



**Westbourne Park & Royal Oak Portal
Site-Specific Archaeological
Written Scheme of Investigation**

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1 Executive Summary

This Site-Specific Written Scheme of Investigation (WSI) deals with the Crossrail works at Westbourne Park and Royal Oak. It includes consideration of advanced and main works required for the western portal for the Crossrail tunnels (Royal Oak Portal) and approach ramp and train reversing facility (Westbourne Park turnback).

The WSI sets out the level of mitigation proposed on the potential archaeological resources which have been identified. It addresses the scope, specification, timing and order of works and the deliverables required to successfully integrate the archaeological aspects of the works into the project phasing. *Within the cutting, only railway archaeology, the former channel of the River Westbourne, and the Ranelagh Sewer are likely to survive.*

At the Royal Oak Worksite East and Paddington Central worksites potential archaeological remains include:

Potential remains of Brunel's Great Western Railway of 1838 and the contemporary engine shed and station; and subsequent later 19th-century railway features, including the 1850s Goods Shed. The more important features, such as the engine shed and Goods Shed, lie outside of the footprint of the Portal

The course of the former Westbourne River

The Victorian Ranelagh Sewer

At the Royal Oak Worksite West potential archaeological remains include

- Possible alluvial deposits identified during geotechnical investigations

Engine sheds, workshops, turntables and infrastructure from Brunel's Great Western Railway of 1838 and the later 19th-century goods yard

- The late 19th and early 20th-century Portobello Junction

Post-medieval occupation activity associated with 19th-century Albert House

Construction works with potential to remove archaeological remains are excavation of the Royal Oak Portal, ground reduction for a new retaining wall and trackwork, sewer diversions, drainage, and utilities, footings for platforms and OLE, landscaping and access.

The recording of Non-listed Built Heritage at in all three worksites has been completed in 2010 in advance of demolition.

Further mitigation measures are required at all three worksites in the form of preservation by record during Advance and Main Works, comprising targeted watching briefs (TWB) and general watching briefs (GWB).

The Enabling Works and Main Works requiring mitigation (watching briefs) at the Royal Oak Worksite East and Paddington Central worksites are programmed from July 2010 to 2014. These have commenced in advance of this version of the WSI.

At the Royal Oak Worksite West, relevant Advance Works requiring mitigation are programmed to commence in October 2010 and finish in September 2011. The Main Works requiring mitigation are currently programmed to commence in November 2013, concluding in April 2015 (*to be revised by the Network Rail archaeologist*).

2 Project Background

2.1 Site Location

The Westbourne Park and Royal Oak Portal sites are located in the City of Westminster on the northern side of the Great Western mainline tracks west of Paddington Station, and south of the A40 Westway flyover. Postcode London W2.

The Westbourne Park site lies between Green Lane Bridge (carrying the Great Western Road; adjacent to Westbourne Park Station) to the west, and the Hampden Street/Westbourne Passage footbridge to the east (where it abuts the Royal Oak Portal site). It consists of the Royal Oak Worksite West. Approximate site centre: NGR 525180 181730.

The Royal Oak Portal site lies between the Hampden Street/Westbourne Passage footbridge to the west, and the Paddington Central development to the east. It consists of two worksites: the Royal Oak Worksite West (the portal will be constructed in the western half of this, west of Lord Hill's Bridge), and Paddington Central Worksite (to be used as offices and construction compound). Approximate site centre: NGR 525800 181600.

Figure 1 and Figure 2 show the location of these areas, with Figure 7 and Figure 8 showing the work areas in further detail and Figure 3 showing the work areas in c 2009.

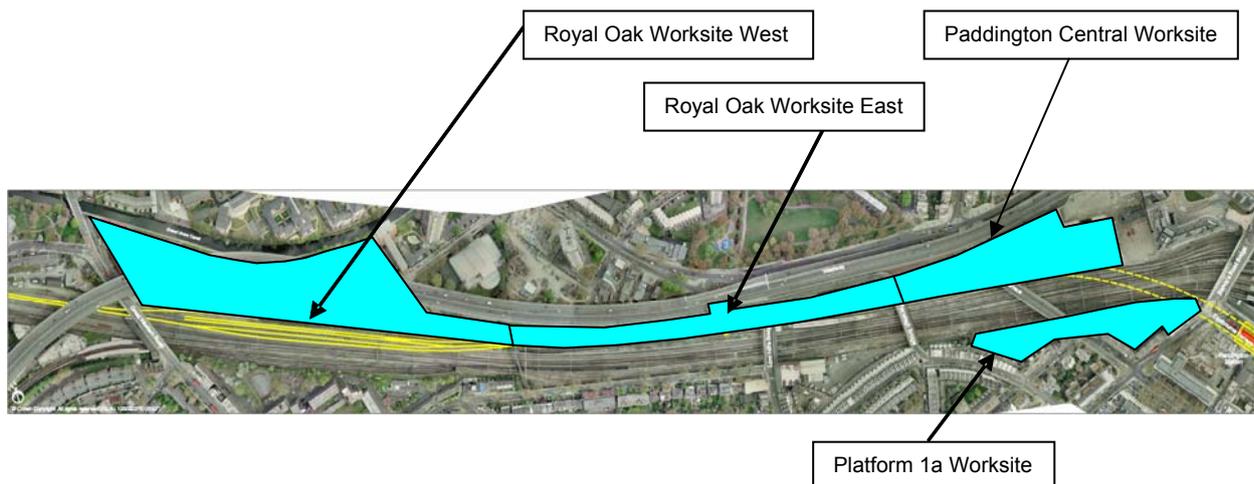


Figure 1. Westbourne Park and Royal Oak (drawing from Advanced Works review 26th Feb 2008) (Nb. For the purposes of this WSI, the Platform 1a worksite is included within the Paddington Station WSI)

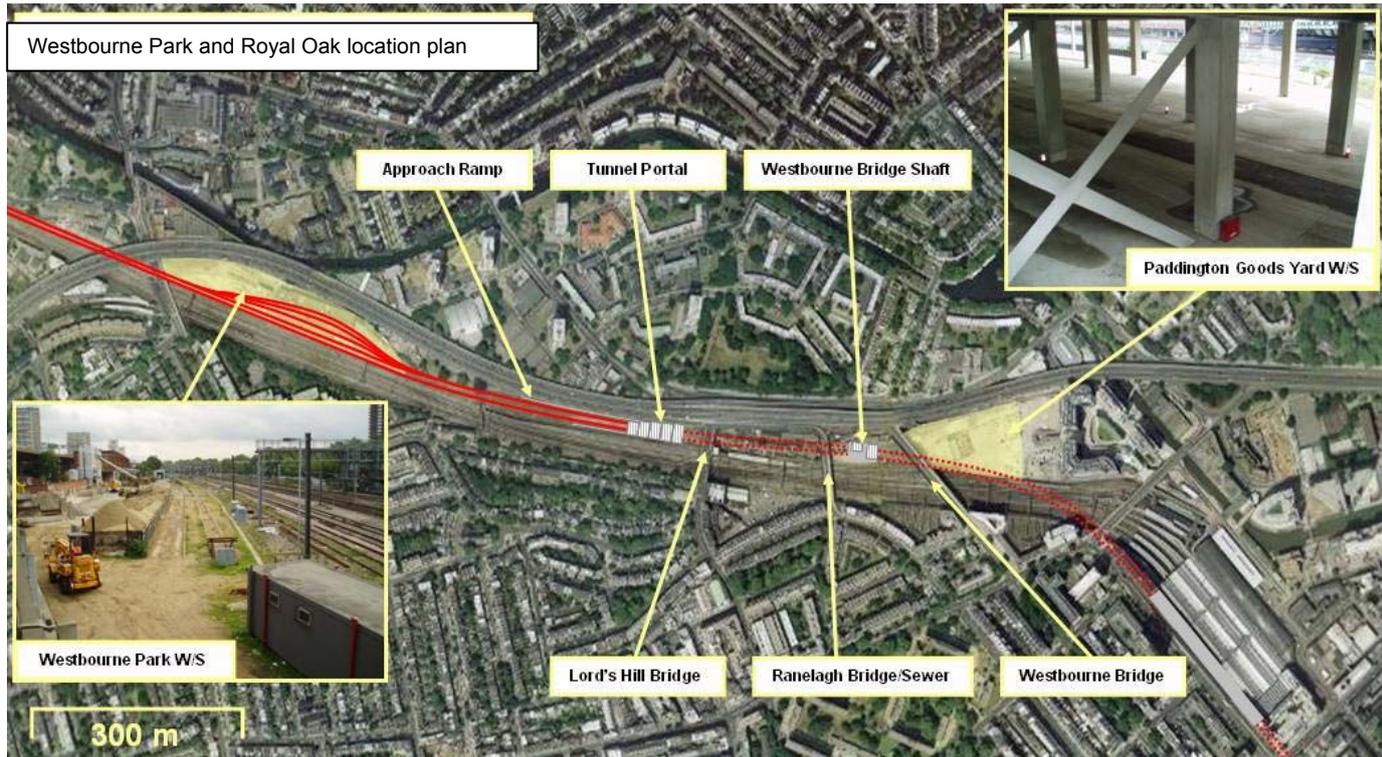


Figure 2. Site locations from Figure 10.1 (Vol. 3-Civil, Structural & Tunnel Engineering Report, CR-SD-CT1-RT-00010 vol. 1)

Note: Westbourne Bridge shaft is no longer part of the project works.



Westbourne Bridge taken from Ranelagh Bridge, the Westbourne Bridge Shaft location is to the left of the LU and NR track on the right.



Looking east into Paddington New Yard (Westbourne Park) Worksite, Tarmac Topmix plant on left, showing Tarmac Topmix railway line.

Figure 3. Westbourne Bridge & East towards the Royal Oak Worksite West

2.2 Introduction

The overall framework within which archaeological work will be undertaken is set out in the Environmental Minimum Requirements (EMR) for Crossrail (3rd draft November 2007).

The requirements being progressed follow the principles of Planning Policy Guidance Note 16 on archaeology and planning (1990), superseded by PPS5 as of 23 March 2010. Accordingly the nominated undertaker or any contractors will be required to implement certain control measures in relation to archaeology before construction work begins.

The strategy for archaeological works has been set out in the Crossrail Generic Written Scheme of Investigation (WSI) (Document Number 14022008-44ES-P2Z1); it presents the strategy for archaeological design, evaluation, mitigation, analysis, dissemination and archive deposition that will be adopted for design and construction of Crossrail. The Generic WSI provides a general statement of objectives, standards and structure for the planning and implementation of archaeological works.

2.3 Summary of Previous Crossrail Studies

Previous studies of specific relevance to the archaeological works relate to the work undertaken by the Museum of London Archaeology (MOLA, formerly MoLAS) as technical advisors to CLRL during the Bill process, the subsequent detailed desk based assessment (DDBA) conducted by ARUP/Atkins. The impact of the Crossrail Bill scheme on archaeological remains and deposits has been assessed in:

the Specialist Technical Reports: Assessment of Archaeology Impacts (Parts 1, 2, and 6) prepared in support of the Environmental Statement 2005 (Crossrail 2005).

Detailed Desk Based Assessment for Royal Oak Portal and Westbourne Bridge Shaft (Document Reference CR-SD-CT1-EN-SR-00002).

The reports on the fieldwork are described in section 2.4 below.

2.4 Fieldwork completed to date

2.4.1 Royal Oak Worksite East

The initial watching brief tasks listed below were carried out by C254 (Archaeology West), Oxford Archaeology (see 5.1.1, 6.2.1, & Table 5). Further watching brief tasks are ongoing (as of October 2010).

- TWB on the Royal Oak Portal guide walls: July/August 2010
- TWB Marcon Sewer Temporary diversion: September/October 2010

An archaeological watching brief is planned to be continue in 2010 by MOLA on selected geotechnical ground investigation works at Royal Oak, adjacent to the Ranelagh Sewer (part of Package 16A) being undertaken by FES for ARUP/Atkins, on behalf of CLRL (see 2.8.1). The results of this work have potential to inform subsequent mitigation.

Non-listed built heritage recording was conducted in advance of demolition and reported on (see 5.2.1).

2.4.2 Royal Oak Worksite West

Geotechnical ground investigation works of Package 17B have been completed. There was no requirement for an archaeological watching brief during these works, although the results have been reviewed and assessed in order to inform this WSI (section 2.7.2 below).

Intrusive trial pit surveys have also been undertaken across the Royal Oak Worksite West area. Advanced works Package WEP-S-008 comprised the excavation of trial pits targeted to identify the location and depth of utilities, cable routes and other subsurface hazards including the former GWR engine sheds of Brunel's railway, on and around the Network Rail Great Western Mainline between CH 0m 45c and 1m 20m. Several of these intrusive trial pits were selected for monitoring as an archaeological watching brief in order to identify and record any subsurface archaeological deposits (Crossrail (Scott Wilson), 2009, *Westbourne Park GI Report, WEB-S-0008C*).

Non-listed built heritage recording was conducted in advance of demolition and reported on (see 5.2.2).

2.5 Consultation and monitoring

2.5.1 Consultation to date

As some of the fieldwork commenced in advance of this revision of the WSI, GLAAS (Greater London Archaeology Advisory Service) officers for the City of Westminster (the 'external consultee'), John Brown and later Rob Whytehead, were informed in advance of the commencement of the standing building recording (see 5.2) and initial watching brief (portal guide walls and temporary Marcon Sewer diversion, see 5.1.1 and 6.2.1) in 2010.

Rob Whytehead was subsequently consulted over the content of this WSI on 22.09.10, and was satisfied with the mitigation. The arrangements for monitoring of the mitigation measures were also discussed, and he asked that the design archaeologist should contact him/GLAAS if anything significant or interesting is found during the course of the watching briefs that might require a visit, as well as being kept up to date on progress. In addition, he would wish make at least one monitoring visit at a strategic point in the project; the design archaeologist suggested that during the ground reduction within the diaphragm walls of the portal would be a suitable time (currently programmed for January to September 2011).

2.5.2 Future consultation

The GLAAS officer shall be informed in writing at least one week in advance of commencement of fieldwork.

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 Principal Contractor's health and safety, site access and security requirements. Arrangements for GLAAS monitoring of the archaeological works will be made during and following the above consultation.

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

2.6 Geology and Topography

Information within this Section and Section 2.3 has been summarised from the Detailed Desk Based Assessment (Document Reference CR-SD-CT1-EN-SR-00002) prepared for Royal Oak Portal and Westbourne Bridge Shaft and relevant Scheme Design reports.

The study area slopes down from c 130m TD (Tunnel Datum) in the north around the Grand Union Canal, to below 122m TD around Westbourne Park to the south.

2.6.1 Royal Oak Worksite East and Paddington Central Worksite

The site is situated on London Clay. The geological cross section (Annex 2, dwg. no. C150-CSY-C2-DDL-CR076_PT001-00012) shows an interpretation of the geological information across the Royal Oak Worksite East. Of interest archaeologically and geo-archaeologically is that although alluvium was only encountered in some of the boreholes, this alluvium is interpreted as being a relict of the course of the former Westbourne River which once traversed the site, prior to its reroute to the Ranelagh Sewer. Much of the former Westbourne River channel has been removed by the construction of the 19th-century railway cutting. However, the boreholes indicate that the alluvium is present across approximately the eastern third of the portal footprint, and extends further to the east of Lord Hill's Bridge. It was recorded to depths 2.8 to 4.0m below ground level (dwg. C150-CSY-C2-DDL-CR076_PT01-0012 Rev. P01). The thickness of this alluvium is between up to 3.2m, at 117.9 to 121.2m TD.

A ground model design based on boreholes RT 1 to 5 (Royal Oak Portal and Westbourne Bridge Shaft Geotechnical Summary Note (document reference CRDV- CT1-X-RT-00020)), demonstrates a thickness of Made Ground from between 0.8 to 2.5m (121.4 to 122.9m TD). The Made Ground may include archaeological remains as well as more modern material. Underlying the Made Ground, alluvium was encountered in some of the boreholes and this has been interpreted as being a relict course of the Westbourne River. The top of the London Clay has been defined as being fairly level except at borehole 4 where it dipped to a level of 117.3m TD. This has been interpreted as possibly being the location of the former course of the Westbourne River.

2.6.2 Royal Oak Worksite West

The Royal Oak Worksite West is located on London Clay, within a cutting constructed for the Great Western Railway (GWR) forming a terraced land parcel located within between the Grand Union Canal and the Network Rail mainline to Paddington Station (Figure 1 and Figure 2). With the exception of an area of level ground in the north-east corner occupied by the TFL Archive and Murphy's yard, the upper terrace slopes from c 129m ATM adjacent to the Grand Union Canal, to between c 128m and 125m TD at the top of the concrete retaining wall as it extends west to east across the site. The lower terrace is relatively flat, sloping gently from c 123m ATM at the base of the concrete retaining wall of the railway cutting to c 122.6m TD the existing track level of the Network Rail mainline. The extensive railway cutting indicates that there is a low likelihood of locating archaeology pre-dating the 1830s railway.

Geotechnical and geo-environmental conditions within the Royal Oak Worksite West were investigated as part of geotechnical ground investigations Works Package 17B undertaken between February and June 2009. The upper terrace of the site, immediately east of the Great Western Studios (GWS) was investigated by five cable percussion boreholes (ROP6–9 and ROP6A), five window samples (WS114–118) and two test pits (TP350 and TP 351). For Package 17B borehole locations see Annex 2, Dwg. E8902 02 Rev. 1.

The stratigraphic sequence in this area is summarised below in Table 1.

Stratum	Elevation at top, m TD	Thickness, m
Made Ground	128.38 to 125.95	1.0 to 3.05
Alluvium ¹	126.48 to 125.94	0.30 to 1.05
Organic Alluvium ²	125.64	0.30
Reworked London Clay ³	125.71 to 124.38	0.40–1.40
London Clay	125.78 to 122.98	Not proven

Notes: ¹ Window Samples WS114–116 only.

² Window Sample WS116 only.

³ Only identified in boreholes ROP6A and ROP8.

Table 1. Stratigraphic summary for the upper terrace east of the GWS

The area of the site within the GWR cutting and immediately north of the permanent way (comprising the Tarmac depot and bus washing facility) was investigated by two cable percussion boreholes (ROP12 and ROP14), three rotary boreholes (ROP13R, ROP15R and ROP16P) and five window samples (WS113 and WS120-WS123).

The stratigraphic sequence for the area within the GWR cutting is summarised in Table 2 below:

Stratum	Elevation at top, m TD	Thickness, m
Made Ground	122.74 to 122.54	0.80 to 1.80
Alluvium (Boreholes ROP15R, WS114–6 only)	121.45 to 126.48	0.05–1.05
London Clay	121.90 to 120.78	Not proven

Table 2. Stratigraphic summary for the Tarmac depot and Bus washing facility (within the GWR cutting).

The ground investigation confirmed the natural slope of the underlying London Clay southward. The investigation also confirmed that the site has been subjected to significant truncation relating to the excavation of the GWR cutting, construction of railway buildings and track layout and more recently the A40 Westway although, the depth of truncation and made ground is variable.

Three window samples (WS114–116) located outside the GWR cutting on the upper terrace of the site (area around Murphy's Yard) identified a firm brown/brown mottled orange clay alluvial deposit (0.30–1.05m thick), overlain by between 1.00 and 1.90m of made ground. In WS116 the brown alluvial deposit sealed a grey mottled black, organic alluvium 0.30m thick which overlies the London Clay.

Within the GWR cutting borehole (ROP15R) identified a light brown/blue grey clay alluvial deposit (0.05m thick) sealed by 1.15m of made ground. The alluvial deposit sealed the London Clay.

The provenance and geo-archaeological potential of these alluvial deposits is unknown, the relict course of the Westbourne River lies further to the east within the Royal Oak East worksite and these deposits may represent another former watercourse, rather than flood plain deposits of the Westbourne.

2.7 Archaeological and Historical Development of the Site

A summary of the archaeological and historical development of the Royal Oak Worksite East and the Royal Oak Worksite West is set out below.

2.7.1 Royal Oak Worksite East and Paddington Central Worksite

A map regression exercise was carried out as part of the DDBA (Crossrail, 2008a). This demonstrated that until the mid 19th century the area remained in fields and was not extensively developed. Later maps showed how the increase of population within London required an upgrade to the existing transport system. The assessment demonstrated that the construction of the GWR through to Paddington, along with the Canal and road upgrades has had the most impact on the study area. The Ranelagh Sewer is also noted as a significant feature of the area.

The deposit data for the site indicates that made ground may exist to a depth of 1.0–2.5m below existing ground level across the site. Archaeologically this is predicted to contain 19th-century railway features. Excavations to the east of the site (Table 1, below archaeological sites PGY90 and PYD00) suggest that it is unlikely that any material pre-dating the mid-19th century survived construction of the railway.

Confusingly, the findspot(s) of two Palaeolithic hand-axes in the Greater London Sites and Monuments Record have been located adjacent to the GWR cutting (GLSMR 081122). However, the actual location of the finds is imprecise, and it is likely that these were either redeposited during construction activity (as the majority of the site is located on London Clay which pre-dates the Palaeolithic), or that they were within terrace gravels, eg east of Bishops Road Bridge.

Truncation in this area is expected to relate to the railway industry from the 1830s onwards, including track laying, and cuttings in which the majority of the Crossrail construction works will take place. There is limited construction occurring outside the cutting. Construction of the bridges crossing the line would also have contributed to truncation of the archaeological resource. These bridges are the Lord Hill's Bridge, the Ranelagh Bridge and the Grade II listed Westbourne Bridge. Further truncation is anticipated to have occurred as part of road construction activity, through the Westway which was constructed in 1970 and runs to the immediate north of the Crossrail works sites.

Further information derived from the deposit data suggests that the course of the Westbourne River may be identified in some areas (see 2.6.1). This is of moderate archaeological interest, where this alluvium survives the rerouting to the Ranelagh Sewer. Deposits of geoarchaeological interest may survive which will assist in the understanding of the prehistoric and early medieval environment. In particular it will assist reconstructing the nature of the landscape and resources which people would have used during that time. The Ranelagh Sewer is a 2.4m diameter Victorian brick sewer which crosses the site below the Ranelagh Bridge. This also has slight archaeological interest and its line, foundation trench and form should be recorded if located within the works.

The first railway line through this area, constructed by Brunel c 1836–1838, initially terminated in a temporary timber station. As indicated below (2.8.1), little of this is likely to have survived later truncation. These lines would have run within the later railway corridor seen on Stanford's map of 1862 (Annex 1, Figure 10), through the proposed Royal Oak Portal and all three worksites. Part of what *may* be a turntable from this Brunellian phase of railway construction has recently been observed just west of Westbourne Bridge – see section 2.8.1.

The part of Paddington Central Worksite which lies east of Westbourne Bridge was previously the location of a GWR temporary terminus that occupied the site between 1838 and 1854. Designed by Brunel and constructed primarily from timber, the terminus was intended to be a

purely functional and temporary affair before the building of a more permanent station to the south-east in 1854. The engine shed, with an octagonal 'roundhouse' housing a turntable and eight 'roads' (apparently with sunken working pits), stood to the west of carriage sheds and offices lying within the part of Paddington Central Worksite east of Westbourne Bridge (Brindle 2004, 20).

Subsequent modern development of this area of the Paddington Central Worksite, to the east of the Westbourne Bridge, lies at a lower level than the area to the west of the Bridge, and this may have removed shallow remains of these structures. However, previous fieldwork to the east of the worksite revealed truncated remains associated with the 19th-century railway. Features associated with Brunel's original broad gauge railway may survive further west, however, where less truncation is evident within the permanent way and Marcon Sidings.

After the opening of the second Paddington Station south of Bishops Bridge Road in 1854, the area of the earlier terminus became the site of the second goods depot, shown on Stanford's map of 1862 (Annex 1, Figure 10). This map indicates three sets of tracks at the west of the Royal Oak East worksite, running eastwards past Lord's Hill Bridge and Ranelagh Bridge and terminating at the goods depot and the new Paddington station. The precise location of Brunel's original 1830s trackwork is uncertain, but it must have lain within the footprint of the tracks shown on the Stanford map.

The trackwork leading to the goods depots and Paddington Station was progressively expanded to the south to encompass Royal Oak Station as shown on the 1872 and 1914 Ordnance Survey maps (Annex 1 - Figure 11 and Figure 12). Royal Oak Station was constructed on an area of gardens that originally lay to the south of the railway, between Ranelagh Bridge and Lord Hill's Bridge. This area and Victorian terraces to its west were gradually subsumed by the railway expansion, and the remainder of the Royal Oak Worksite East and Paddington Central Worksite used for sidings or goods related activities, such as cattle sheds. During the 20th century the area was generally used as railway sidings, light industry and service facilities.

2.7.2 Royal Oak Worksite West

To the north-east of the worksite lay the medieval settlement of Westbourne Green, recorded in AD 1222 as one of the three settlements in the parish of St Margaret's Westminster and would have formed part of the estates held by Westminster Abbey (Elrington et al, 1989). A historic map regression exercise indicates that the Royal Oak Worksite West comprised open fields until the mid 19th century, and it is therefore unlikely that occupation extends to either of the Crossrail sites. The construction of the Grand Union Canal (by 1805) defined the northern boundary of the worksite, the area of which was formed on the piece of land between the canal and the cutting for the Great Western Railways (GWR) mainline from Bristol to Paddington built in 1836–1838.

The Great Western Railway transformed the land use of the site, extensive truncation of the southern half of the site was caused by the excavation of the railway cutting which effectively terraced the site creating two levels. Stanford's Map of 1862 shows a GWR engine shed straddling a single railway line, a second workshop lay just to the north of the tracks both constructed within the cutting. The GWR mainline passed to the south of the engine shed. Further disturbance of the upper level of the site is evidenced by an oval reservoir shown in the north-east corner of the site; the construction of the reservoir will have truncated both the terrace gravels and potential archaeological deposits in this area. The eastern part of the site (now occupied by the bus depot) was in the 1860s occupied by the Westbourne Schools, to the south of the GWR mainline lay the Crimea Goods Yard.

By 1870 the site had been developed further with the addition of a new engine shed to the north-west of the main engine shed, in the area now occupied by the Tarmac Topmix depot. A

turntable had also been constructed on one of four railway tracks which at that time passed through the main engine shed. A lifting shop is also shown to the east of the workshop, in the areas now occupied by the eastern end of the bus washing facility.

The 1872 Ordnance Survey Map depicts little change within the GWR cutting (Figure 4). In addition to the engine sheds, turntable and sidings, a crane and a second turntable north of the main engine shed are clearly visible in the southern part of site (now the Tarmac Topmix depot). A large residential property 'Alfred House' and gardens occupy the south-east corner of the site, now the Murphy's yard. The northern part of the site is separated from the GWR yards by an access road leading to Alfred Road north of which the site remains undeveloped with the exception of the reservoir which has been enlarged. The lifting shop at the eastern end of the site is not shown and may either have been demolished by this time or post-dated the survey for the map.

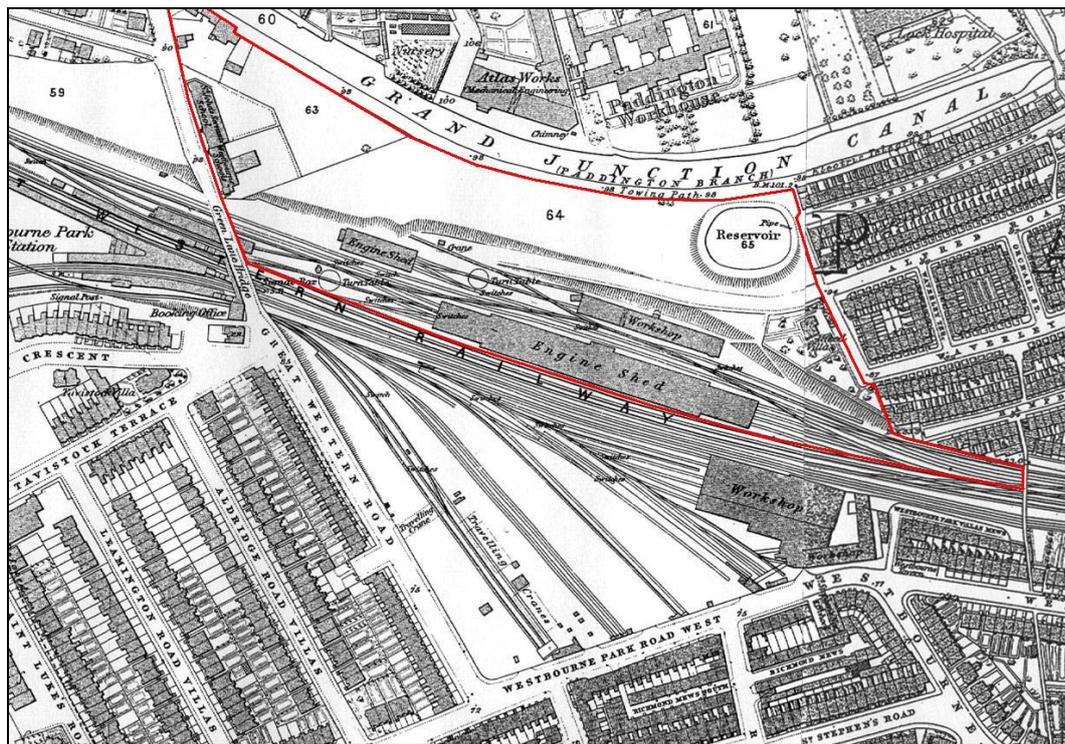


Figure 4. 1872 Ordnance Survey Map Extract.

The 1880s and 1890s were the heyday of the GWR and the worksite, then known as the Paddington New Yard. A GWR survey plan dated 1880 depicts a new Sand House and storage tank had been constructed at the eastern end of the site adjacent to the Westbourne School.

A GWR survey dated 1890 shows that the GWR cutting had been extended northwards almost to the site boundary with the Grand Union Canal at the western end of the site and up to the reservoir at the eastern end. Within the cutting the main workshop straddles four tracks and had a number of inspection pits at either end of its structure. The turntable depicted on the 1870 survey had by this time been removed to make way for the additional tracks. In the area now occupied by Tarmac Topmix depot the smaller engine shed, Sand house and tanks are still in use and a 45 foot diameter turntable with short platform have been added to the west of the smaller engine shed. To the north of the main engine shed, in the area currently occupied by the Great Western Studios were the locomotive workshop and offices, to the west of which lay a lifting shop and a 55 foot diameter turntable. All of these structures are linked by sidings and

three lines branch north of the locomotive workshop to the north-west corner of the site where they pass under Great Western Road.

The layout of these structures is depicted on a GWR plan dated 29th May 1899 (GWR Drawing No. 2515-410-1331) although some of the track detail is not shown (Figure 5 below).

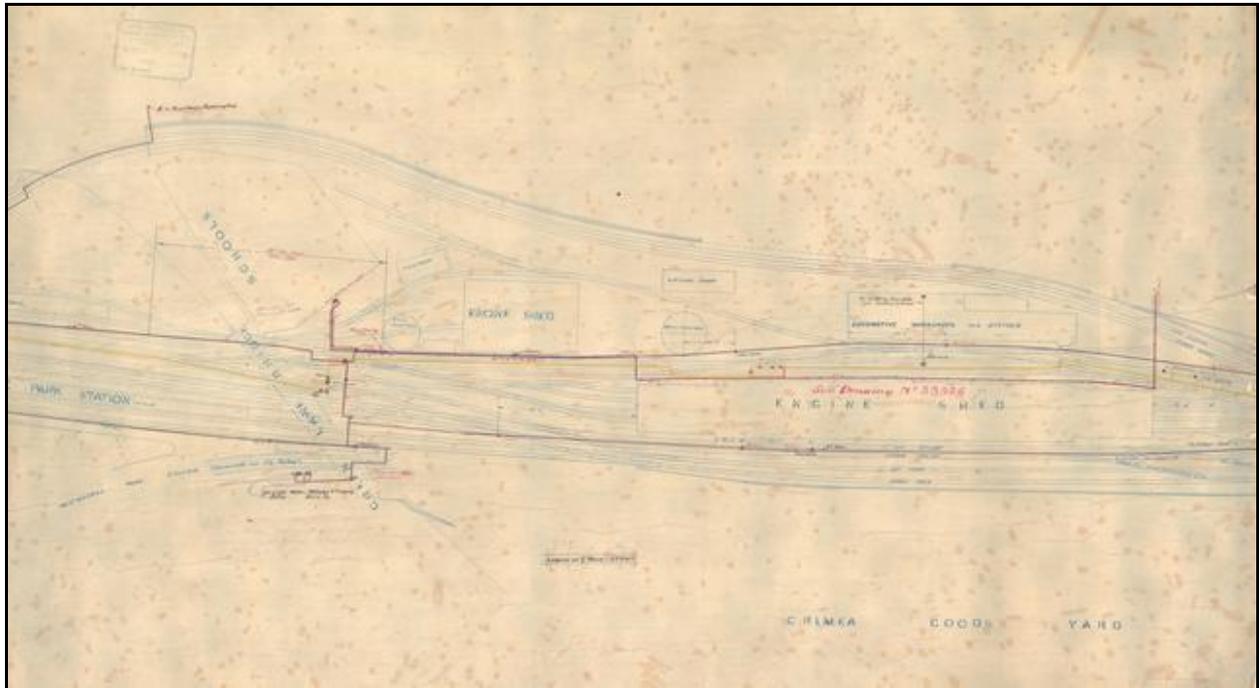


Figure 5. 1899 Westbourne Park GWR Survey Plan Sheet 5 (© Wiltshire and Swindon Heritage Centre GWR Drawing No. 2515-410-1331)

Between 1907 and the publication of the 1914 Ordnance Survey Map the worksite was redeveloped to provide a new goods depot for GWR.

The 1914 Ordnance Survey Map shows that the engine sheds have been demolished and the two turntables and much of the trackwork removed. The Sand House is still extant at this time and the Lifting shop and locomotive workshop have been converted into goods sheds. In the northern part of the site the reservoir had been in-filled and buildings comprising the GWR motor works constructed in the area now occupied by the TFL archive building.

The present Great Western Studios building was constructed in 1938 formerly being known as the Alfred Road Warehouse replacing the earlier goods sheds on the site. The access ramp from Alfred Road into the site from the east was also modified at this time with the brick retaining wall and grass embankment being replaced by the extant concrete retaining wall topped with guard rail immediately north of the Great Western Studios.

The Paddington New Yard closed as a good yard in 1972 and the Alfred Road Warehouse became a British Rail lost property depot until its sale and conversion into the Great Western Studios in 1994.

The remaining two sidings have since 1972 been used to serve the Tarmac Topmix (Marcon) aggregate plant.

2.7.3 Summary

There is likely to be a low potential for locating prehistoric, Roman, or medieval features and a moderate potential for locating post-medieval archaeology outside the cutting at each of the above sites.

Within the 1830s cutting, archaeological remains pre-dating it are not likely to survive, with the exception of the former channel(s) of the Westbourne. Any features associated with Brunel's GWR are likely to be of moderate importance. Archaeological interest is likely to be associated with post-medieval industrial archaeology, including construction of the 19th-century railway, and at the Royal Oak Worksite East the Victorian sewer and the relict watercourse of the Westbourne. These are likely to be of low to moderate importance.

2.8 Deposit Survival

Table 1 below sets out the deposit survival information for Royal Oak Worksite East and Paddington Central worksite. The data indicates that the overall archaeological potential is likely to be minimal, but is likely to be mainly 18th–19th-century deposits.

NB heights in Table 1 are metres TD, not OD.

Data ID	Easting	Northing	Data Location	Natural surface	Description	Ground Level	Notes
PYD00	526331	181600	London Street, Paddington Goods Yard (Paddington Central Worksite)	122.0	London Clay	127.0-129.0	London Clay truncated by railway cutting. No archaeology survived; localised truncation of natural geology by concrete slab to c 120.0m OD
PGY90	526336	181613	London Street, Paddington Goods Yard (Paddington Central Worksite)	122.0	London Clay	129.0	London Clay truncated by railway cutting. Wooden pile (probably from Brunel's 1838 GWR terminus), and mid-late 19th-century brick foundation, cut into the London Clay.
SIR92	525640	181880	Senior Street, Bourne Terrace	122.7	London Clay	124.5	18th-19th-century deposits at c 122.7-123.5m OD; 19th century basement floors at c 122.5m OD; Garden features at 122.5-123.0m OD
PRT93	526450	181750	1-14 Porteus Road	130.0	London Clay	130.2-130.8	19th-century garden deposits at 129.7-130.6m OD; Localised truncation of London clay by modern drains and cellars of late Victorian villas to maximum of 129.5m OD

Table 3. Deposit Survival from previous archaeological investigations

2.8.1 Royal Oak Worksite East and Paddington Central Worksite

Within the cutting, only the former course of the Westbourne, the Ranelagh Sewer, and railway archaeology (see 2.7.1) are likely to survive.

The part of Paddington Central Worksite east of Westbourne Bridge lies in an undercroft car park, with surface levels c 1.0–1.5m lower than the remainder of the worksite. This is likely to have removed potential archaeological deposits, with the possible exception of the bases of

deeply-cut features (eg possibly the lower parts of turntable pits and working pits from the 1838 engine sheds).

There is a greater potential for surviving archaeological remains to the west of Westbourne Bridge. This was demonstrated by a red brick surface or surfaces, recently observed c 1.2m below ground level in three starter pits for a borehole just to the west of the bridge (MOLA watching brief for ARUP/FES GI Package 16A, WS258, 15.01.10). The function of the surface(s) is uncertain, no structures are shown in this location on the Ordnance Survey maps of 1872 or 1914 (Annex 1 - Figure 11 and Figure 12), but a plan of 1845 (redrawn as Fig 2.7 in Brindle 2004) depicts what is apparently a large turntable in this area. Further work will be needed to identify this feature(s), but it appears possible that it is part of a turntable from Brunel's original railway of the 1830s or early 1840s. If it is not, it is most probably from another 19th or 20th-century railway structure. In either case, this indicates localised survival of railway archaeology below the base of the cutting in this area, and potentially across the remainder of both worksites west of Westbourne Bridge, which lie at a similar level. However, the evidence from historic maps suggests that such features are unlikely to extend to the Portal footprint (an area of railway tracks), but would probably be confined to the area immediately to the west of Westbourne bridge, and to the east of it. It should be noted that the height of 1.2m below ground level would probably represent the surface of the base of a turntable pit (if that is what it is), and any sides of the pit could survive much closer to ground level.

There will have been additional localised truncation below the cutting level from below-ground services across the worksites (including London Underground services adjacent to the site boundary, the 600mm diameter surface water track drain which runs the length of the Royal Oak Worksite East and West, and further high voltage cables).

In conclusion, to the west of Westbourne Bridge there is a moderate potential for the former course of the Westbourne, the Ranelagh Sewer, and railway archaeology. To the east of Westbourne Bridge there is a low potential for heavily truncated railway archaeology only.

2.8.2 Royal Oak Worksite West

The development of the Royal Oak Worksite West has been dominated by the construction of the Great Western Mainline, the excavation of the GWR cutting, associate engine sheds, goods yard and Portobello junction. The worksite is located on London Clay (Soil Mechanics, 2009) extensive cutting for the railway has removed any subsurface stratigraphy pre-dating the 19th century across the lower site area, with the exception of the area of possible alluvium (see 2.6.2).

Geotechnical ground investigations (Package 17B), established the extent and depth of made ground deposits both outside of the GWR cutting and within it in the area of the existing Tarmac depot and Bus washing facility (see section 2.4.2 above).

Limited potential for subsurface stratigraphy exists on the upper level of the site as a result of construction impacts and regrading for the elevated A40 Westway. However, three window samples (WS114-116) have recorded the survival of alluvial deposits, sealed beneath (and probably truncated by) made ground deposits and overlying the London Clay solid geology.

A number of underground utilities and services are known to be located within the area of the worksite between CH 0m 45c and 1m 20m, these will have caused localised truncation in areas not already disturbed by the GWR cutting. There is likely to be a low potential for locating prehistoric, Roman, or medieval features and a moderate potential for locating post-medieval archaeology, notably any remains associated with Alfred House that may survive in the area of the current Murphy's Yard.

Within the railway cutting there is a moderate potential for the survival of 19th-century remains associated with the construction and operation of the Great Western Railway and the Westbourne Park engine houses, workshops, goods yard and the Portobello Junction, the tracks of which are still partially visible to the south-east of the bus depot. Any features associated with Brunel's GWR are likely to be of moderate importance.

2.9 Results of trial pit monitoring

A trial pit investigation (Works package S-0008) has been undertaken at the Royal Oak Worksite West to identify and locate the presence of utilities, services and sub-surface structures.

Five test trenches (S3/03, S3/04, S3/11, S3/12 and S3/13) were targeted to locate and identify any surviving remains associated with the GWR main engine shed constructed in the 1860s within the existing permanent way and the smaller engine shed constructed by 1870 and located in the area of the Tarmac Topmix depot and Marcon sidings (see Figure 6 below).

Test trenches S3/03, S3/11 and S3/12 excavated during April 2009 and monitored by an archaeologist under watching brief conditions. Trenches S3/04 and S3/13 were excavated in October–November 2009. The results of the archaeological watching brief are summarised in Table 4 below (LAARC sitecode XRP09).

Trench	Image	Results
S3/03	 <p>© Scott Wilson 2009</p>	<p>Multiple east-west aligned brick wall foundations recorded between the northern side of Marcon Line 2 and the centre of Relief Line 4. Typically constructed from red brick, bonded by a cream sandy mortar and survived to varying depths. A number of the walls appeared to be internal elements of the engine shed and were capped by dark blue-grey copping stones or purple engineering bricks. Red brick and concrete floor levels were also identified at depth of c 121.45 and 121.35 m TD.</p> <p>Stratigraphic sequence successive layers of made ground which comprised; pale pinkish-grey modern railway ballast, dark grey sandy gravel and cinder and a brownish-yellow sandy gravel with mortar fragments, overlying natural London Clay encountered at a depth of between c 121.25 and 121.07m TD,</p>
S3/04	No Image	<p>S3/04 revealed two north–south aligned concrete foundations at a depth of c 121.88m TD. Located on the on the southern side of the Marcon Line these foundations fell outside of the engine shed and it is unclear what structure they may relate to.</p> <p>Made ground was recorded to the limit of excavation at 1.50m b.g.l. (c.121.10m TD).</p>

Trench	Image	Results
S3/11	 <p data-bbox="347 929 726 996">Wall foundation under Relief Line 4 © Scott Wilson 2009</p>	<p data-bbox="805 264 1444 459">Revealed multiple east-west aligned brick wall foundations recorded between the northern side of Marcon Line 2 and the northern side of Relief Line 4. The brick foundations were typically constructed from red brick, bonded by a cream sandy mortar, capped or faced with purple engineering bricks and surviving to varying depths below the existing track level.</p> <p data-bbox="805 470 1444 582">Again a number of the walls appeared to be internal elements of the engine shed inspection pits or troughing. Brick and concrete floor levels were also recorded of c 121.52 and 121.67m TD.</p>
S3/12	 <p data-bbox="347 1361 494 1384">© Scott Wilson 2009</p>	<p data-bbox="805 1012 1444 1097">Test trench S3/12 was aligned east-west across the 'open' western end of the 1860s main engine shed, but proved to be negative revealing only modern railway ballast.</p>
S3/13	<p data-bbox="347 1402 454 1424">No Image</p>	<p data-bbox="805 1402 1444 1512">Excavated on an east-west alignment between the Marcon Lines 1 and 2 S3/13 partially uncovered a single concrete foundation which ran the entire 30m length of the southern side of the trench at a depth of c 121.15m TD.</p> <p data-bbox="805 1523 1444 1601">Made ground was recorded to the limit of excavation at 1.50m b.g.l. (c.121.10m TD) where London Clay was exposed.</p>

Table 4. Results of Archaeological Monitoring of Trial Pit Investigation (Works package S-0008)

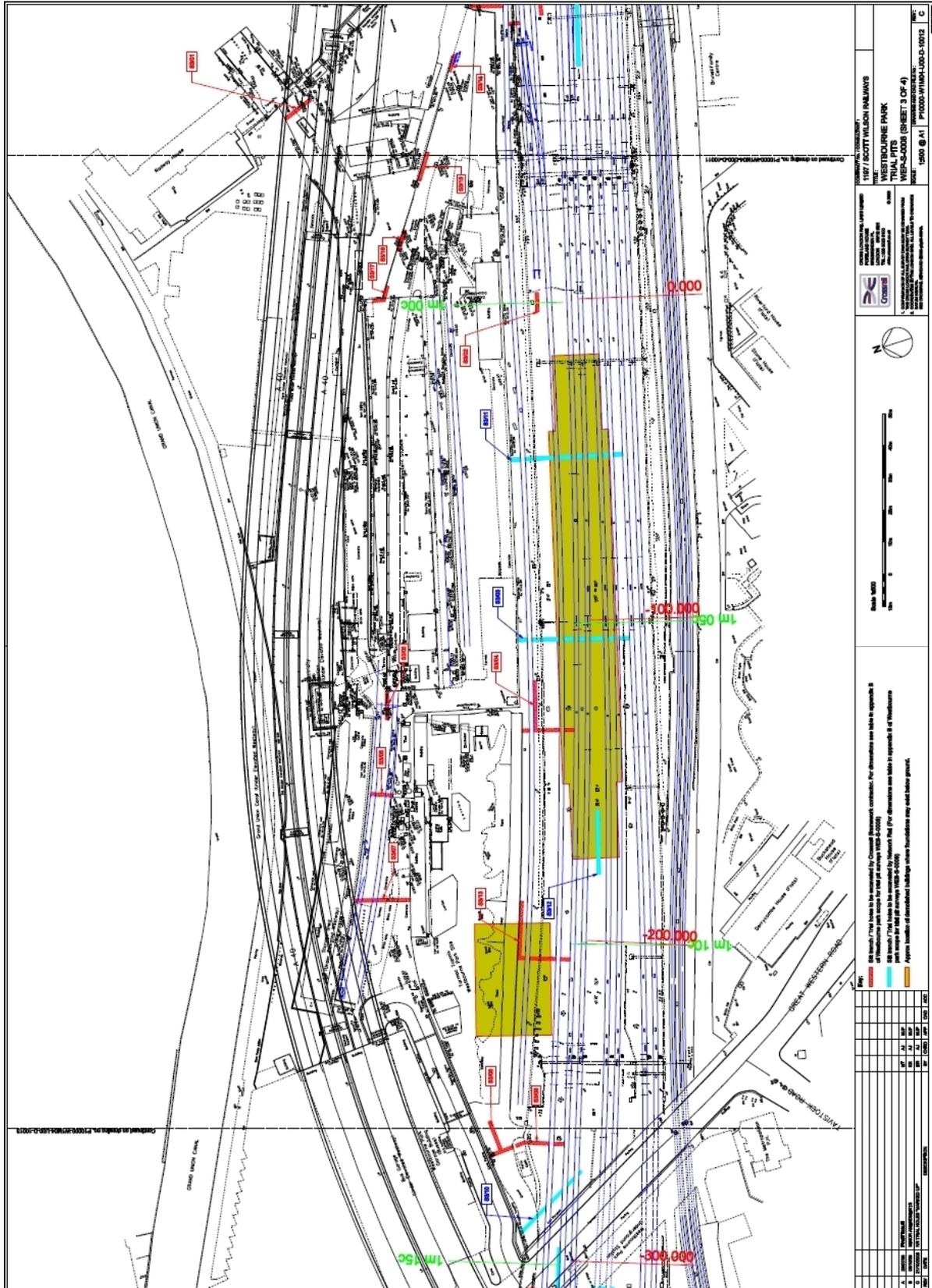


Figure 6. Drawing No. P1000-W1M04-U00-D-10012 for Trial Pit Surveys (WEP-S008)

3 Construction Impacts and Outline Mitigation

From the information in sections 2.6 and 2.8, it is assumed that there is a minimum of c 1.0m of modern disturbance across the three worksites (and greater in localised areas). Therefore, only works greater than c 1.0m deep have potential to affect archaeological remains. Following discussions with the ground works contractors (Costain Skanska jv and Morgan Sindall) and the PDP Environmental manager for the site (01.07.10 & 27.08.10), the impacts of works previously described in version 3 of this WSI have been revised accordingly.

3.1 Crossrail contract numbers

3.1.1 Westbourne Park (Royal Oak Worksite West)

- **C230 Enabling Works Westbourne Park** (demolitions, retaining wall, utilities, sub-station): Morgan Sindall

[?C181 Network Rail archaeologist to complete] **Main Works Westbourne Park**

3.1.2 Royal Oak Portal (Royal Oak Worksite East and Paddington Central Worksite)

C201 Enabling Works Royal Oak Portal (demolitions/enabling works): Keltbray (*now completed*)

C330 Main Works Royal Oak Portal (portal construction): Costain Skanska jv

C300 Tunnel Boring

C335 Headhouse, fit out, landscaping and access road etc at Royal Oak Portal

3.2 Construction Summary

Figure 7 and Figure 8 indicate the general location of the Enabling Works described below.

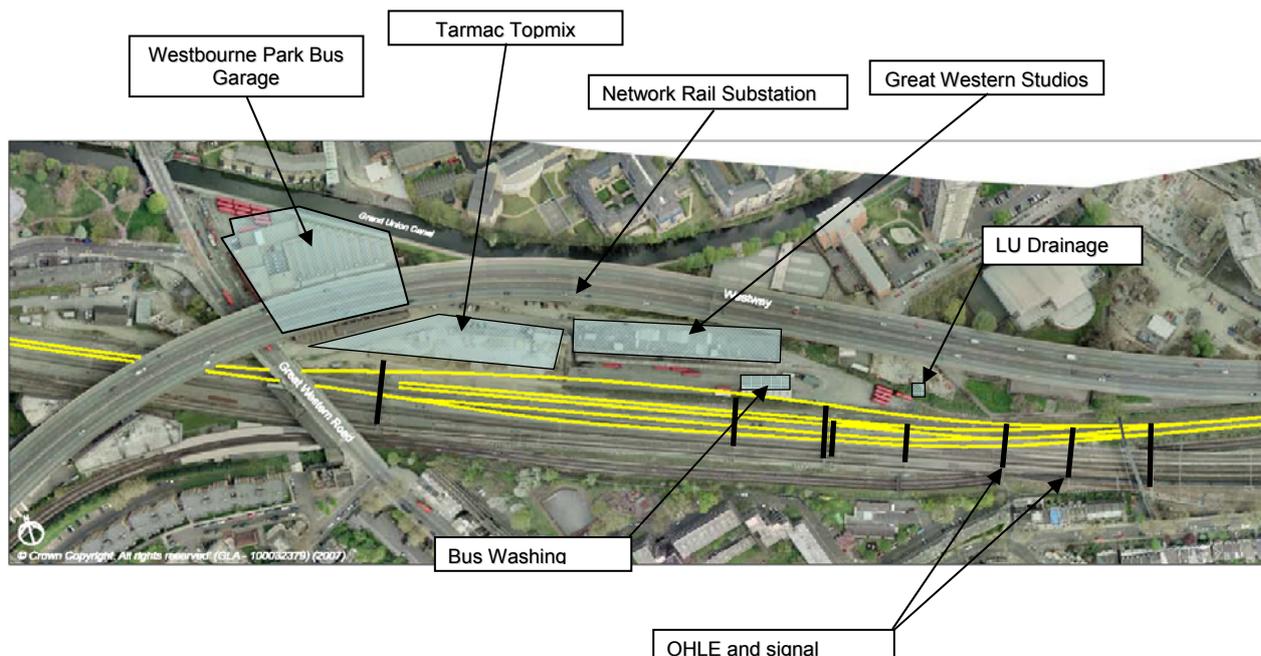


Figure 7. Westbourne Park and Royal Oak Portal (west)

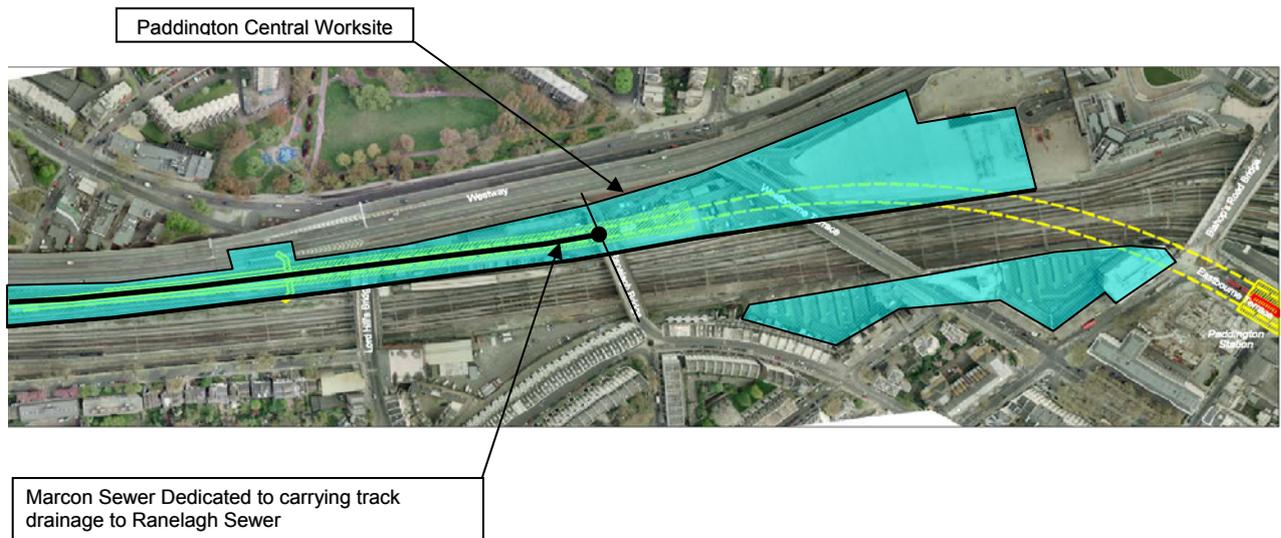


Figure 8. Royal Oak Portal (Royal Oak Worksite East & Paddington Central Worksite)

3.2.1 Royal Oak Worksite East and Paddington Central Worksite – Enabling Works

Enabling Works at the Royal Oak Worksite East and Paddington Central worksite are demolitions (including the existing buildings, structures and infrastructure associated with the existing 20th-century taxi facilities), with minimal potential to disturb below-ground archaeological remains. The Marcon Sewer diversions now fall within the Main Works, see 3.2.2). No advanced utility diversions are now required, as it has been determined that all former utilities within the portal footprint were not live, and do not require replacement/diversion.

Demolitions and site clearance (now completed following mitigation) had potential to remove or affect non-listed built heritage features (see 5.2.1).

Outline Mitigation for Enabling Works

Demolitions and any removal of associated above-ground railway features (see 5.2) have already been mitigated by built heritage recording in May 2010.

3.2.2 Royal Oak Worksite East and Paddington Central Worksite – Main Works

The Main Works at the Royal Oak Worksite East and Paddington Central Worksites will comprise the construction of the Royal Oak Portal approach ramp (detailed below), and the Marcon Sewer diversions.

Marcon Sewer

Temporary and permanent diversion of the Marcon Sewer.

The excavations for the manhole for the temporary diversion, and the shafts and 3m-deep open cut trenches for the permanent diversion, have the potential to remove any surviving archaeological deposits (see 2.8.1).

Portal

The construction works for the portal and ramp comprise:

The excavation of 1.5m deep guide wall trenches (completed August 2010), followed by:

Excavation up to 3m deep for the capping beams for the guide walls (but through the area previously disturbed by the 1.5m-deep guide wall trench).

diaphragm wall construction (excavations conducted beneath/through Bentonite clay slurry).

Between Ch 805 to 900 the portal ramp would be supported by sheet piled walls instead.

Including a flood protection wall at the western end of the portal, and the tunnel eye and head house structure at the eastern end.

Cover slab above ground treatment (overlapping rotary cores and grout mixing) for c 10m east of tunnel eye

Other Main Works

Post-construction landscaping and access roads between Lord Hill's Bridge and Westbourne Bridge, approx. ch 130 to ch 370 (depth varies considerably, but up to 2.5m excavation in some areas).

New drainage and utilities east of the portal, and connection of the foul water drainage to the Ranelagh Sewer, up to c 4m deep.

The excavations for the Portal and other Main Works listed above have the potential to remove any surviving archaeological deposits (see 2.8.1).

Outline Mitigation for Main Works

To mitigate the impact of the Main Works on archaeology, targeted watching briefs and general watching briefs will be undertaken across the relevant parts of Royal Oak Worksite East and Paddington Central Worksite west of Westbourne Bridge (see 5.1.1). A plan of the main areas that are currently thought to require watching brief is shown on Figure 14 (in Annex 1).

3.2.3 Royal Oak Worksite West – Enabling Works

Enabling Works at the Royal Oak Worksite West will facilitate the portal construction and include:

- WP2B: Ground Reduction in front (south of) the new Murphy's Yard/Westminster Academy retaining wall
- WP6: Shafts for the relocated LUL pumped drainage tunnel (tunnel is pipe-jacked at c 7–8m depth)
- WP15: Demolition works of the existing buildings and infrastructure associated with 1930s Great Western Studios and the 20th-century Westbourne Park bus facilities (now completed following mitigation) had potential to remove or affect non-listed built heritage features (see 5.2.2)

utility diversions

the modification of existing sidings layout and relocation of associated railway equipment

The location of the works at the Royal Oak Worksite West is detailed in the extract from Westbourne Park - Advanced Works, Westminster Academy/ Murphy's Yard Work Packages Plan, P10201-W1M04-R00-D-12079, in Annex 2.

The impact of the WP2B ground reduction in front of the new Westminster Academy/Murphy's Yard retaining wall between CH 0+000 and CH+200.000, would be to remove any archaeological remains that survived immediately outside (north of) the excavation of the existing cutting for the 1862 railway.

The WP6 Shafts for the relocated LUL pumped drainage tunnel at c CH+100.000, and the WP12 diversion of utilities and services across the worksite area have the potential to cause localised removal of any surviving archaeological deposits or sub-surface structural remains relating to Brunel's Great Western Railway and the later Portobello Junction.

Ground reduction for temporary track connections for the sidings and relocation of the substation are unlikely to be deep enough to affect potential archaeological remains.

Ground reduction associated with the modification and realignment of the Marcon sidings (WP13) will only be 330mm deep, and therefore have no impact on any surviving remains of the engine shed between CH-225.000 and CH-180.000. Construction Drawing No. P10502-W1M04-R00-D-2023 prepared for the retaining wall advanced works indicates that the ground reduction for the new sidings between CH+180.000 and CH+225.000 has the potential to impact on any surviving sub-surface remains of Brunel's Great Western Railway. *To be confirmed by the Network Rail archaeologist.*

The WP15 demolition of the 1930s Great Western Studios building will remove the 1930s structure and associated railway features (e.g. a cobbled surfacing possibly associated with the early 20th century GWR goods yard). The demolitions will have no impact on sub-surface remains. The bus depot/parking facilities, also to be demolished, are not of historical interest (see 5.2.2).

Outline Mitigation for Enabling Works

The impact of the above enabling works on the archaeological resource will be mitigated by a targeted watching brief on ground reduction in front of the new Westminster Academy/Murphy's Yard retaining wall. Utilities diversions, track and siding modification (where >1m deep) will be mitigated by a general watching brief. See 5.1.2 and Figure 13 (in Annex 1).

Demolition of the Great Western Studios and removal of associated above-ground railway features/street furniture (see 5.2) has already been mitigated by built heritage recording in June 2010.

3.2.4 Royal Oak Worksite West – Main Works

[Network Rail archaeologist to revise]

The Main Works at Royal Oak Worksite West will comprise:

- Demolition of existing Tarmac Topmix facility and provision of temporary and permanent replacement concrete batching plant and sidings;
- Construction of Eastbound and Westbound turn-back Platforms;

- Installation of permanent track layout for Royal Oak Portal; and
- Installation of permanent track layout for Crossrail Westbound line.

The construction activities for the main Crossrail works will be phased. Intermediate stages will include the temporary relocation of the Tarmac Topmix facility and use of the existing Tarmac site for spoil storage. Following the construction of the Royal Oak Portal (see 3.2.2) the new Crossrail track layout and Westbound turn-back Platforms will be installed, and the Tarmac Topmix facility will be permanently relocated to a new site.

The construction of both the Eastbound and Westbound turn-back Platforms and their associated amenities and track layout will impact on any surviving remains of the former GWR engine and goods sheds and track layout which existed in the area between CH-250.000 and CH0.000.

Any ground reduction more than 1.0m deep associated with the construction of the new Tarmac sidings has the potential to impact on archaeological remains associated with Brunel's Great Western railway that may survive within the railway cutting including foundations, floor levels, inspection pits and troughing associated with the later 1860s engine shed, sand house, lifting shop and the 45' and 55' diameter turntables.

The impact of the installation of new track layouts for the Royal Oak Portal and the Crossrail Westbound line will depend on the final track level and the construction methods employed. There is the potential for the survival of the remains of the Brunel's 1862 GWR engine shed and track between CH-200.000 and CH+250.000 with the existing Network Rail mainline corridor.

The Main Works may include the modification, relocation or construction of new of signalling gantries and OLE structures. This may involve intrusive elements which have the potential to damage or remove subsurface archaeological remains. These activities should be reviewed at the detailed design stage, their impact assessed and the mitigation strategy updated as necessary.

Outline Mitigation for Main Works

The impact of the Main Works activities on the archaeological resource will be mitigated by a programme of preservation by record comprising general and targeted watching briefs on any significant ground reduction or intrusive excavation associated with new track and sidings installation, construction of the east and westbound turnback platforms and new Crossrail lines including signalling and OLE infrastructure.

4 Aims and Objectives

4.1 Research Aims

Selected research themes derived from the regional research aims, *A Research Framework for London Archaeology 2002* (Museum of London, 2002), are included in the Assessment of Archaeology Impacts Technical Report, Part 2 (Crossrail 2005), and are set out below.

Below-ground archaeological remains (e.g. the former course of the Westbourne, or those outside the railway cutting) have the potential to contribute to the following research themes:

Examining the concept of core/periphery for different periods in London's past, as a means of understanding a settlement and its environs, a city and its hinterland.

Contributing to our understanding of the creation of the London suburbs.

To define levels of landscape change due either to environment and climate or human interaction.

Evidence relating to early railway construction, particularly that associated with Brunel's rail-line and the Victorian Ranelagh sewer has the potential to contribute to the following research themes:

Understanding the reasons for evolution of the road systems, street layouts, river crossings and ferries, and their importance as engines of development and change.

Examining the concept of core/periphery for different periods in London's past, as a means of understanding how evolving settlement patterns reflect the need for sustainable, beneficial relationships between a settlement and its environs, a city and its hinterland.

Establishing how daily work and life in London reflected and contributed to the rise of London as the commercial centre of the British Empire, and to its continued eminence as a world city thereafter;

4.2 Objectives of the Investigations

The overall objectives of the investigations are to preserve by record any surviving archaeological remains that will be impacted upon by the development.

Crossrail works at the Royal Oak Worksite East and Paddington Central Worksite have the potential to disturb archaeological remains relating to:

railway features relating to Brunel's Great Western Railway Bristol to Paddington Mainline of 1838 and later 19th-century railway activity (possibly including the 1838 engine shed and 1854 goods depot for any works around and east of Westbourne Bridge);

the Ranelagh Sewer (if exposed by the works); and

geoarchaeological deposits within the relict course of the Westbourne River.

At the Royal Oak Worksite West Crossrail works have the potential to disturb archaeological remains relating to:

engine sheds, workshops, Sand House, Lifting Shop, turntables and track layout within the cutting of Brunel's Great Western Railway Bristol to Paddington Mainline of 1862 and goods yard of the 19th century;



post-medieval occupation activity associated with the late 19th-century Alfred House (of only minor importance), which was located outside of the GWR cutting (area of the modern Murphy's Yard);

possible palaeo-environmental remains within alluvial deposits identified during geotechnical investigations (Works Package 17B); and

the late 19th and early 20th-century Portobello Junction.

5 Scope of the Investigation

5.1 Archaeology

The construction tasks, archaeological mitigation, and programming details for both sites are summarised in Table 5.

5.1.1 Royal Oak Worksite East and Paddington Central Worksite

A combination of Targeted Watching Brief (TWB) and General Watching Brief (GWB) is proposed for the Royal Oak Worksite East and Paddington Central Worksite west of Westbourne Bridge, with General Watching Brief (GWB) east of that bridge. A plan of the main areas that require watching brief is shown on Figure 14 (in Annex 1). The watching briefs at Royal Oak Portal will be undertaken under LAARC sitecode XSI10.

TWB will be adopted as part of a programme of observation, investigation and recording of archaeological remains during construction, utilised in specific cases where the likely extent of the remains has been demonstrated, but where detailed investigation prior to the main construction programme is unfeasible (due to safety or logistical considerations) or undesirable (due to environmental or engineering constraints). The tasks which require TWB are specified in Table 5. It is a more controlled methodology developed as part of the construction works to allow archaeological recording to take place to the required standard, focused on particular remains or deposits (predicted or known).

For the works at Royal Oak Portal and Westbourne Park, TWB will involve initial ground reduction of modern made ground or overburden being conducted by the ground works contractors under archaeological supervision. This will be followed, if necessary, by localised hand inspection, and assessment by archaeologists. If no significant or extensive archaeological remains are revealed, then that item of construction work will proceed under archaeological supervision with recording as a General Watching Brief, as defined in The Crossrail Archaeology Generic WSI (Document Reference 14022008-44ES-P2Z1).

If, however, significant or extensive archaeological remains are uncovered, the archaeological contractor will notify the Principal Contractor and Project Archaeologist, and mobilise their on-call archaeological support team, and any specialists required (eg geoarchaeologists), to rapidly excavate and record the remains. This requires a 'draw down' contingency in the construction programme for such work, to be called on if required. The contingency times are noted in Table 5, below. Note that this contingency time may not necessarily mean a delay to construction work for the whole of that period, as archaeologists may be able to work in different areas from construction teams, depending on circumstances and safety issues.

It is considered that given the anticipated extent of existing truncation from utilities, building foundations and basements, the moderate potential of the sites, and the logistical constraints of the site that TWB is an appropriate response to ground works that have potential for an extensive impact on buried remains.

Where works have potential for only a limited impact (eg relatively shallow ground reduction, or excavation over limited areas), GWB is considered the appropriate response.

The post holes for the Asset Protection Barrier will have limited individual footprints (0.45m dia) and will be machine augered to a maximum depth of 2.1m (revised design, Steve Ponsford, Costain/Skanska jv, pers comm. 16.07.10). Minimal (if any) archaeological information can be recovered from monitoring the auger risings and the bases of narrow holes. Therefore these post holes will not be included in the watching briefs.

A number of tasks noted in previous versions of this WSI have now been determined to be too shallow (less than c 1.0m ground reduction) to be likely to affect archaeological remains. These include: levelling etc for piling mat (topsoil strip only); track formation overdig (0.5–0.6m, up to 1.0m in soft spots).

The diaphragm walls for the portal will each be constructed by first excavating a c 1.5m wide by 1.5m deep trench for the guide walls (completed August 2010), excavating for the 3m-deep capping beams, and subsequently excavating the diaphragm wall trench beneath Bentonite (clay slurry to temporarily support the trench). The guide wall trenches have already been dug, and monitored in a targeted watching brief, and the capping beams will be monitored in a general watching brief, but no mitigation is possible for the subsequent diaphragm walls, as the Bentonite will prevent observation of any archaeological deposits. However, any railway archaeology, if present, would have been excavated and removed in the preceding excavations for the guide walls and capping beams. The results from the watching brief on the guide walls indicate that any archaeology deep enough to be affected by the diaphragm walls is confined to sandy alluvium from the former Westbourne in the eastern approximately one-third of the portal (which will be seen over larger areas during the TWB on the subsequent main ground reduction for the portal, and also the preceding capping beams).

Ground stabilisation over a distance of 10m east of the portal will be conducted by means of overlapping rotary cores through the alluvium and overlying deposits, and mixture of the soil with grouting. With this method a watching brief is very unlikely to produce worthwhile archaeological records, but the main potential in this area is for alluvium from the former Westbourne, which will have been examined over much greater areas immediately to the west within the portal. The potential for surviving railway archaeology is limited at the portal construction site, it having been railway tracks only, as depicted on historic maps (Figure 10 to Figure 12 in Annex 1). A cover slab constructed subsequently over this area will have no additional impact. Therefore, no mitigation is currently proposed for this small area; however, this will be reviewed from the results of earlier watching briefs in the adjacent portal area, in particular on the guide walls, capping beams, and excavation within the Portal. Provisional results from the guide walls (August 2010) suggest that remains are confined to former track-bed material of uncertain date, and sandy alluvium, apparently from the Westbourne.

Enabling Works

The NLBH recording having been completed (5.2.1), no enabling works require mitigation (see 3.2.1).

Main Works

The following main works (see 3.2.2 for details) require TWB:

- The manhole and shaft for the **temporary diversion of the Marcon Sewer** and integral pump chamber (the remainder of the diversion being pipe-jacked at depth and having no archaeological impact), including any excavation to connect to the existing sewer.

Foci for TWB: Alluvium (up to c 4m bGL, over area corresponding to approx. eastern third of portal and unknown distance to east); *1838 and later 19th-century railway features* (predicted c 1m bGL plus localised cut features; anywhere within works, if present).

- **Permanent diversion of the Marcon Sewer** (3m-deep open cut and four shafts c 3m x 3m x 3.5m deep for pipe-jacked section: *to be confirmed in advance of fieldwork*). *Foci for TWB: as above* (within areas of shafts and open cuts).
- Excavation for the **guide walls**. *Foci for TWB: as above*.

- Excavation for portal (within the diaphragm and sheet-pile retained cuts, including the tunnel eye and head house). *Foci for TWB: as above.*
- Ground reduction for landscaping and access roads between Lord Hill's Bridge and Westbourne Bridge, approx. ch 130 to ch 370 – where more than 1.0m deep.

Foci for TWB: 1838 and later 19th-century railway features over whole area, and potential for Brunellian turntable pit at eastern end (immediately W of Westbourne Bridge, c 1.2m below ground level – could be much higher ? - see 2.8.1), also for late 19th/early 20th-century Goods shed west of Ranelagh Bridge and cattle pens west of Westbourne Bridge (see Figure 12).

The following main works require GWB:

- Excavation for the Capping Beams
- New drainage and utilities east of the portal, and connection of the foul water drainage to the Ranelagh Sewer (except where over the cover slab which will lie above the ground treatment for c 10m east of tunnel eye), up to c 4m deep.

5.1.2 Royal Oak Worksite West

Archaeological mitigation is required in the form of preservation by record, comprising both targeted watching brief (TWB) and general watching briefs (GWB). In view of the anticipated extent of truncation from the railway cutting, construction of the A40 Westway and utilities across the area of the worksite it is considered that this is an appropriate response. A plan of the main areas that require watching brief is shown on Figure 13 (in Annex 1). The watching briefs at Westbourne Park will be undertaken under a LAARC sitecode *to be determined*.

TWB will be adopted as part of a programme of observation, investigation and recording of archaeological remains during the construction works where specified in Table 5. It will be conducted as described in section 5.1.1.

A number of tasks noted in previous versions of this WSI have now been determined to be too shallow (less than c 1.0m ground reduction) to be likely to affect archaeological remains. These include: temporary relocation of Tarmac Topmix facility (<1m); levelling etc for piling mat (topsoil strip only, <1m); modification etc of Marcon sidings (330mm); relocation of substation (≤600mm); demolish bus stabling area (0.5m maximum); Foundations for Shunters' Cabin (< 1m).

Enabling Works

The following tasks require TWB:

WP2B Ground reduction of the upper level of the worksite between the existing retaining wall and the new retaining wall (Westminster Academy and Murphy's Yard). *Foci for TWB: possible alluvium; 1838 and later 19th-century railway features, including the late 19th and early 20th-century Portobello Junction.*

GWB is required for the following tasks:

WP6 Shafts for the relocated LUL pumped drainage tunnel at c CH+100.000

WP12 The diversion of utilities and services between CH-300.000 and CH225.000; *To be confirmed by the Network Rail archaeologist*



Main works site Supply Diversions (incl. 11kV supply and others) *depending on depth; To be determined by the Network Rail archaeologist*

Ground reduction for the new sidings between CH+180.000 and CH+225.000; *depending on depth – To be determined by the Network Rail archaeologist*

ROP13 Construction of the temporary track connections for the spoil removal sidings; *depending on depth – To be determined by the Network Rail archaeologist*

NB tasks for the Marcon Sewer diversions are covered in section 5.1.1.

Main Works

GWB is required for the following construction tasks:

Ground reduction for the installation of the new final track layout for Royal Oak Portal between c CH0.000 and CH+225.000; *depending on depth – To be determined by the Network Rail archaeologist*

Ground reduction for the installation of the new Eastbound Crossrail connection and Marcon sidings between c CH-250.000 and CH0.000; *depending on depth – To be determined by the Network Rail archaeologist*

Ground reduction to formation levels and foundation excavation for the new Crossrail Eastbound platform between c CH-300.000 and CH+225.000; *To be confirmed by the NR archaeologist*

Foundation excavation for the construction of foundations for new OLE gantries between c CH-300.000 and CH+225.000; *To be confirmed by the NR archaeologist*

Ground reduction to formation level for the installation of the new Westbound Crossrail including Line A between c CH-300.000 and CH+225.000; *To be confirmed by the NR archaeologist*

Ground reduction to formation levels and foundation excavation for the new Crossrail Westbound platform including link to Eastbound platform and relevant OLE gantry foundations between c CH-250.000 and CH0.000; and *To be confirmed by the NR archaeologist*

Ground reduction for the installation of new Lines B and C and scissors crossover track layout between c CH0.000 and CH+225.000. *To be confirmed by the NR archaeologist*

Potentially: permanent relocation of the Tarmac Topmix facility [to be determined by the Network Rail archaeologist] *depending on depth – To be determined by the Network Rail archaeologist*

Table 5 Summary of construction tasks requiring mitigation

WSI Task	PCS04 Task (30 May 2010) <i>Other programmes as stated in italics</i>	Contract	Mitigation	Programme	Notes
WESTBOURNE PARK (WBP)					
WBP ENABLING WORKS C230					
WP2B Ground reduction of the upper level of worksite between the existing and new retaining walls (Murphy's Yard etc)	EWWEB100460 Demolish existing retaining wall & remove incl retained material AWWEBS5012 Reduce Murphy's Yard to Grade (C230 CL32.2: C2140 Excavate surface for piling, C2080 Excavate and reduce existing Retaining wall; C2230 Excavate and remove existing Retaining wall	C230	Excavation (upper part): TWB 'draw down' contingency of up to 3 days	Revised (C230; at 08.10.10) – C2140: 10/12/10 to 23/12/10; C2080: 20/12/10 to 18/1/11; C2230: 25/1/11 to 31/1/11). [PCS04 superseded: 16.11.10–20.12.10]	c 2–3.5m ground reduction Monitoring probably only needed for first week of each task
WP12 Utility Diversions				Overall: 03.12.10–21.04.11	
	AWROOP1301 Reloc of Railway & 3rd Party Utilities	C181 ?	GWB	03.12.10–27.01.11	c 1.2m deep
	AWWEBS5011 Divert Services around Murphy's Yd	C181 ?	GWB	10.01.11–04.02.11	c 1.2m deep
	C3WEBS0545 Complete reloc of railway & 3rd party utilities	C181 ?	GWB	28.01.11–21.04.11	c 1.2m deep
WP6 LUL drainage tunnel (reception and drive Shafts for thrust bored tunnel (aka Relocation of pump control cabin & construction of pump chamber access tunnel at c CH+100)	C230 Cl 32.2 13.8.10: 'pump shaft & thrust bore', tasks C900b/c, C950c EWWEB107130 Excavate for new Pump Station EWWEB108120 Excavate for new Interception Chamber	C230	GWB	22/11/10– 10/12/10 Reception Shaft (C950c) 11–25/1/11 Drive Shaft (C900b)	Shafts 5.0 and 4.0m dia, >10m deep
Ground reduction for new sidings CH+180 to CH+225		C181 ?	<i>To be determined by the Network Rail archaeologist</i>	Post-Tunnelling	
ROP13 Temporary track connections for spoil removal sidings	M2WEBS1280 Install Track Layout (M2WEBS1290 Install Headshunt ?)	C181 ?	GWB depending on depth – <i>To be determined by the Network Rail archaeologist</i>	20.04.11–07.06.11 (23.08.11–13.09.11)	
11kV Main works Site Supply Diversion	AA1060 Main works Site Supply Diversion	C181 ?	GWB depending on depth – <i>To be determined by the Network Rail archaeologist</i>	09.11.10–21.12.10	
Main works Site Supply Diversion	EWR00X0670 Main works Site Supply Diversion	C181 ?	GWB depending on depth – <i>To be determined by the Network Rail archaeologist</i>	22.09.10–05.07.11	
WBP MAIN WORKS [Network Rail]					
Ground reduction for final track layout for Portal c CH0 to +225	? C3WEBS0629 Install Fnl Alignment fm ROP to EEnd of Turnback	C181 ?	<i>To be determined by the Network Rail archaeologist</i>	27.11.13–19.02.14	Depth ?
Ground reduction for new Eastbound Crossrail connection & Marcon sidings c CH-250 to CH0		C181 ?	<i>To be determined by the Network Rail archaeologist</i>		Slewing only ? Depth ? Potential to affect remains of former GWR engine & goods sheds and track layout in area between CH-250 & CH0
Ground reduction to formation levels and foundation excavation for Crossrail Eastbound platform c CH-300 to +225	?	C181 ?	<i>To be determined by the Network Rail archaeologist</i>		
Foundation excavation for OLE gantries c CH-300 to +225	C3WEBS3000 Install new OHLE foundations and structures (12)	C181 ?	<i>To be determined by the Network Rail archaeologist</i>	22.01.15–02.04.15	
Ground reduction to formation level for Westbound Crossrail incl. Line A c CH-300 to +225	?	C181 ?	<i>To be determined by the Network Rail archaeologist</i>		
Ground reduction to formation levels and foundation excavation for the new Crossrail Westbound platform including link to Eastbound platform and relevant OLE gantry foundations c CH-250 to 0				Overall: TBC: 13.11.13–16.05.14	
	? AWWEB54590 Modify NR signals & OLE Gantries	C181 ?	<i>To be determined by the Network Rail archaeologist</i>	13.11.13 –07.03.14	
	? C3WEBS2190 Excavate for fds and soakaways (Sthn)	C181 ?	<i>To be determined by the Network Rail archaeologist</i>	16.04.14–16.05.14	
Ground reduction for the installation of new Lines B and C and scissors crossover track layout between c CH0 and +225	?	C181 ?	<i>To be determined by the Network Rail archaeologist</i>	?	
Permanent Relocation of Tarmac Topmix facility			(all sub-tasks) <i>Need for mitigation, if any, to be determined by Network Rail archaeologist</i>	Overall: 19.02.15–19.01.16	
	M2WEBS1321 Tarmac Sidings Headshunt	?		19.02.15–24.04.15	

WSI Task	PCS04 Task (30 May 2010) <i>Other programmes as stated in italics</i>	Contract	Mitigation	Programme	Notes
	Retaining Wall				
	C3WEBS2960 Construct Fds for New Tarmac Topmix Plant	?		16.04.15–15.06.15	
	C3WEBS5050 Construct Hopper Building	?		15.06.15–10.08.15	
	C3WEBS5052 Construct Silo Building	?		15.06.15–10.08.15	
	C3WEBS5054 Construct Elevated Structures	?		10.08.15–08.09.15	
	C3WEBS0649 Install New Layout@ W End inc Con to Line 6 etc	?		01.12.15–19.01.16	
	C3WEBS0659 Inst Tarmac Sidings inc 2 leads & Xover	?		01.12.15–12.01.16	
ROYAL OAK PORTAL (ROP)					
ROP ENABLING WORKS C201					
None affecting below-ground remains					
ROP MAIN WORKS C330, C335					
Temporary diversion of Marcon Sewer (manhole/shaft including pump chamber)	M2WEBS1301 Divert NR Surf Water & Track drainage inc Marcon Under Track Areas (CL32 Rev 2): ROP4670 Construct temporary manhole 1180; ROP4200 Construct pump chamber ch.700 (single hole c 4–4.5m deep); and ROP4210 Excavate or Grout up Marcon Sewer @ 1090 (c 2.5–3m deep)	C330	TWB 'draw down' contingency: up to 1 day	Manhole/Pump chamber: 31.08.10 (5 days, 2–3 days relevant to archaeology)	<i>Shaft/chamber for pipejack</i>
Permanent diversion of Marcon Sewer	(CL32 Rev 2): ROP4700 temporary works for later Marcon Sewer and (CL32 Rev 2): ROP4650 construct new Marcon sewer	C330	TWB 'draw down' contingency: up to 5 days	Currently: start mid September 2010; may be postponed to July 2011 (S. Ponsford Costain/Skanska jv, email 26.07.10) Durations (CL32 Rev 2): 15 + 15 = 30 days.	<i>Provisionally: c 3.0m deep (both open cut and bored). Currently: open cut & c 40m long bored work; c 4 shafts 3x3 in plan and 3.5m deep (approx). To be Revised from contractor's final design.</i>
Portal: Guide Walls for Diaphragm Walls	A1370 Build Guide Walls	C330	TWB 'draw down' contingency: up to 5 days	14.07.10–21.09.10 (completed)	1.5m deep
Portal: excavation for capping beams	Not in PCS04 ? (CL32 Rev 2): Excavation & Construction Of Capping Beam – various Sections as below: ROP3200 C South 830–900 ROP7200 C North 830–900 ROP7190 C North, South, & End 805–830 ROP32110 N Phase 1 900–960 ROP32130 N Phase 2 960–1040 ROP32160 N Phase 3 1040–1090 ROP4850 S Phase 1 900–960 ROP5030 S Phase 2 960–1040 ROP7270 S Phase 3 1040–1090	C330	GWB, Excavation only (Construction work for capping beams does not require monitoring)	Excavation: 3.11.10 to approximately start December 2010	c 3m deep (through area already disturbed by guide wall trench)
Portal: Excavation within D-Walls etc				Overall: 24.01.11–22.09.11	
	TWROOP0154 Excavate from 122.5TD	C330	TWB 'draw down' contingency: up to 10 days for all excavation sub-tasks within portal	24.01.11–18.02.11	
	TWROOP0214 Excavate Ch320–370 to U/S base slab	C330	see above	11.05.11–01.06.11	cf Alluvium down to c 18m ATD
	TWROOP0254 Excavate Ch370–400 to U/S base slab	C330	see above	02.06.11–29.06.11	
	TWROOP0264 Excavate Ch400–430 to U/S base slab	C330	see above	30.06.11–27.07.11	
	TWROOP0274 Excavate Ch430–475 to U/S base slab	C330	see above	28.07.11–24.08.11	
	TWROOP0314 Excavate Remaining Material from TBM Reception Chamber to U/S of Base Slab	C330	see above	25.08.11–22.09.11	

WSI Task	PCS04 Task (30 May 2010) <i>Other programmes as stated in italics</i>	Contract	Mitigation	Programme	Notes
Ground reduction for landscaping and access roads between Lord Hill's Bridge and Westbourne Bridge, approx. ch 130 to ch 370 (where >1.0m deep)	Not yet programmed in detail	C335	TWB 'draw down' contingency: up to 5 days	2013	Landscaping up to c 2.5m ground reduction (dwgs C150-CSY-D-DDB-CR076-PT00101 to -5, Rev P03 S4) (potential for ?Brunel ?turntable immediately W of Westbourne Br c 1.2m below ground level; also L 19th/E 20th-century Goods shed W of Ranelagh Br and cattle pens W of Westbourne Br)
New drainage and utilities E of portal and Connection of foul water drainage to Ranelagh Sewer	Not yet programmed in detail	C335	GWB	2013/2014 ?	Depth c 4m

5.2 Non-Listed Built Heritage

Non-listed built heritage (NLBH) assessment and recording forms part of the archaeological mitigation strategy for Crossrail. The definition of non-listed built heritage adopted follows Information Paper D22 Archaeology and Crossrail Generic WSI (Document Reference 14022008-44ES-P2Z1), and 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.

5.2.1 Royal Oak Worksite East and Paddington Central Worksite

The non-listed built heritage features at Royal Oak Worksite East and Paddington Central Worksite were assessed by MOLA in January 2010 to determine what features were present, which required recording, and to what level (as specified in English Heritage 2006). The results were listed in the previous version of this WSI, and the required recording was conducted by MOLA in May 2010 (in advance of demolition) according to a written method statement, under London Archaeological Archive & Research Centre (LAARC) sitecode XRT10.

The features and the level of recording enacted are listed in Table 6 below, their general locations are shown on Figure 15 in Annex 1, and the recording reported on in:

Crossrail (MOLA), June 2010, *C150 Royal Oak Portal, Non-Listed Built Heritage Recording*, Document Number: C150-CSY-T1-RGN-CR076_PT001-00010.

5.2.2 Royal Oak Worksite West

Similarly, the non-listed built heritage features at Royal Oak Worksite East and Paddington Central Worksite were assessed by Scott Wilson in or before 2009. The location of NLBH assets are shown on Fig 12 (drawing number P10000-W1M04-A00-D01001).

The results were listed in the previous version of this WSI, and the required recording was conducted by MOLA in June 2010 (in advance of demolition) according to a written method statement, under LAARC sitecode XSA10.

The features and the level of recording enacted are listed in Table 7 and Table 8 below, and the recording reported on in:

Crossrail (MOLA), Draft July 2010, *Westbourne Park, Non-Listed Built Heritage Recording*, Document Number to be assigned.

In addition to the built heritage assets recorded in Table 7 and Table 8, the presence of two 20th-century structures to be demolished as part of the enabling works for Royal Oak Worksite West was noted. These include a bus washing facility of steel framed construction and a diesel fuel tank. Neither of these structures are of any historic value or interest so further assessment or recording was not required.

Name/Figure Ref Location	Image	Description	Significance	Mitigation enacted
<p>NLBH Westway part of 1960s planned townscape – See 1 on Figure 15</p>		<p>Piers and base for Westway superstructure</p>	<p>Not listed, however forms part of Westway 1960s planned landscape and is of local interest</p>	<p>No mitigation required</p>
<p>19th-century railway sleepers (disused – Historic Street Furniture) – See 2 on Figure 15</p>		<p>Railway tracks associated with the 19th-century good shed (as located on 1914 map)</p>	<p>Surviving asset associated with the 19th-century good shed and cattle pens</p>	<p>An English Heritage photographic record with a simple plan.</p>

<p>19th-century retaining wall for railway platform – See 3 on Figure 15</p>		<p>19th-century retaining wall associated with railway platform for goods shed</p>	<p>Surviving feature associated with the 19th-century good yard and cattle pens</p>	<p>An English Heritage photographic record with a simple plan</p>
<p>Historic Street paving (Historic Street Furniture) – see 4 on Figure 15</p>		<p>Historic stone cobbles survive throughout the taxi facility location</p>	<p>Although not listed these are associated with the original paving of the railway goods yard</p>	<p>An English Heritage photographic record with a simple plan</p>

<p>Late 19th or early 20th-century, brick retaining wall – See 5 on Figure 15</p>		<p>Late 19th or early 20th-century brick retaining wall along the north side of site contains small arches,</p>	<p>Surviving feature associated with the 19th-century railway</p>	<p>An English Heritage photographic record with a simple plan</p>
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Table 6. Non-Listed Built Heritage within the Royal Oak Worksite East and Paddington Central Worksite.

Name see Figure 9 for locations	Image	Description	Significance	Mitigation enacted
Great Western Studios building and associated furniture		<p>Three storey, twenty bay, purpose built brick building dating to the mid 20th century. Surmounted by two timber rectangular stair towers presumably used for roof access. Ground floor is located on a brick plinth which may be part of the original goods shed or workshop. On top of the plinth are timber platforms and intermittent breeze block structures. First and second floors are mounted on a concrete ring beam. Window openings feature concrete lintels broken up by brick pilasters. A timber canopy is also extant which may be part of the previous structure. The rear of the building features a projecting section forming part of a covered vehicle bay, extending further on cantilevered concrete piers. Railway tracks associated with original late 19th century goods</p>	<p>The structure retains many features of historic interest including light fittings, timber roof lift towers, timber platforms, runners/rail system for delivery of goods, canopy and cast iron rain water goods</p> <p>The tracks represent an important surviving functional element of the late 19th century goods shed and Portobello Junction and are intrinsic to the development of the site.</p>	<p>Level II English Heritage Survey</p>

Name see Figure 9 for locations	Image	Description	Significance	Mitigation enacted
		<p>shed.</p> <p>Railway tracks dating to the Portobello Junction phase of development.</p>		

Name see Figure 9 for locations	Image	Description	Significance	Mitigation enacted
Retaining wall		<p>Brick built retaining wall with central round headed recess arch for drainage. The retaining wall was built in the late 19th or early 20th century around the same time as the Portobello Junction. It is constructed predominately of blue engineering bricks with a blue vitrified brick capping although the wall has now been rendered with pebble dashed concrete.</p>	<p>The wall is a significant survival of the works undertaken as part of the Portobello Junction construction.</p>	<p>Level II English Heritage Survey</p>

Table 7. Non Listed Built Heritage within the Royal Oak Worksite West.

Name [Figure Ref]	Image	Description	Significance	Mitigation/Further Investigation
GWR fire hydrant cover		<p>Cast Iron Great Western Railway fire hydrant cover. The cover is likely to predate the existing building as the GWR ceased to exist in 1948, it is therefore likely to be contemporary with either the early 20th century goods shed or mid to late 19th century workshop and as such is an important part of the historical development of the site.</p>	<p>Not listed or located within a conservation area. However, it has historic interest as part of the industrial heritage of this area.</p>	<p>If feasible the cover should be incorporated or re-used within the Scheme.</p>
Historic street paving		<p>A large proportion of historic stone setts survive throughout the site (as located in Figure 9 Drawing No. P10000-W1M04-A00-D01001)</p>	<p>Not listed, but is of interest as part of the original street paving of the original goods yard.</p>	<p>No mitigation required.</p>

Table 8. Non Listed Street Furniture within the Royal Oak Worksite West (see Figure 9)

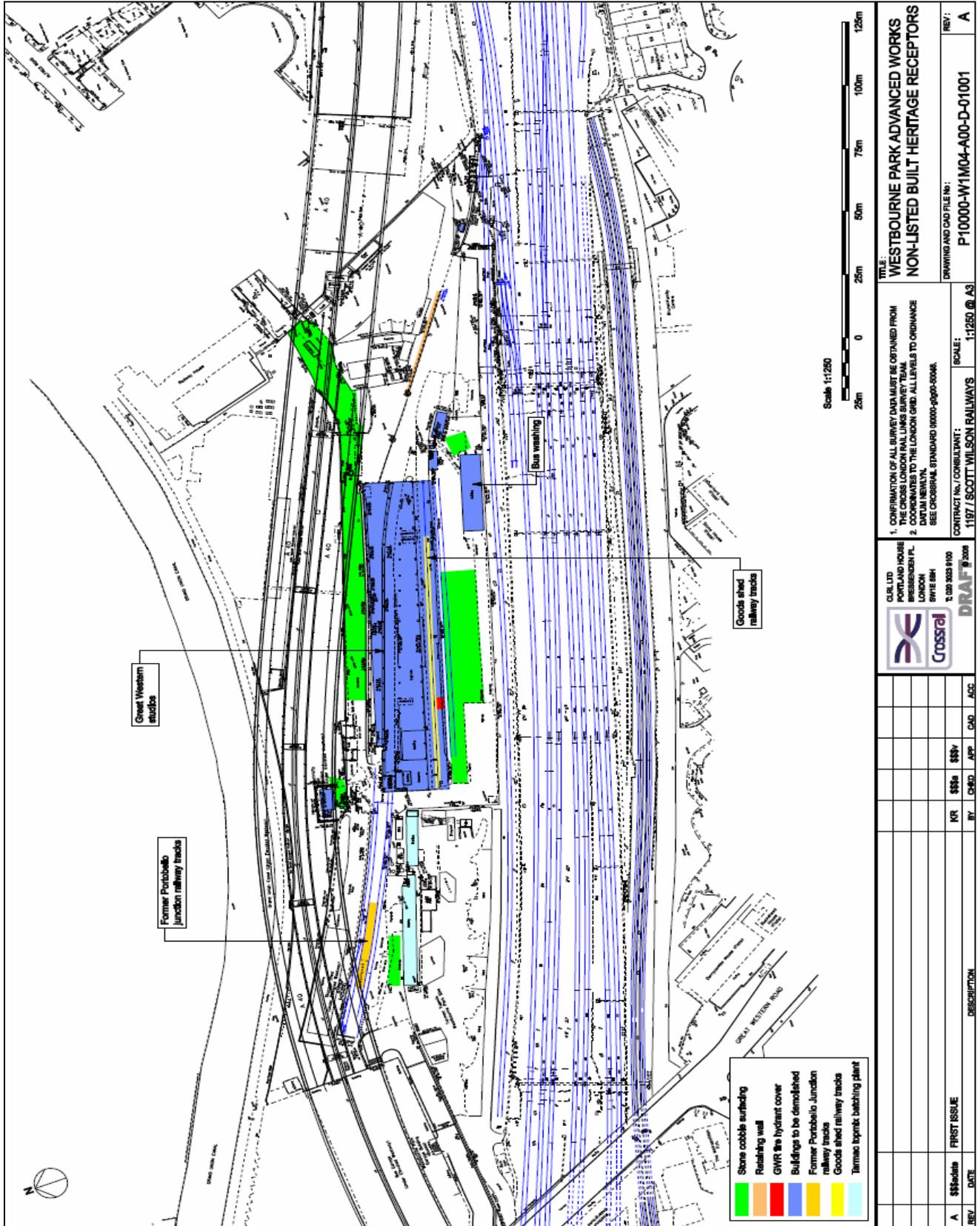


Figure 9. Non-listed Built Heritage Locations in Royal Oak Worksite West, Drawing No. P10000-W1M04-A00-D01001

6 Programme

In this revision of the WSI, current programming information for the archaeological mitigation of individual construction tasks is detailed in Table 5 above (to avoid lengthy repetition and present all of the main task information in one place). A programme for the archaeological design, fieldwork and reporting is presented in Annex 3 – Programme. The following section presents an overview.

6.1 Introduction

Site-specific targeted watching brief and general watching brief mitigation measures are presented using the following phasing:

- **CRITICAL** phase archaeological works which need to be undertaken prior to the enabling works (this may apply to very significant archaeological remains where complex mitigation is required and where early site access is required)
- **Phase 1** archaeological works to be undertaken commensurate with the programme of Enabling Works (advance works)
- **Phase 2** archaeological works to be undertaken commensurate with the Main Works
- **Phase 3** archaeological works to be undertaken after the Main Works phase (e.g. post excavation assessment, analysis, publication and dissemination).

NO sites were identified at Westbourne Park and Royal Oak that required investigation at the CRITICAL phase.

It should be noted that when works are soon to occur, the programmes become rapidly outdated. Programme information for individual tasks will need to be revised or confirmed close to the dates of commencement, by the archaeological contractor and design archaeologist.

6.2 Royal Oak Worksite East and Paddington Central Worksite

The current programming information (see Table 5) is based on:

Extracts from Crossrail programme PCS04 (30.05.10)

Costain/Skanska jv programme CL 32 Rev 2 (06.07.10) for C330

Costain/Skanska jv programme CL 32 (printed 07.07.10) for C230

Discussions with staff from Costain/Skanska jv, Capita Symonds, and PDP

No detailed programming information is currently available for C335 (drainage/utilities for the portal head house, landscaping, and access road).

6.2.1 Outline Programme/Sequence of Archaeological Works

The construction programme for these worksites is summarised below:

Enabling Works commenced in June 2010, and overlapped with the start of the Main Works.

Main Works commenced in July 2010 (with guide walls for portal) and will continue into 2013.

Post-portal construction tasks will continue from 2013 into 2014, but not all are currently programmed in detail (eg the landscaping, drainage, and utilities which require GWB).

6.2.2 Programme requirements

The General Watching Brief on the drainage and utilities has little or no implication for the construction programme. The targeted watching briefs are described below.

Note that the contingency time for TWB may not necessarily mean a delay to construction work for the whole of that period, as archaeologists may be able to work in different areas from construction teams, depending on circumstances and safety issues.

Enabling Works

None.

Main Works

The following Targeted Watching Briefs require 'draw down' contingencies as shown in the table below.

• TWB Task	• 'draw down' contingency
• Manhole and shaft for temporary diversion for the Marcon sewer	• up to 1 day
• Excavation for portal (all excavation sub-tasks within the diaphragm walls)	• up to 10 days
• Excavation for the guide walls (completed)	• up to 5 days
• Permanent diversion for the Marcon sewer	• up to 3 days
• Ground reduction for landscaping and access roads	• up to 5 days

Table 9 'Draw down' contingencies for TWB Royal Oak Worksite East and Paddington Central Worksite

6.3 Royal Oak Worksite West

The current programming information for enabling works (see Table 5) is based on:

- C230 Morgan Sindall programme CI 32.2 of 13.08.10
- Discussions with staff from Morgan Sindall, and PDP

Main Works: To be completed by the Network Rail archaeologist

6.3.1 Outline Programme/Sequence of Archaeological Works

The construction programme for these worksites is summarised below:

- Enabling Works commenced by July 2010 with demolitions. shafts for the LUL drainage are currently programmed to start in November 2010, and Ground reduction for between the Murphy's Yard/Westminster Academy retaining walls on 20/12/10.
- The Main Works are currently programmed to commence in April 2014, with the permanent relocation of the Tarmac Topmix facility continuing into January 2016.

6.3.2 Programme requirements

The General Watching Briefs during both phases have little or no implication for the construction programme. See note on contingency time for TWB in 6.2.2.

Enabling Works

The following Targeted Watching Brief requires a 'draw down' contingency as shown in the table below:

• TWB Task	• 'draw down' contingency
• Ground reduction of the upper level of the worksite between the existing retaining wall and the new retaining wall (Murphy's Yard)	• up to 5 days

Table 10 'Draw down' contingencies for TWB Royal Oak Worksite West

Main Works

No Targeted Watching Briefs are required for the Main Works. [*To be confirmed by the Network Rail archaeologists*].

6.4 Non-Listed Built Heritage

The NLBH recording has already been conducted for both sites, and no further fieldwork is required (see 5.2).

7 Specification for Evaluation & Mitigation (including Watching Brief)

7.1 Generic Standards

7.1.1 The archaeological mitigation works and scope of any archaeological scientific methods shall be designed and undertaken in accordance with the Generic WSI and relevant best practise guidance (and any subsequent revisions) i.e.:

- Those listed in *Crossrail Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* section 7.A.1 (Crossrail, 2009e, Doc. No. CR-PN-LWS-EN-SP-00001 Ver. 0.3)
- *GLAAS Standards for Archaeological Work, London Region, External Consultation Draft* (English Heritage 2009)
- English Heritage *Understanding historic buildings: a guide to good recording practice* (English Heritage 2006c)

Potentially nationally important remains

7.1.2 Nationally important remains currently appear unlikely to be exposed on the Westbourne Park and Royal Oak Portal sites. If, however, any extensive and well-preserved remains of Brunel's 1830s and 1840s Great Western Railway were present, their significance would need to be rapidly assessed and appropriate mitigation measures determined, in accordance with sections 7.A.1 to 7.A.2 of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e).

7.1.3 Such early railway structures are not predicted at Westbourne Park or the main portal construction site, but might possibly survive immediately to the west of Westbourne Bridge (where landscaping is to be carried out), and east of that bridge (where no ground reduction is planned). See 2.8.1.

7.1.4 The Archaeology Contractor shall submit details of their procedure for excavating and recording potentially nationally important remains in the Archaeology Contractor's Method Statement. 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 Archaeology Contractor in the assessment of the significance of such discoveries and the timescales to be adhered to.

Human Remains

7.1.5 Human remains are unlikely to be present on the Westbourne Park and Royal Oak Portal sites.

7.1.6 If any human remains were to be found, they will be treated in accordance with the procedures in section 7.A.6 to 7.A.15 of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e). Crossrail procedures for

dealing with discoveries of human remains shall identify any specific individual roles or actions that are relevant to the works.

- 7.1.7 If removal of human remains were to be required, an Exhumation Licence would 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.

Treasure Act

- 7.1.8 If any items falling within the scope of the Treasure Act 1996 were found on site, the procedures in section 7.A.16 to 7.A.22 of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e) will be enacted. This currently appears unlikely.

- 7.1.9 Crossrail procedures for dealing with Treasure finds shall identify any specific individual roles or actions 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.

7.2 Health and safety

- 7.2.1 Health and Safety will be addressed in accordance with section 7.B of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e).

- 7.2.2 The Archaeology Contractor shall undertake the works in accordance with the Employer's Health and Safety requirements and the Principal Contractor's Health and Safety Plan. Where specific health and safety constraints or requirements for the Archaeology Contractor's method of work are required, these are set out below and shall be addressed in the Archaeology Contractor's Method Statement (in the Health and Safety Plan).

- 7.2.3 In addition to the general issues arising from conducting watching briefs on a major construction site, the archaeological contractor, in conjunction with the Principal contractor, will need to address:

Conducting TWB and GWB on deep, potentially confined, utility shafts and trenches, including the Marcon Sewer diversions, LUL drainage, and new utilities east of the portal.

Conducting TWB within the restricted areas of the ground reduction within the diaphragm walls of the portal.

7.3 Location and ground elevation of interventions and survey grids

- 7.3.1 The archaeological contractor will survey the site in accordance with section 7.C of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e).

7.4 Specification for watching brief

7.4.1 The watching briefs will be conducted in accordance with section 7.H of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e).

7.4.2 In particular, Targeted Watching Briefs are described generically as follows:

A targeted watching brief shall comprise observation and recording of the Principal Contractor's works with specific operations carried out under the supervision of the Archaeology Contractor. Under targeted watching brief, the Archaeology Contractor may impose constraints on, or require changes to, the Principal Contractor's or his sub-contractor's method of working to enable the archaeological investigation to take place alongside construction works (7.H.4).

In archaeologically sensitive areas, where the need for a targeted watching brief has been identified in the SS-WSI, the Principal Contractor will strip soils (which may include modern made ground, topsoil, subsoil, alluvium and colluvium) using a 360 degree excavator and **smooth-bladed ditching bucket** under the supervision of the Archaeology Contractor. The Principal Contractor will limit their tracking of vehicles and plant within areas specified in the SS-WSI and/or as instructed by the Project Archaeologist. The Principal Contractor will facilitate mapping and sampling of deposits by the Archaeology Contractor through use of agreed plant, a site share agreement and careful liaison between the Archaeology Contractor's supervising archaeologist and the Principal Contractor's site supervisor (7.H.9).

7.4.3 The Principal Contractor and Archaeological Contractor will devise safe method of work for conducting the TWB during ground reduction within the portal, to be previously specified in their approved Method Statements. This will include:

- designated safe working areas, separated from the remainder of the portal worksite by robust barriers
- traffic management in the surrounding area, to prevent accidental machine/traffic entry
- safe access for the archaeological team to the working area

7.4.4 Other site-specific requirements for the watching briefs at Westbourne Park and Royal Oak Portal are described in section 5.1.1 of this WSI.

7.4.5 The Archaeology Contractor shall undertake Targeted and General Watching Briefs during Enabling Works and Main Works at Royal Oak Worksite West, and Main Works at Royal Oak Worksite East and Paddington Central Worksite, for the construction tasks referred to in Section 5.1 and specified in Table 5.

7.5 Archaeological science

7.5.1 Investigation and sampling of archaeological, geoarchaeological, and palaeo-environmental deposits will be conducted following the site-specific sampling strategy and in accordance with section 7.H of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e).

7.5.2 At Westbourne Park such methods are potentially required in the area around Murphy's Yard, and possibly to its south (east of the Great Western Studios), where borehole logs suggest the presence of alluvium (see 2.6.2). At Royal Oak Portal they are likely to be

required for the former channel of the Westbourne stream (see 2.6.1). Other deposits requiring geoarchaeological investigation or environmental sampling etc might be identified in the course of the watching briefs.

- 7.5.3 Absolute dating (eg Radiocarbon or OSL) may be required for alluvial deposits; samples for dating should be taken where appropriate.

8 Deliverables

- 8.1.1 The Archaeology contractor shall produce method statements, reports, site archives, digital data in accordance with section 8 of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e). Additional and site-specific considerations are listed below.

8.2 Archaeological Contractors Method Statement

- 8.2.1 The Archaeology Contractor's Method Statement(s) will include details of how they will conduct the targeted watching briefs, agreed with the Principal Contractor. It will also include a preliminary geoarchaeological and environmental sampling strategy for the site, to be developed, if required, when deposits which require it are encountered.

8.3 Fieldwork Reporting

- 8.3.1 Each fieldwork event requires:

- An Interim Statement
- A Survey Report
- A Fieldwork Report – in this case watching brief reports incorporating a SMR/HER Summary Sheet (OASIS form)
- Summary Reports (Annual summaries for *London Archaeologist*, and for period journals such as *Post-Medieval Archaeology* where appropriate) submitted to the Project Archaeologist. These should conform to the guidance on submission dates and vocabulary at:
<http://www.museumoflondonarchaeology.org.uk/English/ArchiveResearch/Fieldwork-Roundup/>.

- 8.3.2 The individual fieldwork events requiring reporting are currently defined below, and shown on the programme in Annex 3. They may be revised by the Project Archaeologist in the light of archaeological results or project requirements.

- TWB & GWB Westbourne Park Enabling Works 2010–2011
- TWB & GWB Westbourne Park Main Works 2013–2015
- TWB & GWB Royal Oak Portal Main Works (Portal) 2010–2011
- TWB & GWB Royal Oak Portal Main Works (Drainage, Utilities, and Landscaping) 2013–2014
- Where a fieldwork event is of sufficient duration, Summary Reports will be submitted to the Project Archaeologist for each event (sitecode) annually at the start of January. The signed-



off summaries will be sent to LAARC (for *London Archaeologist*) by the annual submission date: the end of February each year (period journals differ).

9 Site Monitoring & Progress Reports

- 9.1.1 Weekly progress reports, other reporting, and site monitoring by the statutory consultees (eg GLAAS) will be conducted in accordance with section 9 of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e).

10 Personnel requirements

- 10.1.1 The Archaeology Contractor shall provide project personnel in accordance with section 10 of *Archaeology, Specification for Evaluation & Mitigation (including Watching Brief)* (Crossrail, 2009e).

11 References and glossary of terms

11.1 References

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11.2 Glossary

BP	Years before present, conventionally taken to be 1950
Bronze Age	c 2000–650 BC
DDBA	Detailed desk-based assessment(s)
Devensian	Geological era from 70,000 to 10,000 BP
Eyot	A small island (in this work, one within the existing or former courses of the Thames or its tributaries)
GLAAS	Greater London Archaeology Advisory Service (an English Heritage department providing archaeological advice to the planning departments of the London boroughs (excepting the City and Southwark))
GWR	Great Western Railway
m OD	Metres above Ordnance Datum (Newlyn). To obtain Tunnel Datum heights (m TD) add 100m to OD heights.
m TD	Tunnel Datum (Crossrail project datum, see above)
Medieval	AD 1066–1485
OLE	Overhead Line Electrification
Palaeochannel	Deposits representing a former stream channel
Post-medieval	AD 1485–present
Roman (Romano-British)	AD 43–c 410
Saxon (early-medieval)	AD 410–1066
TBM	Tunnel boring machine.

Annex 1 – Additional Figures

Figure 10. 1862 Stanford map extract

Figure 11. 1872 Ordnance Survey map extract

Figure 12. 1914 Ordnance Survey

Figure 13. Archaeological Mitigation areas (approximate) - Royal Oak Worksite West enabling works (to be revised by the Network Rail archaeologist, incl. all Main Works)

Figure 14. Archaeological Mitigation areas (approximate) - Royal Oak Worksite East and Paddington Central Worksite

Figure 15. Location of Non-listed Built Heritage on the Royal Oak Worksite East and Paddington Central Worksite

Annex 2 – Engineering Plans and Drawings

- Royal Oak Portal location plan (dwg. no. C150-CSY-S-DDA-CR076_PT001-00010, Rev P02)
- Royal Oak Portal plan and profile (dwg. no. C150-CSY-S-DDL-CR076_PT001-00051, Rev P02)
- Royal Oak Portal Geological Cross Section (dwg. no. C150-CSY-C2-DDL-CR076_PT001-00012, Rev P01)
- Royal Oak Portal Existing Utilities Layout, Sheet 1 of 5, C330 (dwg. no. C150-CSY-U-DDA-CR076_PT001-02003, Rev. P03)
- Royal Oak Portal Existing Utilities Layout, Sheet 2 of 5, C330 (dwg. no. C150-CSY-U-DDA-CR076_PT001-02004, Rev. P03)
- Royal Oak Portal Existing Utilities Layout, Sheet 3 of 5, C330 (dwg. no. C150-CSY-U-DDA-CR076_PT001-02005, Rev. P03)
- Royal Oak Portal Existing Utilities Layout, Sheet 4 of 5, C330 (dwg. no. C150-CSY-U-DDA-CR076_PT001-02006, Rev. P03)
- Royal Oak Portal Existing Utilities Layout, Sheet 5 of 5, C330 (dwg. no. C150-CSY-U-DDA-CR076_PT001-02007, Rev. P03)
- Royal Oak Portal, diaphragm wall and ramp, typical construction sequence, (Cross Sections Ch. 1014 to 1056, dwg. no. C150-CSY-R5-DDB-CR076_PT001-00202, Rev P02)
- Royal Oak Portal Electrical Services, External Walkway, Services Duct Route, Sheet 1 of 2 (dwg. no. C150-CSY-E-DDA-CR076_PT001-00522, Rev P01)
- Royal Oak Portal Electrical Services, External Walkway, Services Duct Route, Sheet 2 of 2 (dwg. no. C150-CSY-E-DDA-CR076_PT001-00523, Rev P01)
- Royal Oak Portal Utility Supplies To Head House, Sheet 1 of 2, C335 (dwg. no. C150-CSY-U-DDL-CR076_PT001-02001, Rev. P03)
- Royal Oak Portal Utility Supplies To Head House, Sheet 2 of 2, C335 (dwg. no. C150-CSY-U-DDL-CR076_PT001-02002, Rev. P03)
- Royal Oak Portal Drainage Layout, Sheet 1 of 2, C330 / C335 (dwg. no. C150-CSY-D-DDA-CR076_PT001-00501, Rev. P04)
- Royal Oak Portal Drainage Layout, Sheet 2 of 2, C330 / C335 (dwg. no. C150-CSY-D-DDA-CR076_PT001-00502, Rev. P04)
- Royal Oak Portal Drainage Schematic Layout
- Royal Oak Portal, Landscaping and Access Road Alignment (dwg. no. C150-CSY-D-DDA-CR076_PT001-000101, Rev. P03)
- Royal Oak Portal, Landscaping and Access Road cross-sections, Lord Hill's Bridge to Ranelagh Bridge (dwg. no. C150-CSY-D-DDB-CR076_PT001-00103, Rev. P03)
- Royal Oak Portal, Landscaping and Access Road cross-sections, Ranelagh Bridge to Westbourne Bridge (dwg. no. C150-CSY-D-DDB-CR076_PT001-00104, Rev. P03)
- Westbourne Park, Package 17B borehole locations: Site Plan off track, Paddington Approaches Package 17B, Dwg. E8902 02 Rev. 1



Extract from: Westbourne Park - Advanced Works, Westminster Academy/ Murphy's Yard Work Packages Plan, P10201-W1M04-R00-D-12079, Rev. D

Westbourne Park, demolitions and new retaining wall (proposed compound layout, dwg. no. R/333438/001, Rev. P0)

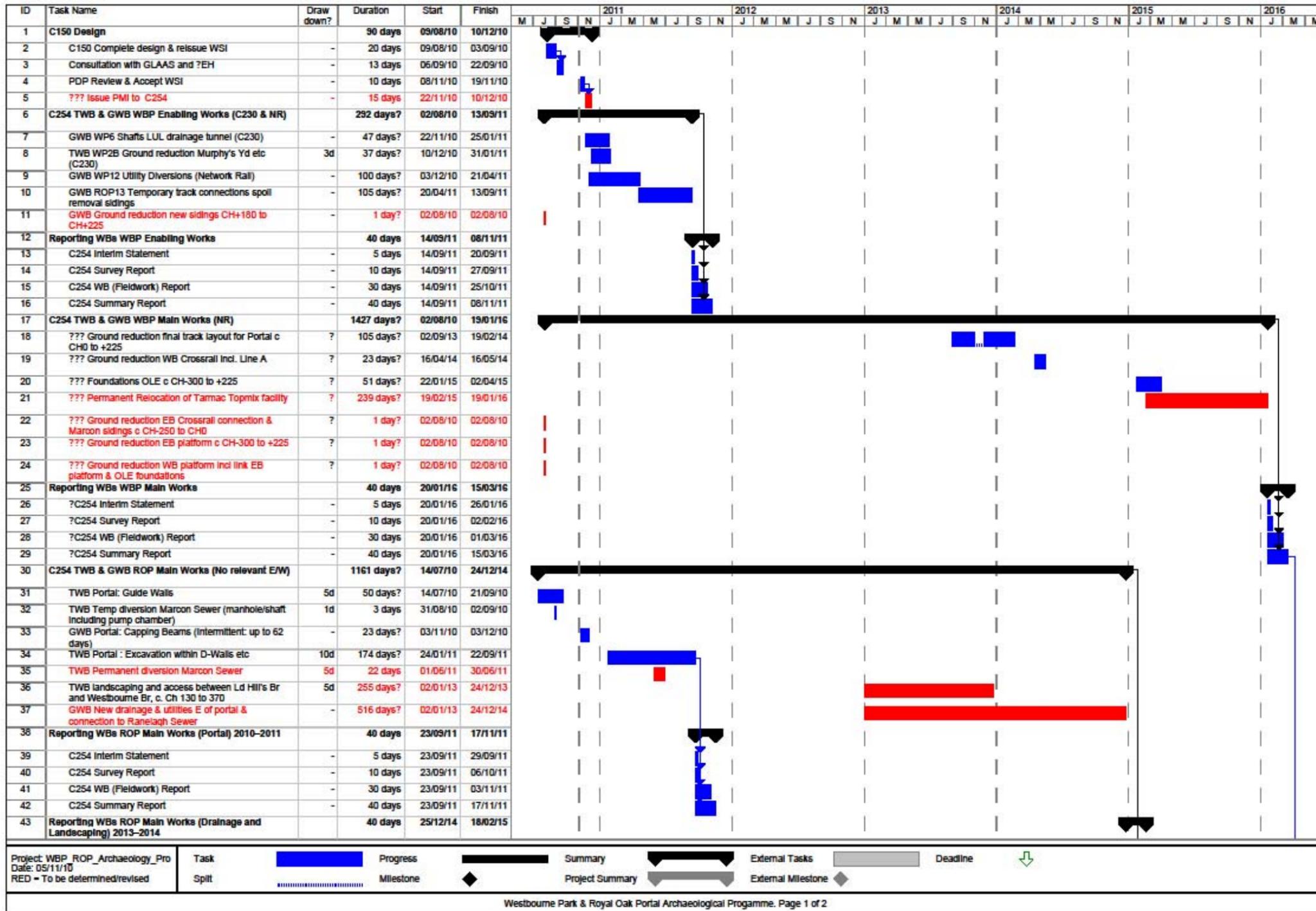
Westbourne Park, LUL drainage pump shafts (LU Pump Relocation Proposed Works Pal and Long Section, dwg. no. P10206-W1M04-R00-D12170, Rev. A)

Annex 3 – Programme

NB This programme is best read as the separate PDF file

Tasks and information in Red are either to be confirmed or refined either by the Network Rail archaeologist (for some aspects of the Westbourne Park works), or when further programming or design work is carried out, eg by a contractor.

Durations of watching briefs are for the whole of the construction task, as per the currently available programmes; they will be refined and monitoring requirements determined in conjunction with the contractors closer to the date of the works.



Annex 4 – Health & Safety Requirements

Designer's Risk Assessment

- CDM requirements
- Archaeological Contractors risk assessments and Health and Safety Plans
- Archaeological Contractor's Safety Audits, Safety Inspections, Reporting of Accidents
- Personal Protective Equipment (PPE)
- Labelling of Hazardous Substances, Contaminated Land
- Crossrail Health and Safety Management System, Crossrail Drugs and Alcohol Policy

Crossrail Policy for work on Network Rail Land

Designer's overall Risk Assessment

Assessment assumes standard good practice procedures are adhered to by experienced and competent contractors carrying out the work using an approved safe method of working													
				Inherent Risk Level					Residual Risk				
Location	Activity	Hazard	Risk	Likelihood	Consequence	Index	Risk Owner	Review date	Control Action	Likelihood	Consequence	Index	Anticipated future control measures
Royal Oak Portal	Targeted Watching Brief during portal construction	Machinery and vehicles working within portal	Staff injured by machinery or vehicles	3	5	15	Archaeological contractor supervisor	Production of archaeological contractor's and principal contractor's method statements for ground reduction within portal and TWB	WSI specifies: Principal contractor and archaeological contractor to devise safe method of work, previously specified in their approved Method Statements. To include designated safe working areas, separated from the remainder of the portal worksite by robust barriers, and traffic management in the surrounding area, to prevent accidental machine/traffic entry. Also safe access for archaeological team to working area.	2	5	10	As control actions

Likelihood
1 - Improbable, extremely unlikely to occur in relevant period

2 - Remote, unlikely to occur in relevant period

3 - Occasional, likely to occur in relevant period

Consequence

5 - Very High, fatality

4 - High, major injury or illness with long term effects / long absence from work

3 - Medium, lost time injury or illness

Index - Likelihood x Consequence (see CIRIA SP125)

15 - 25 High risk, apply further mitigation measures, reduce risk further

4 - 14 Medium risk, acceptable if as low as reasonably practical

4 - Probable,
likely to
occur in
relevant
period

2 - Low, minor
injury (not long
term), first aid
treatment
required and
operative
ceases work

0 - 3 Low risk,
acceptable if
all control
measures are
in place

5 - Frequent,
likely regular
occurrence
in relevant
period

1 - Very low,
minor injury /
inconvenience
(no long term
effects),
operative can
continue to
work

Prepared by	Nicholas		
:	Elsden	Date	14.10.10
Reviewed by	Dawn		
:	Jackson	Date	15.10.10

CDM requirements

The archaeological contractor for the watching briefs will be working under and reporting to the Principal Contractor and to the Crossrail Project Archaeologist and CDM Co-ordinator. The archaeological contractor will review and comply with the Principal Contractor's Construction Phase Plan under the CDM Regulations 2007.

For other requirements see the C254 Works Information forming part of the Crossrail contract for C254 Archaeology West.

Archaeological Contractors risk assessments and Health and Safety Plans

The archaeological contractor will prepare method statements, site-specific risk assessments and a health and safety plan to be approved by the Principal Contractor.

For other requirements see the C254 Works Information forming part of the Crossrail contract for C254 Archaeology West.

Archaeological Contractor's Safety Audits, Safety Inspections, Reporting of Accidents

See the C254 Works Information forming part of the Crossrail contract for C254 Archaeology West.

Personal Protective Equipment (PPE)

The minimum requirement is: hard hat, safety boots with toe and mid-sole protection (no rigger boots), gloves, safety goggles or glasses, and hi-visibility jacket or vest. Where necessary or required: ear defenders, flame-retardant overalls, and any other protection required for specific tasks.

At Westbourne Park there is an additional requirement, that full orange (NR Specification) PPE is worn (including trousers).

For other requirements see the C254 Works Information forming part of the Crossrail contract for C254 Archaeology West.

Labelling of Hazardous Substances, Contaminated Land

See the C254 Works Information forming part of the Crossrail contract for C254 Archaeology West.

Crossrail Health and Safety Management System, Crossrail Drugs and Alcohol Policy

See the C254 Works Information forming part of the Crossrail contract for C254 Archaeology West.



Crossrail Policy for work on Network Rail Land

No Network Rail training is required to access the area of works at Royal Oak Portal or the enabling works at Westbourne Park. Main Works at Westbourne Park *to be determined by the Network Rail archaeologist*.

For other requirements see the C254 Works Information forming part of the Crossrail contract for C254 Archaeology West.

Annex 5 – Environmental protection requirements

Royal Oak Portal

All contractors and visitors to site will comply to the following documents:

Construction Phase Plan: C330-PDP-01-TCP-CR076_PT001-00001 Version 3.
Environmental section PART C

Environmental control plans:

1. Green Travel Plan - CSJV-C330-PLN-016
2. Energy Control Plan - CSJV-C330-PLN-019
3. Contaminated Land Control Plan - CSJV-C330-PLN-017
4. Dust and Air Quality Plan - CSJV-C330-PLN-023
5. Heritage and Archaeology Control Plan - CSJV-C330-PLN-020
6. Noise and Vibration Control Plan - CSJV-PLN-C330-022
7. Water Management Plan

Costain/Skanska JV Section 61

On-site requirements will be explained in induction, but the archaeologists will be supervised by the Principal Contractor at all time. The archaeological contractor will work according to Construction Phase Plan, and Environmental Control Plans.

The following desk based assessment has been undertaken: Phase 1 Contaminated Land Assessment – Royal Oak Portal to Paddington Station (ref. CR-PN-PAA-EN-RT-00001). Royal Oak was classified as a Category 1 site i.e. "high or medium risk site with more complex issues".

Spoil removal from any archaeological works would be conducted by the Principal Contractor, according to their method statement and procedures. When carrying out any works the archaeological contractor should be aware of the potential presence of contaminated land, and if any visual or olfactory evidence of contamination is observed during the works then the works should be stopped pending further investigation by the Principal Contractor.

Any works conducted by the archaeological contractor will need to comply with the Principal Contractor's S61 prior consent for noise, i.e. any physical archaeological works would need to be carried out within the site working hours covered by the S61 consent (unless a separate variation or dispensation is agreed with the local authority).

Royal Oak Portal and Westbourne Park are classified as high risk sites for dust, and hence dust management will need to be taken into account within the method statements for machine excavation. However, as the mitigation is all in the form of watching briefs, such excavation should all be conducted by the Principal Contractor. If any machine excavation were to be carried out by the archaeological contractor, then their method statement would also need to take dust issues into account.

Westbourne Park

Environmental requirements will be explained to the archaeological contractor during an initial induction at the commencement of fieldwork.

Annex 6 – Enabling and temporary works design requirements, attendances and implementation

The Principal Contractor 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.

The Principal 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:

- **locating and making safe any live services or hazardous substances (above or below ground)**: preliminary services searches should be carried out by the Principal Contractor via the statutory undertakers etc, plus on-site inspection and testing where required. Where there is reason to believe from previous uses that the ground or adjacent buildings may be contaminated the Principal Contractor should make arrangements for advance inspection, sampling, testing and where necessary specialist remediation. The results of such surveys should be forwarded to the archaeological contractor *prior to commencement on site*. Any identified hazards will be addressed in the health and safety planning. Any unexpected hazards encountered during the investigations will also need to be made safe by the Principal Contractor before archaeological fieldwork may continue. In the event of the accidental disruption of a live service by archaeologists or sub-contractors under archaeological supervision the archaeological supervisor will inform both their project manager and the Principal Contractor and, when appropriate, call the relevant emergency number.
- **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.
- **accreditation and supervision of operatives, plant and equipment**, including supply of sufficient qualified banks men to control plant movements
- **temporary support**: design, installation and maintenance of appropriate temporary support to excavations, where deeper than c 1.2m. Where such temporary support is not provided, archaeologists will not be able to enter the excavations, and will have to make observations and records from the surface, reducing the effectiveness and validity of that work as mitigation.
- **other safety measures in deep excavations** monitoring of air quality and provision of rescue facilities and equipment in any areas defined by the Principal Contractor as a confined space. Where hoists are used in shored shafts less than 4m x 4m size the archaeological contractor's staff will leave the shaft before hoisting of buckets takes place. Beyond a depth of 3m within such shafts gas monitoring equipment will be required to ensure appropriate air quality for those working there. 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.

- *pumping-out* : a suitable method to keep the trenches dry, e.g. pumping into a previously investigated trench, to create a sump.
- **managerial services** – nominated points of contact for Principal Contractor and other key members of development team.
- *technical advice* to be available if required (e.g. via client or Principal Contractor's consulting engineer) re: protection of adjacent streets and buildings, removal of obstructions, depth of excavation, live services etc.
- **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 e.g. via a robust physical barrier.
- adequate *ventilation and protection from noise, fumes and dust* where plant is in use, especially within standing buildings.
- **site accommodation** and welfare facilities with electricity and water. To include furnished main base cabin as work space; separate male/female changing areas, toilets and washing facilities; plus additional steel cabin for storing tools and finds.
- If required: *110v. site lighting* for access routes to excavations, plus individual task lighting within trenches (e.g. tripod-mounted spotlights). The need for lighting depends on the depth, season and weather conditions.

general site security including hoardings, gateway, warning notices, etc; to create a secure site perimeter, sufficient to prevent unauthorised access. If the Principal 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 may be necessary to separately secure individual archaeological trenches via a physical barrier (such as Heras fencing) eg if there are public areas nearby or human remains are encountered.

Annex 7 – Security requirements

The archaeological contractor will comply with the Principal Contractor's Security Plan.

Human remains are not likely to be present on the Westbourne Park or Royal Oak Portal sites. However, if they should be present, the Principal Contractor will need to provide secure storage on site for human remains, in advance of them being removed by the archaeological contractor.

See also general and specific site security in Annex 6.

Annex 8 – Need for screening or other protective works

Human remains are not likely to be present on the Westbourne Park or Royal Oak Portal sites. However, if they should be present, the Principal Contractor will be required to screen them from public view, including buildings overlooking the site, passengers on trains passing the site, and Royal Oak station.

Such screening may include semi-opaque roofing if the public may see the relevant area(s) from above.

Annex 9 – Procedure for notification of the Discovery of Human Remains

In the case of unexpected discoveries the Crossrail procedures will be adhered to. The Project Archaeologist shall be informed immediately and the remains left in situ, covered and protected pending a decision on exhumation. If removal is essential, it should be undertaken under appropriate Ministry of Justice (Coroner's Division) licence and environmental health regulations. It will be necessary for the Principal Contractor to provide adequate site security, and screening (see Annex 8).

Annex 10 – Procedure for notification of the Discovery material falling under the Treasure Act 1996

All finds falling within the definitions of treasure (Treasure Act 1996) 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.

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, in liaison with the Project Archaeologist, that adequate site security is provided by the Principal Contractor.

Annex 11 – Procedure for notification of major unexpected discoveries

In cases where unexpected discoveries cannot be preserved in situ, the response plan would revert to the normal Crossrail mitigation strategy of further archaeological investigation (preservation by record). The aim would be a rapid and commensurate response, targeted to just those remains unavoidably affected by the works. Recording and sampling methods would also be proportionate to the significance of the remains. Additional archaeological resources would be deployed to achieve this, in order to minimise any delay to the Principal Contractor's works. With flexibility and good communication it is often possible for the development works to continue in other areas while localised discoveries are recorded.