The cemetery

contained 158 inhumations and nine cremations and a small number of outlying cremation burials were reported from Zone 4, in the western part of the site. Evidence of a small settlement, probably focussed on the *oppidum*, was also found (Fig 6).

2.6.4 During the Anglo-Saxon and Medieval periods (AD 410–1485) the site was located in the parish of Woolwich in marshy land on the edge of the settlement. Evidence of medieval flood defences and reclamation works was found during evaluation at the Arsenal (RYA99) to the north (outside) of the site. Excavations (RYA99) outside the site to the north, and on the Teardrop site (TDP07) to the west recorded evidence of medieval 'London-ware' pottery manufacture. These are the only known production sites for this ware in London.

2.6.5 During the post-medieval period (AD 1485–present) a manor house and estate with a rabbit warren, ponds, moats, mills and a mill pond were located in the area. Later historic maps show a stream crossing the site from north-east to south-west (Fig **2**), and possible evidence of this has been found in one of the boreholes. It is likely that some of the mills and water management features were associated with this stream and may have been located within the site.

2.6.6 By the end of the 16th century ordnance was being stored at Woolwich gun wharf and during the 17th century guns were trialled at Woolwich and a battery was constructed to protect the Woolwich dockyard from Dutch raids. During the late 17th and 18th centuries the site was located to the south and east of the developing Woolwich Arsenal.

2.6.7 In the second half of the 18th century, three prison 'Hulks' (old wooden ships) were moored at Woolwich and their prisoners employed at the Arsenal. No structures associated with the convicts are believed to be present on the site, but the location of the convicts' burial ground is unknown and is likely to have been built on as the Arsenal extended eastwards. Informal burial grounds for convicts are known to have existed and large quantities of human remains were recorded during 19th and 20th century building works. It is therefore possible that the burials of convicts extended onto the site, either singly or as a larger group of inhumations, but it is not known how well such remains (if present) would have survived later building works.

2.6.8 During the 18th to 20th centuries the buildings of the Arsenal extended south and eastwards to cover the site. Most of these buildings have since been removed, except for Gunnery Terrace. Table 2 of the DDBA lists buildings within the site which have been identified from historic maps and these buildings are shown on Fig 16–24 of the DDBA.

2.6.9 In 1802–3 the first buildings of what is now Gunnery Terrace were constructed as part of the Carriage Works, where gun carriages were made and cannon fitted on them. The buildings of Gunnery Terrace are now separated from the Carriage Works (Building 10) by Arsenal Way, and the grade II listed Carriage Works (including Building 10) are located outside the site to the north. Since their initial construction in 1802–3, the buildings of Gunnery Terrace have undergone considerable modification and addition and, with some possible exceptions, the original buildings seem not to have survived subsequent rebuilding and enlargement. None of the Gunnery Terrace buildings are statutorily listed, but they are located in the Woolwich Arsenal Conservation Area.

2.6.10 Part of the non-extant Officer's Quarters (OA numbers Building 11 and 81 on DBA Figs 16–24), in the western part of the site were excavated in 1999–2000 (RYA99) and revealed the structural plan of the foundations and cellar walls of a WW2 bunker and Cadet Quarters (Old and New Barracks). No remains earlier than the

Arsenal were recorded in this area (Zone 4 in the relevant reports), but it is possible that earlier remains exist below the level of the excavations (1.5m below ground level).

2.6.11 The geotechnical boreholes clearly indicate the presence of made ground, natural river terrace, Lambeth Group and Thanet Beds across the site, with some areas of alluvium. Across much of the site, the made ground and alluvium (where present) could potentially contain archaeological remains, and archaeological features may also be cut into the underlying natural river terrace gravels and Lambeth Group.

2.6.12 It should be noted that following the remediation work undertaken by OA in 1999 and 2000, all archaeological remains above 1.5m bGL will have been removed from OA Zones 4 on the western part of the site, and all remains above 0.75m bGL will have been removed from Road 9, bisecting the site in a north-south direction. Zone 5 which was not remediated will still have a moderate to high potential for archaeological remains. The subsequent OA archaeological evaluation in 2004–5 identified archaeological remains present beneath the level of remediation, and these areas are shown in Fig **6**.

2.6.13 Should archaeological remains survive, the DDBA has indicated the following potential for deposits:

- Known potential to contain the footings of buildings from the Arsenal (Low to Moderate importance) shown on Figs 16–24 and listed in Table 2 of the DDBA. Although none of these buildings is considered as being of high importance (e.g. major military or historic building within the Arsenal), collectively they potentially provide useful information on the development of the Arsenal.
- Moderate potential for Roman remains, comprising settlement evidence and burials. Burials would be of high importance (depending on their degree of preservation), while settlement evidence may be of moderate to high Importance (depending on extent and preservation). The potential within the previously remediated area (Zone 4) in the western part of the site may be considered low to moderate.
- High potential for later medieval remains (moderate importance), as the site lay immediately south-east of the medieval manor house, and straddled a stream or channel, along the course of which were tenements, cottages and mill houses.
- Moderate potential for later prehistoric remains including Iron Age remains (of high Importance) linked to the nearby *oppidum.* Although it is very unlikely that the *oppidum* extends into the site, evidence for Iron Age occupation was found beyond the limits of the *oppidum*, therefore similar remains might be found within the site.
- Low potential for Anglo-Saxon remains, as the site lay east of the known Anglo-Saxon settlement, in marshy land (importance would depend on the nature and preservation of any remains).
- Low potential for post-medieval burials of convicts (high importance). Convicts were interred in large numbers in informal burial grounds of unknown extent at the Woolwich Warren from *c* 1776 to 1856.
- Very low/negligible potential for *in-situ* Palaeolithic remains (high importance). Occasionally, these are found sealed beneath or within the Head deposits, but Head deposit, although depicted on BGS mapping, were not recorded by two subsequent phases of geotechnical investigations at the site.
- Among the existing buildings Unit 12 and 14–16 Gunnery Terrace (the southernmost buildings of the group) would be demolished as part of the proposals. Gunnery Terrace is not listed, but is of local interest.

2.7 Deposit survival data

RTG = River Terrace Gravels

Borehole/Trial Pit/Trench no.	Ground Level	Thickness of modern overburden	Top of structural features	Surface of natural geology
AA625/TP1	106.87m ATD	0.4m	None	Not exposed
AA627/TT6	108.14m ATD	? >= 1.0m	None	105.40m ATD / 2.74m bGL (Thanet)
AA628/TP26	106.74m ATD	0.4m	None	106.34m ATD / 0.4m bGL (?RTG)
AA629/TP27	107.59	?0.70m	106.83m ATD / 0.76m bGL *and* 106.19m ATD / 1.4m bGL (drainage pipes for buildings 83, 88, & 89)	?106.89m ATD / 0.7m bGL (?RTG)
AA638/TT7	107.49m ATD	?2.1m	None	105.29m ATD / 2.20m bGL (RTG)
AA640/TP22	106.32m ATD	>= 0.32m	(wall of standing building 10a, 1802–03, base 2.50m bGL)	?103.92m ATD / 2.4m bGL (Thanet – ?in situ or redeposited)
AA645/TP29	107.65m ATD	>=0.4m	107.25m ATD / 0.4m bGL (foundation from building 86, extant by 1818, 0.9m deep)	107.25m ATD / 0.4m bGL (Thanet)
AA646/TP28	107.48m ATD	0.54m	None	106.94m ATD / 0.54m bGL (RTG)
AA647/TP25	106.75m ATD	0.58m	105.81m ATD / 0.94m bGL (unmapped building, >>0.2m deep – base not exposed)	Not exposed
AA652/OT6	107.16m ATD	1.4m	105.76m ATD / 1.4m bGL (brick flue ?assoc w Block 2 and Building 10a, base not exposed)	Not exposed
AA653/OT8	107.42m ATD	1.5m (remediation)	105.92m ATD / 1.4m bGL (brick wall *c* 1916–31; 0.5m deep)	?105.42m ATD / 2.0m bGL (?RTG)
AA654/OT6a	107.11m ATD	Uncertain: 0.4m or >2.5m ?	None	Not exposed
AA662/TT4	108.95m ATD	2.9m (incl. remediation)	None	106.05m ATD / 2.9m bGL (Thanet)
AA663/TP21	106.60m ATD	?0.4m	(foundation of standing building 10a, 1802–03, base 1.30m bGL)	Not exposed
AA669/TP22a	106.67m ATD	0.70m	105.83m ATD / 0.84m bGL (1860s gas pipe assoc. w buildings 10a & 88,)	105.27m ATD / 1.4m bGL (Thanet)
Combined borehole results	106.70–108.22	0.4 to 4.7m	104.27–106.38m ATD (water pipe at 102.72m ATD) 0.4–1.20m bGL (water pipe at 4m)	103.00–106.79m ATD / 0.4–4.7m bGL outside palaeochannels Up to 99.90m ATD / 7m bGL in western palaeochannel
Summary: overall levels	**106.6–109.0m ATD**	**0.4 to 4.7m**	**105.76–107.25m ATD** **0.4–1.4m bGL**	**103.0–107.3m ATD / 0.4–4.7m bGL outside palaeochannels**

3 Construction Impacts and Mitigation

3.1 Summary

3.1.1 The works for Woolwich Station box have been divided into Enabling Works and Main Works. Enabling works are defined in the Programme (ref no: BH_RAW_BOX_201112P1 Rev 00, 30.04.11) as the 'works necessary to prepare the site for the undertaking of the main box construction works'. This includes the excavation for the piling mat(s). See Annex 1: Development Plans for figures. The construction works undertaken during the project will consist of the following:

Enabling Works

- Site Establishment and Hoardings
- Demolition of 12 and 14–16 Gunnery Terrace
- Sewer diversion (1.2–4.0m dia. Shafts, and pipe-jack at depth)
- Utilities Diversions (water, gas, HV electricity), up to 1.5m deep
- Ground reduction to 107.7m ATD for perimeter/OSD basement contiguous piled wall
- Ground reduction to 105m ATD (*c* 1.6–4.0m bGL), including area for OSD

Main Works

- Diaphragm walls
- Piling (tension piles within diaphragm wall box and foundation piles to OSD basement)
- Dewatering within diaphragm wall box
- Excavation within diaphragm wall box (approximately 14–16m deep x 22–27m wide and 256m long internally)

There is potential for archaeological remains to survive at Woolwich Station at the locations of the following works (see Annex 1 for plansFig 8 **Location of GI Package 37 boreholes monitored by MOLA in 2011 (Capita Symonds)**

Fig 9 Borehole transect based on Package 37 and earlier results

For development plans see Annex 1

):

- Sewer Diversion shafts
- Other utilities diversion trenches, where more than *c* 0.5m deep
- Diaphragm walls and piling
- Excavation (comprising the Station Box, Station Box working area and area within the maximum extent of batter)

3.1.2 Set out below is a summary of the relevant Enabling, Advanced and Main Works that could affect archaeology or built heritage at Woolwich Station.

Enabling Works

- Demolition of 12 and 14–16 Gunnery Terrace (built heritage)
- Sewer and other Utilities diversions
- Ground reduction for main piling mat to 105m ATD

Main Works

- Diaphragm walls and Piling
- Excavation (Station Box, Station Box working area and area within the maximum extent of batter)

3.2 Enabling Works

3.2.1 Establishment of the Woolwich Station worksite and hoardings (Project Office to be established in an existing building east of Cornwallis Road) is unlikely to have an impact on archaeological remains, as the past site investigation work has shown the upper levels of the ground comprise modern made ground across most of the site.

3.2.2 The demolition of 12 and 14–16 Gunnery Terrace will completely remove any built heritage features present on the site. These are non-listed.

3.2.3 Utilities diversion has the potential to remove or partially truncate archaeological remains, although this will depend on the depths of the utility trenches and presence of any sensitive archaeological remains).

3.2.4 The ground reduction for the perimeter wall piling mat, to *c* 107.7m ATD, is unlikely to affect potential archaeology, as most of the site perimeter lies at levels low enough not to require ground reduction deeper than the minimum *c* 0.5m of modern overburden, and those that do have already been remediated to a depth of 1.5m, deeper than these works.

3.2.5 The extensive ground reduction (archaeological strip) to 105m ATD will be carried out as a succession of reduced level digs. It will result in the removal of any archaeological remains within the area of ground reduction to the extent of the lowest batter (see dwg no. BH0201-E2M40-R00-D-01001 in Annex 1). This is likely to remove all archaeological remains except deep foundations and the lower parts of the palaeochannels (see Fig 9).

3.3 Main Works

3.3.1 The construction of the diaphragm walls and piling will remove any archaeological remains within the footprint of the piles and diaphragm walls, which have not previously been removed during the enabling works by the ground reduction to 105m ATD.

3.3.2 Excavation of the station box will remove any archaeological remains within these areas not already removed during the enabling works by the ground reduction to 105m ATD.

3.3.3 Dewatering is unlikely to affect archaeological remains on the site, as it will occur within the footprint of the station box after archaeological remains will have been excavated,

and the water table lies within the natural geology of the Thanet Sands, between 100 and 102m ATD (Waterman 2011b, 8).

3.4 Outline Mitigation Design

3.4.1 No further specific site investigation works of the underlying deposits and the foundations of surrounding buildings are proposed at this stage, but the service diversion works associated with the large sewer will provide an early opportunity to examine the deposits present along almost the full length of the station box. This investigation would allow some further archaeological assessment of the nature, presence and depth of any archaeological remains which are present.

3.4.2 It is intended that mitigation would be undertaken during the enabling works phase to facilitate the smooth progress of the later construction phases.

3.4.3 The Crossrail Environmental Statement (Crossrail 2005), and the DDBA (MOLA 2009) indicate that no archaeological remains of *national importance* are expected at the site. It is therefore anticipated that the mitigation design for archaeological remains will entail *preservation by record.*

3.4.4 The mitigation design will include:

- **Non-listed built heritage recording** (to English Heritage level II standard) of standing buildings (12 and 14–16 Gunnery Terrace) marked for demolition. This has been **completed** (see 5.5.6).
- **General Watching Brief** on the excavation of any **utilities trenches or shafts deeper than *c* 1.0m**. This will include all the shafts for the **sewer diversion**. To be undertaken according to procedures detailed in the Crossrail Generic WSI (Crossrail 2008) and section 7.2 of this document.
- **Targeted Watching Brief** (including strip, map and record excavation) during the **ground reduction to 105m ATD**. To be undertaken according to procedures detailed in the Crossrail Generic WSI (Crossrail 2008) and section 7.2 of this document during stripping of the made ground. This should allow for rapid recording of building remains within the made ground, and more detailed recording of any significant features. As the final stage of the targeted watching brief, localised excavation and geoarchaeological sampling of any remaining archaeological or geoarchaeological remains within the footprint of the station box and other works within the that area (in advance of piling mat installation). Such remains are likely to be limited to deep foundations and the two palaeochannels.

3.4.5 The details of the archaeological mitigation will be refined during the detailed design phase, and will be programmed according to feasibility in the construction sequence.

4 Aims and Objectives

4.1 Objectives of the Investigation

4.1.1 The overall objectives of the investigation are to identify, excavate and record any archaeological or non-listed built heritage remains on the site, which would be adversely impacted by the Woolwich Station works.

4.1.2 The non-listed built heritage recording has the potential to recover:

- Evidence of the construction and usage of non-listed historic buildings on the site.
- Evidence of the origins and history of the non-listed historic buildings on the site.
- Build upon the knowledge already accumulated about the development and operation of the Arsenal complex.

4.1.3 The general watching brief has the potential to recover:

- Evidence of the construction and development of non-listed historic buildings on the site
- Remains of previously demolished buildings associated with earlier phases of the Royal Arsenal.

4.1.4 The targeted watching brief during the removal of the made ground has the potential to recover:

- Remains of previously demolished buildings associated with earlier phases of the Royal Arsenal. This could include evidence of foundations and unusual practices (eg the use of former gun carriages as foundation base plates which has been noted elsewhere at the site).
- Any post-medieval convict burials
- Any evidence of the post-medieval buildings on the site prior to the construction of the Arsenal.

4.1.5 The targeted watching brief (strip, map and record) following removal of the made ground has the potential to recover:

- Burials associated with the Roman cemetery on the Arsenal site
- Evidence of the former watercourse crossing the site, and whether it is natural or manmade.
- Any evidence of outlying settlement or activity associated with the Iron Age *oppidum* or subsequent Roman occupation.
- Any evidence of the Roman road, if it is present on the site.
- Any evidence of the pre-Arsenal later medieval and post-medieval use of the site.

4.2 Research Aims

4.2.1 Research themes, derived from *A Research Framework for London Archaeology 2002* (Museum of London 2002) have been identified in the Crossrail Specialist Technical Reports: Assessment of Archaeological impacts (Part 1–6) *(*Crossrail 2005). The following research themes would be appropriate to the mitigation design for Woolwich Station:

- Investigating corroborative research with other historic disciplines to elucidate a framework for future research.
- Understanding the relationship between landscape, river and settlement, and the influences of the Thames in particular on communications and social interaction.

4.2.2 Any evidence for Iron Age or Roman settlement may contribute to the following themes:

- Evaluating potential oppida – Uphill Camp and *Woolwich* are of regional importance and require publication. It will be valuable to clarify the relationship between these sites and other extensive settlements further out in the Thames estuary on the Hoo peninsula and at Rochester.
- Elucidating various elements in the settlement pattern from the small rectilinear enclosures to the larger enclosed sites. How do they compare with other elements in the local landscape?
- Understanding whether the transition from late pre-Roman Iron Age to Roman Britain was wholly about change, or whether there is more evidence than previously thought for continuity.

4.2.3 Any evidence for Roman burials may contribute to the following themes:

- Understanding the differences, if any, between burial practices in the city and outlying cemeteries.
- Considering cultural interaction between immigrant, invaders and indigene, between, for example Britons and Romans, in terms of diversity and marginality, or issues of social inclusion and exclusion.
- Estimating population sizes, character and composition, and changes in these over time, including evidence for settlement and transient occupation.
- Understanding life expectancy, origins and belief, seen through studying health, diet and disease, and preparing models for future research.
- Considering the relationship between cemeteries and major and minor road, in terms of symbolism, status, privacy and convenience – both in London and at roadside settlements around the region.

4.2.4 Any evidence for Post-medieval military and industrial activity (including remains of former Arsenal buildings) may contribute to the following themes:

- Charting how and why different parts of London developed as specialist producers, and understanding the implications of this for London as a world city.
- Understanding functionality and specialisation within buildings, and the impact on social interaction and economic linkages.
- Understanding the cultural and symbolic roles played by London's defences through the ages as reflections of power and political security or imposition and dominance.
- Establishing how well the various defence systems around London from the 16th-century to the beginning of the 20th-century survive, and considering their influence and effect

on Londoners both practically, and psychologically as reflections of power and physical security.

5 Scope of the Investigation

5.1.1 Evidence from the watching briefs in the early phases of the enabling works may refine the final methodology for the targeted watching brief on ground reduction to 105m ATD. The detailed methodology and timetable for the works will be determined during the detailed design phase and will be programmed according to feasibility in the construction sequence. It is currently anticipated that the investigation (described below) will take place during the enabling works phase.

5.2 Works not requiring mitigation

5.2.1 **No archaeological mitigation** is required for:

- Hoardings and site establishment
- Ground reduction to 107.7m ATD for the perimeter piling mat
- Utilities trenches less than *c* 1.0m deep
- Dewatering within diaphragm wall box

5.3 Enabling works requiring mitigation

5.3.1 These works **require a general watching brief:**

- The shafts for the **sewer diversion** (see dwgs no. BH0201-E2M40-U00-D-00301 to -04 in Annex 1)
- **Utility diversion trenches more than *c* 1.0m deep** (which trenches will be of this depth to be determined from the detailed designs) (see dwg no. BH0201-E2M40-U00-D-00101 in Annex 1)

5.3.2 A **targeted archaeological watching brief** is required for:

- **Ground reduction** to **105m ATD** (the area within the batter ('excavation slope') and piling mat on dwg no. BH0201-E2M40-R00-D-01001 in Annex 1)

5.3.3 To appropriately mitigate the ground reduction, the targeted archaeological watching brief should conform to the existing mitigation strategy for Woolwich Arsenal (also described as 'strip, map and record excavation') as agreed by GLAAS (Mark Stevenson, GLAAS pers. comm. 09-11-09). This will include removal of low-grade/bulk deposits by tracked machine. Deposits of potentially greater interest will be cleaned utilising smaller tracked machines under archaeological supervision.

5.3.4 If deposits meriting more detailed recording or investigation are exposed then the surface will be cleaned (using a machine with a flat ditching bucket and/or hand-tools as appropriate) followed by localised hand-excavation and recording.

5.3.5 Where Roman burials or settlement activity are encountered localised formal hand-excavation by the archaeological team will take place. Where structural remains from former Arsenal buildings are present digital data capture techniques allied to artefact retrieval sampling and removal of structures to expose potential earlier phases of activity will take place.

5.4 Main works requiring mitigation

5.4.1 No additional mitigation works should be necessary for the station box (diaphragm wall, piling, and excavation) as it is intended that all archaeological remains will have been recorded, and where appropriate excavated/sampled, by the end of the targeted watching brief (see 5.3).

5.5 Non-Listed Built Heritage Recording

5.5.1 Non-listed built heritage assessment and recording forms part of the archaeological mitigation strategy for Crossrail. The definition of non-listed built heritage that has been adopted follows Information Paper D22 Archaeology and encompasses above ground historic features and structural elements of historical interest.

5.5.2 Two main groups are:

- Non-listed buildings proposed for demolition in conservation areas; and
- Historic street furniture and materials falling within a worksite and being temporarily or permanently impacted upon by the works.

5.5.3 The detailed scope for this element of works includes:

- Important non-listed buildings of historic interest proposed for demolition in conservation areas (as set out in Information paper D18, Listed Buildings and Conservation Areas);
- Important non-listed historic street furniture and materials;
- Other important non-listed buildings and structures of historic interest outside conservation areas, locally listed station buildings and railway structures and any industrial and defence archaeology of significance.

5.5.4 An assessment of the Woolwich Station site has been undertaken by MOLA in order to identify any non-listed built heritage which will be demolished as part of the proposed works. The results of the survey are presented in the DDBA and summarised in Table 1 below.

5.5.5 No other non-listed features (such as street furniture) of note were identified.

5.5.6 Units 12 and 14–16 Gunnery Terrace were recorded in April and May 2011 (prior to demolition) to the equivalent of English Heritage Level 3 (English Heritage 2006, 14), see MOLA in prep a.

Name	Image	Description	Significance	Impact	Mitigation/Further Investigation
Building 7, Units 12 and 14–16, Gunnery Terrace		Late 19th-century and 20th-century industrial structures, with brick walls and wrought-iron and steel roof frames and columns.	Documented as built from the third quarter of the 19th century onwards. Considerably modified in the course of use for iron founding and fitting guns to gun carriages. Not listed but located in the Woolwich Arsenal Conservation Area.	To be demolished	Appropriate mitigation by means of archaeological and historical survey, before demolition, to Level 3 in English Heritage specifications (2006). This recording was carried out by MOLA in April and May 2011 (MOLA 2011) No further fieldwork is required.

Table 1 Non-listed buildings of built heritage interest within the Woolwich Station site

6 Programme

6.1 Introduction

6.1.1 For Crossrail SSWSIs site-specific mitigation measures are structured as follows:

- **Critical phase** advanced archaeological works to be undertaken prior to Enabling Works (this may apply to important archaeological remains requiring complex mitigation, where early site access is therefore essential).
- **Phase 1** archaeological works to be undertaken during enabling/Advanced Works.
- **Phase 2** archaeological works to be undertaken during main works.

6.2 Archaeological Investigation at Woolwich Station

6.2.1 **Critical phase:** Built heritage recording of 12 and 14–16 Gunnery Terrace was been completed in April/May 2011 (see 5.5.6).

6.2.2 **Phase 1 (Enabling Works):**

- General watching brief on sewer diversion shafts: 20 June to 7 October 2011
- General watching brief on Utilities trenches deeper than *c* 1.0m: 1 August to 30 September 2011
- Targeted watching brief on ground reduction to 105m ATD: 12 September to 23 December 2011

6.2.3 The general watching briefs will have no significant effect on the construction programme.

6.2.4 The targeted archaeological watching brief covers two tasks on the current construction programme (ref no: BH_RAW_BOX_201112P1 Rev 00, 30.04.11):

- EW.CN.1950, 'Local Excavation and archeology search in areas of high interest', 12-Sep-11 to 10-Oct-11
- EW.CN.3810, 'Main excavation to formation (Archeology - watching brief)', 10-Oct-11 23-Dec-11

6.2.5 **These two tasks should be run as a single rolling phased programme of excavation and targeted watching brief** by the main Groundworks Contractor (to be appointed) across this period (not as separate tasks) working in close conjunction with the Archaeological Contractor. The month allowed for archaeology in the programme as task EW.CN.1950 will need to be spread across this period.

6.2.6 It is understood that the ground reduction will be conducted in phases, comprising areas of excavation moving across the site. The time for the archaeological targeted watching brief will be integrated into these phases (see section 7.2 for further description).

6.2.7 **Phase 2 (Main Works):** none (nb 'initial piling mat' and piling/d-wall establishment commence 9 January 2012)

6.2.8 **Phase 3:** scope of the off-site post-excavation programme to be determined on the basis of the archaeological fieldwork results.

7 Specification for Archaeological Contractor

7.1 Generic standards

7.1.1 The archaeological evaluation and mitigation works and scope of any archaeological scientific methods shall be designed and undertaken in accordance with the Generic WSI, Archaeology Specification for Evaluation and Mitigation (Crossrail 2009) and relevant best practise guidance (and any subsequent revisions).

- Crossrail standards and specifications;
- IFA Standards and Guidance;
- Museum of London collections and archive policies and guidance;
- English Heritage – Geoarchaeology, 2007;
- English Heritage – Archaeological Science at PPG16 interventions: Best Practice Guidance for Curators and Commissioning Archaeologists, 2003;
- GLAAS Archaeological Guidance Papers 1999;
- GLAAS *Standards for Archaeological Work, London Region, External Consultation Draft (*English Heritage 2009*)*
- Museum of London site recording manual (MOL 1994);
- English Heritage – *Understanding Historic Buildings – A guide to good recording practice* (English Heritage 2006c)

7.2 General Watching Brief Specification

7.2.1 The scope of the **general watching briefs** on **sewer shafts and utilities trenches** is set out in section 5.3.1.

7.2.2 The general watching brief shall comprise observation and recording by the Archaeological Contractor of the Services Contractors' works, without constraint on the latter's working methods.

7.2.3 The purpose of a watching brief is to identify any archaeological remains that are uncovered in the course of the works and record them appropriately (as far as is reasonably practicable). The watching brief shall result in the preparation of an ordered archive which will be incorporated into the post-excavation works and into publication of the project results.

7.2.4 The Archaeological Contractor shall:

- Provide a team of suitably qualified archaeologists, experienced in archaeological site evaluation and the nature of archaeological deposits which are expected on this site;
- Provide a method statement for carrying out the works;
- Provide a risk assessment and health and safety plan;
- Monitor those works with potential to expose or remove archaeological remains, by means of periodic visits or a more continuous presence, as appropriate. The service trenches more likely to merit intermittent visits, and the sewer shafts may require a more frequent, or continuous, presence.

7.3 Targeted Watching Brief Specification

7.3.1 The scope of the **targeted watching brief** on **ground reduction to 105m ATD** is set out in sections 5.3.2 to 5.3.5.

7.3.2 The methodology for the targeted watching brief at Woolwich Station is specific to this site, and takes the form of a 'strip, map, and record excavation', conforming to GLAAS' (the statutory consultee) accepted methodology for the Royal Arsenal. The details of the methodology and how it is to be conducted will need to be agreed between the Archaeological Contractor and the Groundworks Contractor in advance of the fieldwork, and may need to be modified during the course of the fieldwork according to the density and nature of the archaeological remains and site conditions etc. It is expected that it will be conducted in the following manner:

- The Groundworks Contractor will be carrying out a preparatory site strip across the site to a depth of 105m ATD. This will progress sequentially across the site in a series of sub-areas (to be determined).
- The preparatory site strip will be carried out under archaeological monitoring and supervision (targeted watching brief), with attendant sample-based archaeological investigation and recording being carried out where significant archaeological structures and remains are uncovered (strip map and record/sample excavation).
- The predicted archaeological features consist of mainly 19th-century foundations and structural remains from former (demolished) Arsenal buildings, with possible remains of earlier prehistoric and Roman landscapes underneath. At the 105m ATD base of the strip (piling platform formation level) localised atypically deep archaeological or geoarchaeological features may be present (eg the palaeochannels shown in Fig 9).
- Within each sub-area, the Groundworks Contractor will conduct the preparatory strip as follows:
    - Remove up to *c* 1m below ground level of over modern overburden to expose former Arsenal buildings, by mechanical excavator under archaeological monitoring and supervision. Make final clean using toothless ditching blade and remove any localised deeper areas of modern fill, using a smaller Kubota-type excavator if required.
    - Archaeologists then hand clean, investigate and record local features at this first archaeological horizon. This is done to a targeted sample-based approach, not full archaeological excavation. Whist this investigation is carried out, the Groundworks Contractor can continue preparing the next sub-area (as above).
    - The above method is repeated, in approximately 1m horizons (to be determined based on site conditions), in each sub-area until the 105m ATD formation level is reached. This will proceed from sub-area to sub-area in an integrated rolling programme, with the Groundworks Contractor and Archaeological Contractor working in close co-operation to achieve both the archaeological and engineering requirements.

      (over much of the site, the surface of the natural geology is predicted to lie above 105m ATD (see Fig 9), and few archaeological features are expected to remain at/below this surface, apart from the palaeochannels and deep foundations etc).
    - At the 105m ATD formation level, further selective archaeological investigation may need to be carried out. It is anticipated that there will be relatively few archaeological features at this depth, but there may be a requirement for localised machine excavation (and subsequent reinstatement) by the Groundworks Contractor of archaeological features below 105m ATD.

- There may be two geoarchaeological (naturally formed) palaeochannels penetrating below the formation level (Fig 9). If present, these will be sample investigated using trial trenches to address man-made deposits (to an anticipated safe depth of 2m using a benched profile) and/or geoarchaeological boreholes to address geoarchaeological deposits.
- Geoarchaeological boreholes would be undertaken by a specialist borehole contractor working for the archaeological contractor. The main contractor will need to facilitate safe access for the borehole rig.

7.4 Investigation during watching brief

7.4.1 An appropriate sample shall be excavated from cut features and other archaeological remains of importance. Sampling of cut features shall include feature intersections to establish relative chronologies. The extent of sampling shall be determined by the Archaeological Contractor in liaison with the Project Archaeologist (and as discussed with the relevant local authority and English Heritage, and a quaternary specialist, if necessary) but may, for instance, include the sample excavation of a selected number of deposits (both layers and negative, cut features), recording of structural remains, drawn sections and profiles, and/or be aimed at recovering sufficient information to determine function, form, and date. Any specific variations from this specification shall be indicated in The Archaeological Contractor's Method Statement.

7.5 Temporary works and use of mechanical excavators

7.5.1 Temporary works and any required hand investigation to address below ground hazards shall be carried out by the Main Contractor under supervision by the Archaeological Contractor in accordance with their approved Method Statement and Risk Assessment. All subsequent excavations shall be excavated by the Main Contractor under supervision by the Archaeological Contractor using a mechanical excavator with toothless ditching bucket, except where the nature of the made ground or surface of the pits is such that an alternative bucket or means of breaking out prior to excavation is required (and the Project Archaeologist has agreed an alternative method). At Woolwich the large number of Arsenal foundations likely to be present may require greater use of a toothed bucket than would normally be the case. Precise procedures will be adapted on site to progress the bulk excavation without the loss of archaeological information. The approach adopted will be detailed in the Archaeological Contractor's Method Statement and is likely to include provision for successive machine stripping of the various phases of Arsenal structures with localised investigation of 'soft deposits' comprising archaeological strata as they are revealed.

7.5.2 All machine work and demolition of below-ground obstructions (e.g. removal of basement slabs) shall be carried out by the Main Contractor under supervision by the Archaeological Contractor. The Main Contractor shall cease work when archaeological evidence is revealed and allow the Archaeological Contractor to undertake investigation, as appropriate. An excavator shall not be used to cut arbitrary trial trenches down to natural deposits without regard to the archaeological stratification.

7.5.3 All undifferentiated topsoil, or overburden of recent origin, shall be removed down to the first archaeological layer. An exception to this would be where a focused soil-sampling strategy is proposed to record and collect data from reworked soil contexts above recognisable stratified archaeological contexts. If a mechanical excavator is to

be used to remove modern overburden, such as floor slabs or recent levelling layers, this shall be undertaken in spits of a depth dependant on specific site conditions, moving along the length of the trench or area. The Archaeological Contractor's supervising archaeologist shall use their professional judgement to determine the appropriate depth of each spit and will advise the Main Contractor accordingly. Any variations to the excavation methodology shall be at the discretion of the supervising archaeologist and recorded in writing for inclusion in the final report to the Project Archaeologist.

7.5.4 Each spit shall be examined carefully to assist the recovery of any archaeologically significant artefacts and thus to determine when to cease machining.

7.5.5 The archaeological level shall be cleaned in plan by the Main Contractor using appropriate plant and/or hand tools. If the machine has to re-enter the trench, as is likely at Woolwich, care will need to be taken to ensure that it does not damage underlying remains.

7.6 Hand excavation and recording

7.6.1 All works will be carried out in accordance with appropriate professional codes, standards and guidance as stated in the Generic WSI; Section 5.4 and Section 10 (Crossrail 2008) and Archaeology Specification for Evaluation and Mitigation (Crossrail 2009). The following specifications will be followed as a minimum.

7.6.2 During watching briefs, it may not be possible to clean and record the archaeological profile of geotechnical test pits, due to health and safety or access constraints. Every effort shall be made to establish the presence or absence of archaeological deposits by establishing the absolute level (ATD/OD) for the height of significant deposits, including the depth of modern intrusions, key stratigraphic components and natural deposits.

7.6.3 The archaeological remains shall be recorded to best practice standards, recognising the special circumstances of a watching brief which demand flexibility in order to achieve archaeological objectives and requirements within the construction environment.

7.6.4 A sufficient sample of the archaeological features and deposits revealed must be sampled/or fully excavated to allow the resolution of the aims and objectives of the work.

7.6.5 The Archaeological Contractor shall undertake hand excavation and cleaning of any archaeologically significant horizons, to fulfil the aims of the work. Within alluvial sequences the Archaeological Contractor shall pay particular attention to establishing the vertical extent of layers of archaeological potential and shall be aware that horizons of cultural activity may be interdigitated with horizons of sterile alluvium. The Archaeological Contractor shall supervise the excavation of each trench in such a manner so as to allow a complete record of the deposits present to be obtained.

7.6.6 The Archaeological Contractor's excavation, sampling and recording policy shall be included in the Archaeological Contractor's Method Statement. This is to include, as a minimum:

- The recording of individual contexts on appropriate pro-formas;
- Excavation plans at 1:50 scale; planning and section drawing of appropriate single contexts and features (usually at 1:20 scale for plans and 1:10 scale for inhumations and sections);

- Other appropriate drawn and written records shall also be produced (for environmental sampling etc.).
- Photographs; and other appropriate drawn and written records; and
- Permanent Ground Markers (PGMs), any temporary benchmarks and approved OS benchmarks shall be indicated on the relevant plans.

7.6.7 The Archaeological Contractor's survey and recording policy shall meet the following requirements:

- All levels shall be recorded to London Grid standards and reduced to OS datum;
- The electronic survey record shall be retained with the project archive.

7.6.8 In alluvial sequences, each trial excavation shall be excavated to the base of the alluvial sequence, and shall be appropriately shored and kept free of water by the Main Contractor to allow 'person entry' to the excavations i.e. to allow the Archaeological Contractor to undertake investigation and recording to fulfil the aims of the work.

7.6.9 A sufficient sample shall be excavated from cut features and other archaeological deposits to fulfil the aims of the work. Sampling of cut features shall include feature intersections to establish relative chronologies.

7.6.10 The investigations shall be recorded by the Archaeological Contractor to the standards of current best practice. The recording systems adopted during the investigations must be fully compatible with those published by the Museum of London (MoL 1994 and MoL 1998).

7.6.11 Site plans shall identify both London Grid and OS co-ordinates. A 'site location plan', indicating site north shall be prepared at 1:1250. Individual 'trench plans' or 'excavation area plans' at 1:200 (or 1:100) shall be prepared which show the location of archaeology investigated in relation to the investigation area.

7.6.12 Section drawings shall be located on the relevant plan and both London Grid and OS co-ordinates recorded. The locations of the OSBM or PGM bench markers used and any site TBM shall also be indicated.

7.6.13 A record of the full extent in plan of all archaeological deposits as revealed in the investigation shall be made; these plans shall be on polyester based drawing film, and be at a scale of 1:10 or 1:20 unless otherwise agreed with the Project Archaeologist. 'Single context planning' shall be used on deeply stratified sites. Drawing information shall be digitised for eventual CAD applications. The GLSMR will accept AutoCAD .DXF or .DWG format of extent of site and location of major features with the completed Sites and Monuments Report Form.

7.6.14 A 'Harris matrix' stratification diagram shall be employed to record stratigraphic relationships (Harris 1993). This record shall be compiled and fully checked by the Archaeological Contractor during the course of the excavations. Spot dating shall be incorporated onto this diagram during the course of excavations.

7.6.15 Recording of structural evidence revealed below ground level will vary according to the level of special interest of the structure and its relationship to below-ground archaeology. Structures of little or no significance shall be noted on a site plan. Detailed element detail drawings of important features revealed in investigations may be required in accordance with the aims and objectives of the investigation.

7.6.16 The photographic record shall consist of monochrome prints/negatives and colour transparencies. A 35mm format SLR camera or digital camera of equivalent

specification is acceptable for all site photography. The Archaeological Contractor shall maintain a minimum of two such cameras on site at all times during working hours. The photographic record shall include photographs and transparencies of archaeological features, appropriate groups of features, structures, and quaternary deposits. Each photograph and transparency shall clearly show details of the above. Each photograph and transparency shall include an appropriate graduated scale, a north arrow, and a header board detailing (as a minimum) the event code and context/feature number. In addition, the Archaeological Contractor shall take appropriate record photographs to illustrate work in progress.

7.6.17 Transparencies shall be mounted in suitable frames for long-term curation in preparation for deposition with the archive. Digital photography and video recording may be appropriate in some circumstances and the Archaeological Contractor shall set out proposals for such recording in the Archaeological Contractor's Method Statement for approval by the Project Archaeologist.

7.7 Survey requirements

7.7.1 Site specific survey requirements shall be developed at detailed design but will meet the following requirements from the Archaeology Specification for Evaluation and Mitigation (Crossrail 2009) as a minimum.

7.7.2 Heights for all deposits shall be related to approved Permanent Ground Markers (PGMs) or approved Ordnance Survey Bench Marks (OSBM), where reasonably accessible. Levelling accuracy between OSBMs/PGMs and site Temporary Bench Marks (TBMs) shall be within 10 mm per k: where 'k' is the total distance levelled in kilometres. Each TBM shall be levelled as part of a closed loop starting and finishing on approved OSBMs or URL PGMs. Where more than one TBM is required per site, the Archaeological Contractor shall establish the TBMs as part of the same closed loop. The Archaeological Contractor shall prepare a record of their surveying methodology for inclusion in the archive. The details of the methodology will be included in their Method Statement.

7.7.3 The spatial extent of the investigation(s) shall be set out in accordance with the setting out co-ordinates supplied by the Project Archaeologist. All spatial setting out and recording shall be in accordance with The London Survey Grid Standard (formerly Crossrail Survey Grid). See Crossrail standard CR-STD-010.

7.7.4 Interventions shall be located to a horizontal accuracy of +/-500mm in relation to the detail illustrated in the contract drawing(s). The corner points of each excavation or the centre point of each soil core location shall be set out with a Total Station Theodolite or other suitable automated equipment referenced from approved Permanent Ground Marker (PGM) data supplied to the Archaeological Contractor by the Project Archaeologist. The positions of the trenches and survey points shall be verified by the Archaeological Contractor taking additional check measurements to additional known location points of detail. Surface heights shall be recorded and related to PGMs or approved Ordnance Survey Bench Marks (OSBM) .The full descriptions and locations of PGMs and OSBMs known to the Employer will be supplied to the Archaeological Contractor by the Project Archaeologist. Levelling accuracy between OSBMs/PGMs and site TBMs shall be within 10 mm k: where 'k' is the total distance levelled in kilometres. Each TBM shall be levelled as part of a closed loop starting and finishing on approved OSBMs or Crossrail PGMs. Where more than one TBM is required per site the Archaeological Contractor shall establish the TBMs as part of the same closed loop.

7.7.5 The Archaeological Contractor shall include details of their surveying methodology within their Method Statement (see Section 8), including the setting out of the grid and how they intend to provide the project grid co-ordinates to the Project Archaeologist with the Survey Report.

7.7.6 The Archaeological Contractor shall ensure that all trench or excavation limits, and significant archaeology detail are surveyed 'as dug' in relation to the project grid before leaving the site. Ground level height data shall be recorded for each intervention. Survey methodology and a detailed survey record shall be provided to the Project Archaeologist within the Survey Report.

7.8 Specification for geo-archaeological investigation (coring and boreholes)

7.8.1 Specification for geo-archaeology investigation shall be in accordance with English Heritage guidance and, where instructed by the Project Archaeologist, advice from the English Heritage regional scientific advisor. A number of features of potential geoarchaeological interest have been identified as being present at the site which may warrant further geoarchaeological investigation during the course of the works.

7.8.2 The scope of any required laboratory analysis and proposed presentation of results shall be agreed with the Project Archaeologist, as appropriate to the context and scope of the investigation. Where required, laboratory analysis shall be addressed in the Archaeological Contractor's Method Statement.

7.8.3 Open tube sampling (U100/U4 Sampling) shall be used at each survey location (14 in total) to establish a measured stratigraphic profile, soil descriptions, and recover sediment samples for on- or off-site processing (according to the requirements of each SS-WSI). The proposed methodology and equipment type to be used to fulfil the aims of the investigation shall be set out in the SS-WSI and specified in the Archaeological Contractor's Method Statement. Hand excavation shall precede power assisted methods where specified in the approved Archaeological Contractor's Method Statement and/or Risk Assessment.

7.8.4 Each soil core sample hole shall be assigned a unique number by the Project Archaeologist. The Archaeological Contractor shall not vary this number unless agreed by the Project Archaeologist in writing. Soil core sample holes shall be drilled and reinstated in accordance with the SS WSI, Works information, or other instruction from the Project Manager to protect the groundwater, minimise contamination pathways and/or address any other residual hazards. Each worksite location shall be reinstated in full prior to leaving the site.

7.8.5 Soil cores shall be drilled to sufficient depth to record the surface of the recorded floodplain gravels. Should significant obstruction be encountered within the predicted depth to impenetrable deposits, an additional hole shall be drilled at a distance of 1.0m from the survey point in a direction at the discretion of the event supervisor (if feasible). Should the additional hole encounter an obstruction of a similar nature the circumstances shall be recorded and the holes ceased. Sample diameter shall be selected in consideration of local ground conditions but should be in the range of 50mm to 100mm depending on strata. Sampling tube length should be capable of retrieving minimum sample length of 400mm and maximum of 2000mm. The Archaeological Contractor shall log the stratigraphic sequence in the field through close observation of sample contents. The logging is to follow conventional standards and include colour (Munsell colour coding), grain size, sorting, roundness/angularity, composition, fabrics, structure, compaction, fossil content (including archaeological artefacts), visible floral/faunal inclusions, secondary characteristics, unit contacts, and general observations. The sedimentary record shall be recorded through use of graphic logs

and written description by the Archaeological Contractor's suitably qualified geoarchaeologist.

7.8.6 Wherever practicable, soil samples shall be processed and recorded on-site by the Archaeological Contractor's suitably qualified environmental archaeologist to enable identification of archaeological remains, palaeo-environmental content and potential. Any such works shall be undertaken in accordance with the Main Contractor's environmental requirements for the site (in particular any relevant consents relating to discharge of water). In cases where on-site sample processing is not practicable, samples shall be investigated and recorded by the Archaeological Contractor at their own premises, as agreed with the Project Archaeologist). Samples judged by the environmental specialist to contain palaeo-environmental indicators or cultural remains shall be retained for off-site (or further) processing. Samples shall be wet-sieved through 5mm and 1mm mesh sequentially. Results shall be reported at the weekly progress meetings with the Project Archaeologist and shall inform the survey strategy.

7.8.7 Each (sub) sample shall be recorded with a unique sample record number, cross-referenced to a unique soil core sample number, and a written description of the processing record made on a standard environmental recording pro-forma. Sample flots shall be recovered for further analysis at the discretion of the Contractor's environmental archaeologist. Sample residues shall be retained for further off-site processing if showing significant potential for further analysis. Soil profile data shall be entered into a field computer for daily mapping of sub-surface topography, utilising topographic survey software.

7.8.8 On-site interpretation of contiguous deposits shall be made to provide a sub-surface site plan to inform the survey strategy and weekly progress meetings with the Project Archaeologist.

7.8.9 A colour photographic record utilising 35mm film or digital format shall be made of the site survey works whilst they are in progress to graphically demonstrate each activity. Significant soil core samples shall be photographically recorded (in colour), prior to processing. These may include significant contacts revealed in the sample window or deposits containing significant palaeo-environmental or cultural assemblages. All records shall be cross-referenced to the unique soil core sample number.

7.8.10 The Archaeological Contractor shall provide a detailed methodology for stratigraphic recording and presentation of results, sample recovery, sample processing and recording within their Method Statement.

7.9 Archaeological science

7.9.1 The strategy for sampling archaeological and palaeo-environmental deposits and structures (which can include soils, timbers, pollen, diatoms, animal bone, human bone etc.) will be developed by the Project Archaeologist in consultation with English Heritage Regional Science Advisor and the Archaeology Consultant.

7.9.2 On-site work and off-site analysis of the processed samples and remains will be undertaken by the Archaeological Contractor's environmental archaeologist as specified in the Archaeological Contractor's Method Statement. The finds retrieval policies of the appropriate recipient museum will be adopted. In accordance with the collection and retention strategy set out in SS-WSI, all finds (artefacts and ecofacts) visible during excavation shall be collected and processed by the Archaeological Contractor. In some cases, sampling may be the most appropriate strategy.

7.9.3 Finds shall be appropriately packaged and stored under optimum conditions, as detailed in the RESCUE/UKIC publication First Aid for Finds (Watkinson and Neal 1998). Where there is evidence for industrial activity, macroscopic technological residues (or a sample of them) shall be collected by hand. Separate samples (c. 10ml) shall be collected for micro-slags (hammer-scale and spherical droplets). Reference should be made to the Centre for Archaeology Guideline on Archaeometallurgy (English Heritage 2001). Assessment of any technological residues shall be undertaken.

7.9.4 Where appropriate, samples shall be taken for scientific dating (for example radiocarbon dating, OSL, thermoluminescance at the evaluation stage). This may apply where dating by artefacts is insecure or absent, and where dating is necessary for development of the SS-WSI for subsequent mitigation strategies. Procedures and specifications shall follow English Heritage guidance (English Heritage 2008b). Buried soils and sediment sequences shall be inspected and recorded on site by the Archaeological Contractor's geoarchaeologist, since field inspection may provide sufficient data for understanding site formation processes. Procedures and techniques presented in the English Heritage documents Environmental Archaeology (English Heritage 2002) and Geoarchaeology (English Heritage 2007) shall be followed. Samples for laboratory assessment shall be collected where appropriate, following agreement with the Project Archaeologist. Deposits shall be sampled for retrieval and assessment of the preservation conditions and potential for analysis of biological remains following English Heritage guidance (English Heritage 2002).

7.9.5 The sampling strategy shall include a reasoned justification for selection of deposits for sampling, and shall be developed by the Archaeological Contractor's environmental archaeologist or recognised bioarchaeologist in liaison with the Project Archaeologist. Flotation samples and samples taken for coarse-mesh sieving from dry deposits shall be processed at the time of the fieldwork wherever possible, to permit variation of sampling strategies if necessary. Sampling strategies for wooden structures shall follow the methodologies presented in Brunning (1996). Artefacts, biological samples and soils shall be assessed for evidence of site and deposit formation processes and taphonomy and especially for evidence of recent changes that may have been caused by alterations in the site environment.

7.9.6 Assessment of finds assemblages shall include x-radiography of all iron objects (after initial screening to exclude obviously recent debris) and, where appropriate, non-ferrous artefacts (including all coins). Where necessary, active stabilisation /consolidation shall be carried out to ensure long-term survival of the material, but with due consideration to possible future investigations. Once assessed, all material shall be packed and stored in optimum conditions, as described in First Aid for Finds (Watkinson and Neal 1998). Waterlogged organic materials shall be processed in accordance with: Guidelines for the care of waterlogged archaeological leather (English Heritage/Archaeology Leather Group 1995) and Waterlogged wood: the recording, sampling, conservation and curation of structural wood (Brunning 1996).

7.9.7 Samples for absolute dating shall be submitted promptly to the supply laboratory proposed by the Archaeological Contractor or other supplier as instructed by the Project Archaeologist. Delivery times shall be agreed to ensure that the results are available to aid development of specifications for subsequent mitigation strategies in the SS-WSI. Where it is proposed to date human remains, any time limits for reburial imposed by Schedule 15 of the Crossrail Act (for remains removed from burial grounds) or set out in the relevant burial licence under the Burial Act 1857 (in all other cases) shall be adhered to. Processing of all soil samples collected for biological

assessment, or sub-samples of them, shall be completed as soon as reasonably practicable.

7.9.8 The preservation state, density and significance of material retrieved shall be assessed by the Archaeological Contractor's recognised specialist. Special consideration shall be given to any evidence for recent changes in preservation conditions that may have been caused by alterations in the site environment. Unprocessed sub-samples shall be stored in appropriate conditions in accordance with the Archaeological Contractor's Method Statement. Samples collected for geo-archaeological assessment shall be processed promptly by the Archaeological Contractor's specialist, particularly where storage of unprocessed samples is thought likely to result in deterioration. Appropriate assessment shall be undertaken as agreed with the Project Archaeologist.

7.9.9 Where preservation in situ is a viable option, consideration shall be given to minimising the possible effects of compression and loading on the physical integrity of the site and any hydrological or chemical impacts of the proposed construction works (English Heritage 2002).

7.9.10 Animal bone assemblages, or sub-samples of them, shall be assessed by the Archaeological Contractor's specialist with reference to English Heritage guidance (English Heritage 2002).The results from any specific investigations in Archaeological Science shall be included in the Site Archive and presented in the evaluation report or final fieldwork report. Post-excavation assessments shall include sufficient detail to permit assessment of potential for analysis. They shall include tabulations of data in relation to site phasing and contexts, and include non-technical summaries. The objective presentation of data shall be clearly separated from interpretation i.e. recommendations for further investigations, (both on samples already collected, and at future excavations), shall be clearly separated from the results and interpretation.

7.10 Potentially nationally important remains

7.10.1 Where unexpected, potentially nationally important archaeological remains (as defined in the Crossrail Environmental Minimum Requirements and Generic WSI) are identified during the works, the Archaeological Contractor shall undertake works in accordance with the Environmental Requirements (archaeology) section of the relevant package Works Information and shall adhere to procedures as set out in the SS-WSI.

7.10.2 The Archaeological Contractor shall submit details of their procedure for excavating and recording potentially nationally important remains in the Archaeological Contractor's Method Statement.

7.10.3 Details shall be in accordance with Crossrail procedures and include how relevant parties are to be informed of such discoveries, the criteria to be utilised by the Archaeological Contractor in the assessment of the significance of such discoveries and the timescales to be adhered to.

7.10.4 As a result of the discovery of unexpected, potentially nationally important archaeological remains, the SS-WSI will be updated and reissued to incorporate any additional specific primary fieldwork event aims.

7.11 Human remains

7.11.1 If removal of human remains is required, an Exhumation Licence will be required from the Coroner's Office of the Ministry of Justice, under the terms of the 1857 Burial Act. This would be obtained by the archaeological contractor, unless otherwise required by the Project Archaeologist.

7.11.2 Where human remains are identified, all subsequent works must be undertaken in accordance with relevant legislative and environmental health requirements as set out in the Environmental Requirements (archaeology) section of the relevant package Works Information.

7.11.3 The Archaeological Contractor shall confirm how the requirements set out in the SS-WSI will be implemented as part of their procedure for excavating and recording human remains in the Archaeological Contractor's Method Statement. This should incorporate best practice guidance e.g. English Heritage (2002 and 2002a).

7.11.4 At sites known in advance to have a high risk of encountering human remains, provision shall be made by the Archaeological Contractor for site inspection by a recognised specialist. Should human remains be discovered, the Archaeological Contractor shall notify the Project Archaeologist immediately so that these procedures can be implemented. This notification may be initially made personally or by telephone but shall be confirmed in writing within 24 hours of discovery.

7.11.5 The Main Contractor will be required to cease all works at that location until further instruction is provided by the Project Archaeologist. The Archaeological Contractor shall undertake an initial in situ observation and assessment of the remains and shall advise the Project Archaeologist of the course of action required.

7.11.6 Lifting of human skeletal remains shall be kept to the minimum which is compatible with an adequate evaluation or excavation. Notwithstanding this, the Archaeological Contractor shall ensure that all burials are planned/photographed in-situ and that appropriate samples have been recovered prior to any lifting.

7.11.7 Visible grave goods and other obvious artefacts, shall be recorded and lifted before the end of the working day to avoid the risk of vandalism and theft. Where this is

not feasible or appropriate, the Archaeological Contractor shall ensure, on liaison with the Project Archaeologist that adequate site security is provided by the Main Contractor. As a minimum, this will require a 24 hour comprehensive security regime until sensitive remains have been recorded and lifted. As a result of the discovery of unexpected, potentially nationally important archaeological remains, the SS-WSI will be updated by the Project Archaeologist to incorporate any additional specific primary fieldwork event aims.

7.12 Treasure Act

7.12.1 The Treasure Act 1996 defines 'Treasure' as:

- Any object at least 300 years old when found which is: not a coin, but has metallic content of which at least 10% is precious metal; or
- One of at least two coins with at least 10% precious metal content;
- One of at least 10 coins;
- Any object at least 200 years old designated as treasure by the Secretary of State;
- Any object which would have been 'Treasure Trove';
- Any object found with any of the above.

7.12.2 The Treasure (Designation) Order 2002 extends the definition of treasure to include:

- Finds of at least two base metal objects (other than coins) of prehistoric date; and
- Any object (other than a coin) of prehistoric date with any precious metal content.

7.12.3 All finds falling within the definitions of treasure shall be reported immediately to the Project Archaeologist and all subsequent works must be undertaken in accordance with the relevant legislative requirements as set out in the Environmental Requirements (archaeology) section of the relevant package Works Information.

7.12.4 The Project Archaeologist will insert the procedure (or reference to the procedure) to be followed in the SS-WSI, identifying any specific individual roles or circumstances that are relevant to the works. Details shall include how relevant parties are to be informed of such discoveries, the criteria to be utilised in the assessment of the significance of such discoveries and the timescales to be adhered to.

7.12.5 To protect the finds from theft, the Archaeological Contractor shall record the finds and remove them to a safe place. Where recording and removal is not feasible or appropriate on the day of discovery, the Archaeological Contractor shall ensure, on liaison with the Project Archaeologist that adequate site security is provided by the Main Contractor.

7.12.6 Subject to the Provisions of the Treasure Act 1996, all material that is defined as Treasure is vested in the franchisee or, if none, the Crown. With respect to Treasure finds, a reward may be payable to the finder, the landowner and/or the occupier. The Crown usually offers finds to a museum.

7.13 Health and safety

7.13.1 The Archaeological Contractor shall undertake the works in accordance with the Main Contractor's Health and Safety Plan and requirements.

7.13.2 Where specific health and safety constraints or requirements for the Archaeological Contractor's method of work are required, these shall be set out in this section and detailed in the Archaeological Contractor's Method Statement (in the Health and Safety Plan).

7.13.3 No ground intervention or other survey shall be made without approval of the Archaeological Contractor's Health and Safety Plan, Method Statement and Risk Assessment by the CDM co-ordinator. Hand excavation or other remote sensing method may be required prior to any mechanical excavation in the first instance to locate any known or suspected below ground hazards.

7.13.4 The Archaeological Contractor's Method Statement and Risk Assessment shall take account of any design information (including the Designer's and Main Contractor's Risk Assessment) pertaining to above ground hazards such as buildings and other structures or public rights of way and below ground hazards such as services, utilities and infrastructure and shall contain a site specific Risk Assessment for unknown below ground hazards such as contaminants including unexploded ordnance.

7.13.5 All appropriate mitigation measures shall be in place prior to commencement of any ground intervention or other survey. Trench excavation method and earthworks support design, shall conform to Health and Safety legislation and safety standards as well as incorporating current engineering best practice, where appropriate.

8 Requirements for Service Diversion Contractor(s) during general watching briefs

8.1 Scope

8.1.1 The scope of the **general watching briefs** on **sewer shafts** and **utilities trenches** is set out in section 5.3.1.

8.2 Specific Requirements for the Service Diversions Contractor(s):

8.2.1 The method of working for the service diversions contractors during the ground reduction shall allow for:

- Provide attendances as listed in section 9 to the extent relevant and required for the watching brief.
- Information on the depths of the service diversion trenches will be provided in advance to the archaeological contractor, in order to determine which will be more than *c* 1.0m in depth, and therefore require monitoring.
- Service diversion excavations to be undertaken with a monitoring archaeologist in attendance.
- Provide safe access into the relevant work areas and excavations for the archaeological contractor to rapidly record any significant archaeological deposits which may be encountered. To include provision of any necessary ladder access, temporary support, etc, as per section 9.
- Allow for up to 2 archaeologists to be on site (including site accommodation and welfare facilities).
- Provide further technical advice to the archaeological contractor as may be required to safely complete the works.

9 Requirements for Groundworks Contractor during targeted watching brief

9.1 Scope

9.1.1 The scope of the **targeted watching brief** on **ground reduction to 105m ATD** is set out in sections 5.3.2 to 5.3.5.

9.2 Specific Requirements for the Groundworks Contractor:

9.2.1 The method of working for the service diversions contractors during the ground reduction shall allow for:

- Provide attendances as listed in section 9.
- Agree with the archaeological contractor a detailed method of work for the ground reduction to facilitate the targeted watching brief methodology described in section 7.3. This may vary with ground conditions, areas of the site, logistics of access, etc.
- Provide safe access for archaeological operatives into the site, individual work areas and ground excavations, as generally set out in section 9.
- Agree a safe method of working with the archaeological contractor that will facilitate a combined rolling programme of ground reduction and targeted watching brief. This should be achieved by separating out and demarking archaeological work areas from Groundworks Contractor's plant using barriers etc, as outlined in section 9.
- Use of excavators or other plant within the area shall only be undertaken with the agreement and under the observation of the Archaeologist.
- Allow for up to 6 archaeologists to be on site (including site accommodation and facilities).
- Provide further technical advice to the archaeological contractor as maybe required to safely complete the works.

10 Service Diversion and Groundworks Contractors supply of attendances during general and targeted watching briefs

10.1.1 The Main Contractors (Service Diversion Contractor(s) for the general watching brief on utilities, the Groundworks Contractor for the targeted watching brief on excavation to 105m ATD) will provide technical services and attendances to the archaeologists as set out below. This may require the installation of temporary works or other attendances such as pumping out, in order that the archaeologists may enter the works excavations safely, to carry out the works described in this WSI.

10.1.2 The Main Contractor will be responsible for supplying the necessary support items on site, to allow the archaeological investigations to be carried out safely. *Those items in bold will be required – others may be required, depending on site conditions, which will be reviewed on site by the archaeological contractor in conjunction with the Main Contractor's nominated Site Manager (these requirements will be communicated to the Main Contractor in the event that they are needed)*:

- ***Health and safety planning***: the archaeological contractor will submit a method statement and risk assessment covering their activities as a contribution to the Main Contractor's Health and Safety Plan under CDM. The Main Contractor will be responsible for overseeing health and safety and developing the necessary precautions in conjunction with the archaeological team, based on their method statement.
- ***general site security*** including hoardings, gateway, warning notices, etc; to create a secure site perimeter, sufficient to prevent unauthorised access. If the Main Contractor has retained security guards, it is recommended that the archaeological investigation areas be added to their schedule for regular patrols, particularly out of hours.
- ***specific site security***: it will be necessary to separately secure individual archaeological trenches via a physical barrier (such as Heras fencing) as the trenches are located in public areas and human remains are likely to be encountered. Secure storage (eg lockable tool store/hut) is required for human remains, other finds, samples, tools and equipment and any human remains (if found) at the worksite.
- ***locating and making safe any live services, UXO, or hazardous substances (above or below ground):*** All know live services and/or ground contamination to be removed or otherwise made safe prior to commencement of archaeological investigation. Main Contractor to exercise due diligence (eg scanning, tracing, sampling) to locate any unknown services or ground contamination during archaeological investigations. Any unexpected hazards encountered during the investigations to be isolated and made safe by the Main Contractor before archaeological fieldwork may continue.
- ***development of a safe method of working:*** archaeologists will not be able to work within excavations whilst attendances (such as installing temporary support or removing spoil) are taking place, and when demolition, construction or heavy plant activity occurs adjacent or overhead.
- ***providing safe access*** to the site and the specified archaeological investigation areas via separately identified pedestrian routes, signing, safety guard-rails, secure ladders etc. This includes segregating these areas from any vehicles and plant operating nearby eg via a robust physical barrier.
- ***managerial services*** – nominated points of contact for Main Contractor and other key members of development team.
- ***technical advice*** to be available if required (eg via client or Main Contractor's consulting engineer) re protection of adjacent streets and buildings, removal of obstructions, depth of excavation, live services etc.
- ***site accommodation and welfare facilities with electricity and water.*** To include: furnished main base cabin as work space; separate male/female changing areas (as required), toilets and washing facilities; plus additional steel cabin for secure storage of Archaeological Contractor's PPE, equipment, camera and paperwork and finds (including human remains). It is provisionally estimated that accommodation etc for 1 to 2 people will be required for the general watching brief, and 2 to 6 for the targeted watching brief.
- ***site preparation and clearance***. Removal of structures, rubbish, spoil heaps, demolition materials, slab, modern obstructions, infill, made ground, etc. as required, prior to and during the archaeological investigation. The majority will be by mechanical excavator, under archaeological supervision, but occasional hand work

by labourers may be needed (eg clearing individual obstructions, modern intrusions, or removing spoil from investigation areas if the machine cannot re-enter).

- ***transport/mounding/storage of spoil*** from archaeological investigation areas. This includes removal from site, if necessary.
- ***TWB ONLY: filling back and reinstatement*** upon completion (likely to be confined to localised investigation areas (where required) below the 105m ATD formation level.
- ***TWB ONLY: supply of plant and equipment***; in addition to the mechanical excavator(s) used by the Main Contractor in initial clearance, a 360º tracked mechanical excavator of appropriate size to clean archaeological features and areas; supplied with driver, (breaker if required), toothed digging bucket and toothless ditching blade; hoists for removal of spoil from trenches and operators. Other plant such as a Kubota type mini excavator, dumpers, compressor/breakers and pumps may also be needed.
- ***accreditation and supervision of operatives, plant and equipment***, including supply of sufficient qualified banksmen/supervisors to control plant movements and adequate certification for plant and operatives.
- *temporary support:* (if required) design, installation and maintenance of appropriate temporary support to excavations, where deeper than *c* 1.2m (or as required in unstable ground). This will be via benching/battering back and/or shoring, depending on a depth and ground conditions.
- ***GWB SEWER SHAFTS ONLY: other safety measures in deep excavations:*** monitoring of air quality and provision of rescue facilities and equipment in any areas defined by the Main Contractor as a confined space. Where hoists are used in shored shafts less than 4 metres x 4 metres area, the Archaeological Contractor's staff shall leave the shaft before hoisting of bucket takes place and not under normal operations re-enter until bucket is lowered back into position: Unless:
  - suitable space or protection is afforded within the shaft so that staff will not be at risk should the bucket fall;
  - a banksman or topman is constantly present to ensure that the bucket is not re-lowered or suspended over the trench while staff are working in the trench;
  - there is clear agreement that the hoist or machine operating as a hoist will not be in operation for a specified time period at that location and will not in any case recommence operations without the agreement of the Archaeological Contractor supervisor or suitable deputy.
  - Where mechanical or electrical hoists are in use in larger excavation trenches, the area in which the hoist is in use must be clearly demarcated and no staff will enter this area while the hoist is being raised or lowered or in the interval between these operations except under the circumstance specified above.
- ***First Aid:*** provision of First Aid facilities, and an emergency plan. On evaluations or watching briefs with small numbers of staff, Archaeological Contractor may not be able to supply a first aider. In that case, the services of the Utilities Diversion Contractor's qualified first aider(s) may be required.
- *pumping-out*: a suitable method to keep the trenches dry, eg pumping into a previously investigated trench, to create a sump. Only likely in any deep localised investigation below the 105m ATD formation level.

- *110v. site lighting and power supply* for access routes to excavations, plus individual task lighting within trenches (eg tripod-mounted spotlights) if required. The need for lighting depends on the depth, season and weather conditions or on ambient light level if working inside a standing building or roofed screening/cover.
- *temporary roofing and side screening to archaeological excavations if burials are exposed* (eg monoflex on scaffolding frame or similar) in order to screen any human remains from public view (including from above, if overlooked by buildings).
- adequate *ventilation* and protection from noise, fumes and dust where plant is in use, especially within the sewer shafts

11 Required deliverables

11.1 Archaeological Contractor Method Statement

11.1.1 The Archaeological Contractor shall provide a detailed Method Statement for the works for the Project Archaeologist's approval. The Method Statement shall be prepared in association with the Main Contractor, taking account of their Environmental Management Plan and other relevant site information provided by them and requirements for the works set out in the Works Information (e.g. relating to health and safety, security, engineering design requirements and attendances). The Method Statement shall include, as appropriate:

a) A resource plan and programme and CVs;

b) The Archaeological Contractor's IT capability and proposed IT plan (including specific survey methods for on-site recording of stratigraphic profiles and sub-surface topographic modelling [where required]);

c) The Archaeological Contractor's approach to Archaeological Science;

d) The methods for survey and setting out works;

e) The methods to address the specific event types required (trial trench, area excavation etc);

f) The safe method of working whilst excavating trenches or pits including any temporary works required;

g) The method for disposing of water from trenches and test pits in waterlogged ground;

h) Site management plan to include details of the method for preparing safe access route to the working areas, the proposed site accommodation, services and welfare [where required] ;

i) The retention and disposal policies for samples and artefacts recovered during the work;

j) The method for excavating and recording inhumations and cremations in compliance with the generic Crossrail standards for Human Remains;

k) The method for preparation of the required reports, archive and all associated deliverables;

l) The procedures for assessment of potential for analysis (post excavation assessment);analysis and publication proposals;

m) The method for preparation of the digital dataset, digital drawings, and digital report deliverables;

n) The Archaeological Contractor's methods and approach for undertaking the site based works and off site processes to completion.

o) The Health and Safety Plan and Site-Specific Risk Assessment (including unexploded ordnance);

p) The Quality Assurance Plan;

q) The procedures for on- and off- site security and emergency response plan (including environmental incidents);

r) The method for complying with project generic and site specific environmental and consent requirements; and

s) The Archaeological Contractor's requirements and specification for services and facilities and attendances required to be supplied by the Main Contractor or the Employer.

11.2 Archaeological Contractors Health and Safety documents (Annex 4)

11.2.1 The archaeological sub-contractor shall be required to prepare and submit for approval the health and safety documentation as detailed in Annex 4.

11.3 Programme

11.3.1 The archaeological sub-contractor shall be required to prepare and submit for approval a detailed programme setting out his work breakdown structure and timing and order of the works to meet the requirements of the Crossrail construction programme.

11.4 Reports

11.4.1 The archaeological sub-contractor shall submit a survey report, Interim statement, Summary Report, OASIS Summary Sheet and an illustrated report on the results of the works. The deliverables shall be prepared and submitted in accordance with appropriate standards and guidance as stated in the Generic WSI (Section 5.4 and Section 10 Crossrail 2008) and Archaeology Specification for Evaluation and Mitigation (Crossrail 2009).

11.5 Interim Statement

11.5.1 Within 7 days of completion of a fieldwork event the Archaeological Contractor shall submit an Interim Statement to the Project Archaeologist.

11.5.2 The Interim Statement shall be brief, and the information contained commensurate with the timescale for production. The report shall not duplicate effort to be utilised at a later date and shall draw on the data gathered during the initial assessment undertaken during fieldwork.

11.5.3 The report will include a site plan indicating all as-dug investigations, key stratigraphic profiles and topographic templates of the major stratigraphic units. The Interim Statement including illustrations shall be submitted as a single PDF file to the Project Archaeologist together with relevant CAD drawing files.

11.5.4 The Interim Statement text shall be submitted in hard copy and as an MS Word *.document in accordance with the Employer's information management standards and procedures.

11.5.5 The Interim Statement shall include an approved report title sheet and QA page (to be supplied by the Employer).

11.5.6 The following shall appear in the footer or header of each Interim Statement:

11.5.7 Copies of the Interim Statement shall be provided by the Project Archaeologist to the relevant English Heritage advisors (and other statutory authorities) for comment.

11.6 Survey report

11.6.1 The Archaeological Contractor shall provide a written and graphic survey report for the works upon completion of fieldwork. Evidence shall be provided for a check of measurements and results of levelling for the establishment of TBMs. The survey report shall be submitted by the Archaeological Contractor to the Project Archaeologist within 2 weeks of the completion of fieldwork.

11.6.2 The Archaeological Contractor shall prepare and submit 'as excavated' site area outlines and levels in accordance with Crossrail standard CRS-SDT-05. Each drawing shall identify the relevant event code and sub-site division, if applicable,

11.7 Fieldwork Report

11.7.1 A Fieldwork Report (the evaluation, excavation or watching brief report) shall be prepared by the Archaeological Contractor within 6 weeks of the completion of the fieldwork (unless this is varied by the Project Archaeologist). The Fieldwork Report shall follow the standard structure set out in City of London Planning Advice Note 3 and IFA standards:

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Non technical summary

1. Introduction

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3. Previous work(s) relevant to archaeology of site (DBA, DDBA, surveys etc)

4. Geology and topography of site

5. Research objectives and aims

6. Methodology of site-based and off-site work

7. Results and observations including quantitative report, stratigraphic report (including any constraints on site).

8. Assessment of results against original expectations (using criteria for assessing national importance i.e. period, relative completeness, condition, rarity, and group value) and review of evaluation strategy

9. Statement of potential of archaeology

10. Conclusions and recommendations for appropriate mitigation strategy (if at assessment or evaluation stage) or post –excavation assessment (if at mitigation stage)

11. Publication and dissemination proposals (in addition to fieldwork report)
12. Archive deposition
13. Bibliography
14. Acknowledgements
15. Sites & Monuments Record form
16. A3 plans

11.7.2 The Fieldwork Report shall provide an illustrated factual statement and statement of importance with associated assessment of potential for further fieldwork and/or analysis of the archive. The Fieldwork Report shall utilise information collected during archaeological fieldwork and from any other appropriate sources agreed with the Project Archaeologist.

11.7.3 The Fieldwork Report shall include sections detailing the background to the project, any previous relevant research and investigation, location and topography/geology, a description of the methodology employed and the techniques adopted. Where relevant, the sections will include location plans with scale and grid co-ordinates.

11.7.4 Each component of the works (eg. stratigraphic/structural, artefactual and environmental/economic) shall be supported by a statement setting out:

- A quantification of the resource (tabulated and cross referenced as appropriate);
- Provisional dating and evidence for residuality and intrusiveness;
- The range of material, including sampling and/or taphonomic biases; and
- The condition of the material, including preservation bias.

11.7.5 The stratigraphic statement shall include: a description of the geomorphology and sedimentation record of the survey area; a description of the fieldwork results (brief context descriptions supported by plans and sections as necessary, with levels related to Tunnel Datum); a trench summary table indicating depths of all major stratigraphic units, and their boundaries. Photographs shall be included where appropriate.

11.7.6 The Archaeological Contractor shall produce a subsurface model(s) and profiles to illustrate the extent, character and depth of the major stratigraphic topology identified. The model shall be correlated with previous works within the survey area in order to inform the mitigation design. The processing software and presentation format of the data shall be included in the Archaeological Contractor's Method Statement for approval by the Project Archaeologist.

11.7.7 The assessment of results and statement of potential shall include the Archaeological Contractor’s conclusions based on the recorded data, e.g. the monument/site class represented, site/feature function and relevant parallels. The statement shall also comment on the potential of the data to address the projects’ research themes. As appropriate, comment shall be made on the site as a whole and the individual components (e.g. artefactual, palaeo-environmental or economic). The statement shall utilise the criteria laid down by the Secretary of State for Culture, Media and Sport Criteria for Scheduling, to establish importance.

11.7.8 In reporting the results of the works, the accuracy of the original expectations and the appropriateness of the methods adopted shall be assessed by the Archaeological Contractor in order to illustrate what level of confidence can be placed on the

information. The Project Archaeologist will use that information as the basis for developing any further mitigation strategy and/or further analysis and publication.

11.7.9 The report shall be illustrated with a site location plan, survey location plans as appropriate (to include archaeological interpretation of results), and individual trench and area plans identifying archaeological features exposed and investigated.

11.7.10 When submitted at evaluation stage, the report shall set out an outline recommendation for mitigation. This may include preservation in situ and/or further investigation and recording of the remains and/or watching brief. The development of a detailed mitigation strategy shall be progressed by the Project Archaeologist in liaison with the Project Manager's engineering design team, the Archaeological Contractor, and the English Heritage Regional Science Advisor (and other statutory authority), as appropriate.

11.7.11 Copies of the Fieldwork Report shall be provided by the Project Archaeologist to the relevant English Heritage advisors (and other statutory authorities) for comment.

11.8 SMR/HER Summary Sheet

11.8.1 The Archaeological Contractor shall complete a GLSMR HER/SMR Summary Sheet (via OASIS) for the works (i.e. one per fieldwork event). The Summary Sheet shall be included in the Fieldwork Report.

11.9 Summary Report

11.9.1 A short summary report of no more than 500 words (the Summary Report) for the works shall be prepared by the Archaeological Contractor for submission to the Project Archaeologist for subsequent publication within London Archaeologist or another local (county) journal or publication outlet specified by the Project Archaeologist.

11.9.2 The Archaeological Contractor shall submit the draft Summary Report to the Project Archaeologist for approval within 8 weeks of the completion date of the fieldwork event. The Archaeological Contractor shall allow two weeks in the programme of works for the Project Archaeologist to provide comments. The Archaeological Contractor shall include any amendments required by the Project Archaeologist in the final Summary Report which shall be submitted within one week of receiving the Project Archaeologist's comments on the draft report.

11.9.3 The Summary Report shall be submitted as an MS Word *.document in accordance with the Employer's information management standards and procedures.

11.10 Post-excavation assessment

11.10.1 If instructed by the Project Archaeologist, the Archaeological Contractor shall undertake a post-excavation assessment of the site archive and submit a report of their findings to the Project Archaeologist for approval. Assessment of potential for analysis shall be undertaken in accordance with English Heritage guidelines.

11.10.2 The Archaeological Contractor shall provide details of its current post excavation assessment procedures with their Method Statement.

11.11 Archive

11.11.1 Digital datasets and the site archive will be compiled and accessioned in accordance with appropriate standards and guidance as stated in the Generic WSI

(Section 7 and Section 10 Crossrail 2008) and Archaeology Specification for Evaluation and Mitigation (Crossrail 2009).

11.11.2 The site archive shall be organised to be compatible with other archaeological archives in London. This requirement for archival compatibility includes computerised databases.

11.11.3 Individual descriptions of all archaeological strata and features excavated or exposed shall be entered onto prepared pro-forma recording sheets which include the same fields of entry on the recording sheets of Museum of London Archaeology. Sample recording sheets, sample registers, finds recording sheets, registered finds catalogues and photographic record cards shall also follow the Museum of London Archaeology equivalents.

11.11.4 Archives shall be prepared to conform with current best practise (e.g. Brown and Duncan 2007; Institute of Field Archaeologists 2008f) The archive shall cover all finds, samples and records (drawn, written, photographic and electronic) collected and produced during the works. The archive shall be indexed and internally consistent. The Archaeological Contractor shall complete the site archive and submit to the Project Archaeologist within 8 weeks of completion of a fieldwork event.

11.11.5 The site archive shall be deposited by at a museum to be confirmed by the Project Archaeologist.

11.12 Digital data

11.12.1 The Archaeological Contractor shall produce a digital data archive of all primary field data produced during the works in accordance with ADS guidelines (Richards and Robinson 2001).

11.12.2 The Archaeological Contractor shall prepare and provide field and laboratory data, evaluation or excavation trench and phasing plans showing archaeological features recorded, and report text in digital form, as well as in paper form. Consideration should be given to recording electronic plans during fieldwork.

11.12.3 The digital archive for each fieldwork event shall be copied to CD-R or DVD (recordable laser disc) and submitted to the Project Archaeologist for archiving in the Employer's document management system.

11.12.4 Final reports, site plans and other illustrations shall be prepared in accordance with the Employer's Information Management standards and procedures.

11.12.5 All data files submitted shall be scanned by a virus detection programme updated to the most current version. The disk label shall clearly indicate:

- Confirmation that this check has been carried out (including details of the virus checking programme name and version used) and that the submission is virus free.
- Fieldwork event name and code.
- Supplier company name, date and QA details (as a minimum, the name, position and signature of the approver).

11.12.6 Prior to commencing the works, the Archaeological Contractor shall submit an example hard copy and data output of each of the data formats required (i.e. data, graphic, CAD and text) produced by their current software, for approval by the Project Archaeologist. The Archaeological Contractor shall inform the Project Archaeologist of any changes or upgrades made to approved software prior to processing any works data. The sample disk shall include data from a previous real job or jobs.

11.12.7 A sequential numbering of data issues shall be rigorously adhered to so that no data versions are submitted out of sequence. The organisation of the data prior to submission shall be the responsibility of the Archaeological Contractor. The Archaeological Contractor shall ensure that data originating from different sources within the Archaeological Contractor's organisation is compatible with the project requirements. The Archaeological Contractor shall nominate one person to the Project Archaeologist who is the main point of contact for matters relating to the digital data submissions.

11.12.8 Where errors or inconsistencies are noted in the data, by either the Project Archaeologist or Archaeological Contractor they shall be corrected by the Archaeological Contractor and a corrected data file issued to the Project Archaeologist. When a change or addition is made to the data within an issue, a complete data group shall be re-issued, not just the changed fields. This may not require complete replacement of the whole data set which includes other previous issues.

11.12.9 Where any changes are made to a data record between digital data submissions, the Archaeological Contractor shall record the date of the change and the name of the person carrying out the change. The Archaeological Contractor shall ensure that each data amendment is carried out correctly.

11.12.10 The Archaeological Contractor shall make two identical copies of the digital archive. The first copy shall be retained by the Archaeological Contractor until the expiry of the Contract maintenance period. The second copy shall be issued to the Project Archaeologist.

11.12.11 A digital archive for each Crossrail site (incorporating individual event archives) shall be submitted to a regional or national data archive as agreed with the service provider by the Employer.

12 Site monitoring & progress reporting

12.1.1 Prior to commencing the works the Archaeological Contractor shall agree a programme of weekly written progress reports and periodic progress meetings with the Project Archaeologist and/or Project Manager and shall be represented at such meetings to the satisfaction of the Project Archaeologist. The Archaeological Contractor shall provide information describing progress on-site to date, the processing of samples and artefacts and feedback from any initial assessment.

12.1.2 The relevant Local Planning Authority archaeologist or GLAAS officer and, if required the English Heritage Inspector for works affecting a Scheduled Monument (collectively the 'external consultees') shall be informed in writing at least one week in advance of commencement of fieldwork by the Project Archaeologist.

12.1.3 Periodic updates on the progress of the Crossrail archaeology programme shall be submitted to the external consultees by the Project Archaeologist. The Archaeological Contractor shall provide information to the Project Archaeologist as requested to inform this reporting.

12.1.4 The Project Archaeologist shall arrange and convene monitoring site visits by the external consultees, as appropriate. There shall be no unauthorised access to the works in any other circumstances. Any visits to the works shall be in accordance with the Main Contractor's health and safety, site access and security requirements.

12.1.5 The Archaeological Contractor may propose that archaeological excavation be carried out as an extension to evaluation works, if the scope of such work is readily incorporated into the SS-WSI. The detailed method for this work shall be agreed between the Archaeological Contractor and the Project Archaeologist at a site meeting and subsequently in writing between the Project Archaeologist and the relevant external consultees.

13 Personnel requirements

13.1.1 The Archaeological Contractor shall provide project personnel of experience as described below. The personnel shall be approved by the Project Archaeologist. Approval may be withdrawn by the Employer at their discretion and in accordance with the contract conditions.

13.1.2 The Archaeological Contractor shall submit CVs of all proposed personnel including any specialists, but excluding site technician grades, to the Project Archaeologist for approval if this has not already been done as part of the pre-qualification process.

13.1.3 The works shall be managed, directed and staffed by appropriately qualified and experienced personnel. The Archaeological Contractor's Key Person shall possess at least ten years relevant experience.

13.1.4 The excavation, sampling and recording of the works shall be directed in the field by a Fieldwork Director who is a Member of the Institute of Field Archaeologists (MIFA) or Of equivalent experience. The Fieldwork Director shall be on site throughout the targeted watching brief.

13.1.5 The Archaeological Contractor's project team shall include [where required] an environmental archaeologist suitably qualified in archaeological science and geo-archaeological sediment description methods, and on site sample processing and assessment techniques.

13.1.6 The Archaeological Contractor's project team shall be staffed by technician grades with minimum six months experience in appropriate aspects of excavation and recording.

13.1.7 Specialist staff employed on any aspect of the works, including post-excavation assessment or analysis of any kind including the writing of reports, shall be suitably qualified and shall be supervised by personnel with a minimum of ten years of relevant experience in their field (this may be inclusive of post-graduate studies).

13.1.8 Specialist staff shall be available, normally at 24 hours notice, for the duration of the works to provide advice on any specialist tasks to be undertaken.

14 References and glossary of terms

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15 Figures

Table 2 Buildings identified from historic maps (used in Fig 3**,** Fig 4**, &** Fig 5**)**

NB not all of these buildings appear on the figures in the WSI, for the remainder see the DDBA

No.	Description	Map
1	Mr Pritton's House. Elongated building with gabled roof.	1701
2	Irregular feature marked 'mortar for experiment'	1701
3	'Packmans house' (*c* 1660–1740) (just beyond north-western site boundary)	1701 1717
4	"New Barracks and "Old Barracks" shown in the western side of the site.	1749 1777 1845
5	Linear building and small garden plots (immediately west of site, probably outside site boundary)	1749 1777
6	L-shaped building of unknown function	1777 1845?
7	Cadet barracks (south of site, possibly outside)	1777 1845?
8	Verbruggen's House (built 1772–3). Grade II listed. Buildings 13 in MoD plans and OA reports. This building is extant and is located outside the western boundary of the site.	1777 to 1980
9	Wagon sheds	1777 1845
10	Carriage works. 'Waggon' sheds, etc. 'Gunnery Terrace'. Not listed. Building 7 in MoD plans and OA reports.	1810 1845 1867 1930s 1952
11	Three elongated buildings, probably sheds and/or barracks, and a smaller building of unknown function, probably related to the adjacent barracks, in the eastern part of the site. (Some of these are possibly the same as or a development of No. 6.)	1845 1867 1930s
12	Group of small buildings labelled 'Works Department Offices' at the west end of the Police Quarters (No. 13)	1867 1930s 1952
13	Police Quarters	1867 1930s 1952
14	Large Timber shed (development of No. 9?)	1867 1930s
15	Pattern Room and Stores	1867 1930s 1952
16	Officers' Quarters (development of No. 4?)	1845 1867 1930s

17	Row of small buildings along Plumstead Road, along southern boundary of the site (development of No. 7?)	1930s 1952 1980
18	Small buildings (part of the Engineering Department) in the central area of the site.	1952

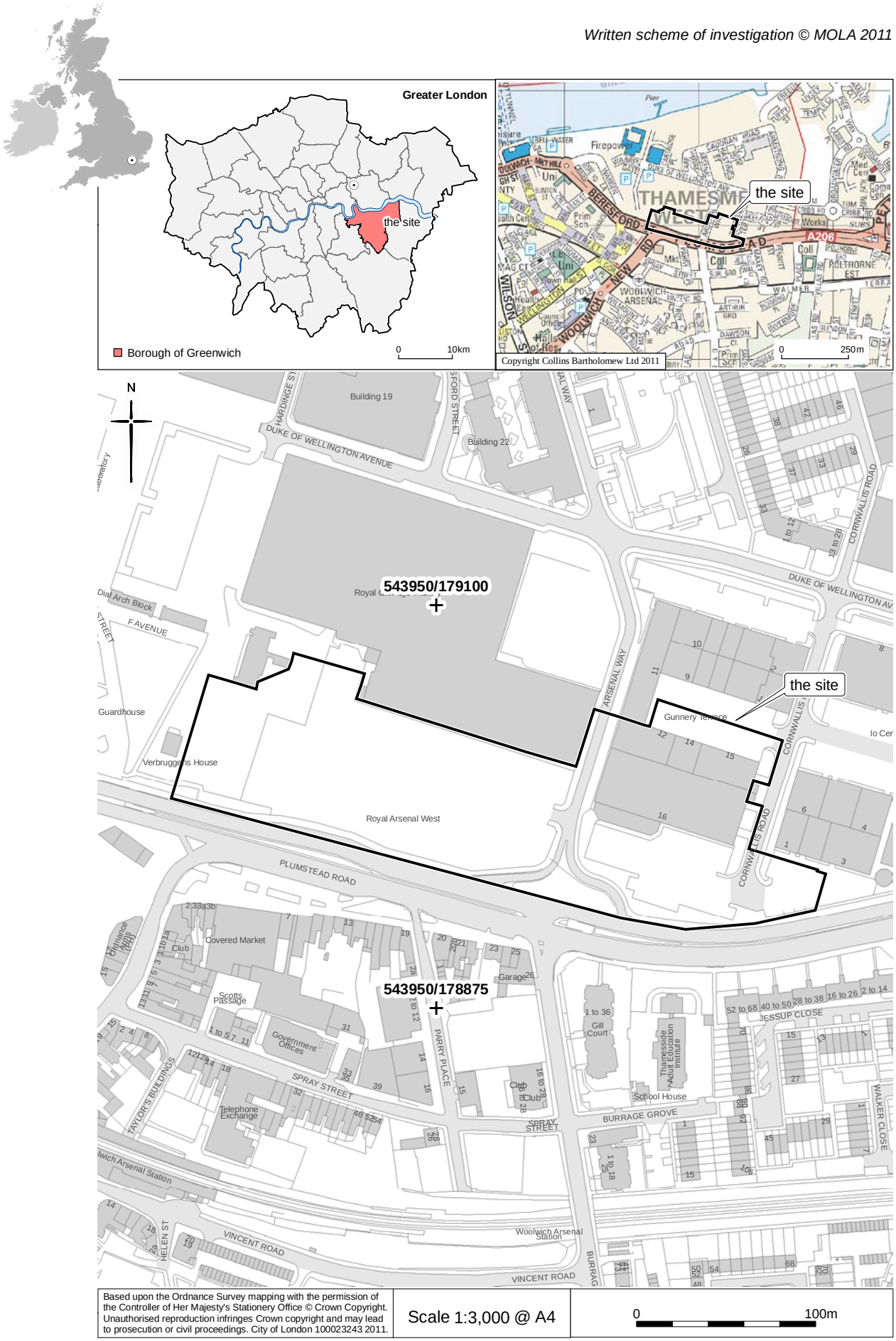


Fig 1 Site location

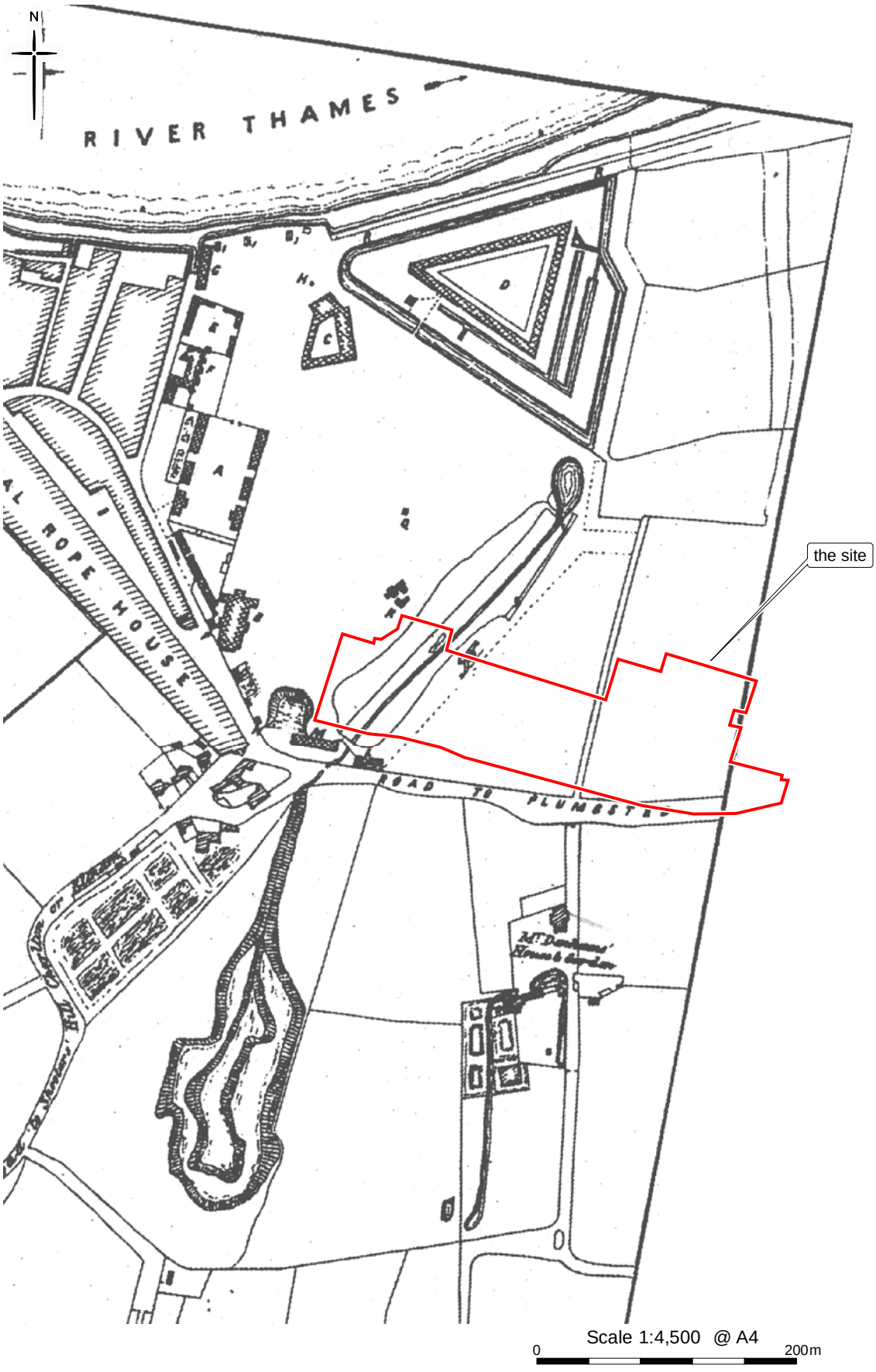


Fig 2 Woolwich Arsenal in 1717

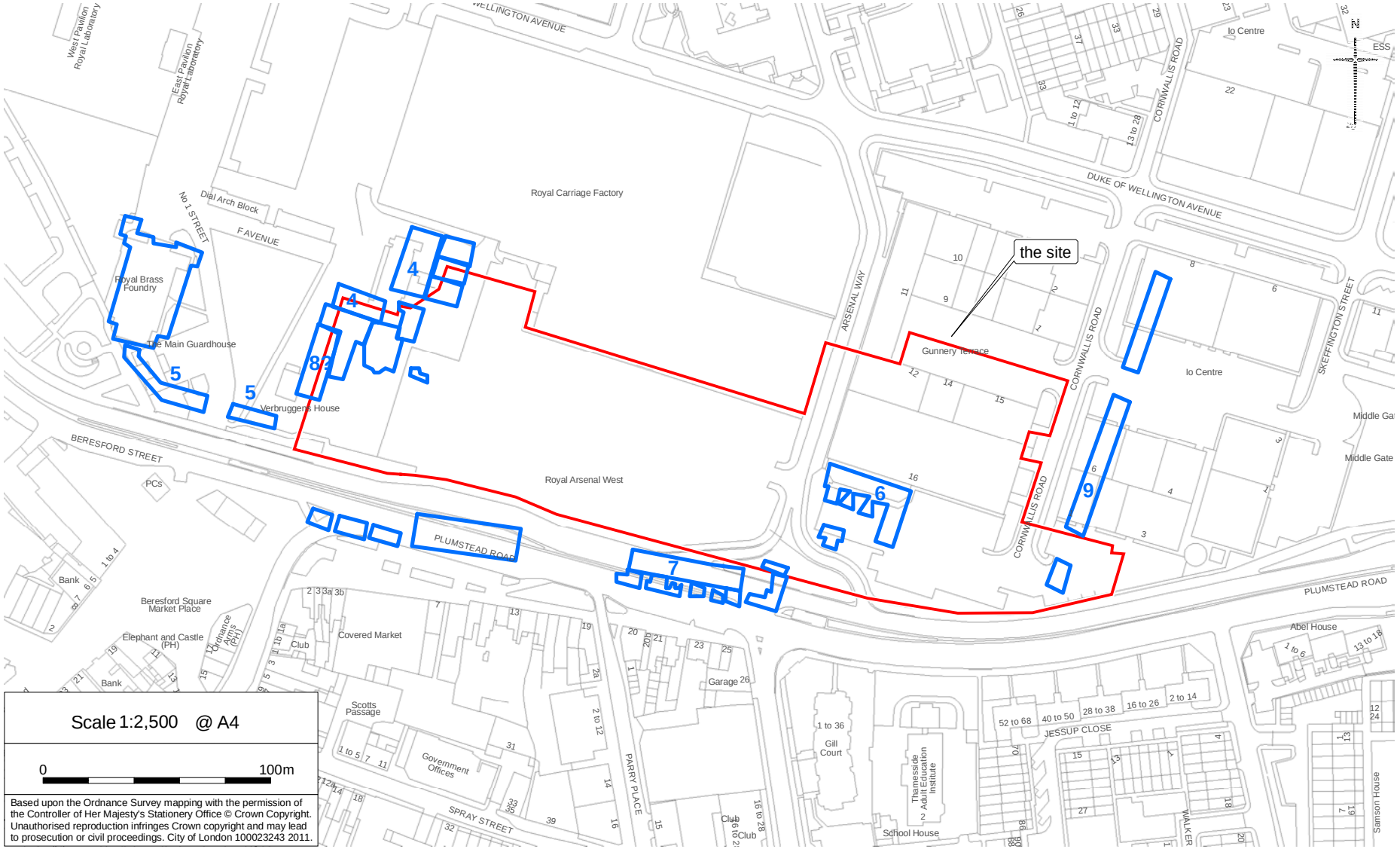


Fig 3 Schematic plan of the site with buildings shown on 1777 plan (see table 2)

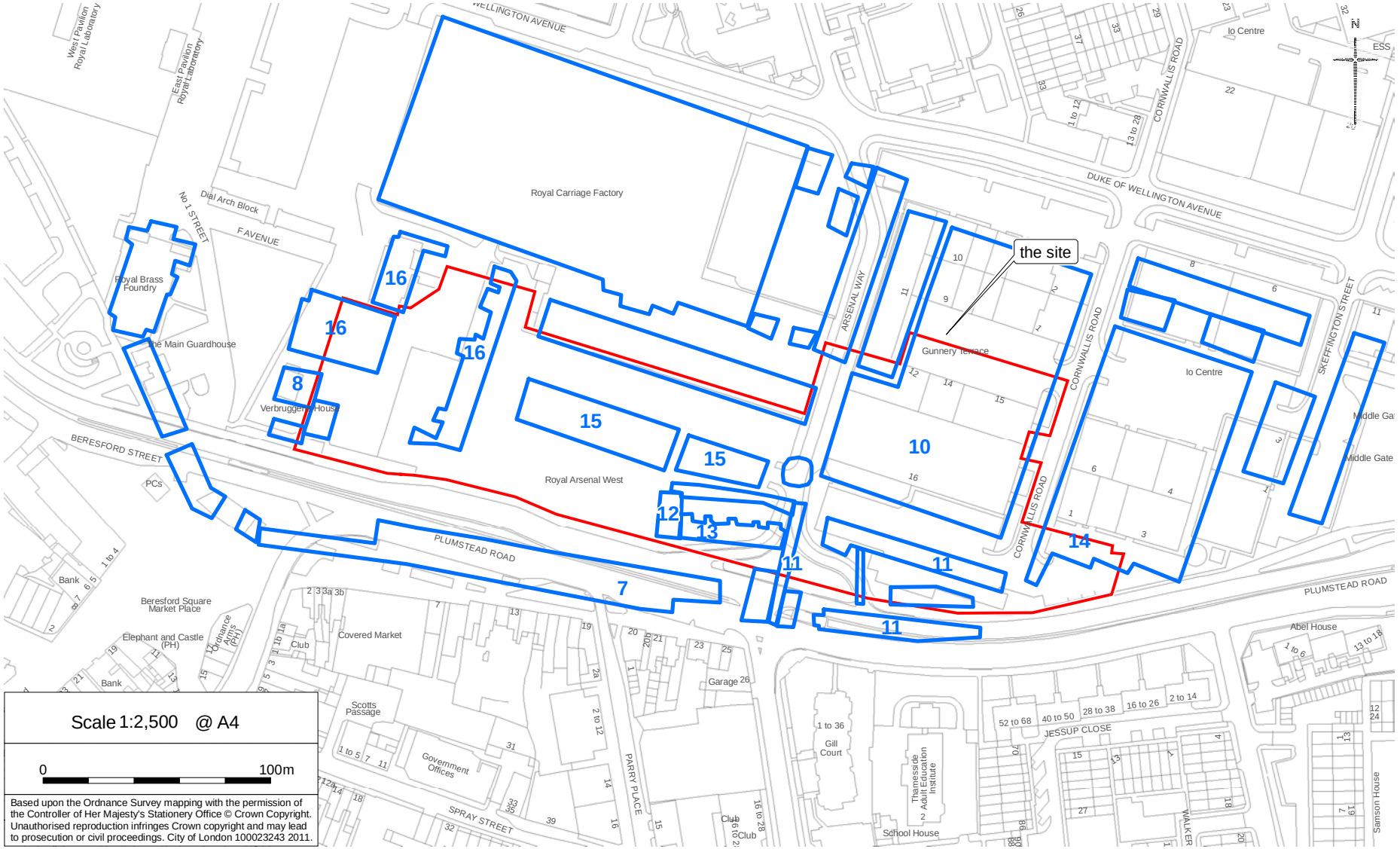


Fig 4 Schematic plan of the site with buildings shown on 1867 plan (see table 2)

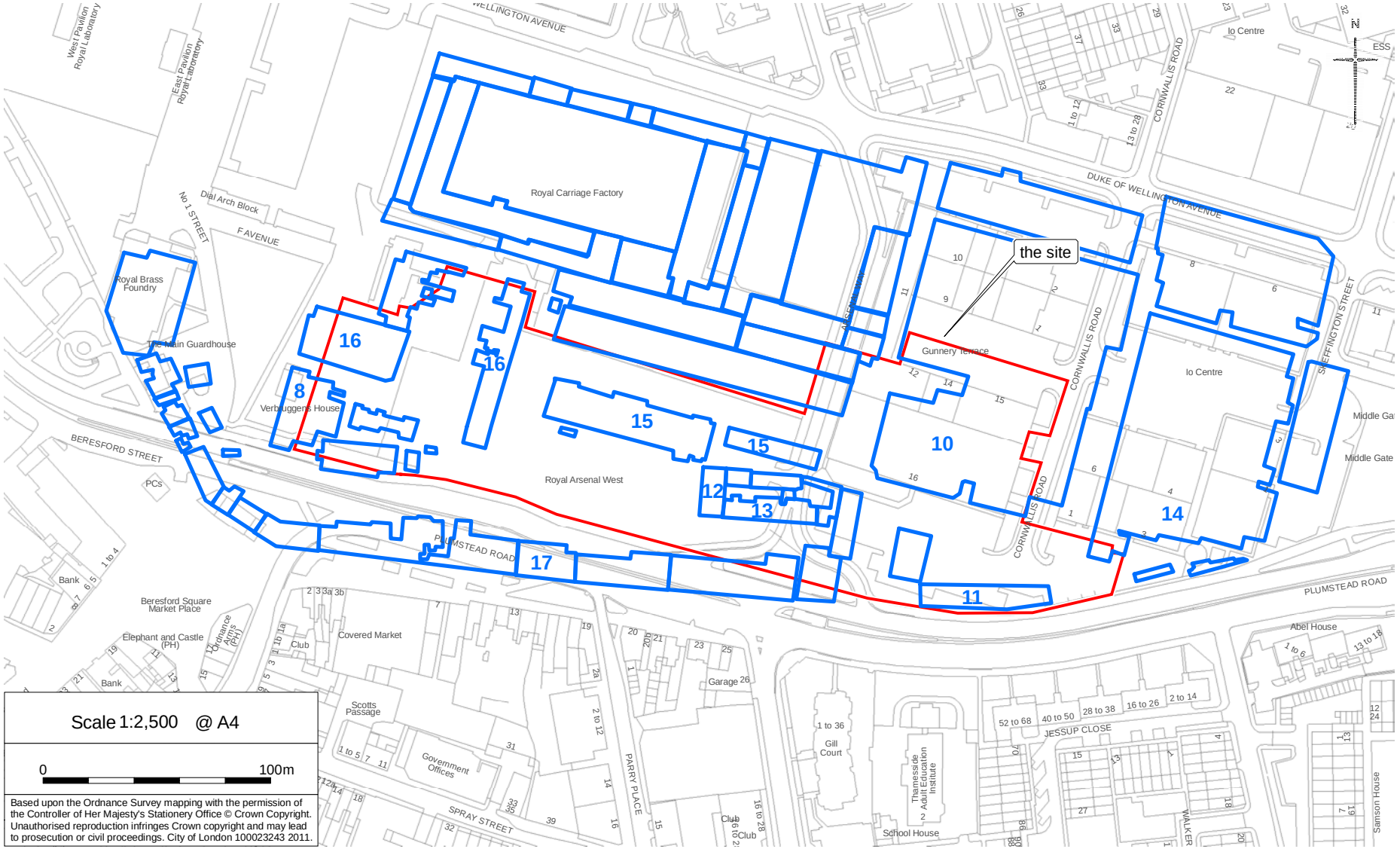


Fig 5 Schematic plan of the site with buildings shown on 1930s plan (see table 2)

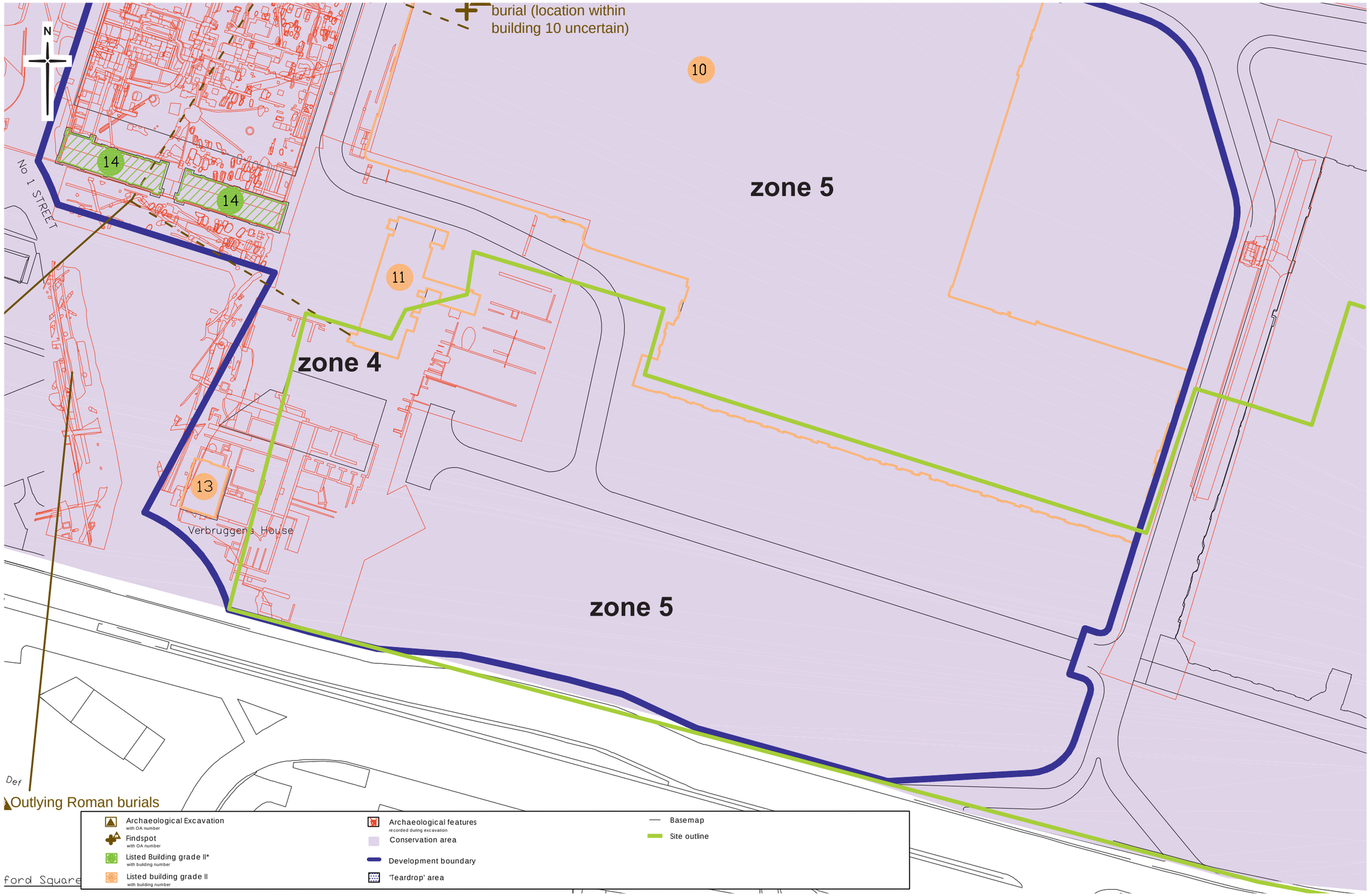


Fig 6 Location of OA investigations (OA 2004, fig 4) (site outline marked in green)

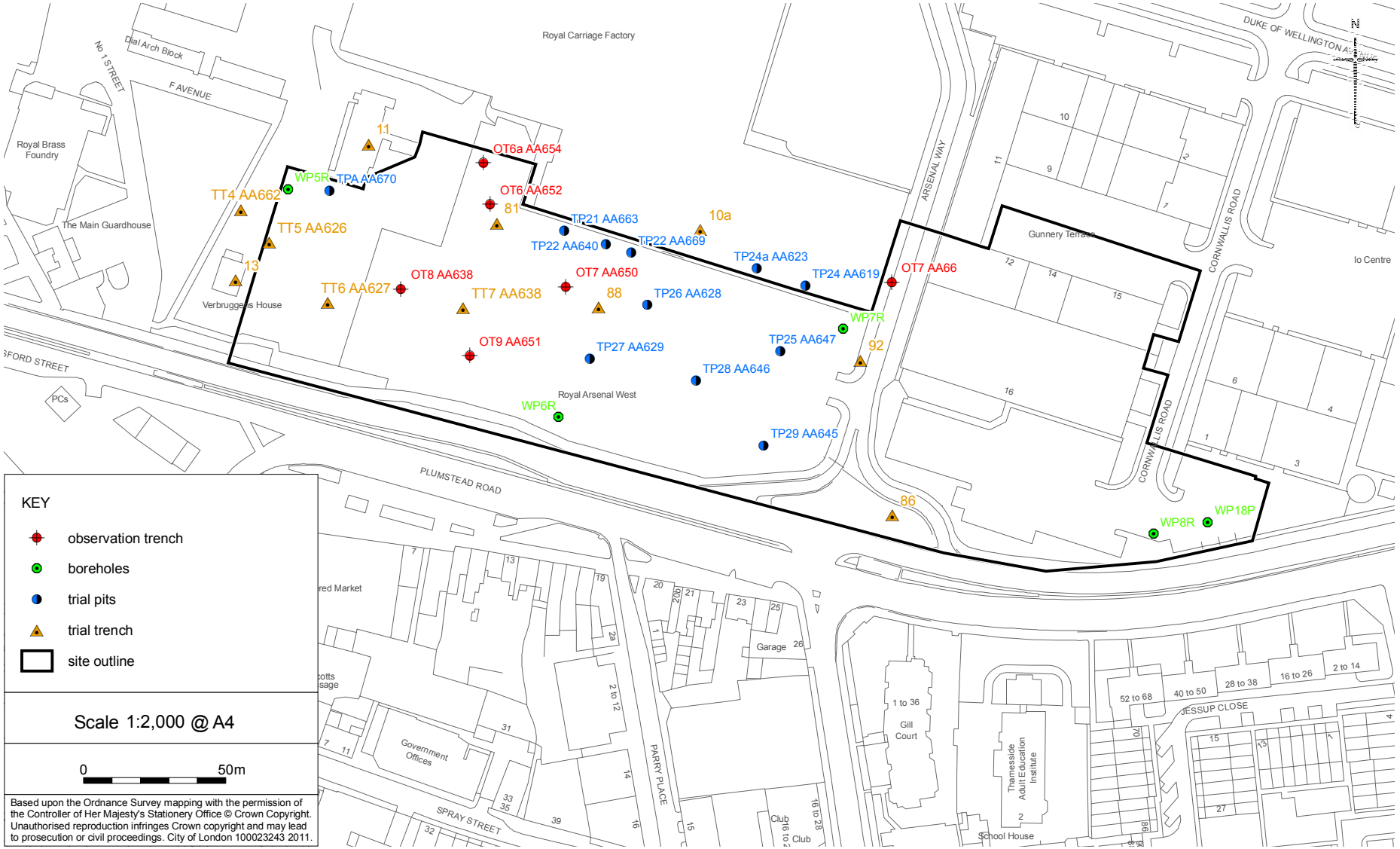
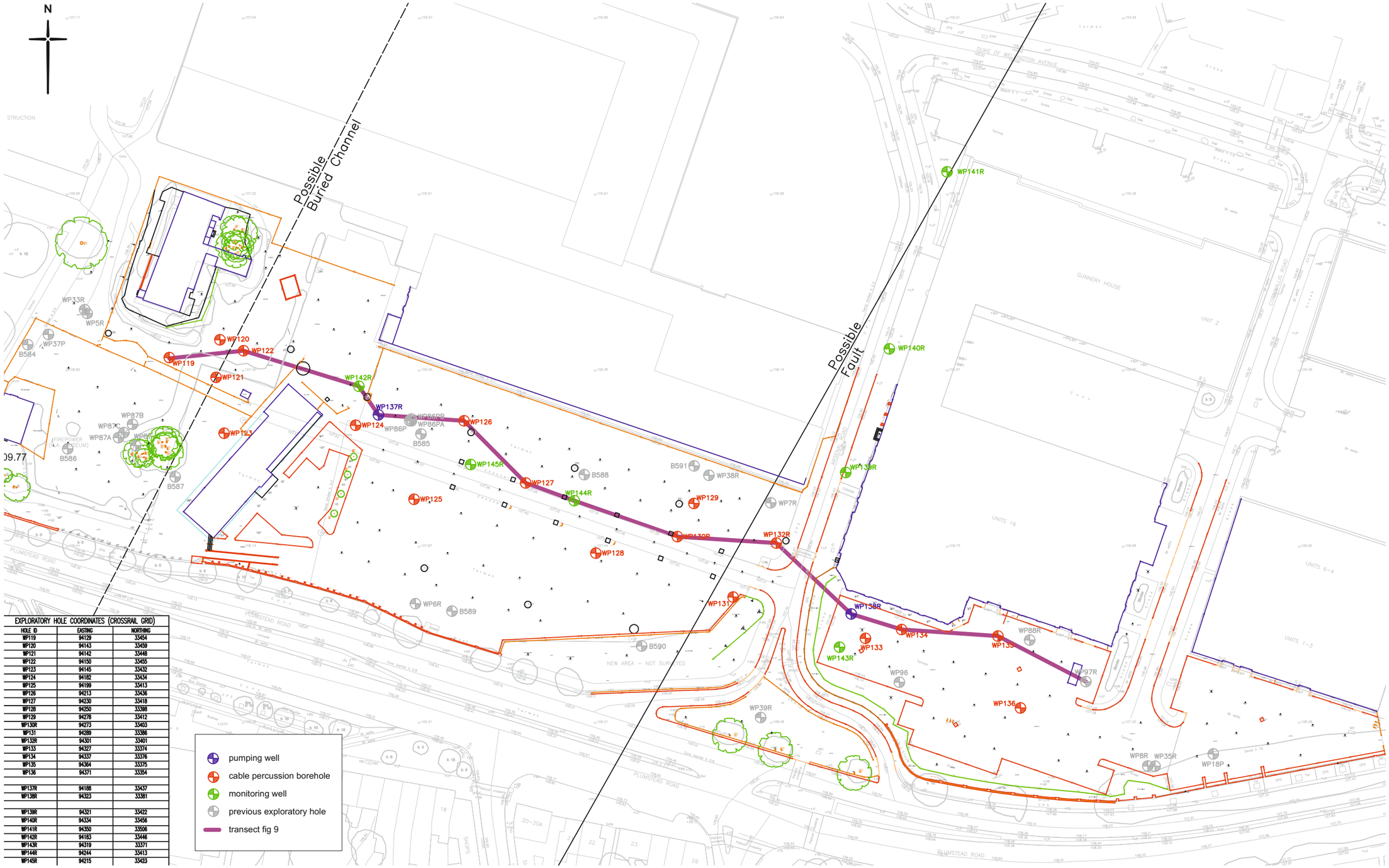


Fig 7 Location of boreholes monitored by MoLAS in 2006 and evaluation trenches investigated by OA in 2004–5



EXPLORATORY HOLE COORDINATES (CROSSRAIL GRID)

HOLE ID	EASTING	NORTHING
WP119	94129	33454
WP120	94143	33459
WP121	94142	33448
WP122	94150	33455
WP123	94145	33432
WP124	94182	33434
WP125	94199	33413
WP126	94213	33436
WP127	94230	33418
WP128	94250	33398
WP129	94278	33412
WP130R	94273	33403
WP131	94289	33386
WP132R	94301	33401
WP133	94327	33374
WP134	94337	33376
WP135	94364	33375
WP136	94371	33354
WP137R	94188	33437
WP138R	94323	33381
WP139R	94321	33422
WP140R	94334	33456
WP141R	94350	33506
WP142R	94183	33446
WP143R	94319	33371
WP144R	94244	33413
WP145R	94215	33423

Fig 8 Location of GI Package 37 borehole, and transect (see fig 9), monitored by MOLA in 2011 (Capita Symonds)

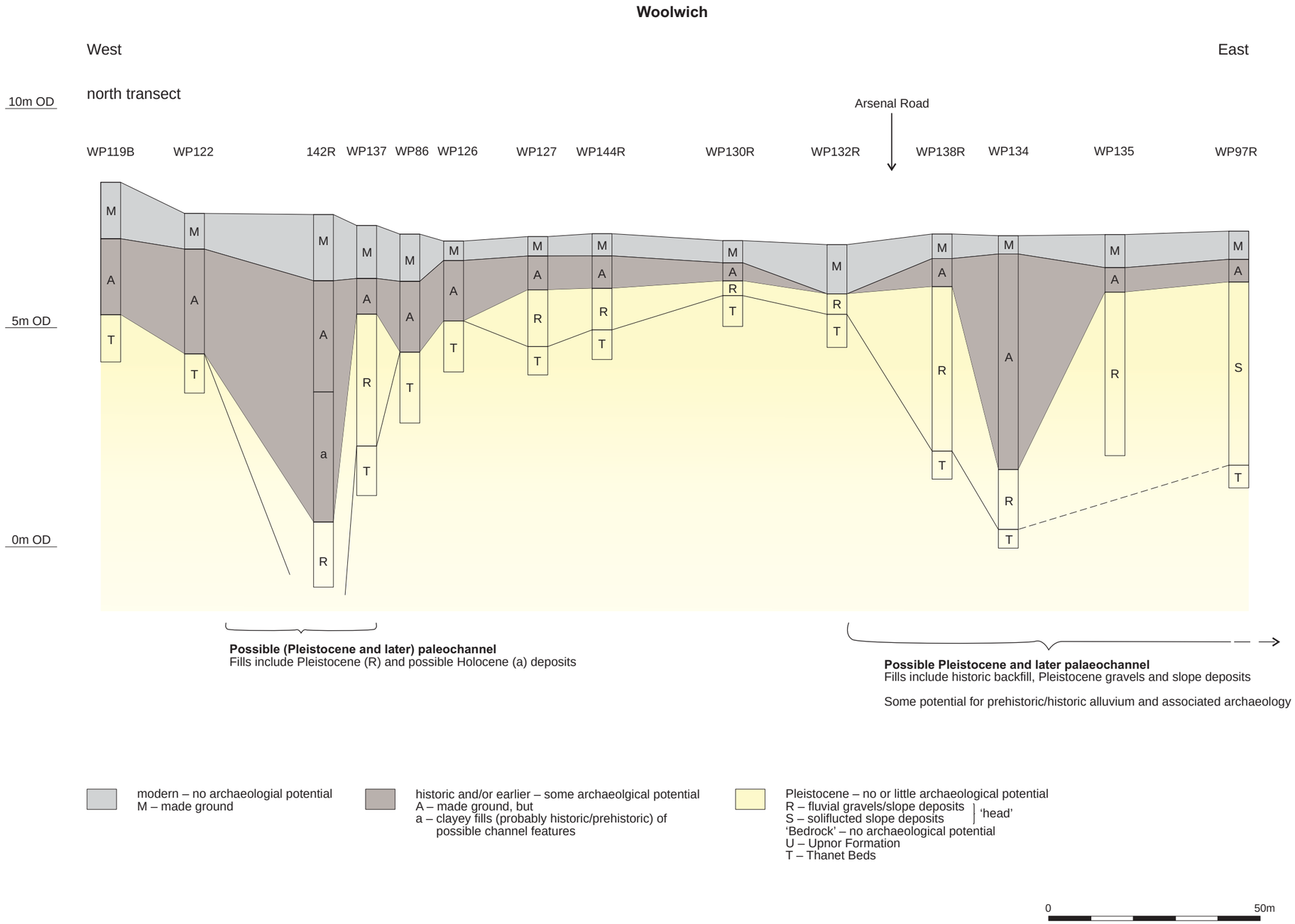
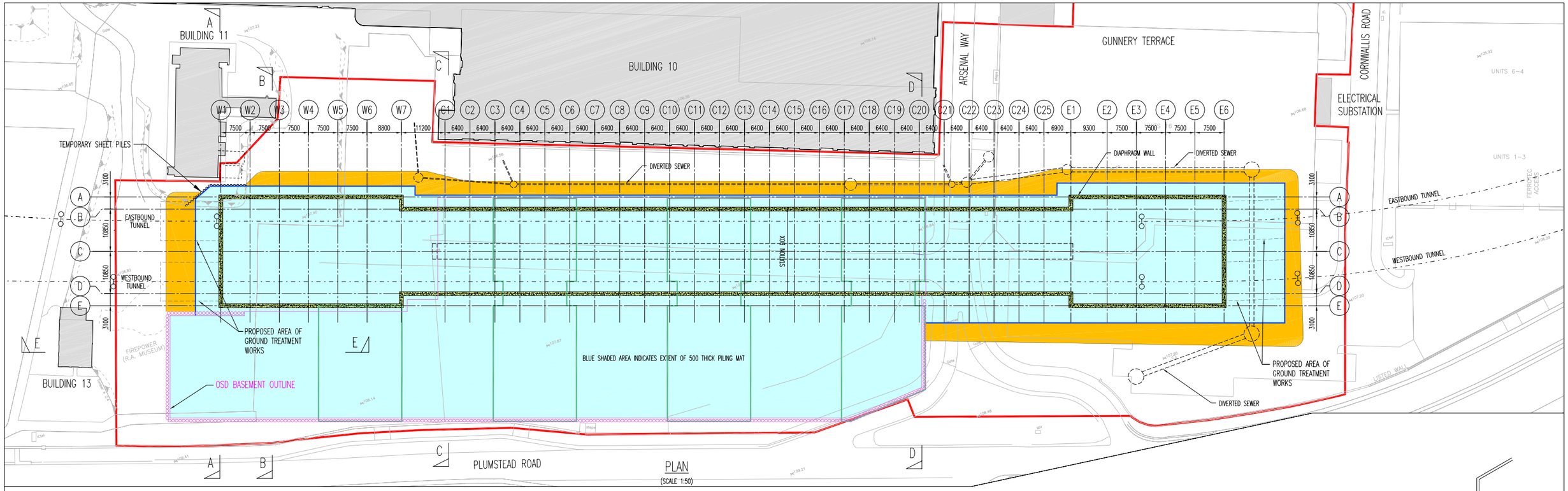


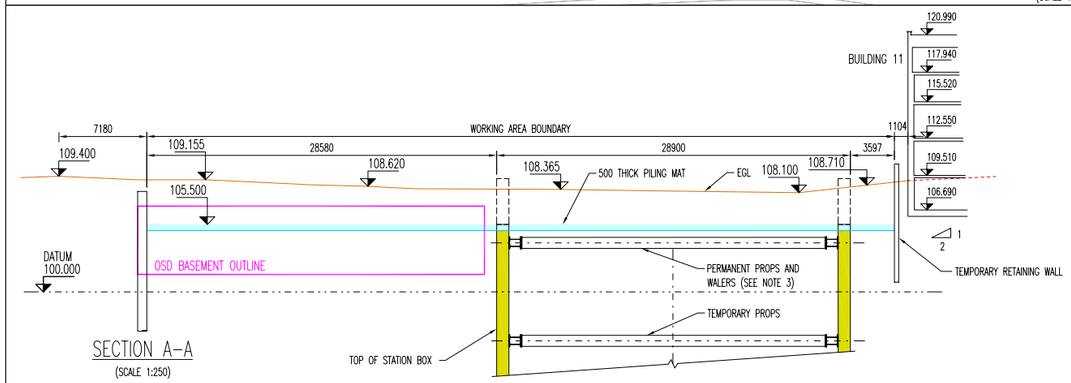
Fig 9 Borehole transect based on Package 37 and earlier results, for location see Fig 8

16 Annex 1: Development Plans

From the GRIP4/Outline Design Report (vol 2): Waterman 2011c, May 2011

- Site Plan and Sections, dwg no. BH0201-E2M40-R00-D-01001 Rev B02
- Construction sequence Central Box West End, dwg no. BH0201-E2M40-R00-D-01121 Rev B02
- Construction sequence Central Box below OSD, dwg no. BH0201-E2M40-R00-D-01122 Rev B02
- Construction sequence East End Box, dwg no. BH0201-E2M40-R00-D-01123 Rev B02
- Construction sequence West End Box, dwg no. BH0201-E2M40-R00-D-01124 Rev B02
- Existing Drainage and Proposed New Sewer, dwg no. BH0201-E2M40-U00-D-00101 Rev C01
- Existing Gas Services and Proposed Diversion, dwg no. BH0201-E2M40-U00-D-00301 Rev A05
- Existing Electrical Services and Proposed Diversions, dwg no. BH0201-E2M40-U00-D-00302 Rev A05
- Existing Water Supply and Proposed Diversion, dwg no. BH0201-E2M40-U00-D-00303 Rev A05
- Combined Proposed Service Diversion Layout, dwg no. BH0201-E2M40-U00-D-00304 Rev A04





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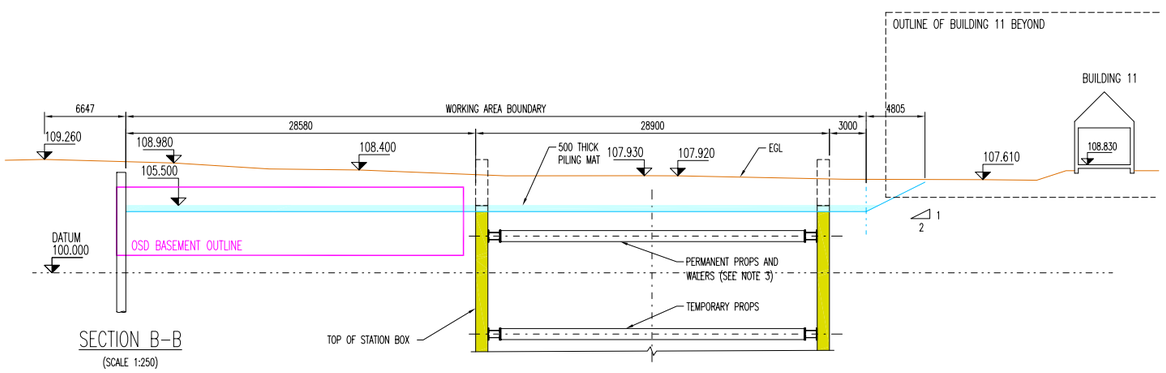

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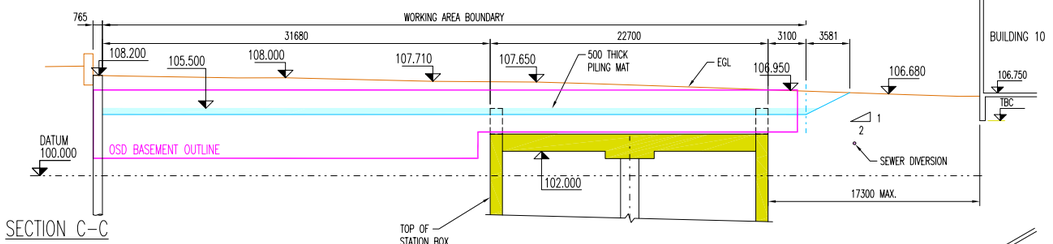

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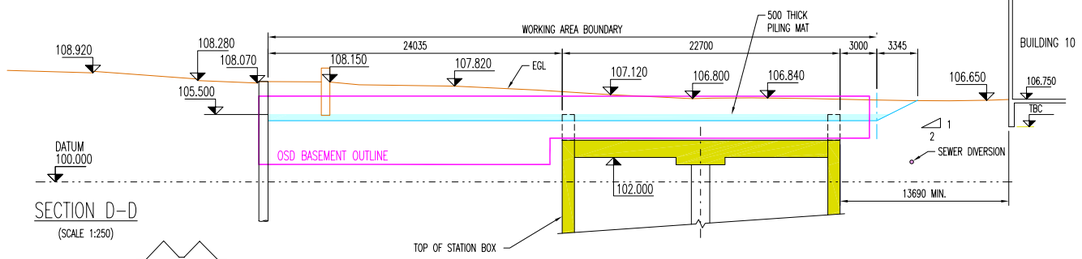
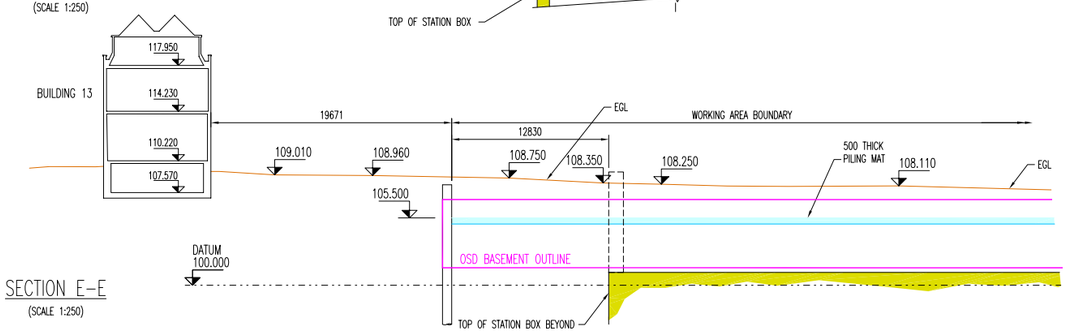


SECTION D–D
(SCALE 1:250)



SECTION E–E
(SCALE 1:250)

REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
B02	20/05/11	UPDATED FOR GRIP 4 REPORT					
B01	11/05/11	STATION BOX AND OSD DETAILS REVISED. KEY ADDED. LEVELS ADDED. DRAFT ISSUE FOR COMMENT	SPO	ASR	PJK		
A03	26/02/10	REVISED IN ACCORDANCE WITH CRL REVISED ALIGNMENT "OPTION 5"	SPO	ASR	PJK		
A02	11/12/09	DRAWING RENUMBERED FROM 11331-C-SA-04-0003. BATTER LINE UPDATED IN PLAN AND SECTIONS	SPO	ASR	PJK		
A01	05/10/09	PRELIMINARY ISSUE FOR COMMENTS	SPO	ASR	PJK		

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ALL LEVELS ARE IN METRES AND RELATE TO SITE DATUM
3. PERMANENT PROPS AND WALERS AT BOX EAST AND WEST END FORM PART OF THE STRUCTURE AT HANDOVER TO CRL. THEY CAN ONLY BE REMOVED ON COMPLETION OF RELEVANT INTERNAL FIT-OUT SLABS (BY OTHERS)

KEY:

- DIAPHRAGM WALL
- STATION BOX
- EXTENT OF PILING MAT
- EXCAVATION SLOPE
- EXISTING BUILDINGS
- OSD BOUNDARY
- SITE BOUNDARY

Construction/Maintenance & cleaning/Demolition & adaptation Risks

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of the above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

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Waterman
Transport & Development
Pickfords Wharf
Clink Street
London SE1 9DG
t 020 7928 7888
f 020 7928 3033
mail@waterman-group.co.uk
www.watermangroup.com

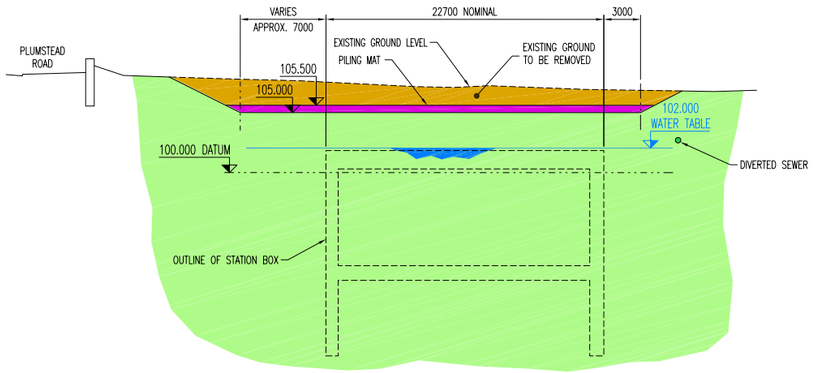
JOB No. / TITLE : C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT

DRAWING TITLE :
SITE PLAN AND SECTIONS SHOWING EXCAVATION LEVELS FOR DIAPHRAGM WALL CONSTRUCTION

SCALE @ A1: 1:250 1:500

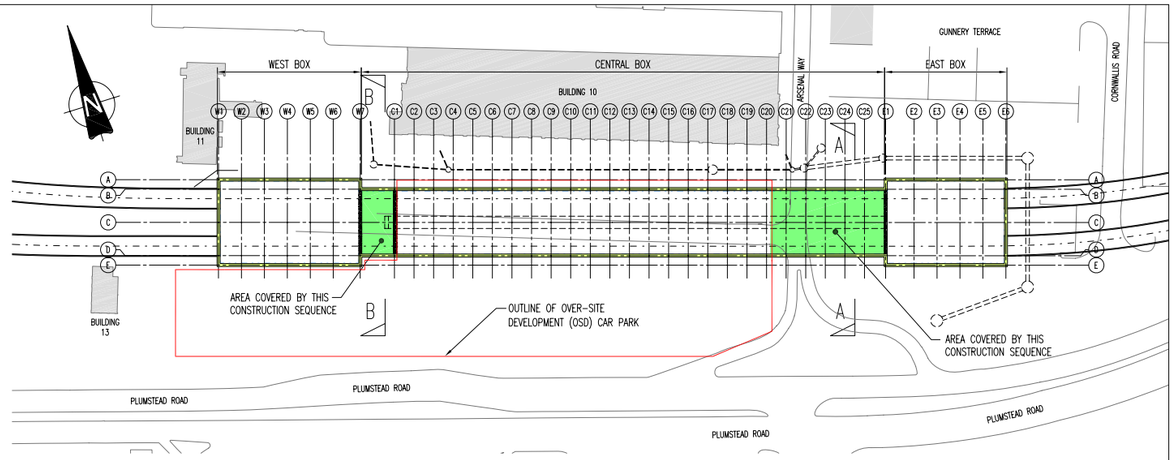
DRAWING AND CAD FILE No : BH0201-E2M40-R00-D-01001

REV : B02



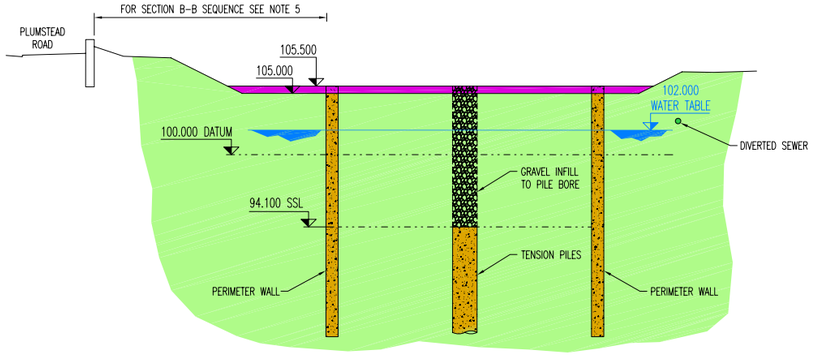
STAGE 1

- CLOSE ARSENAL WAY
- COMPLETE SERVICES DIVERSIONS
- EXCAVATE TO UNDERSIDE OF PILING MAT AND CONSTRUCT PILING MAT TO 105.500m



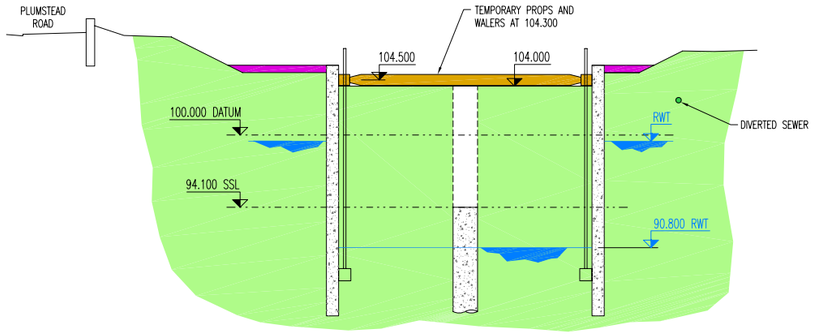
KEY PLAN

(SCALE 1:1000)



STAGE 2

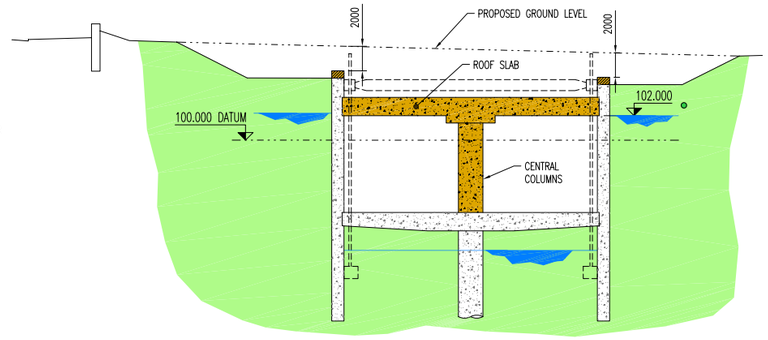
- CONSTRUCT STATION BOX PERIMETER WALLS
- CONSTRUCT TENSION PILES TO APPROX. 94.100



STAGE 4

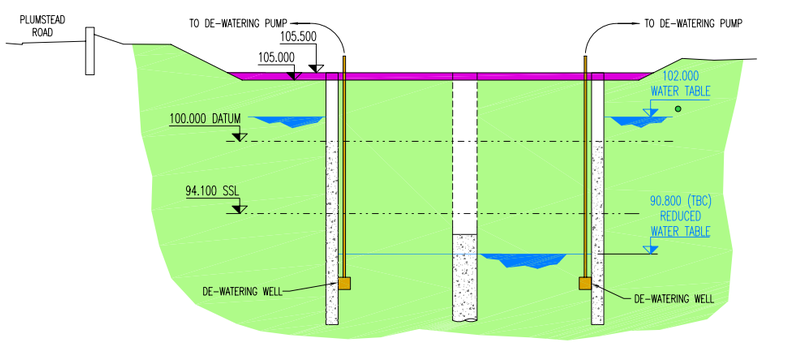
(STAGES 3 AND 4 ARE INTERCHANGEABLE)

- EXCAVATE TO APPROX. 104.000
- INSTALL TEMPORARY PROPS AND WALERS AT 104.500



STAGE 6

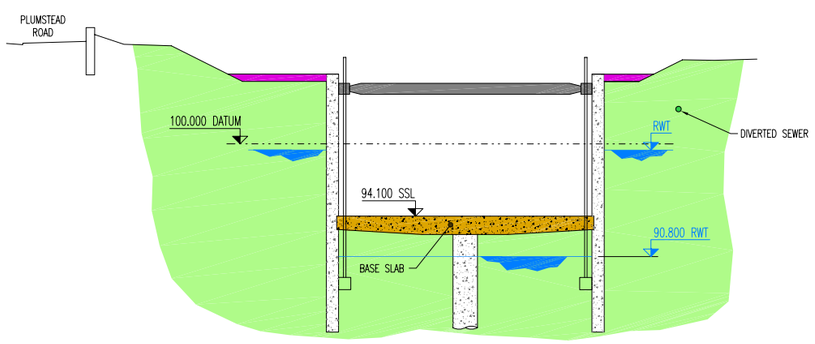
- CONSTRUCT CENTRAL COLUMNS
- CONSTRUCT ROOF SLAB
- REMOVE TEMPORARY PROPS AND WALERS
- BREAK DOWN PERIMETER WALLS AND CONSTRUCT CAPPING BEAM TO APPROX. 2m BELOW PROPOSED GROUND LEVEL



STAGE 3

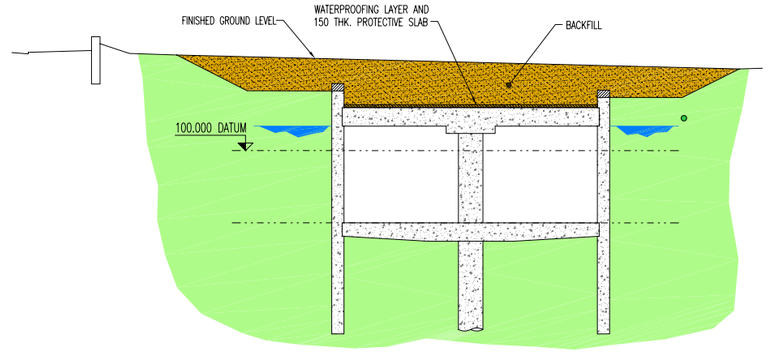
(STAGES 3 AND 4 ARE INTERCHANGEABLE)

- INSTALL DE-WATERING WELLS AND DE-WATER TO BELOW UNDERSIDE OF BASE SLAB LEVEL (SEE NOTE 3)



STAGE 5

- EXCAVATE TO UNDERSIDE BASE SLAB
- CONSTRUCT BASE SLAB
- TERMINATE DE-WATERING ON COMPLETION OF BASE SLAB (SEE NOTE 3)



STAGE 7

- INSTALL ROOF WATERPROOFING AND PROTECTIVE SLAB
- BACKFILL ABOVE STATION BOX TO FINISHED GROUND LEVEL

SECTION A-A SHOWING CONSTRUCTION STAGES
(SECTION B-B SIMILAR - BUT SEE NOTE 5)

(SCALE 1:250)

REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
B02	??/??/??	OSD OUTLINE AND DRAWING TITLE REVISED. GRIP 4 ISSUE	SPO	PJK	PJK		
B01	15/04/11	ISSUED FOR CDS. LEVELS REVISED TO REFLECT RAISED TRACK LEVEL	SPO	PJK	PJK		
A03	26/02/10	REVISED IN ACCORDANCE WITH CRL REVISED ALIGNMENT "OPTION 5". TEMPORARY PROPS REVISED TO SUIT	SPO	ASR	PJK		
A02	04/12/09	DRAWING RENUMBERED FROM C-11331-SA-20-1053. BASE SLAB PROFILE REVISED	SPO	ASR	PJK		
A01	18/11/09	FIRST ISSUE FOR COMMENTS	SPO	ASR	PJK		

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ALL LEVELS ARE IN METRES ABOVE TUNNEL DATUM (mATD)
3. STAGING OF DE-WATERING SCHEME TO SUIT ENTIRE STATION BOX REQUIREMENTS. LOCATION OF DEWATERING WELLS (INSIDE OR OUTSIDE BOX) TBC
4. CUT SLOPES IN MADE GROUND ASSUMED TO BE 1:2
5. FOR SECTION B-B CONSTRUCTION SEQUENCE FOR OSD APPLIES, REFER TO SECTION A-A ON DRAWING No. BH0201-E2M40-R00-D-01122

- Unidentified buried structure and ordnance
- Contaminated ground / Glauconite
- Failure of dewatering system

Construction/Maintenance & cleaning/Demolition & adaptation Risks

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of the above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

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TEL : 020 3229 9100
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Clink Street
London SE1 9DG
t 020 7928 7888
f 020 7928 3033
mail@waterman-group.co.uk
www.watermangroup.com
Transport & Development

JOB No. / TITLE : C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT

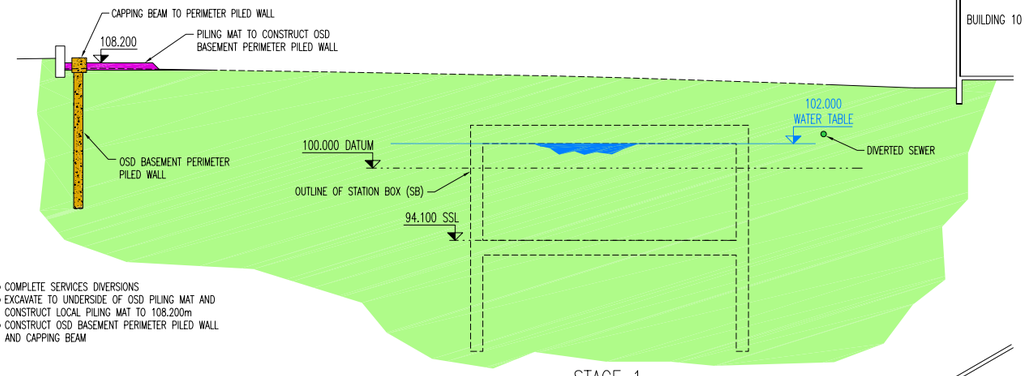
DRAWING TITLE :

CONSTRUCTION SEQUENCE
CENTRAL BOX EAST END

SCALE @ A1: 1:250 1:1000

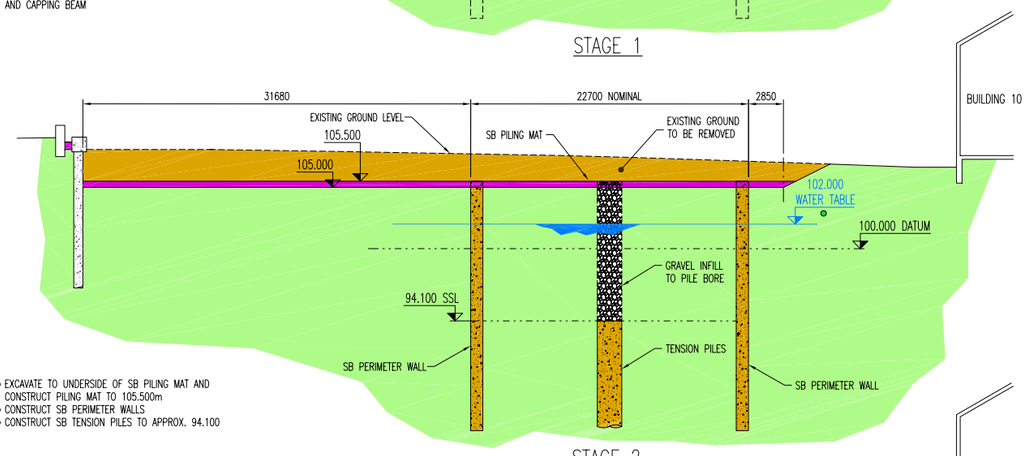
DRAWING AND CAD FILE No : BH0201-E2M40-R00-D-01121

REV : B02



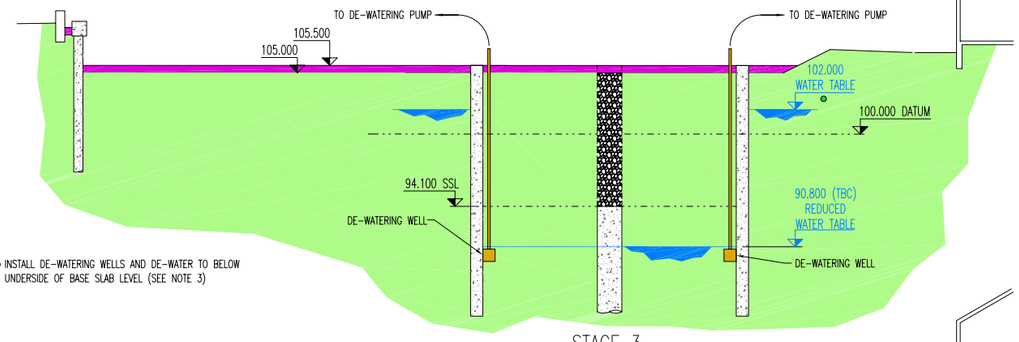
- COMPLETE SERVICES DIVERSIONS
- EXCAVATE TO UNDERSIDE OF OSD PILING MAT AND CONSTRUCT LOCAL PILING MAT TO 108.200m
- CONSTRUCT OSD BASEMENT PERIMETER PILED WALL AND CAPPING BEAM

STAGE 1



- EXCAVATE TO UNDERSIDE OF SB PILING MAT AND CONSTRUCT PILING MAT TO 105.500m
- CONSTRUCT SB PERIMETER WALLS
- CONSTRUCT SB TENSION PILES TO APPROX. 94.100

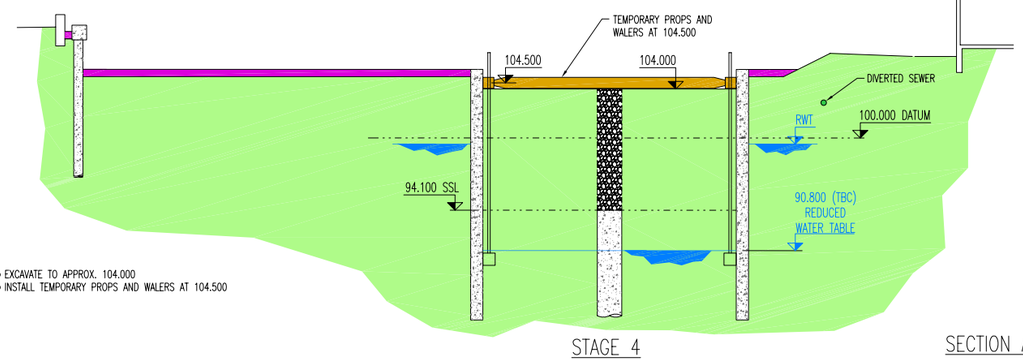
STAGE 2



- INSTALL DE-WATERING WELLS AND DE-WATER TO BELOW UNDERSIDE OF BASE SLAB LEVEL (SEE NOTE 3)

STAGE 3

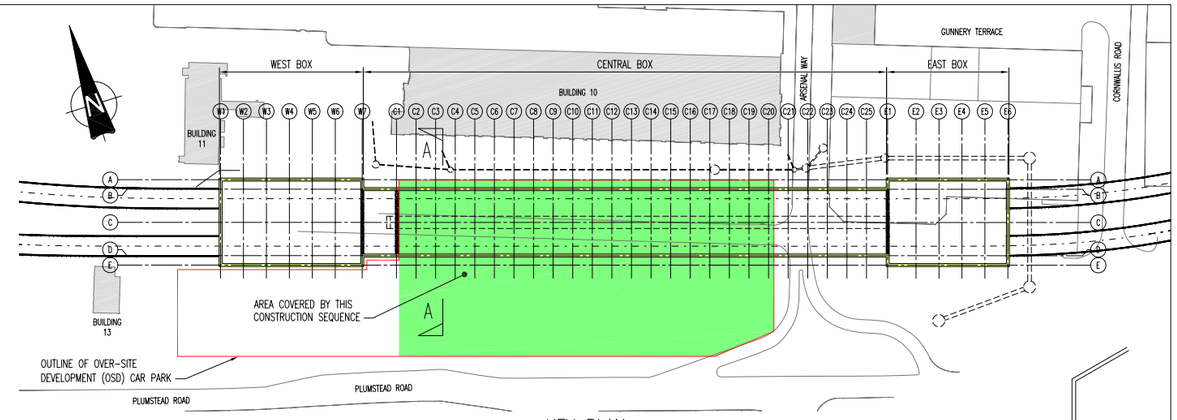
(STAGES 3 AND 4 ARE INTERCHANGEABLE)



- EXCAVATE TO APPROX. 104.000
- INSTALL TEMPORARY PROPS AND WALERS AT 104.500

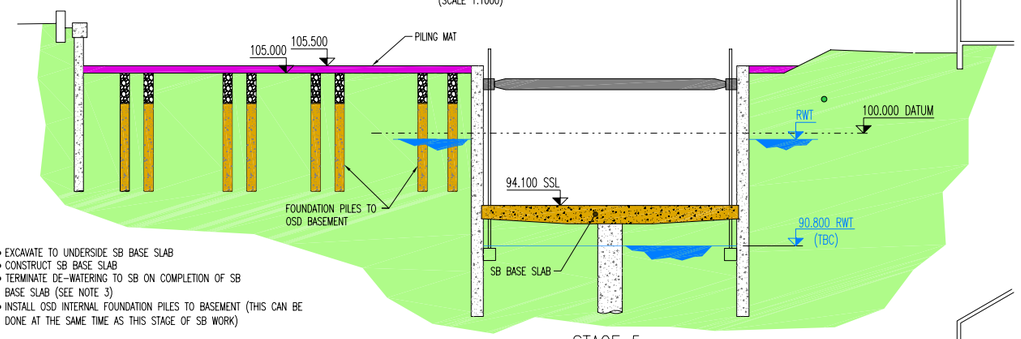
STAGE 4

(STAGES 3 AND 4 ARE INTERCHANGEABLE)



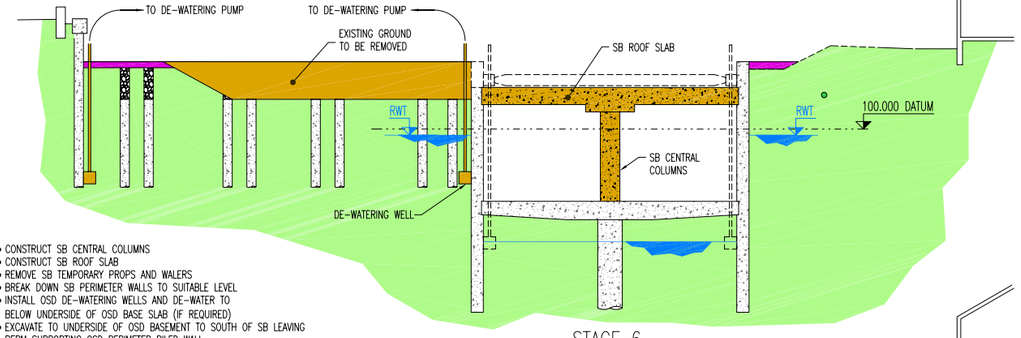
KEY PLAN

(SCALE 1:1000)



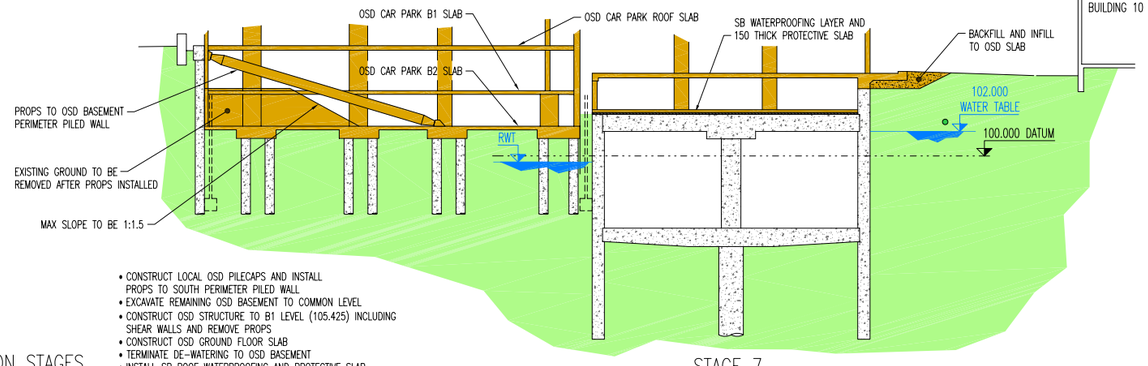
- EXCAVATE TO UNDERSIDE SB BASE SLAB
- CONSTRUCT SB BASE SLAB
- TERMINATE DE-WATERING TO SB ON COMPLETION OF SB BASE SLAB (SEE NOTE 3)
- INSTALL OSD INTERNAL FOUNDATION PILES TO BASEMENT (THIS CAN BE DONE AT THE SAME TIME AS THIS STAGE OF SB WORK)

STAGE 5



- CONSTRUCT SB CENTRAL COLUMNS
- CONSTRUCT SB ROOF SLAB
- REMOVE SB TEMPORARY PROPS AND WALERS
- BREAK DOWN SB PERIMETER WALLS TO SUITABLE LEVEL
- INSTALL OSD DE-WATERING WELLS AND DE-WATER TO BELOW UNDERSIDE OF OSD BASE SLAB (IF REQUIRED)
- EXCAVATE TO UNDERSIDE OF OSD BASEMENT TO SOUTH OF SB LEAVING BERM SUPPORTING OSD PERIMETER PILED WALL

STAGE 6



- CONSTRUCT LOCAL OSD PILECAPS AND INSTALL PROPS TO SOUTH PERIMETER PILED WALL
- EXCAVATE REMAINING OSD BASEMENT TO COMMON LEVEL
- CONSTRUCT OSD STRUCTURE TO B1 LEVEL (105.425) INCLUDING SHEAR WALLS AND REMOVE PROPS
- CONSTRUCT OSD GROUND FLOOR SLAB
- TERMINATE DE-WATERING TO OSD BASEMENT
- INSTALL SB ROOF WATERPROOFING AND PROTECTIVE SLAB
- INSTALL OSB GROUND FLOOR SLAB OVER SB

STAGE 7

SECTION A–A SHOWING CONSTRUCTION STAGES

(SCALE 1:200)

REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
B02	20/05/11	REVISED TO SHOW LATEST OSD BASEMENT ARRANGEMENT. GRIP 4 ISSUE	SPO	PJK	PJK		
B01	15/04/11	ISSUED FOR CDS. SLAB LEVELS REVISED TO REFLECT RAISED TRACK LEVEL	SPO	PJK	PJK		
A03	26/02/10	REVISED IN ACCORDANCE WITH CRL REVISED ALIGNMENT 'OPTION 5'. TEMPORARY PROPS REVISED TO SUIT	SPO	ASR	PJK		
A02	04/12/09	DRAWING RENUMBERED FROM C-11331-SA-20-1054. BASE SLAB PROFILE REVISED	SPO	ASR	PJK		
A01	18/11/09	FIRST ISSUE FOR COMMENTS	SPO	ASR	PJK		

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ALL LEVELS ARE IN METRES ABOVE TUNNEL DATUM (mATD)
3. STAGING OF DE-WATERING SCHEME TO SUIT ENTIRE STATION BOX REQUIREMENTS LOCATION OF DEWATERING WELLS (INSIDE OR OUTSIDE BOX) TBC
4. CUT SLOPES IN MADE GROUND ASSUMED TO BE 1:2

KEY:

SB: STATION BOX
OSD: OVER-SITE DEVELOPMENT
OSB: OVER STATION BOX DEVELOPMENT

- Unidentified buried structure and ordnance
- Contaminated ground / Glauconite
- Failure of dewatering system

Construction/Maintenance & cleaning/Demolition & adaptation Risks

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of the above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

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www.watermangroup.com

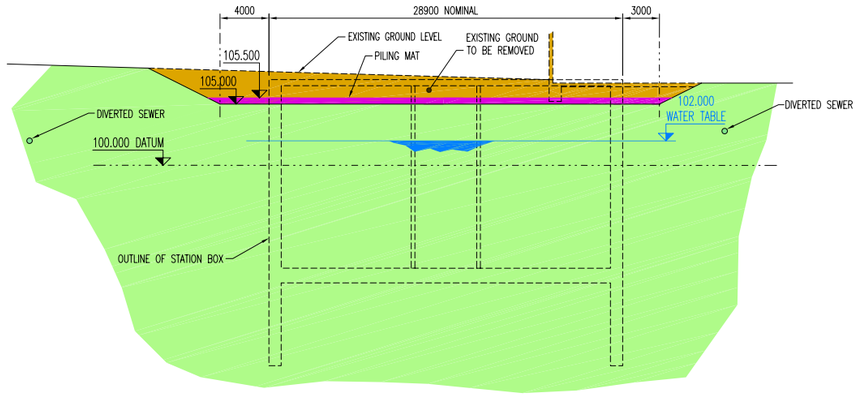
JOB No. / TITLE : C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT

DRAWING TITLE : CONSTRUCTION SEQUENCE CENTRAL BOX BELOW OSD

SCALE @ A1: 1:250 1:1000

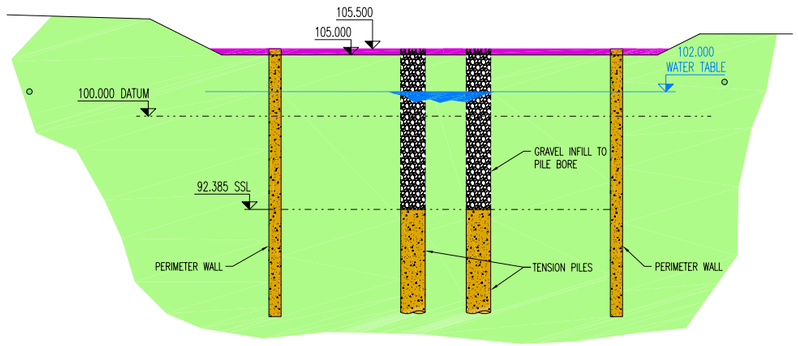
DRAWING AND CAD FILE No : BH0201-E2M40-R00-D-01122

REV : B02



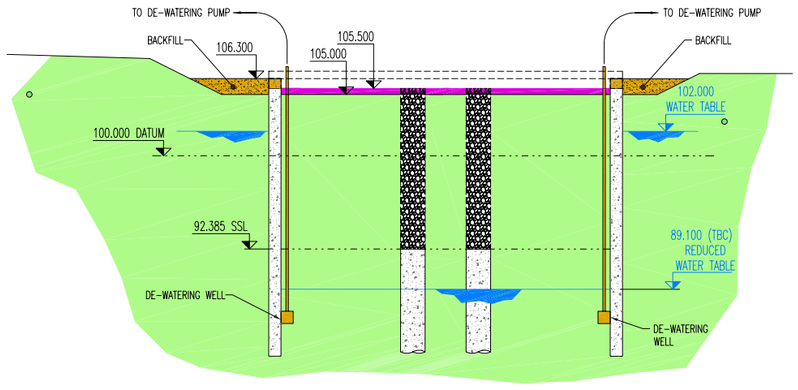
STAGE 1

- COMPLETE SERVICES DIVERSIONS
- EXCAVATE TO UNDERSIDE OF PILING MAT AND CONSTRUCT PILING MAT TO 105.500m



STAGE 2

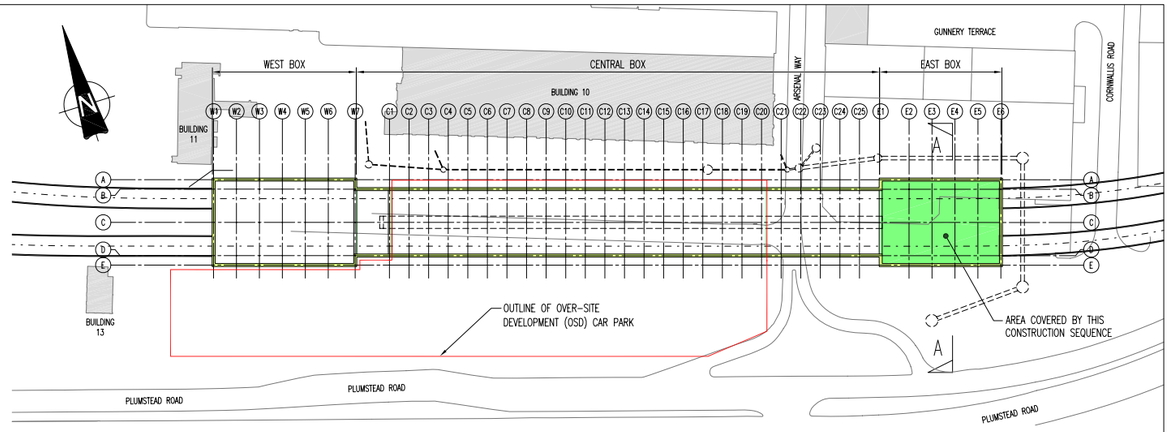
- CONSTRUCT STATION BOX PERIMETER WALLS
- CONSTRUCT TENSION PILES TO APPROX. 92.385



STAGE 3

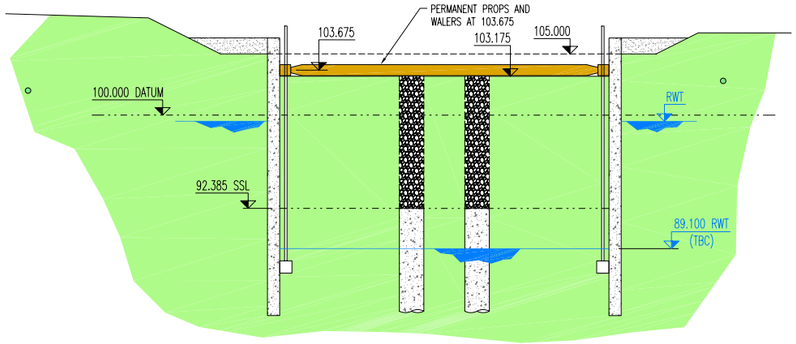
(STAGES 3 AND 4 ARE INTERCHANGEABLE)

- INSTALL DE-WATERING WELLS AND DE-WATER TO BELOW UNDERSIDE OF BASE SLAB LEVEL (SEE NOTE 3)
- EXTEND DIAPHRAGM WALL TO 106.300
- BACKFILL AROUND EAST END BOX TO 106.300



KEY PLAN

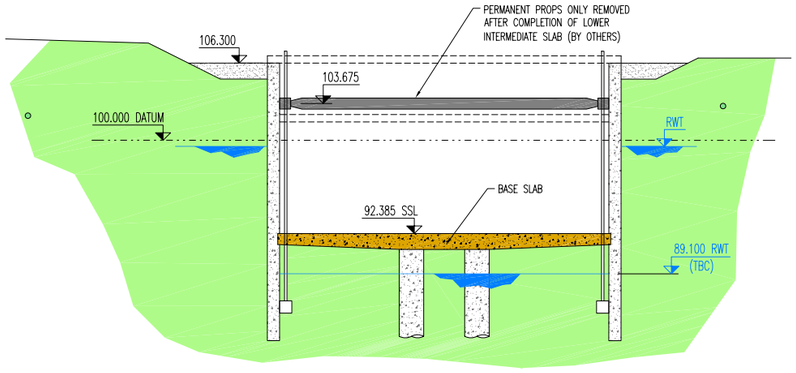
(SCALE 1:1000)



STAGE 4

(STAGES 3 AND 4 ARE INTERCHANGEABLE)

- EXCAVATE TO APPROX. 103.175
- INSTALL PERMANENT PROPS AND WALERS AT 103.675



STAGE 5

- EXCAVATE TO UNDERSIDE BASE SLAB
- CONSTRUCT BASE SLAB
- TERMINATE DE-WATERING ON COMPLETION OF BASE SLAB (SEE NOTE 3)

STAGE 6: TBM BREAKTHROUGH

NOTE: THIS STAGE OCCURS AFTER THE HANDOVER OF THE STATION BOX TO CRL, AND THEREFORE IS TO BE UNDERTAKEN BY OTHERS. IT IS ALSO ASSUMED THE LOWER LEVEL FIT-OUT SLAB HAS NOT BEEN INSTALLED

- PRIOR TO ARRIVAL OF THE FIRST TBM, INSTALL TEMPORARY TRUSS TO EAST WALL AT APPROX. 101.270
- 1ST TBM BREAKTHROUGH
- 2ND TBM BREAKTHROUGH
- REMOVE TEMPORARY TRUSS TO EAST WALL

SECTION A-A SHOWING CONSTRUCTION STAGES

(SCALE 1:200)

REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
B02	20/05/11	OSD OUTLINE AND DRAWING TITLE REVISED. GRIP 4 ISSUE	SPO	PJK	PJK		
B01	15/04/11	ISSUED FOR CDS. SLAB LEVELS REVISED TO REFLECT RAISED TRACK LEVEL	SPO	PJK	PJK		
A03	26/02/10	REVISED IN ACCORDANCE WITH CRL REVISED ALIGNMENT 'OPTION 5'. TEMPORARY PROPS REVISED TO SUIT	SPO	ASR	PJK		
A02	04/12/09	DRAWING RENUMBERED FROM C-11331-SA-20-1055. ROOF LEVEL REVISED, SLAB SEQUENCE REVISED	SPO	ASR	PJK		
A01	18/11/09	FIRST ISSUE FOR COMMENTS	SPO	ASR	PJK		

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ALL LEVELS ARE IN METRES ABOVE TUNNEL DATUM (mATD)
3. STAGING OF DE-WATERING SCHEME TO SUIT ENTIRE STATION BOX REQUIREMENTS LOCATION OF DEWATERING WELLS (INSIDE OR OUTSIDE BOX) TBC
4. CUT SLOPES IN MADE GROUND ASSUMED TO BE 1:2

- Unidentified buried structure and ordnance
- Contaminated ground / Glauconite
- Failure of dewatering system

Construction/Maintenance & cleaning/Demolition & adaptation Risks

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of the above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

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CANARY WHARF
LONDON E14 5LQ
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London SE1 9DG
t 020 7928 7888
f 020 7928 3053
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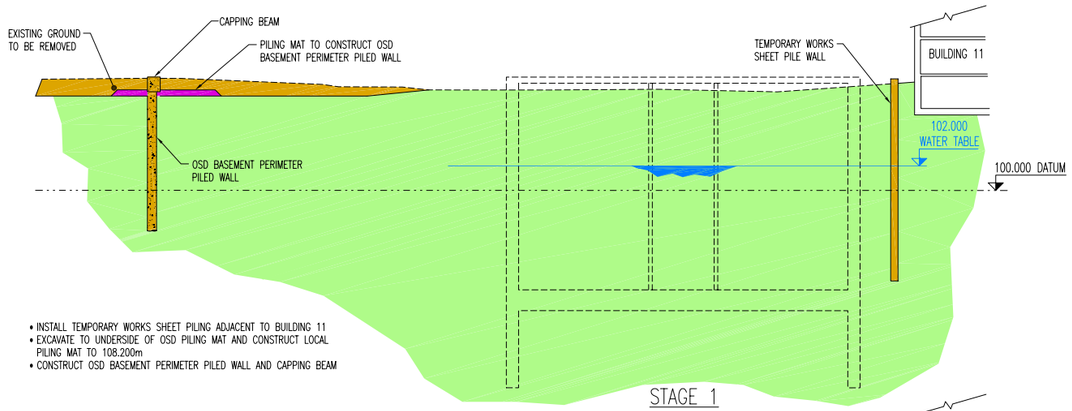
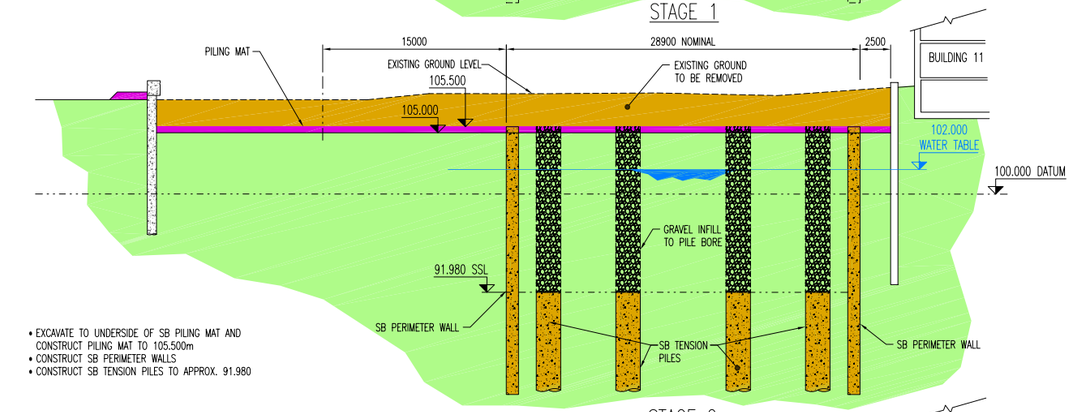
www.watermangroup.com

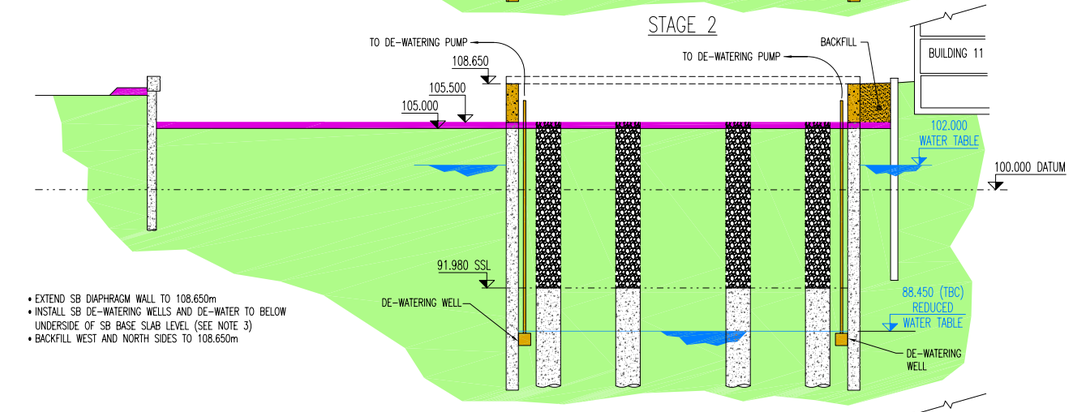
JOB No. / TITLE :	C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT
DRAWING TITLE :	CONSTRUCTION SEQUENCE EAST END BOX
SCALE @ A1:	1:250 1:1000
DRAWING AND CAD FILE No :	BH0201-E2M40-R00-D-01123
REV :	B02



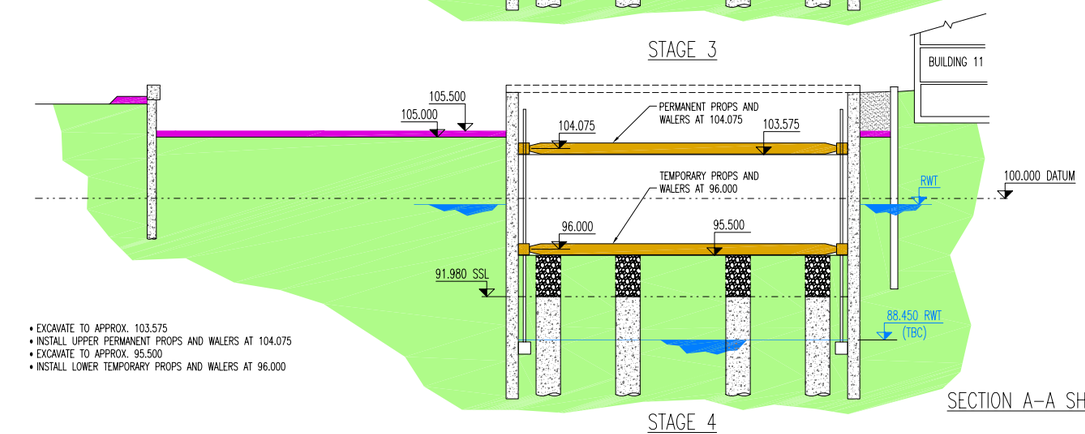
STAGE 1



STAGE 2



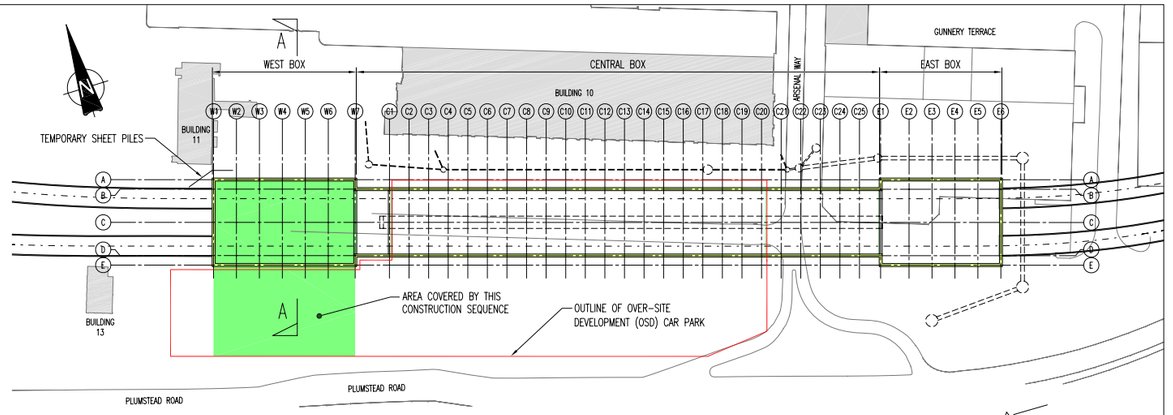
STAGE 3



STAGE 4

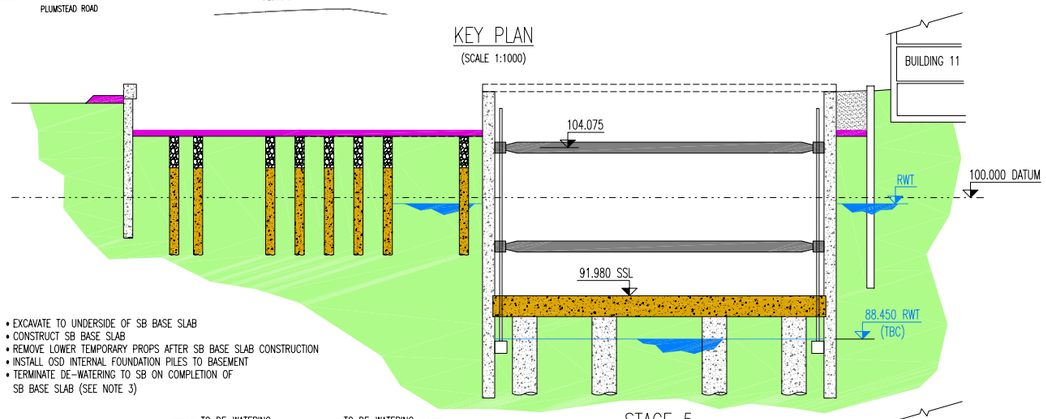
SECTION A–A SHOWING CONSTRUCTION STAGES

(SCALE 1:200)

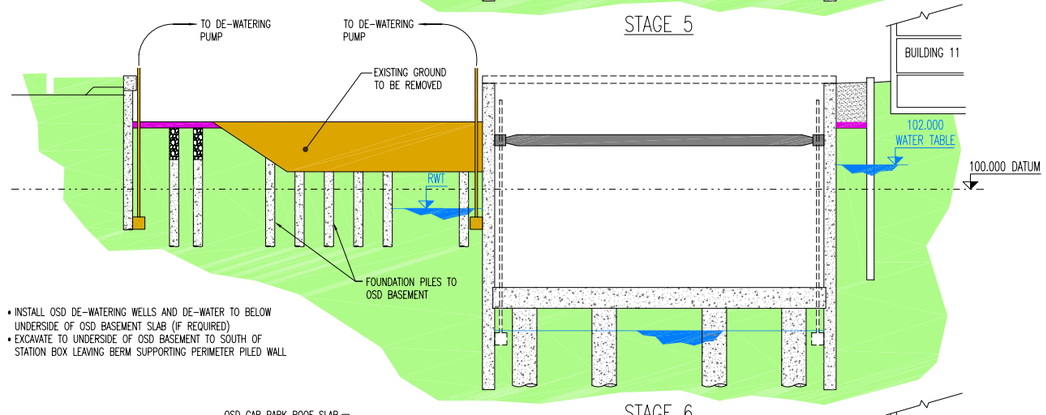


KEY PLAN

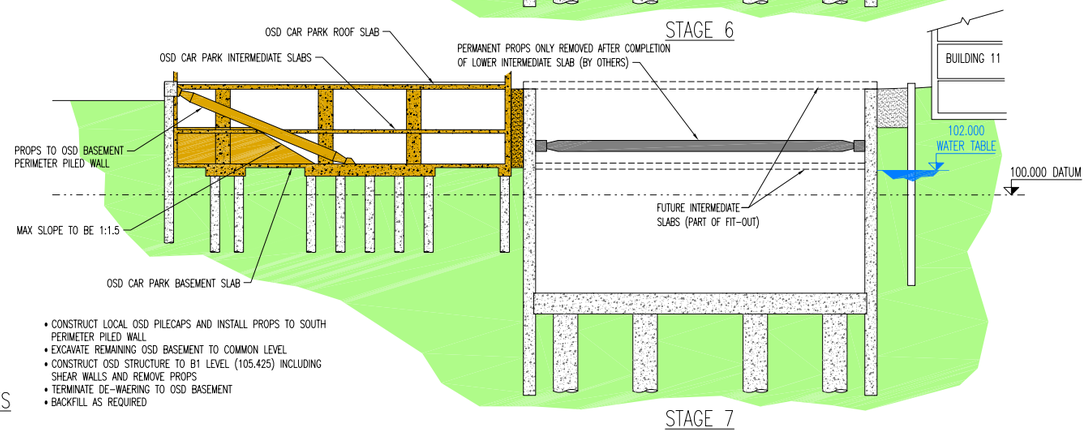
(SCALE 1:1000)



STAGE 5



STAGE 6



STAGE 7

REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
B02	20/05/11	REVISED TO SHOW LATEST OSD BASEMENT ARRANGEMENT. GRIP 4 ISSUE	SPO	PJK	PJK		
B01	15/04/11	ISSUED FOR CDS. SLAB LEVELS REVISED TO REFLECT RAISED TRACK LEVEL	SPO	PJK	PJK		
A03	26/02/10	REVISED IN ACCORDANCE WITH CRL REVISED ALIGNMENT 'OPTION 5'. TEMPORARY PROPS REVISED TO SUIT					
A02	04/12/09	DRAWING RENUMBERED FROM C-11331-SA-20-1056. SSL REVISED. NUMBER OF PILES REVISED	SPO	ASR	PJK		
A01	18/11/09	FIRST ISSUE FOR COMMENTS	SPO	ASR	PJK		

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ALL LEVELS ARE IN METRES ABOVE TUNNEL DATUM (mATD)
3. STAGING OF DE-WATERING SCHEME TO SUIT ENTIRE STATION BOX REQUIREMENTS LOCATION OF DEWATERING WELLS (INSIDE OR OUTSIDE BOX) TBC
4. CUT SLOPES IN MADE GROUND ASSUMED TO BE 1:2

KEY:

SB: STATION BOX
OSD: OVER-SITE DEVELOPMENT

- Unidentified buried structure and ordnance
- Contaminated ground / Glauconite
- Failure of dewatering system

Construction/Maintenance & cleaning/Demolition & adaptation Risks

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of the above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

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CANARY WHARF
LONDON E14 5LQ
TEL : 020 3229 9100
www.crossrail.co.uk

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Pickfords Wharf
Clink Street
London SE1 9DG
t 020 7928 7888
f 020 7928 3033
mail@waterman-group.co.uk
www.watermangroup.com

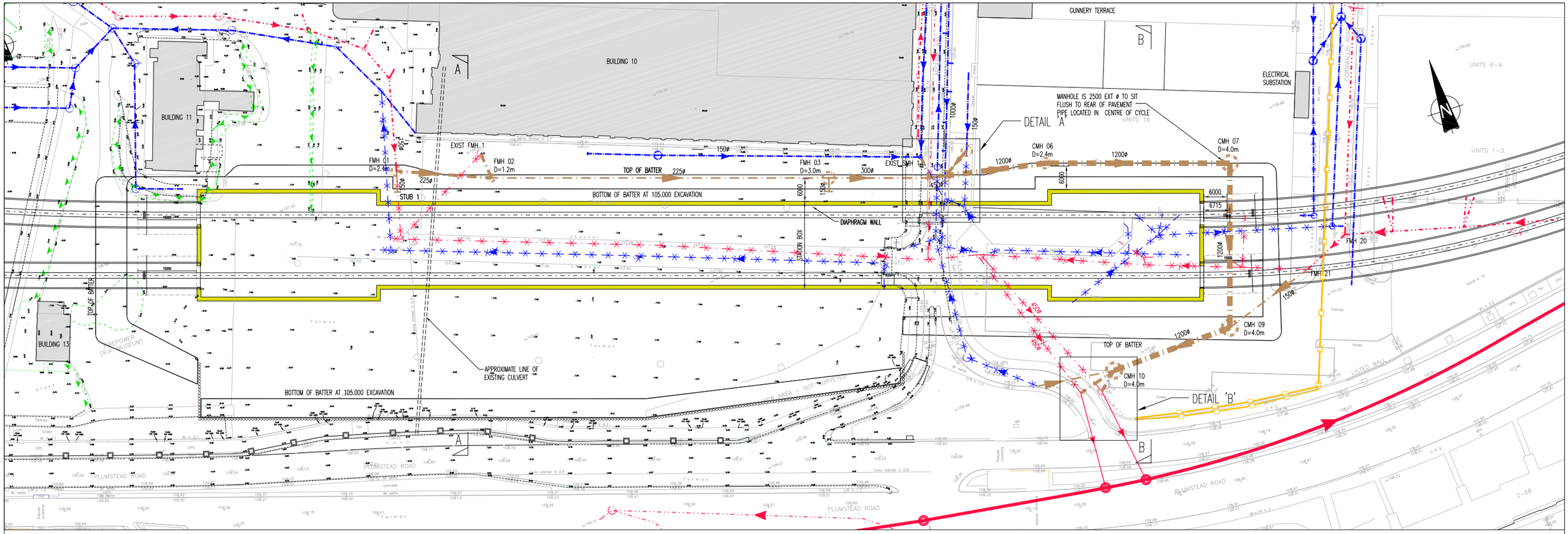
JOB No. / TITLE : C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT

DRAWING TITLE : CONSTRUCTION SEQUENCE WEST END BOX

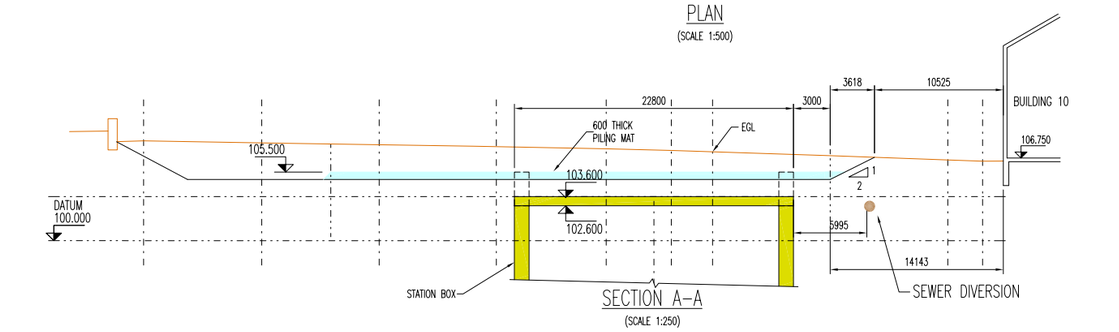
SCALE @ A1: 1:250 1:1000

DRAWING AND CAD FILE No : BH0201-E2M40-R00-D-01124

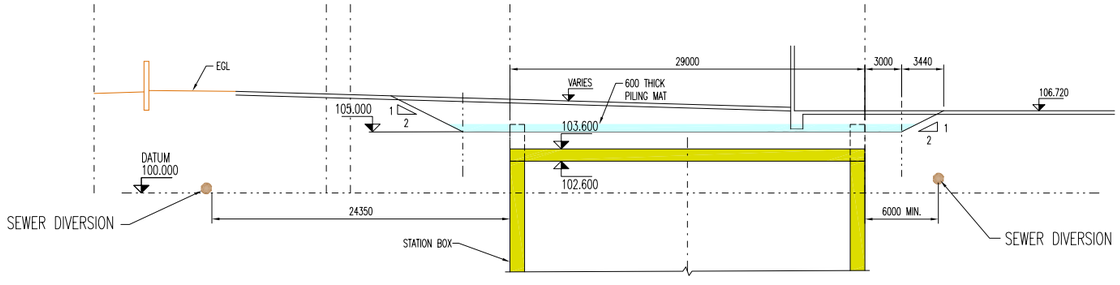
REV : B02



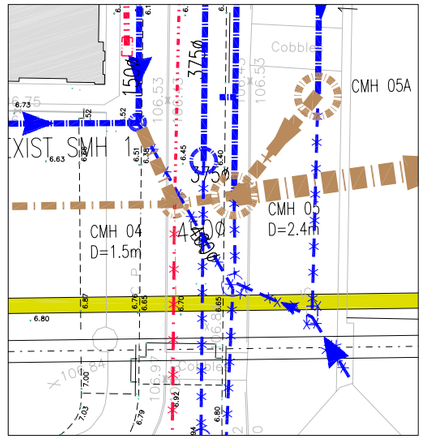
PLAN
(SCALE 1:500)



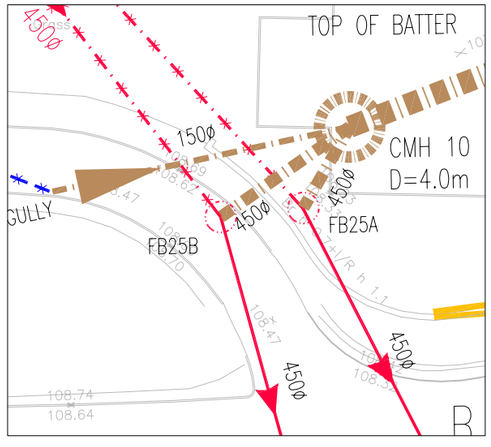
SECTION A-A
(SCALE 1:250)



SECTION B-B
(SCALE 1:250)



DETAIL 'A'
(SCALE 1:200)



DETAIL 'B'
(SCALE 1:200)

LEGEND

- PROPOSED SEWER DIVERSION
- EXISTING COMBINED SEWER
- EXISTING F.W. SEWER
- EXISTING F.W. SEWER TO BE ABANDONED
- EXISTING S.W. SEWER
- EXISTING S.W. TO BE ABANDONED
- PROPOSED HOARDING LINE

REFERENCES:

PROPOSED DRAINAGE LONG SECTION – BH0201-E2M40-U00-D-00102

1:500 0 10000 20000 30000 40000 50000
1:1 0 10 20 30 40 50 60 70 80 90 100

1:250 0 5000 10000 15000 20000 25000
1:1 0 10 20 30 40 50 60 70 80 90 100

1:200 0 5000 10000 15000 20000
1:1 0 10 20 30 40 50 60 70 80 90 100

REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
C02	11.05.11	CONSTRUCTION RISK INFORMATION ADDED.	BM	M.C.		BM	
C01	18.04.11	TWIN ø675 PIPES REPLACED WITH ø1200 PIPE. DRAINAGE HORIZONTAL AND VERICAL ALIGNMENT AMENDED TO SUIT THIS CHANGE. ISSUED FOR TENDER.	BM	M.C.		BM	
A04	04.04.11	FOUL WATER SEWER DIVERSION AMENDED	BM	M.C.		BM	
A03	14.03.11	FOUL WATER SEWER DIVERSION RELOCATED 6m AWAY FROM END OF BOX	AKL	M.C.		AKL	
A02	26.02.10	EXISTING SEWERS AMENDED TO SUIT LATEST SURVEY.	AKL	H.C.		AKL	
A01	03.12.09	DRAWING NUMBERING AND SHEET AMENDED TO CROSSRAIL DATA MANAGEMENT STANDARD. PREVIOUSLY ISSUED AS DRAWING C-SA(92)0201.	AKL	H.C.		AKL	

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ALL LEVELS ARE IN METRES AND RELATE TO CRL PROJECT DATUM
3. ALL CO-ORDINATES ARE IN METRES AND RELATE TO CRL PROJECT CO-ORD SYSTEM.
4. FOR DRAINAGE LONG SECTION AND MANHOLE SCHEDULE SEE DWG. BH0201-E2M40-U00-D-00102
5. FOR DRAINAGE DETAILS SEE DRAWING BH0201-E2M40-U00-D-00103

THE CONTRACTOR'S ATTENTION IS DRAWN TO THE HIGH WATER TABLE WITHIN THE AREA OF THE SEWER DIVERSION. IF ANY DEWATERING IS DEEMED NECESSARY, THIS MAY CAUSE SETTLEMENT WHICH COULD HAVE A DETRIMENTAL EFFECT UPON BUILDING 10, POSSIBLY REQUIRING MITIGATION.
ANY TEMPORARY WORKS WILL NEED TO BE REVIEWED BY THE ENGINEER.

Construction/Maintenance & cleaning/Demolition & adaptation Risks

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of the above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

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25 CANADA SQUARE
CANARY WHARF
LONDON E14 5LQ
TEL : 020 3229 9100
www.crossrail.co.uk

Waterman Transport & Development
Pickfords Wharf
Clink Street
London SE1 9DG
t 020 7928 7888
f 020 7928 3033
mail@waterman-group.co.uk
www.watermangroup.com

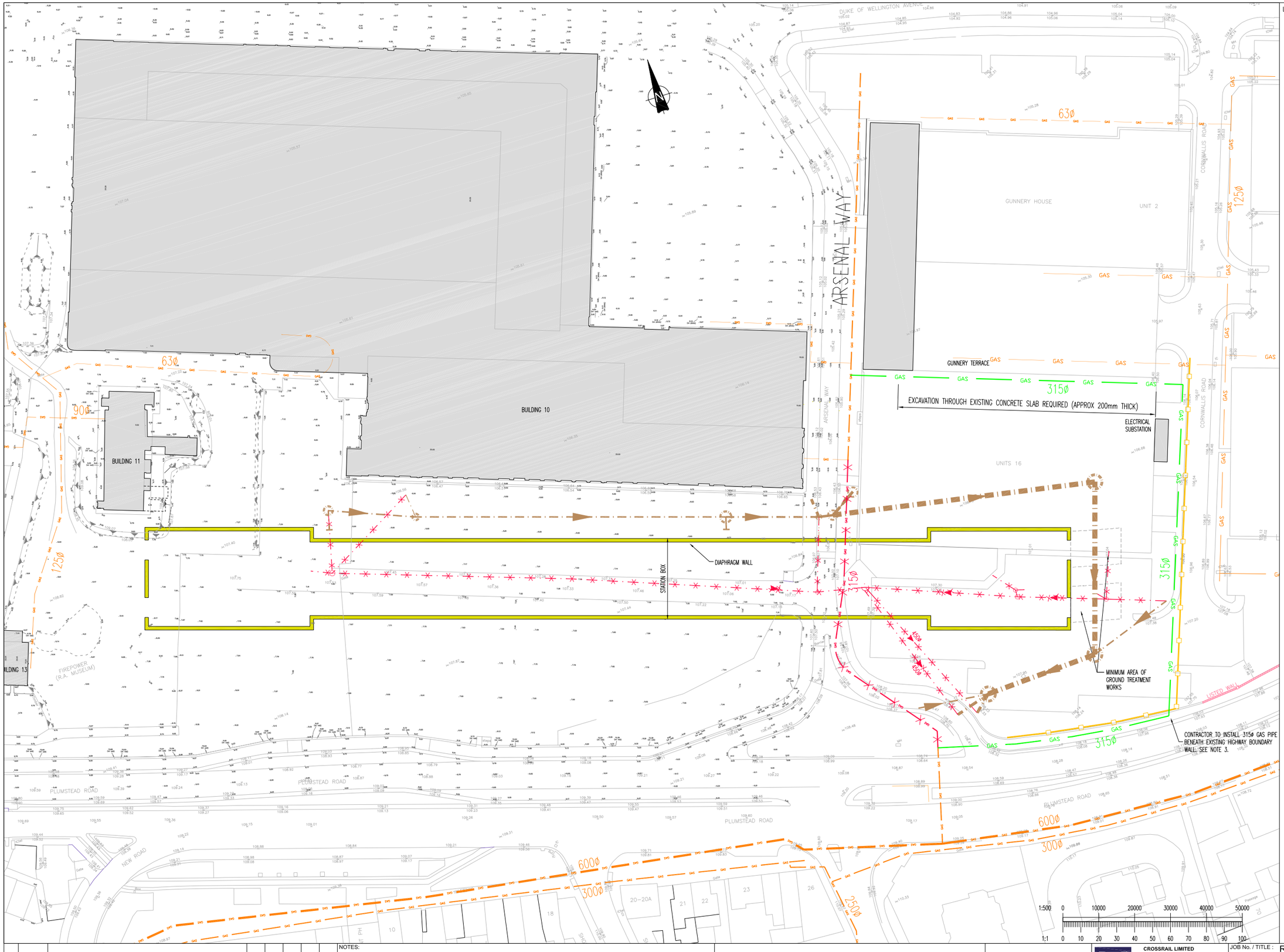
JOB No. / TITLE : C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT

DRAWING TITLE : EXISTING DRAINAGE AND PROPOSED NEW SEWER

SCALE @ A1: AS_SHOWN

DRAWING AND CAD FILE No : BH0201-E2M40-U00-D-00101

REV : C02



LEGEND

- EXISTING GAS MAIN
- PERMANENT DIVERSION
- EXISTING GAS MAIN TO BE REMOVED PERMANENTLY
- PROPOSED HOARDING LINE BY OTHERS
- PROPOSED SEWER DIVERSION BY OTHERS

REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
A05	16.05.11	EASEMENT AREA DELETED. NOTES AMENDED.	B.M.	M.C.		B.M.	
A04	27.04.11	EASEMENT AREA HATCHED AND GENERAL AMENDMENTS.	AKL	M.C.		AKL	
A03	19.04.11	DIVERSION ALIGNMENT AMENDED	B.M.	M.C.		B.M.	
A02	08.04.11	EASEMENT LINE ADDED.	AKL	M.C.		AKL	
A01	03.12.09	DRAWING NUMBERING AND SHEET AMENDED TO CROSSRAIL DATA MANAGEMENT STANDARD. PREVIOUSLY ISSUED AS DRAWING C-SA(96)0100.	AKL	R.W.		AKL	

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METRES AND RELATE TO SITE DATUM.
3. REFER TO DRAWING No. BH0201-E2M40-U00-D-00307 FOR SUGGESTED LOCATION OF SERVICES UNDER BOUNDARY WALL.
4. SETTING OUT DETAILS TO BE AGREED ON SITE WITH THE ENGINEER PRIOR TO COMMENCEMENT.
5. LIMIT OF WORKING AREA AND SITE COMPOUND AREA TO BE AGREED WITH BERKELEY HOMES PRIOR TO COMMENCEMENT ON SITE.

Construction/Maintenance & cleaning/Demolition & adaptation Risks

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of the above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

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CANARY WHARF
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f 020 7928 3033
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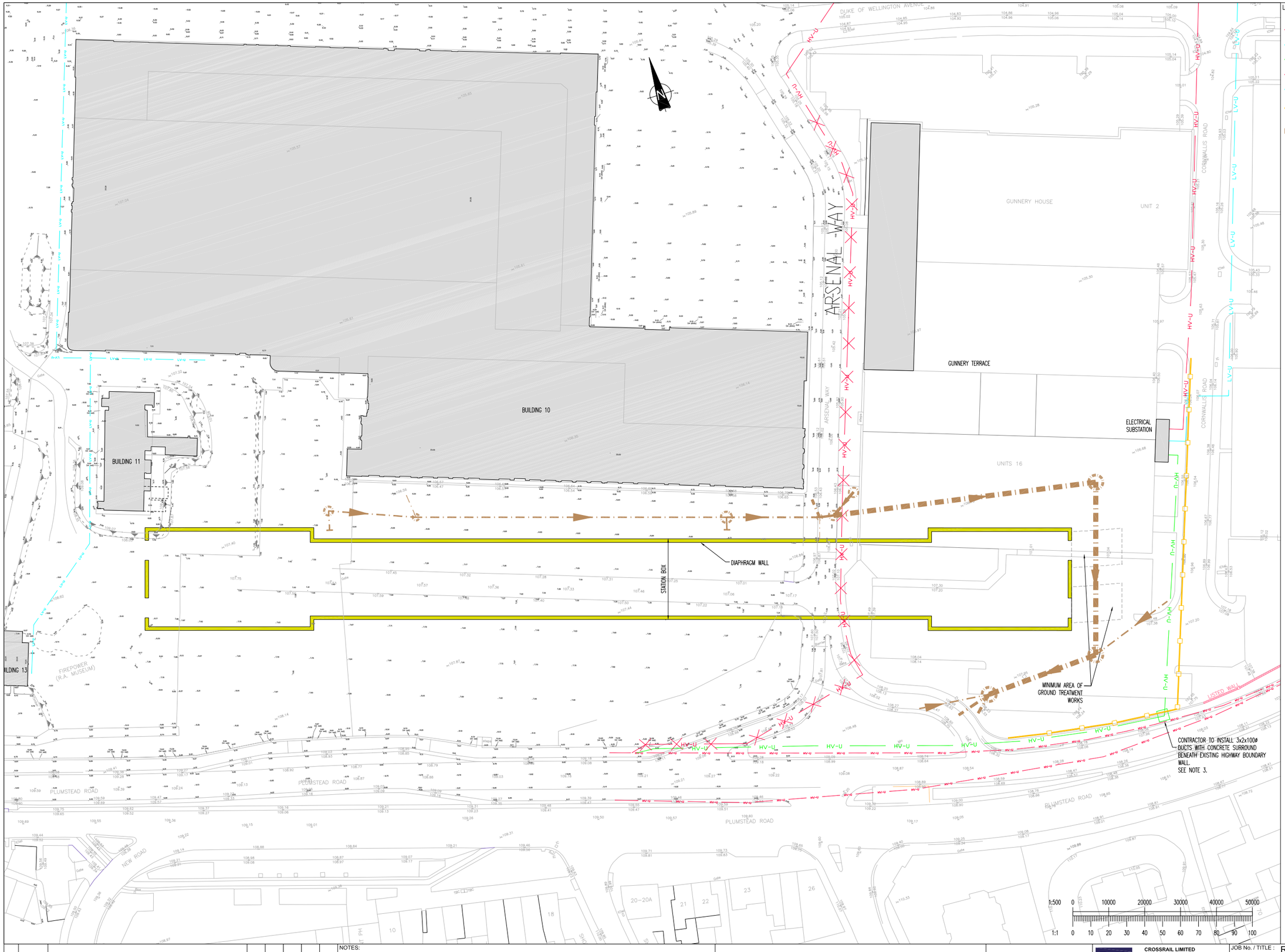
JOB No. / TITLE : C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT

DRAWING TITLE : EXISTING GAS SERVICES AND PROPOSED DIVERSION

SCALE @ A1: 1:500

DRAWING AND CAD FILE No : BH0201-E2M40-U00-D-00301

REV : A05



LEGEND

- EXISTING HIGH VOLTAGE ELECTRICITY
- EXISTING LOW VOLTAGE ELECTRICITY
- PERMANENT HV CABLE DIVERSION
- HV CABLES REMOVED PERMANENTLY
- LV CALBES REMOVED PERMANENTLY
- PROPOSED HOARDING LINE BY OTHERS
- PROPOSED SEWER DIVERSION BY OTHERS

REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
A05	13.05.11	EASEMENT AREA DELETED. NOTES AMENDED.	B.M.	M.C.		B.M.	
A04	09.05.11	ELECTRICAL SERVICES AMENDED	B.M.	M.C.		B.M.	
A03	27.04.11	EASEMENT AREA HATCHED.	AKL	M.C.		AKL	
A02	08.04.11	EASEMENT LINE ADDED.	AKL	M.C.		AKL	
A01	03.12.09	DRAWING NUMBERING AND SHEET AMENDED TO CROSSRAIL DATA MANAGEMENT STANDARD. PREVIOUSLY ISSUED AS DRAWING C-SA(96)0101.	AKL	R.W.		AKL	

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METRES AND RELATE TO SITE DATUM.
3. REFER TO DRAWING No. BH0201-E2M40-U00-D-00307 FOR SUGGESTED LOCATION OF SERVICES UNDER BOUNDARY WALL.
4. UTILITY SUPPLIER WILL MAKE AMENDMENTS AND CHANGES TO THE LV CIRCUIT ELSEWHERE TO ALLOW THE LV OVER THE STATION BOX TO BE MADE REDUNDANT.
5. SETTING OUT DETAILS TO BE AGREED ON SITE WITH THE ENGINEER PRIOR TO COMMENCEMENT.
6. LIMIT OF WORKING AREA AND SITE COMPOUND AREA TO BE AGREED WITH BERKELEY HOMES PRIOR TO COMENCEMENT ON SITE.

Construction/Maintenance & cleaning/Demolition & adaptation Risks

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of the above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

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Clink Street
London SE1 9DG
t 020 7928 7888
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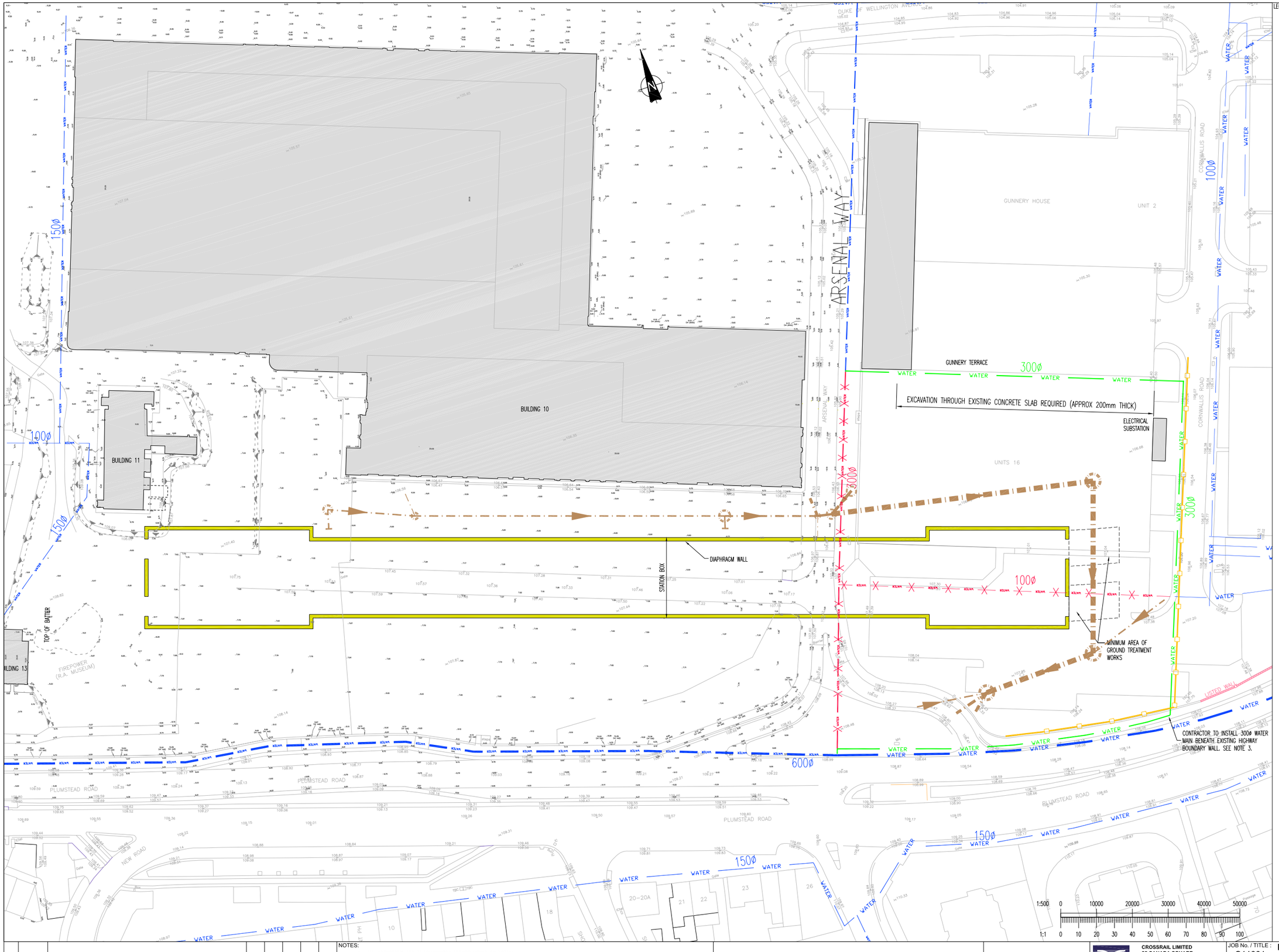
JOB No. / TITLE : C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT

DRAWING TITLE : EXISTING ELECTRICAL SERVICES AND PROPOSED DIVERSIONS

SCALE @ A1: 1:500

DRAWING AND CAD FILE No : BH0201-E2M40-U00-D-00302

REV : A05



REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
A05	16.05.11	DIVERSION ALIGNMENT AMENDED, EASEMENT AREA DELETED. NOTES AMENDED.	B.M.	M.C.		B.M.	
A04	27.04.11	EASEMENT AREA HATCHED.	AKL	M.C.		AKL	
A03	19.04.11	DIVERSION ALIGNMENT AMENDED.	B.M.	M.C.		B.M.	
A02	08.04.11	EASEMENT LINE ADDED.	AKL	M.C.		AKL	
A01	03.12.09	DRAWING NUMBERING AND SHEET AMENDED TO CROSSRAIL DATA MANAGEMENT STANDARD. PREVIOUSLY ISSUED AS DRAWING C-SA(96)0102.	AKL	R.W.		AKL	

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METRES AND RELATE TO SITE DATUM.
3. REFER TO DRAWING No. BH0201-E2M40-U00-D-00307 FOR SUGGESTED LOCATION OF SERVICES UNDER BOUNDARY WALL.
4. SETTING OUT DETAILS TO BE AGREED ON SITE WITH THE ENGINEER PRIOR TO COMMENCEMENT.
5. LIMIT OF WORKING AREA AND SITE COMPOUND AREA TO BE AGREED WITH BERKELEY HOMES PRIOR TO COMMENCEMENT ON SITE.

Construction/Maintenance & cleaning/Demolition & adaptation Risks

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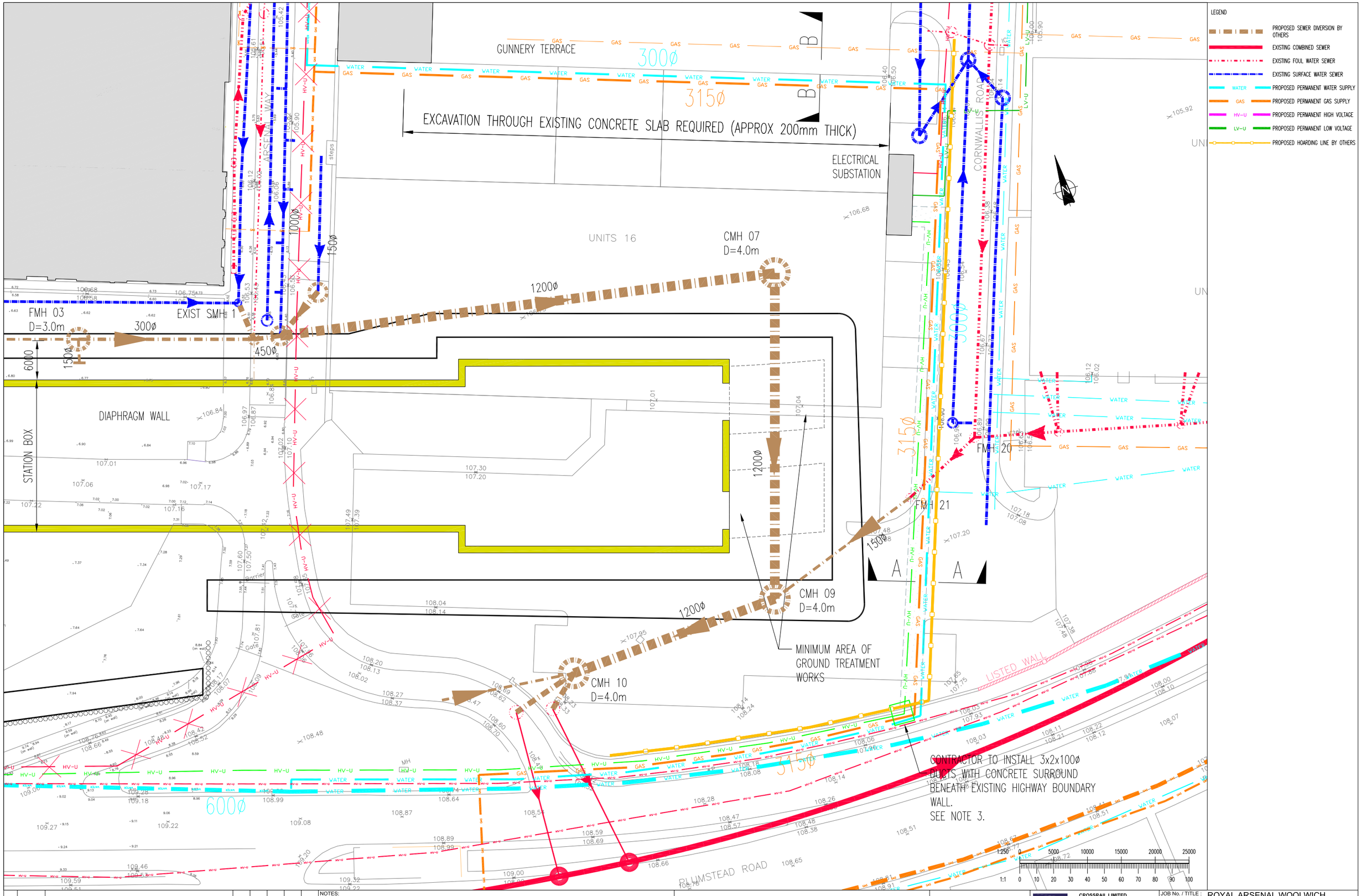
JOB No. / TITLE : C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT

DRAWING TITLE : EXISTING WATER SUPPLY AND PROPOSED DIVERSION

SCALE @ A1: 1:500

DRAWING AND CAD FILE No : BH0201-E2M40-U00-D-00303

REV : A05



REV	DATE	DESCRIPTION	BY	CHKD	APP	CAD	ACC
A04	16.05.2011	ISSUED FOR INFORMATION – SERVICES UPDATED. NOTES AMENDED.	B.M.	C.M.		B.M.	
A03	04.05.2011	ISSUED FOR INFORMATION – SERVICES UPDATED.	B.M.	C.M.		B.M.	
A02	15.04.2011	ISSUED FOR INFORMATION – SERVICES UPDATED.	B.M.	C.M.		B.M.	
A01	04.04.2011	FIRST ISSUE.	AKL	R.W.		AKL	

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METRES AND RELATE TO SITE DATUM.
3. REFER TO DRAWING No. BH0201-E2M40-U00-D-00307 FOR SUGGESTED LOCATION OF SERVICES UNDER BOUNDARY WALL.
4. FOR SERVICES CROSS SECTIONS A – A AND B – B REFER TO DRAWING BH0201-E2M40-U00-D-00309.
5. SETTING OUT DETAILS TO BE AGREED ON SITE WITH THE ENGINEER.
6. LIMIT OF WORKING AREA AND SITE COMPOUND AREA TO BE AGREED WITH BERKELEY HOMES PRIOR TO COMMENCEMENT ON SITE.

Construction/Maintenance & cleaning/Demolition & adaptation Risks

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of the above. It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

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JOB No. / TITLE : C11331 ROYAL ARSENAL WOOLWICH CROSSRAIL STATION BOX PROJECT

DRAWING TITLE : COMBINED PROPOSED SERVICE DIVERSION LAYOUT

SCALE @ A1: 1:250

DRAWING AND CAD FILE No : BH0201-E2M40-U00-D-00304

REV : A04