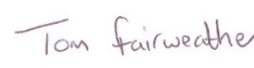


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EXECUTIVE SUMMARY

The approximately 7.66-hectare Western Access scheme provides a new link road from Pump Lane to the Southall Waterside development, in Southall, West London. The scheme comprises a new section of road embankment, two new road bridges, amalgamation of two watercourses (the Yeading Brook and River Crane), construction of a flood compensation area, detention pond and road works on the junction with Pump Lane. FM Conway (FMC) is delivering the scheme on behalf of Berkeley Homes (Southall) (BSO) and has engaged Card Geotechnics Limited (CGL), through Clark Smith Partnership (CSP), as part of their design team, to provide geoenvironmental and geotechnical design and support services.

The scheme is located in a roughly triangular plot of land, located between Pump Lane to the west, the Southall Waterside development to the east, Great Western Mainline railway to the south and the Minet Country Park to the north. The Grand Union Canal (GUC) is present in the eastern section, oriented approximately north east to south west. The former Minet Tip, located within the adjacent park, encroaches into the northern section and a lagoon, owned and operated by Canal and River Trust (CRT), formed within the tip and used to contain dredging's from the GUC, is located immediately adjacent, with the southern lagoon bund partially within the embankment footprint. The geology comprises Lynch Hill Gravels (a Principal Aquifer) over the London Clay Formation (unproductive stratum) with Made Ground located in the northern section, primarily associated with the Minet Tip. The Yeading Brook, River Crane and GUC traverse the scheme.

This verification report provides the geoenvironmental validation information for the western section of the scheme, which comprises the area to the west of the GUC, which falls within the London Borough of Hillingdon (LBH). A separate report has been prepared for the eastern section, east of the GUC, which is within the London Borough of Ealing (LBE). The report is designed to satisfy Planning Condition 21 of the LBH Planning Permission for the development (54814/APP/2009/430), relating to remediation completion and verification of the West Grand Union Canal (WGUC) Western Access works, and is based on an agreed Remediation Scheme Addendum (RSA), which built upon previous investigation, assessment, a preliminary remedial strategy developed by CGL and the approved Remediation Scheme produced by Arup¹, under planning condition Decision Notice No. 19.

The western section of the scheme comprised construction of a western and central embankment including a retaining wall on the southern side, diversion of the River Crane into the Yeading Brook and construction of a new bridge over the combined water course, construction of a new flood

¹ ARUP (2016). *Proposed Bridge Works for Southall Gas Works Redevelopment – Remediation Scheme [Issue 6], 5th August 2016 (A720-E02-PA-ARU-EN-RP-0003 P6). Planning Application Ref. 54814/APP/2015/4215.*

compensation area (FCA) in the northern section, detention pond to the south of the roadway and junction works with Pump Lane.

The scheme remediation strategy focused on the reuse of site won soils, based on site-specific reuse criteria, protective of the sensitive controlled waters, which were presented within the RSA. Material reuse included management and treatment of certain materials to render them acceptable for use as fill, primarily within the embankment. Cognition Land and Water (Cognition) was appointed as earthworks and remediation contractor and the adjacent lagoon was converted into a temporary material holding and treatment area. A materials management plan was established which declared a preliminary estimation, that approximately 74,000m³ of fill material would be required for the whole of the Western Access scheme, the majority of which was to be sourced from site won soils. This estimation was based on a cut/fill exercise by Morgan Tucker and included fill for a bund on Pump Lane, the river channel diversion infill, highway embankments, and in the Flood Compensation Area, as well as fill to the embankment to the east of the GUC (located within the London Borough of Ealing).

Based on material tracking records and topographical surveys provided by FMC and Cognition, the total volume of material used to complete the Western Access was 53,320m³ of which 39,870m³ was used within the London Borough of Hillingdon (LBH). The volume of fill used within the LBH area was split between 35,390m³ of site won material (11,500m³ Made Ground, and 23,890m³ natural arisings), and 4,480m³ of imported material.

The remediation / earthworks comprised excavation of Made Ground and natural soils to formation level, stockpile management of soils in the lagoon area, including treatment of unsuitable material, verification sampling and testing to confirm materials complied with the established reuse criteria, construction monitoring of surface- and groundwater, maintenance of a watching brief and implementation of environmental and health and safety controls.

Verification testing of this material was undertaken to confirm compliance on a frequency to meet the minimum required by the RSA (1 test per 500m³ placed material). Waste materials, deemed unsuitable for reuse in the scheme, comprised deleterious materials (predominantly metal, timber and concrete) from the Minet Tip bund, silt / sediment arisings from the former River Crane and concrete from the channel of the Crane. Asbestos containing materials were also identified, through visual inspection and testing, predominantly within the Minet Tip Made Ground and were subject to hand picking on several occasions by specialist, licenced contractors. Waste materials were disposed off-site to suitably licenced facilities and Duty of Care information is contained herein.

Imported materials comprised structural fills for the bridge abutments and retaining walls and aggregates for pile mat construction which were incorporated in the permanent works. These

materials were verified through review of supplier / source information and subsequent verification testing to meet the agreed criteria and frequency.

A programme of construction monitoring of both groundwater and surface water was established and implemented throughout the construction phase, building on obtained baseline data. The construction monitoring identified generally sporadic exceedances of baseline trigger levels though elevated ammoniacal nitrogen was recorded consistently within certain boreholes and additional monitoring of Yeading Brook was undertaken to demonstrate this was not impacting the watercourse.

As part of the stakeholder engagement for the scheme, regular meetings were held with the key parties, including the Environment Agency and Local Authority, to discuss and agree issues as they arose during construction.

A post construction monitoring programme was discussed and agreed with the regulators. Residual works to be completed comprise decommissioning of boreholes where not required for monitoring future works. These works do not form part of the remediation requirements for the Western Access scheme.

Based on the works undertaken and presented herein, remediation of the Western Access scheme and specifically the verification thereof, is considered to be in accordance with the agreed remediation strategy, as presented within the RSA.

This report is to be submitted to LBH, as Local Planning Authority, for discharge of Condition 21 of 54814/APP/2009/430, for the West Grand Union Canal (WGUC) Western Access works.

1. INTRODUCTION

1.1 General

FM Conway Limited (FMC) has constructed the Western Access highway scheme, involving a new section of road embankment and amalgamation and crossing of two watercourses, which will provide access to the Southall Waterside development, an 88-acre mixed regeneration project being delivered by Berkeley Homes (Southall) (BSO), part of the Berkeley Group. A site location plan showing the Western Access is presented as Figure 1 and as-built earthworks, are included in Appendix A.

Card Geotechnics Limited (CGL) has been instructed by Clark Smith Partnership, design co-ordinator on behalf of FMC, to verify the remediation works undertaken as part of the redevelopment of the Western Access site. CGL was previously commissioned to provide geotechnical and geoenvironmental consultancy services on the Western Access project and to produce a Remediation Scheme Addendum (RSA) (Appendix O), which built upon previous investigation and assessment by others, including the approved Remediation Scheme produced by Arup¹, and which outlined the remedial requirements to achieve the redevelopment of the site.

This report provides a summary of the site context, the remediation strategy and details the verification works that have been completed during the remediation within the section of the site located within the London Borough of Hillingdon (LBH), west of the Grand Union Canal referred to as 'WGUC' in this report. A site plan showing the areas and site zones, included within the LBH boundary, is presented as Figure 2. This report is to be submitted to the Local Planning Authority and its consultees, including the Contaminated Land Officer (CLO) at LBH and the Environment Agency (EA), as evidence of the remediation and completed verification works, for discharge of the relevant development planning conditions.

Previous ground investigations and reports have been completed at the site by CGL and others, the findings of which are summarised in this report. However, the original reports should be referred to for further details, where appropriate.

This verification report relates to works undertaken by FMC across the LBH section of the Western Access scheme and details the validation information required to verify the works undertaken. All works undertaken by FMC east of the GUC are covered within a separate verification report, issued to London Borough of Ealing (LBE). This latest version of the report (revision 7) has been updated to address comments raised by Canal and River Trust (CRT) as a planning consultee, following submission of the report to the LBH Planning Authority.

1.2 Objectives

The main objective of this verification report is to seek discharge of LBH Planning Condition 21, of the development Planning Permission No. 54814/APP/2009/430, which states:

“Following completion of each part of site remediation, and prior to the commencement of any further development on this part, a validation/verification report demonstrating completion of the works set out in the remediation scheme together with amendments and longer-term monitoring for the relevant part shall be submitted to and approved in writing by the London Borough of Hillingdon as the local planning authority.”

1.3 Key Parties

The pertinent parties and stakeholders involved with the geoenvironmental and geotechnical aspects of the Western Access scheme are listed in Table 1. Regular consultations and discussions were held with key parties to agree and resolve issues as they arose during construction.

Table 1. Key Parties

Role	Organisation
Developer	Berkeley Homes (Southall) (BSO)
Environmental Guardian (on behalf of BSO)	Ramboll UK Limited (formerly Ramboll Environ) (Ramboll)
Build Contractor	FM Conway (FMC)
Design Coordinator and Structural Engineer (on behalf of FMC)	Clark Smith Partnership (CSP)
Client Consultant (Civils and Drainage, on behalf of FMC)	Create Consulting Engineers (CCE)
Client Consultant (Geotechnical and Geoenvironmental, on behalf of FMC)	Card Geotechnics Limited (CGL)
Client Consultant (Main Southall Waterside Development)	Atkins Limited (Atkins)
Client Consultant (Outline Remediation Designer)	ARUP
Principal Remediation & Earthworks Contractor (Southall Waterside)	CA Blackwell (CAB)
Principal Remediation & Earthworks Contractor (Western Access)	Cognition Land & Water (CLW)
Subcontractor to FMC	SOCOTEC UK Limited (SOCOTEC)
Subcontractor to FMC (Soils Verification Testing and Groundwater Monitoring)	CET
Subcontractor to FMC (Specialist Asbestos Removal)	ECON Construction Limited (ECON)
Subcontractor to CGL/FMC (Laboratory Testing)	I2 Analytical Limited (i2)
Co-ordinator for Definition of Waste, Development Industry Code of Practice use (Materials Management Plan)	Contaminated Land: Applications in Real Environments (CL:AIRE)
Reviewer of Material Management Plan (undertaken by independent QP within CGL)	Qualified Person (QP)
Planning Authority and Regulator (west of the Grand Union Canal)	London Borough of Hillingdon
Planning Authority and Regulator (east of the Grand Union Canal)	London Borough of Ealing
Public Body, Regulator	Environment Agency (EA)
Regulator	Transport for London (TFL)

Role	Organisation
Regulator	Network Rail (NR)
Grand Union Canal and Lagoon Regulator	Canal and River Trust (CRT)

2. SITE CONTEXT

2.1 General

The Western Access scheme has been delivered by FMC, who provided 'design and build' services under contract to BSO. The above scheme, herein referred to as 'the site', comprised the construction of two new access bridges, associated carriageway and supporting embankments, plus junction access works off Pump Lane, to link the main Southall Waterside development to the existing Pump Lane carriageway. In addition, the scheme included the merging of two watercourses (the River Crane and Yeading Brook) into a single channel and construction of a flood compensation area. For simplicity, "the site" in the context of this report and the following sections refers to the whole of the Western Access scheme, including both London Borough of Hillingdon (LBH) and London Borough of Ealing (LBE) aspects.

This verification report relates to works undertaken across the LBH section of the Western Access scheme, the west of the Grand Union Canal (WGUC) section. All works undertaken east of the Grand Union Canal (EGUC) are covered within a separate verification report, issued to LBE.

Extensive documentation has historically been compiled for this scheme, which contains details of the site, the proposed development and site geology and hydrogeological regimes. The following sections provide a concise summary of the information contained within the previous reports. A summary of historical scheme documentation can be found within the Remediation Scheme produced by Arup¹.

2.2 Site Location and Description

The full site crosses both the LBH and LBE tertiary areas occupying a total land area of approximately 7.66Ha. The area encompassing all three permanent earthwork embankments is centred approximately at National Grid Reference (NGR) 511254, 179810. The boundary between the two Local Authorities is the GUC and the 'site' referred to within the LBH includes all zones north west of the GUC. This area within the LBH boundary is referred to as 'West Grand Union Canal' (WGUC) in this report. A site location plan is included as Figure 1.

The area of WGUC is an irregular triangular shaped section of land bound to the east by the GUC and main Southall Waterside development beyond, the Minet Country Park to the north and the Great Western Mainline to the south. The site is bound to the west by the existing Pump Lane carriageway, onto which the new Western Access highway intersects.

2.3 Development

Planning permission under planning No: 54814/APP/2009/430 was granted by LBH on 29th September 2010 for the construction of the new access highway into the Southall Waterside development². The Western Access works is split into five areas, Area 1 to 4 within the LBH west of the GUC, and Area 5 within the LBE east of the GUC. The areas within the LBH were split into separate working zones (numbered Zones 1, 2, 3, 3A, 4, 4A, 6, 7, 8, 9 & 10), which are referred to in the verification and materials management documentation, reported here-in. The bunded lagoon, Zone 5, which lies outside of the Western Access planning boundary, was used as a temporary holding area for stockpiling and treatment of site won materials. A summary of each area and the working zones is provided below which may be cross referenced with the site layout plan in Figure 2. The Planning Decision Notice outlining Condition 21 (for completion and verification of remediation) is presented as Appendix B.

2.4 Earthwork Materials and Volumes

The majority of the site won Made Ground required screening/riddling to remove deleterious material (e.g. wood, metal, plastics, bricks, concrete, ceramics and man-made objects) prior to reuse; 9,300m³ stockpiled within the lagoon, and 2,000m³ of Made Ground excavated from the FCA. An additional 2,000m³ of Made Ground was screened and riddled within the FCA and then used as Class 4 landscape fill within the LBE in Zone 5 east of the GUC. Of the material stockpiled within the lagoon, 3,900m³ required bioremediation treatment to reduce hydrocarbons, and a further 250m³ required handpicking to removed asbestos containing material, prior to riddling. Approximately 650m³ of deleterious material was removed by riddling, leaving 8,650m³ suitable for reuse. The majority of site won material was stony cohesive which was lime/cement stabilised once placed at the final location within the works.

A total of 5,470m³ of topsoil was site won, which was excavated and stockpiled in the lagoon or FCA for direct reuse, and around 500m³ of topsoil was imported. A total volume of 6,950m³ of Class 6N, and 4,600m³ of Class 6F5/6F2/Type1 was imported into the Western Access scheme. A total of 1,580m³ of Class 6N and 2,900m³ of the Class 6F5/6F2/Type1, was incorporated into the permanent works within the LBH scheme area. The rest of the Class 6N and 6F5 were used within the LBE area of the scheme, to the east of the GUC.

² Greater London Authority (September 2010.) *Development & Environment Directorate. Planning Permission Decision Notice. 54814/APP/2009/430.*

2.4.1 Area 1 (Zones 1, 2, 6, 7, 8 and 9): Diversion Channel & Western Embankment

Area 1 includes the realignment of the River Crane flood channel to intersect the Yeading Brook further upstream and provides a flood compensation storage area to offset the flood volume taken up by the road embankments. The area comprises;

 Zone 1 - Flood Compensation Area (FCA);

 Zone 2 - River diversion channel cut;

 Zone 6 - Flood attenuation basin;

 Zone 7 & 8 – Redundant River Crane channel and western embankment; and

 Zone 9 – Pump Lane earth bund.

2.4.2 Area 2 (Zones 4A & 4B): Central Embankment

Zone 4 is divided into Zone 4A and Zone 4B and incorporates the construction of the central embankment. Zone 4A refers to the western half of the central embankment nearer to the Yeading Brook bridge and Zone 4B refers to the eastern half of the central embankment, nearer to the GUC bridge. Collectively the central embankment zone is referred to as Zone 4 and includes temporary works, permanent structures and associated wing walls.

 Zone 4 - Linking central embankment between Yeading Brook and GUC bridges, bridge structures and associated wing walls;

 Zone 4A – Central embankment western section adjacent to the East Yeading Brook bridge abutment; and

 Zone 4B – Central embankment eastern section in the former Minet Tip area and adjacent to the WGUC bridge abutment.

2.4.3 Area 3 Lagoon Complex

The central embankment forming the Western Access incorporates a section of land within an area known as the Minet Tip, which forms the southern site boundary. The Minet Tip land is owned by the Canal and River Trust (CRT) and this area has been used for the storage of dredged materials from the GUC. Enabling earthworks were undertaken to modify the lagoon complex to provide a quarantined soil storage facility, allowing the safe temporary storage and treatment of site won material for reuse within the scheme, including materials from the Minet Tip and visually impacted arisings, which were

subject to treatment to render them acceptable. These proposals were presented in CGL's Lagoon Temporary Stockpile Appraisal³ presented in Appendix C. A portion of this land was acquired by BSO under Compulsory Purchase Order to facilitate the construction of the central embankment. Following completion of the Western Access embankment, the lagoon will be reconfigured in order to maintain the existing capacity for future CRT activities. The reconfiguration of the lagoon is not within FMC's scope of works for the Western Access scheme, in accordance with Planning Permission No. 54814/APP/2009/430, and is, therefore, not included in this report.

2.5 Summary of Site History

The key historical uses of the site and surrounding area are as follows:

-  Prior to its development in the early 19th century, the site formed part of the Yeading Brook valley and associated flood plains;
-  The Grand Union Canal was constructed in the early 19th century;
-  A gasworks (within the main Southall Waterside development) was developed to the east of the canal between the mid-19th century and the end of the century; and
-  Tipping started between the canal and the brook in the 1930s and continued until recently, canal dredging's have only recently been placed on the Minet Tip area.

2.6 Geology, Hydrogeology and Hydrology

Reference should be made to the Arup Remediation Scheme¹ and CGL RSA (Appendix O) for further information on the geological / hydrogeological regime at the site. In summary, much of the site is underlain by Made Ground, however, along the course of the brook, Alluvium is shown with the Lynch Hill Gravel Member also present. These are underlain by London Clay and Chalk at depth. Beyond the immediate valley associated with the brook, the British Geological Survey (BGS) records show the Langley Silt Member to be present.

The site is recorded to be underlain by a Principal Aquifer (Lynch Hill Gravel Member). The underlying London Clay is classified by the EA as Unproductive Stratum. The site is not located within a groundwater Source Protection Zone (SPZ). The closest groundwater abstraction is located 700m southwest of the site boundary, associated with industrial/commercial use and extracting from the Chalk.

³ CGL (June 2017). *Southall Western Access, Lagoon Temporary Stockpile Appraisal – Revision 2*. Ref. CGN03732I (Aconex Ref. A720-E05-IW-CGL-EW-RP-0002).

Three main watercourses cut the site including the River Crane, Yeading Brook and the Grand Union Canal. Both the GUC and the River Crane are lined, whereas the Yeading Brook is unlined.

2.7 Ground Conditions and Previous Investigations

Reference should be made to the CGL RSA (Appendix O) for details regarding the ground conditions identified during previous investigations at the site. In summary, the results identified areas of contamination largely associated with the Minet Tip and central embankment areas. When screened against conservative generic assessment criteria for risks to human health based on a commercial land use, soil contaminants were shown to be below the maximum permissible concentrations though leachable contaminants were shown to exceed initial screening criteria relevant to controlled waters. Groundwater contamination from pre-construction monitoring rounds was shown to exceed conservative controlled waters generic screening criteria for some contaminants. A contamination observation plan highlighting the contaminant type and location is presented as Figure 3.

3. REMEDIATION REQUIREMENTS

3.1 Overview

The CGL RSA (Appendix O) and Materials Management Plan (MMP)⁴, should be referred to for details of the remediation and materials strategy. Both the RSA and MMP were discussed and agreed with the EA and issued to LBH as part of the regular engagement with the statutory authorities throughout the works. The Qualified Person Declaration for Revision 5 of the MMP is included in Appendix E. It should be noted that the latest version of the MMP, Revision 6, did not require an updated QP Declaration as it already included re-use of site won topsoil and the change in material volumes were not significant. The remediation scheme and MMP focused on the reuse of site won material which included the management and treatment of unsuitable material to render them acceptable for use as a general fill. Cognition Land and Water (Cognition) was appointed as the main earthworks and soil remediation contractor and the CRT lagoon was temporarily converted into a soil holding/ treatment facility. The verification works were undertaken throughout construction to confirm that the Western Access works were completed in accordance with the CGL RSA (Appendix O), CGL MMP⁴ and in accordance with the agreed earthworks design set out in the Remediation Scheme produced by Arup¹.

3.2 Assessment Criteria Selection and Justification

A detailed quantitative risk assessment (DQRA) was undertaken as part of the RSA (Appendix O), which modelled the risks to controlled waters, considered to be the key receptors based on the site setting, to derive site-specific reuse criteria. The reuse criteria were designed for assessment of site won soils only. Based on the site setting, where total soils analysis exceeded the maximum permissible concentrations, it was considered leachate analysis could be used to demonstrate compliance, where results meet the leachate criteria. Generic criteria were adopted for assessing imported soils including general and structural fill and landscaping soils. Further details of the chemical assessment suites are provided in the CGL RSA, the assessment criteria for reuse and imported material are presented as Appendix D.

3.3 Remediation Requirements

Based on the refined risk assessment the proposed remediation strategy for the site comprised:

 Excavation and appropriate management of Made Ground material generated as part of enabling works;

 Excavation of natural soils to obtain formation levels for temporary and permanent works;

⁴ CGL (September 2019). *Southall, Pump Lane Western Access Materials Management Plan (MMP)*. CL:AIRE Contaminated Land: Applications in Real Environments. Revision 6. CGN03732G.

-  Separation, quarantine and stockpile management of Made Ground and natural soils within the temporary lagoon stockpile area;
-  Verification sampling and testing including confirming acceptability of site won materials proposed for reuse to comply with site specific Reuse criteria (see above and Section 6 of the RSA(Appendix O));
-  Monitoring of surface and groundwater throughout the construction phases;
-  Watching brief for areas of unexpected / unidentified contamination; and
-  Implementation of environmental controls and health and safety procedures to protect construction workers and adjacent site users from potential risks associated with dust, vapours and nuisance odours.

3.4 Verification Requirements

CGL prepared a Verification Plan to confirm that the remediation works were undertaken in accordance with the proposed strategy. The Verification Plan was included in the RSA (Appendix O) and has been reproduced in Appendix E. The key requirements are summarised below:

-  Details of key parties who undertook remedial works;
-  Laboratory and in-situ test results to demonstrate that the site remediation criteria have been achieved;
-  Monitoring of groundwater and surface water during construction and details of a monitoring programme on completion of the remedial works;
-  Summary data plots and tables relating the reuse of site won soils and imported fill and capping materials;
-  Plans showing treatment areas and details of any differences from the original remediation strategy or identification of unknown contamination;
-  Waste management documentation;
-  Confirmation that remediation objectives have been met; and
-  A long-term monitoring and maintenance plan for monitoring of pollutant linkages, maintenance and arrangement for contingency action and for the reporting of this to the London Borough of Hillingdon.

Site inspections and compliance testing were undertaken during the works by a qualified geoenvironmental engineer for the various elements of the remediation works as follows:

-  Inspect, sample and arrange laboratory analysis of site-won soils for reuse within the scheme;
-  Inspect and sample blended and stabilised fill material prior to reuse within the embankment;
-  Sample and test imported soils, where required, to confirm compliance with the Reuse criteria, including review of source data prior to import of material to site;
-  Construction monitoring of surface waters and groundwater, in line with the monitoring programme to assess trends in water quality and provide an early warning of issues with groundwater quality potentially associated with site activities; and
-  Site inspection records, photographs and testing where unexpected contamination is encountered.

Documentation was also required to be provided by the Contractors including:

-  Photographs of the earthworks undertaken;
-  As built drawings;
-  Duty of Care records for the disposal of soils;
-  Source data and pre-import laboratory data of imported topsoil/subsoil;
-  Material management procedures (i.e. permits, exemptions, MMP etc.) as appropriate;
-  Confirmation of piling methodology and depth of piles;
-  Records of soils treated / stabilised for reuse;
-  Validation laboratory test results for treated soils; and
-  Groundwater and surface water monitoring records.

3.5 Soil Validation Requirements

3.5.1 Materials Testing

Reused materials within the scheme were required to meet the DQRA Reuse criteria, as noted Section 3.2. Where material did not meet the criteria, it was either treated to render it acceptable, for example, via stabilisation, or removed from site either for recovery / treatment or for disposal at a suitably licensed facility.

Testing of materials against the reuse criteria was to be undertaken at the following stages:

-  At the point of origin within the scheme (pre-classified);
-  On material temporally stockpiled within the lagoon area; and/or
-  On the treated fill.

Testing frequencies were aligned with the requirements as set out within the RSA (Appendix O).

3.5.2 Imported Fills

Imported general fill used as embankment construction materials were to be obtained from reputable, certified sources and accompanied by suitable test certificates. Recycled fill materials were ideally to be WRAP (Waste Resource Action Programme) compliant or similar. Imported general fill was to be tested on a frequency of one sample per 500m³ or a minimum of three tests per source and was required to meet the maximum permissible concentrations for imported general fill soils included in the CGL RSA (Appendix O).

3.5.3 Topsoil

Imported landscaping soils / topsoil were obtained from certified, reputable sources and accompanied by suitable test data. The test suite and resultant data were required to meet the maximum permissible concentrations for imported capping soils, presented in the RSA (Appendix O).

4. EVIDENCE OF REMEDIATION WORKS UNDERTAKEN

4.1 General

CGL undertook verification visits for each element of the remediation works between 24 July 2017 and 12 September 2018. CGL provided a supervisory supporting role and provided a watching brief, discovery strategy and validation testing to comply with the verification objectives. The remediation works and evidence for the various objectives is summarised in the following sections.

4.2 Regulatory Licences, Permits and Engagement

The earthworks, treatment, and remedial works on site were carried out by Cognition under a Mobile Plant Permit (MPP) deployed under SP3399EC/W0025. Materials were managed in accordance with the CGL MMP⁴ as summarised in Section 3. The deployment was focussed around the remedial activity carried out in the lagoon material treatment area (Zone 3) detailed within Cognition's Environmental Monitoring Plan. Cognition's completion and validation report is presented as Appendix F.

The following additional permits/licences/exemptions were produced:

-  Thames Water Trade Effluent Discharge Consent⁵, required to enable discharge of surplus water including lagoon dewatering;
-  U1 Exemption⁶ – relating to movement of 1,000 tonnes of soil associated with the former Pump Lane bund (Zone 9) for temporary construction of the lagoon as a stockpile and treatment area; and
-  Materials Management Plan (MMP)⁴ produced by CGL to enable material reuse within the scheme.

Regulator meetings and liaison were continued throughout the scheme construction works to discuss issues as they arose and to agree mitigation measures. This liaison included a monthly environmental meeting / forum attended by the EA and Local Authority representatives, arranged by BSO. Liaison with the other principal stakeholders on the scheme was maintained by BSO and CSP, as FMC's design team co-ordinator. This allowed for unexpected contamination or unforeseen conditions to be discussed during the course of construction, and for changes to the RSA (Appendix O), and updates to the MMP⁴, to be agreed with the regulators as the works progressed. LBH were invited to attend all these meetings though were unable to field a representative between May 2017 and February 2019, although the meeting minutes were issued to LBH on a regular basis.

⁵ Thames Water Utilities Ltd (2017). Permit to discharge groundwater to foul. RM. Case No: RMOG0GS3.

⁶ GOV.UK. Waste Exemption Service (2017). Ref: WEX101521. U1: Use of Waste in Construction.

4.3 Site Clearance and Discovery Strategy

Prior to the excavation of Made Ground and natural deposits, all vegetation and trees were removed from the proposed working areas including shrub and tree roots. Vegetation was disposed off-site in accordance with the contractor's clearance strategy by Powerday under waste management licence No 6272556.

Different site won materials were stored in separate stockpiles within the bunded lagoon. Changes to the stockpile layout and volumes occurred during the course of the works as material was excavated, remediated and reused or disposed off site. These changes were tracked by FMC and are documented in the FMC Soil Management Strategy included in Appendix G which includes stockpile layout sketches and volumes recorded at periodical intervals throughout the earthworks construction.

Timber logs accumulated from tree clearance were stockpiled in the lagoon, in Stockpile 2, which was later disposed off site, in addition to a small quantity of unsuitable topsoil containing deleterious material and tree roots.

Site won topsoil was initially excavated from the working areas (Zones 3, 4, 6, 7, 8, 9) and stockpiled within the lagoon bund area in stockpiles SP1 and SP3. Once all vegetation was removed from the working areas, topsoil was scraped from the East and West Yeading Brook and the River Crane Diversion area (Zone 2) and stockpiled in the lagoon complex (Stockpiles SP1 and SP3). Topsoil from the Flood Compensation Area (FCA) (Zone 1) was later removed and combined with the lagoon stockpile (Stockpiles SP1 & SP3). The combined material was known to contain Himalayan Balsam seedlings, and the land around the site boundary had evidence of Giant Hogweed and Japanese Knotweed is known to be present within the lagoon. During construction, the Japanese Knotweed within the lagoon was fenced off to prevent potential disturbance by site plant and staff working nearby. A separate Method Statement for the eradication of invasive species on site was produced by Ramboll⁷, as referred to under the planning condition Decision Notice No. 24, included in Appendix B, which set out potential treatment methodologies confirming treatment may take up to ten years in the case of Giant Hogweed. Treatment of invasive species is outside the remit of this verification report.

Made Ground was encountered in the Minet Tip bund, WGUC (Zone 4B) an area of known contamination as identified in the previous ground investigation works, and within the FCA. Natural arisings were excavated under strict supervision under watching brief and stockpiled under a stockpile management protocol under the MMP⁴. No visual or olfactory indicators of contamination were observed within the natural arisings.

⁷ Ramboll Environ (2015). *Southall Gas Works. Method statement for the control of Invasive Plant Species. Revision 3.*

CGL provided a watching brief during initial enabling works in July 2017 for the removal and relocation of the Pump Lane bund. Made Ground was excavated from a bund adjacent to Pump Lane (Zone 9) and the material was used, under a waste exception, to raise the base of the existing lagoon area. Made Ground excavated from the Minet Tip bund and WGUC, during enabling works, were removed under watching brief supervision and discovery strategy. Materials were segregated and separated within the lagoon complex in accordance with their contents. FMC provided a stockpile tracking sheet that monitored the movements, composition and volumes of the stockpiled material. The Soil Management Strategy and stockpile tracking is presented as Appendix G. The stockpiled material included hydrocarbon impacted soils (Stockpiles SP5 & SP6), soils containing asbestos materials (Stockpile SP8) and Made Ground containing deleterious material including industrial waste (Stockpile SP4) plus Made Ground sourced from the FCA during construction of the flood compensation area. This allowed targeted and stockpile specific remedial soil treatment, management, classification and stabilisation prior to its reuse as a general fill. CGL's full site visit records are presented as Appendix H.

4.4 Excavation and Placement of Site Won and Imported Materials

4.4.1 Excavation of Made Ground Material

Table 2 summarises the movement and quantity of site won Made Ground from its source to end location. Volume of material have been derived from information provided by FMC. Duty of Care records relating to off-site disposal of Made Ground and other site derived materials is presented in Appendix I, including example waste tickets for material transferred to each licensed waste facility.

Table 2. Excavation and Movement of Site Won Made Ground

Area	Zone	Quantity of Made Ground excavated (m ³)	Classification(s)	Treatment by and details	On-site reuse/ off-site disposal	End use location
Flood Compensation Area (FCA)	1	2,000	Class 9B (7F, 2C)	Cognition - Screened/ riddled and stabilised with OPC	Reused	Zone 3 & 4
Zone 4A & 4B to Minet Tip bund & WGUC (stockpiles 4, 5, 6, 8)	4	4,150	Class 9B (7F, 2C)	ECON - ACM hand picked from SP8. Cognition - Screened/ riddled, bioremediated and stabilised with OPC.	Reused	Zone 4A & 4B
River Diversion and Pile Arisings from Yeading Brook west and east pile mats (stockpiles 7,9 & 16)	4, 6 & 7	2,650	Class 9B (7F, 2C)	Cognition - Screened/ riddled and stabilised with OPC	Reused	Zone 4A & 4B

Area	Zone	Quantity of Made Ground excavated (m³)	Classification(s)	Treatment by and details	On-site reuse/ off-site disposal	End use location
WGUC/Minet Tip arisings (stockpile 17A)	4	2,500	Class 4	FMC - Screened/ riddled	Reused	Pump Lane Bund Zones 8,9,10
Zone 4 (Class 6F5,2C)	4	200	Class 4	Treatment not required	Reused	Zone 4
WGUC/Minet Tip arisings (stockpile 17B & 17C)	4	1,100	Class 4	Not Treated	Disposed	Off-site disposal- Cricklewood ⁸
River Crane Diversion (breakout of concrete channel liner)	3A	300	Concrete	Not Treated	Disposed	Off-site disposal FMC Heathrow/ Dartford Depots & Old Oak Sidings (Powerday) ¹²
FCA & Minet Tip and Lagoon Stockpiles deleterious material	1, 3 & 3A, Lagoon Stockpile	650	Deleterious material	Not Treated	Disposed	Off-site disposal - Old Oak Sidings (Powerday) ¹²

4.4.2 Excavation of Natural Material

Table 3 summarises the excavation and movement of site won natural arisings from its source to end location.

Table 3. Excavation and Movement of Site Won Natural Soils

Area	Zone	Quantity of natural soil(s) excavated (m³)	Description(s)	Classification(s)	On-site reuse/ off-site disposal	End use location
Site wide	All zones	5,470	Topsoil	Not classified	Stockpiled on-site	Finishing landscaping
Flood Compensation Area (FCA) and Bailey Bridge 3 excavation	1	11,220	Lynch Hill Gravel Member	Class 9B (7F, 2C)	Stockpiled on-site	Zone 3, 3A & 4
Flood Compensation Area (FCA) and Pump Lane	1, 8 & 9	1,350	Lynch Hill Gravel Member	Class 1A/1B	Stockpiled on-site	Zone 3 & 3A
River Diversion, Pump Lane and Natural Arisings from Yeading Brook west and east pile mats	2, 3 & 3A, 4, 6, 7 & 8	5,450	Lynch Hill Gravel Member	Class 9B (7F, 2C)	Stockpiled on-site	Zone 3 & 3A, 4 & 7
Detention Basin	6	400	Lynch Hill Gravel Member	Class 2C	Reused	Zone 6

4.5 Lagoon Material Stockpiling Management

To accommodate the construction of the Western Access scheme and facilitate the reuse of site won material in the embankment and road construction, materials were temporarily stockpiled within the

⁸ Waste tickets for deleterious material and general waste available in Appendix I.

lagoon complex. Material from the Pump Lane bund (Zone 9) was used to construct the lagoon base and raise the existing levels. The lagoon was lined with an impermeable membrane and included granular drainage trenches and blanket that captured surplus runoff from the stockpiled material preventing it from cross contaminating nearby controlled waters and the underlying natural strata.

Site won arisings from the Minet Tip area (Zone 4) and in other areas of the site that exhibited visual and/or olfactory indicators of contamination were stockpiled under a stockpile management plan. The material was stockpiled in the lagoon depending on the type of contamination / required treatment to allow for easy material management and reduce the risk of cross contamination. Further details are provided in the stockpile management strategy in Appendix G.

CGL issued an appraisal³ of the potential risks to controlled waters from mobilisation of contamination present in soils and groundwater beneath the lagoon, as a result of the planned scheme's stockpiling and subsequent loading of the underlying lagoon soils. This appraisal was submitted to the EA and formed part of the RSA (Appendix O) for the Western Access which was accepted by the EA. A methodology for the lagoon conversion was then developed which was accepted by both the EA and CRT. The approved lagoon design report, correspondence and photos of its construction are presented in Appendix C.

Due to the quantity of material generated during the earthworks and available space in the lagoon, BSO raised concerns in December 2017 regarding the height of the stockpiled material and potential over spilling onto unprotected bunds and the central spine of the lagoon. Minor exceedances to the agreed maximum height of the stockpiles were noted. This issue was assessed by CGL and discussed with BSO and the regulators and it was concluded that it did not pose an additional unacceptable risk to environmental receptors. Surface water sampling of the Yeading Brook also confirmed that the lagoon stockpiling did not increase contaminant loading to the Brook. Subsequent embankment construction works meant that the residual risk was reduced as the additional material was used within the scheme.

4.5.1 Lagoon Layout and Capacity

The lagoon bunds were constructed from site won Made Ground excavated from the Pump Lane bund under the Waste License during enabling works and the lagoon area was separated into two distinct bowls, Lagoon A (to the east) and Lagoon B (to the west). Based on the allowable 4m maximum height, the capacity of Lagoon A and B were estimated at 10,284m³ and 10,060m³, respectively. Construction of the lagoon bunds and temporary lining and drainage was undertaken in June and July 2017.

4.5.2 Separation and Construction

Construction of the material storage area within the Minet Tip lagoon complex was undertaken in accordance with the CGL RSA (Appendix O), and comprised:

-  Placement of a geotextile separation layer (permeable) on top the existing lagoon floor;
-  Light compaction of site-won material from the Pump Lane bund or flood compensation area to raise levels and create cross-fall;
-  Installation of impermeable basal liner geomembrane placed over sand bedding or protective fleece;
-  Formation of a perimeter swale/ drainage trench to allow collection of water runoff across stockpile area;
-  Infill of swales and liner area with a granular material to form a drainage blanket;
-  Construction of leachate extraction system with perimeter pipework and pumping points; and
-  Groundwater monitoring at external well locations throughout the stockpiling period;
-  Screening (hand picking) and removal of Asbestos Containing Material (ACM). Duty of Care waste disposal documentation for the ACM removed from the lagoon and Minet Tip bund can be found in Appendix I.

4.5.3 Stockpiled Materials

Materials moved and temporarily stored within the lagoon area included site won topsoil, Made Ground and natural strata to be reused, where suitable, within the embankment construction.

The materials stored also included soil arisings determined to be contaminated with hydrocarbons and other contaminants (refer to Section 4.6). The materials were separated from other non-contaminated site-won materials and subsequently remediated, as outlined in Section 4.6.

Further details of the management, tracking and composition of the stockpiled material within the lagoon is presented as Appendix G and details are included within Section 9.

4.5.4 Treatment and Remediation

Cognition was appointed as the earthworks and soil treatment contractor and their treatment and remediation strategy intended to retain as much of the site won Made Ground and natural strata as possible, the scope of treatment to identified contaminated soils included;

-  Bioremediation spraying of stockpiled hydrocarbon impacted soil;
-  Screening and riddling of Made Ground stockpiles to remove deleterious items⁸ such as metal, timber, plastics, tyres and other industrial and commercial waste;
-  Screening and removal of ACMs on discovery, including hand-picking and disposal of identified ACM by specialist contractor Econ Construction Limited (ECON)⁹;
-  Stabilisation of treated soils;
-  Validation testing of treated material prior to reuse;
-  FMC undertook suitable off-site disposal of deleterious material to the relevant waste receiver; and
-  Placing chemically impacted treated soils between the capping layer and above the underlying water table.

Duty of Care records relating to the disposal of deleterious materials are presented in Appendix I.

Based on the testing results of the materials stockpiled within the lagoon, approximately 7,050m³ of soils were considered unsuitable for reuse within the scheme without suitable treatment, due to geotechnical parameters not meeting the earthworks specification and/or containing deleterious material including asbestos. Of this volume ~3,900m³ also had elevated hydrocarbon and ammonia concentrations. Cognition treated this material through a combination of bioremediation, stabilisation and physical screening to render the material acceptable for reuse. Cognition's validation report is presented as Appendix F.

Stockpile 4 and stockpiles 5 and 6 were treated ex-situ within the lagoon using bioremediation methods comprising the application (spraying) of indigenous bacteria into the soils and then aerating the stockpiles (mixing). Bacteria were diluted in water and sprayed over the material using a jet wash. Nutrients in the form of mineral fertiliser were used to enhance the bacterial activity. The material was mixed using an excavator and homogenised during the bacteria application and then regularly during the treatment period over the following weeks. Throughout the treatment period the stockpiles were covered with 1000 gauge plastic.

The top 300mm embankment formation surface and all Made Ground Class 2C embankment fill was stabilised with 2% to 4% Ordinary Portland Cement (OPC) by weight. This was done to ensure compliance with the earthworks specification to achieve the minimum CBR value and relative

⁹ The Hazardous Waste Regulations 2005: Consignment Note: FMLONW1CT076. ECON asbestos removal.

compaction requirements and to help bind the soil to minimise leaching potential. Natural cohesive site won soil was also stabilised with OPC where natural moisture content was in excess of the earthwork acceptability specified limits, to achieve satisfactory compaction.

Site won materials not suitable for treatment and reuse were disposed off-site to suitably licensed recovery or disposal facilities, this included concrete waste from the break out of the redundant River Crane channel lining and river slurry / sediment from the base of the former River Crane channel that was impacted with asbestos and heavy metals. The slurry was contained within the redundant River Crane channel within the concrete lining and earth embankment until suitable off-site disposal was arranged, to Rushton Landfill in March 2018. The slurry was not placed in the lagoon given the risk of cross contamination and contamination of plant and equipment and instead contained within the concrete liner of the redundant River Crane channel. Duty of Care records relating to the disposal of the River Crane concrete liner and river slurry / sediment are presented in Appendix I.

4.5.5 Non-Compliance Issues

The amount of material produced during excavation works and constraints within the lagoon led to slight over-topping of the bund and central spine between the bowls and this material was moved back into the lagoon bunded areas and re-profiled to allow Cognition, the earthworks contractor, to process materials for construction of the embankment. CGL assessed the related potential risks and discussed the issue with BSO and the regulators and it was concluded that there was not an unacceptable risk to environmental receptors, as noted in Section 4.5 above. During excavation and removal of stockpiled material from the lagoon in September and October 2017, the liner at the base of the lagoon was ruptured by the excavator bucket exposing the underlying strata and groundwater. Works ceased immediately, and remaining stockpiled materials were cleared, preventing cross contamination to the underlying stratum. The liner was repaired by the installation contractor, BUTEK and later verified by CGL under watching brief (refer to site records within Appendix H). The tearing of the lagoon liner was not considered a risk to nearby controlled waters because the stockpiled material was removed and the liner repaired promptly.

4.5.6 Waste Water

Water samples were recovered from the lagoon drainage trenches during pumping, and from surface water collected on the lagoon liner. Samples were also obtained from a trial pit excavated adjacent to borehole BH1A next to Yeading Brook, to investigate elevated ammoniacal nitrogen concentrations (See Section 8.4.3) and a small quantity of discoloured surface water adjacent to Yeading Brook (see Section 7.2.4). The waste water was temporarily stored in intermediate bulk containers (IBCs) prior to approval of disposal following testing. The raw test data and screened test results, as referenced in Table 4, are included in Appendix J.

Additional testing was undertaken for parameters specific to the Thames Water discharge consent to allow for safe disposal of the captured run-off water to foul sewer at a discharge point in the northern section of the scheme, see SVR 75 dated 20 December 2017.

Exceedances of the Thames Water discharge permit limits were recorded in two samples, one from the lagoon extraction for chloride, settleable solids (1 hour) and ammoniacal nitrogen, and the other from the trial pit adjacent to Yeading Brook, for suspended and settleable solids. Veolia accepted the leachate from these two IBC's as non-hazardous waste, which was transported by tanker off site by County Clean Environmental Services. Relevant email correspondence and waste tickets are provided in Appendix J.

Table 4. Summary of Waste Water Testing for Disposal or via Thames Water Discharge Consent

Water Source	Laboratory Test Report Ref.	Sample Number/Ref.	Lab Sample Number
Lagoon Leachate Extraction	17-62999	Lagoon 3 Trench L1	831595
Lagoon Leachate Extraction	17-62497	Lagoon 1 DP1, Lagoon 2 DP2	828908, 828909
Lagoon Leachate Extraction	17-69319	LEP1, LEP2	867579, 867581
Lagoon Leachate Extraction (additional tests)	18-71825	LEP 1 EW7, LEP2 EW8	883072, 883073
Yeading Brook Trial Pit	19-35192	IBC W1	1189029
Lagoon Leachate Extraction	19-35192	IBC W2	1189029
Lagoon Surface Water	19-35192	BUND W3	1189030
Surface Water near Yeading Brook	19-78491	YB OIL	1398023

4.5.7 Lagoon Validation

The works were undertaken in accordance with the CGL RSA (Appendix O) and the lagoon construction strategy presented in Appendix C, and works undertaken within the lagoon, together with the stockpiling operations, are not considered to have adversely impacted the underlying soil quality / conditions within the lagoon or the adjacent controlled waters.

4.6 Watching Brief and Discovery Strategy

The CGL RSA (Appendix O) recommended that a watching brief was to be maintained throughout the works and detailed a discovery strategy to be followed in the event that gross contamination or material of an unusual colour was encountered. CGL undertook a total of 124 watching brief visits throughout the works, between 24 July 2017 and 12 December 2019. A summary of the key unexpected finds is outlined below. The full CGL site visit records are presented as Appendix H.

4.6.1 Hydrocarbon Impacted Soils

Hydrocarbon-impacted soils were encountered at the excavation base, within the WGUC area (Zone 4B), during pile cap excavations for the WGUC bridge abutment. A CGL Engineer was on-site during the excavation works to provide a watching brief, the following discovery strategy was undertaken:

-  On-site CGL geoenvironmental engineer assessed the contaminated material and obtained samples for laboratory analysis against the reuse criteria;
-  Works were ceased in that area of the excavation and fenced off; BSO, Ramboll, BSO's Environmental Guardian, and the EA were notified of the findings; and
-  The soils were temporarily stockpiled within the lagoon, tracked as hydrocarbon impacted material and subsequently bio-remediated by Cognition before they were verified and reused in the final scheme.

A single soil sample of the excavated material was recovered, which was scheduled for a comprehensive suite of potential contaminants including cyanides, metals, Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAHs) and phenols. The results identified elevated concentrations of TPH and PAH that exceeded either the reuse criteria or the hazardous waste classification. Five samples were recovered from the resultant WGUC bridge abutment excavation, including from the sides and bases, to verify the removal of contamination within this area. Residual in situ hydrocarbon contamination was identified at the excavation base but as it was located beneath the impermeable structure of the bridge abutment, and above the water table, it was not considered to present a leachable risk. Further removal of the residual contamination was not deemed practicable or warranted due to the depth, the constraints associated with the location being adjacent to the lined GUC, and as the leachable risk would be greatly reduced following GUC bridge construction. This approach was reviewed and discussed at the regulatory meetings, and agreed with the EA.

4.6.2 Live UXB Discovery

On 23 August 2018, a suspected unexploded bomb (UXB) was identified during excavation works of the WGUC pile mat. The potential ordnance was a small torpedo shaped device approximately 200mm in length and 70mm in diameter. The device appeared solid and metallic with limited surface corrosion and a linear split along a metal join and was positioned on a stepped bank section of the excavation running parallel (10m away) to the GUC. It is likely that the device was unearthed whilst works to profile the bank were undertaken, its size and overhead location would have made it difficult to identify from within the excavation base. The on-site engineer immediately ceased any further

excavation works and alerted the FMC Project Manager of the potential UXB discovery, indicating its location, size and general condition using photographs on the site camera. The engineer advised all personnel working in the excavated area to retreat. The site was temporarily shut and UXB specialists from the Metropolitan Police called to undertake a controlled detonation and make safe the UXB. Network Rail was alerted and all services were temporarily suspended along the adjacent railway line until the UXB was destroyed. Following the UXB discovery, the site's UXO risk was heightened and further excavation works in the WGUC were supervised by a UXO specialist, as well as CGL. Toolbox talks were subsequently provided by UXO specialist to all site personnel which included UXO identification and a site-specific discovery strategy. No further potential devices were identified.

4.6.3 Lagoon Flooding

During a site visit on 3 May 2018, surface water was noted to have risen in the lagoon associated with periods of heavy rainfall in the preceding months of March and April. The surface water was above the level of the lagoon drainage trench within the protective 6F5/6F2 layer, rendering the possible risk of permeation of leachate laterally through the lagoon bund wall. The surface water was pumped from the lagoon and disposed via the foul sewer discharge point at Pump Lane under the Thames Water discharge consent.

4.6.4 Run Off to Yeading Brook

Surface water run off downhill from the sides of the lagoon bund and along the toe of the north central embankment slope was observed, causing some localised siltation of Yeading Brook during April 2018 and May 2018, see SVR's 106, 108 to 111. Monitoring test results of surface water around this period recorded exceedances in Phenols, above the limit of detection, although these were at concentrations consistent with intermittent elevated readings recorded from the beginning of the construction works. No further signs of silt run off developing in the brook were observed by CGL or FMC during the works.

4.6.5 Asbestos in the Minet Tip bund and Central Embankment (Zone 4)

Loose ACM fragments were identified during excavation works to remove the Minet Tip bund and reprofile the existing lagoon bund in August 2018. The fragments were identified on the bund surface during the watching brief and discovery strategy. Laboratory analysis identified chrysotile cement board fragments which were subsequently hand pick by a specialist contractor (ECON) and disposed off-site in August 2018. Further excavation of the bund was completed under the supervision of asbestos removal contractor ECON and with the use of appropriate Respirator Protective Equipment (RPE). ACM impacted arisings were stockpiled separately in the lagoon to allow for hand-picking and disposal of ACM, again by specialist contractor (ECON). Duty of Care records for ECON are provided in Appendix I. Cognition subsequently reused the asbestos-free material in the Western Access scheme.

Subsequent finds of ACM were identified on the north facing slope of the central embankment during routine inspections by BSO and Ramboll, and a further visual inspection undertaken by CGL on 12 September 2018. An exclusion zone around the affected area was installed and specialist asbestos contractor (ECON) was employed to hand-pick and dispose of the asbestos. In October 2018, CGL undertook further post verification testing for asbestos on the near surface embankment fill prior to placement of the topsoil on both the north and southern embankment slopes. A summary of the testing is shown in Table 5 and the results are presented in Appendix M [CGL Testing - ACM Testing Post Placement on Zone 4 Embankment Fill]. Discussion on these test results is provided in the CGL technical report for proposed cover soils¹⁰, presented in Appendix N. No ACM was recorded on the southern slope. A maximum concentration of 0.005% ACM was recorded in a soil sample on the northern slope, however, this concentration of asbestos was not considered to present a risk to long term human health once the proposed 300mm of cover soils were placed over the embankment¹⁰, as set out in technical guidance¹¹.

Table 5. Summary of CGL Asbestos Containing Material (ACM) Testing - Post Placement

Source	No. of Tests and Test Location	Test Certificate Ref.	Sample Number	Test Certificate Sample Ref's
Site won Zone 4 and FCA	6 at East Yeading Brook north embankment fill slope, Zone 4	18-14692 18-15303	EYBN	1070329 – 107332 1073408, 1073409
Site won Zone 4 and FCA	3 at East Yeading Brook south embankment fill slope, Zone 4	18-14692	EYBS	EYBS (1070333 – 1070335)

4.6.6 Deleterious Material in Minet Tip Bund

Deleterious materials were encountered within the Pump Lane bund and Lagoon bunds during re-profiling and within the Minet Tip material and included a number of vehicular, domestic and industrial waste materials, including;

-  Three complete and undamaged gas bottles, likely welding gas bottles¹²;
-  50.43 tonnes of mixed metals including metal engine, vehicle parts and two motorbike frames¹³;
-  1.15 tonnes of vehicle tyres¹⁴; and

¹⁰ CGL (2020). *Western Access, Southall. Technical Report on Proposed Landscape Cover Soils – Revision 1*. CGL Ref: CG28308. Aconex Ref: (A720-E05-IW-CGL-EW-RP-0030)

¹¹ BRE (2004). *Cover Systems for Land Regeneration. Thickness Design of Cover Systems for Contaminated Land*.

¹² Waste Care (8 November 2017). *Transport Note: T/N Number 2009455-1. 3 small/ medium gas cylinders. Solid*.

¹³ Powerday (23 May 2018). *Disposal Note: 6265053. 17.04.07/ Mixed metals*.

¹⁴ Powerday 16 July 2018). *Disposal Note: 6271496. 17.09.03/ Mixed Hazardous Construction Waste (COSHH)*.

 33.53 tonnes of industrial refuse including plastics and plastic packaging¹⁵.

Duty of Care records relating to the off-site disposal of the above deleterious materials are referenced in the footnotes below and full records are presented as Appendix I.

4.6.7 Oil Drum Spillage River Crane West Bank

Prior to construction of the Western Access, oil drums had been stored or fly tipped on the western bank of the River Crane opposite the FCA, and leakage from the drums had been observed. Ramboll's (formerly Ramboll Environ) report¹⁶, included in Appendix Q, summarises these observations during a site visit on 15 August 2017 and documents the removal of the drums from site on 18 August 2017, by a licensed waste contractor. Testing on one soil sample from directly beneath the drums confirmed leakage from the drums had impacted the soil with elevated concentrations of TPH (total petroleum hydrocarbons) at concentrations between 25,684 mg/kg and 78,104 mg/kg (total)

In April 2019 the topsoil from the affected area (<10m³) was stripped and segregated from the rest of the topsoil strip undertaken across the riverbank and temporarily relocated to the lagoon, before being disposed off site. Three samples were tested from the remaining unimpacted stripped topsoil stockpiled at the top of the western bank of the River Crane. Test results from the three samples of topsoil did not record exceedances of the established Western Access reuse criteria and asbestos fibres detected (chrysotile) were <0.001%.

Two samples were tested from the surface of the subsoil in the location of the oil spillage. During sampling, hydrocarbon odours were noted in one of these samples and therefore CGL instructed FMC to remove a 75mm to 100mm thickness of subsoil locally from the oil spill area and removed with the impacted topsoil to the lagoon. A third sample of the subsoil was taken and tested, following the removal of this subsoil.

Test results on the three samples of the subsoil did not record exceedances of the established Western Access reuse criteria and asbestos fibres detected (chrysotile) were <0.001%. However, one sample taken from the surface of the subsoil in the impacted area, recorded elevated concentrations of hydrocarbons and heavy metals greater than 1000mg/kg, see report 19-30062 sample reference 1162081. A Waste Acceptance Criteria (WAC) test was undertaken on this sample, report reference 19-30064, which classified this material as hazardous waste and the material was subsequently disposed off site.

¹⁵ Powerday (4 July 2018). *Disposal Note: 6270104. 17.02.03/ Plastics.*

¹⁶ Ramboll Environ (2017). *Report on the Disposal of Waste Drums. Southall Western Access: Mint Tip, Hayes. Ref. LUK11-24029 Drum Disposal_01*

A further sample tested on the segregated impacted material, combined topsoil and subsoil (<10m³) following relocation to the lagoon, also indicated elevated concentrations of hydrocarbons and heavy metals. Although the results were still within the acceptable limits for reuse, as per the Western Access reuse criteria this small quantity of material was disposed off-site as non-hazardous waste.

The results verified the removal of contamination within the oil spill area and that the remaining topsoil on the western bank of the River Crane met the reuse criteria for the protection of controlled waters, and the recommendations set out in CGL's Proposed Landscape Cover Soils report¹⁰ with respect to asbestos concentrations, for reuse as topsoil.

Subsequently, surplus topsoil from both the western and eastern sides of the River Crane within the FCA was transferred to the lagoon and placed in a stockpile of <500m³ for reuse across the rest of the site. One sample tested from this stockpile recorded a marginal exceedance of cadmium (15mg/kg against a reuse criteria of 12.05mg/kg), see screened results in Appendix M [CGL Testing Screening Sheets]. However, there were no exceedances in a further nine samples of the topsoil tested from the FCA area (three from the western bank of the River Crane, and six from topsoil from the FCA east of the River Crane), with a mean cadmium concentration of 1.99mg/kg for the 10 samples compared with a reuse criteria of 12.05mg/kg. As such, the recorded exceedance was not considered to be representative of the majority of the FCA topsoil, which was acceptable for reuse, and was considered to represent a low risk to the principle controlled waters receptor.

A summary of the testing reports is shown in Table 6 and the test certificates are presented in Appendix M [CGL Testing - Environmental Incident (Oil Spill)].

Table 6. Summary of Topsoil/Subsoil Soil Testing in Oil Drum Spillage on River Crane West Bank and FCA

Source	Fill Type	No. of Tests and Test Location	Test Certificate Ref.	Test Certificate Sample Ref's
FCA (east of River Crane)	Site Won Topsoil	6 at stockpiles in FCA	18-15303	1073402 – 1073407
FCA (oil spill area west of River Crane)	Topsoil/Subsoil	3 on slope (post topsoil strip)	19-30062	1162081, 1162083, 1162084
FCA (west of River Crane)	Topsoil	3 in stockpiled topsoil	19-30062	1162082, 1162085, 1162086
FCA – east and west of River Crane	Site Won Topsoil	1 in stockpile transferred to lagoon <500m ³	19-36247	1194577
FCA (west of River Crane oil drum spillage)	Site Won Topsoil - Disposed off site- Cricklewood	1 in stockpile in lagoon	19-36247 19-30064 (WAC)	1194578 1162093, 1162094

4.7 Health and Safety

The CGL RSA (Appendix O) recommended that site works were undertaken in accordance with guidelines prepared by the Health and Safety Executive (HSE, 1991)¹⁷ and CIRIA reports 132¹⁸ and C650¹⁹, in addition to the Contractor's Construction Health and Safety Plan. The RSA (Appendix O) also detailed the precautions to be taken to minimise exposure of workers and the public to potentially harmful substances, as well as to restrict off-site nuisances such as dust and odour emissions. The observations from CGL engineers and outlined in Cognition's verification report were that the works were undertaken in general accordance with health and safety guidelines.

¹⁷ HSE (1991). Protection of Workers and the General Public during the development of contaminated land. Guidance Note HS(G)66, Health and Safety Executive, HMSO.

¹⁸ CIRIA (1996). A guide for safe working on contaminated sites. Steeds JE, Shepherd E and Barry DL, CIRIA Report 132.

¹⁹ CIRIA (2005). Environmental Good Practice – Site Guide, 2nd Edition. CIRIA Report C560.

5. PERMANENT WORKS

5.1 Construction Programme

The general sequencing of the Western Access construction, within the London Borough of Hillingdon section of the site, is summarised below:-

-  Topsoil/subsoil stripping site wide between August and September 2017;
-  Piling works and excavations for Yeading Brook and GUC western bridge abutments / wing walls. It is understood that the piling works were completed by 4th October 2017. Excavations for the abutments were completed by the end of October 2017;
-  Excavation of the River Crane Diversion in Zone 2 commenced in October 2017 and was completed by the end of December 2017. The River Crane Diversion pipes were in place during this period, in October 2017. A second diversion was implemented from around the beginning of May 2018 until mid-May 2018, to allow the dredging of Yeading Brook and installation of reed beds south of Yeading Brook bridge. The brook was diverted from beneath YB bridge and piped around the detention basin to outfall back into the River Crane in the southwest corner of the site;
-  Filling of Zone 4 with imported Class 6N (IBAA) was completed during January 2018 and February 2018;
-  Filling of Zone 4 with site won Class 2C and Class 7F/9B lime/cement stabilised material and material from the Flood Compensation Area and the lagoon stockpiles 4, 5, 6, 8, 9, 12 and 16 was completed between February 2018 and end of March 2018;
-  Zones 3, 4 and 7 placement of imported Class 6F5/6F2 on haul roads and to the WGUC pile mat was completed between August 2017 and February 2018. Stripping of Class 6F5/6F2 from haul roads and WGUC pile mat, and placement to east YB pile mat in Zone 4 and lagoon access road was completed in February 2018. Stripping of Class 6F5/6F2 from east YB pile mat to Zone 5 WGUC was completed in March 2018;
-  Shallow excavation and placement of scour protection rockfill to east and west Yeading Brook occurred between October 2018 and January 2019;
-  Tree pit excavations and planting in Zone 4 embankment was carried out during April 2019;

-  Segregation and placement of topsoil stockpiles SP1, 3 and 13 occurred site wide between April 2019 and July 2019; and
-  The lagoon liner was removed and disposed off site between July and September 2019, following removal of stockpiled material from within the lagoon basin.

5.2 Fill and Embankment Construction

All material used as fill was deemed compliant with the sampling and testing criteria detailed in Section 3, the verification results are discussed in Section 6.

5.3 Detention (Attenuation) Basin

The highway drainage from the embankments located west of the GUC and the access roads around Pump Lane is to be run through an oil interceptor, attenuation storage basin and a flow control device (located in Zone 6). CGL undertook a geoenvironmental investigation within the proposed position of the attenuation basin (Appendix R)²⁰, to establish the chemical suitability and ground conditions of the finished design level. With agreement from the EA (in email correspondence dated 24 April 2018) the attenuation storage was to be constructed with an impermeable geosynthetic clay membrane liner, with a 300g/m² geotextile underlay, protected by suitable subsoil and topsoil to allow marginal planting. The CGL ground investigation identified limited contamination in the Made Ground, marginally above the reuse criteria. In excavating to construct the new basin, the Made Ground was removed and subsequently stockpiled and treated with material from Zone 4, in the lagoon area, for subsequent reuse.

5.4 Flood Compensation Area (FCA)

The FCA is a flood water storage area (Zone 1) that will off-set potential runoff and flood plain land occupied by the newly installed Western Access road. CGL undertook a geoenvironmental investigation of the FCA, (Appendix R)²¹ in December 2017 which recorded existing ground conditions at the proposed finish level to comprise natural and uncontaminated granular material of the Lynch Hill Gravel Member. The findings of this investigation were discussed with the EA and it was agreed that a previously designed and proposed clay / impermeable liner was not required at formation level within the FCA, due to the presence of uncontaminated natural soils at formation. A considerable volume of natural sands and gravels, together with topsoil and some Made Ground were cut from the FCA and either reused directly within the scheme, following suitable verification testing or processed within the

²⁰ CGL (January 2018). *Western Access, Detention (Attenuation) Basin – requirement for an artificial liner.*

²¹ CGL (December 2017). *Western Access, Flood Compensation Area – requirement for a clay or artificial liner. Western Access. CSP on behalf of FMC. CG28308.*

lagoon area, prior to reuse. Landscaping soils previously stripped from the FCA have been replaced across the FCA to allow for suitable seeding and planting.

5.5 Bridge Abutments and Retaining Walls

Piling works were completed for construction of the permanent bridge abutments for the WGUC and Yeading Brook bridge and wing walls plus the retaining walls to EGUC. Sheet piling was also completed to protect the existing GUC concrete panel wall on either side of the canal. Piling works risk assessments (PWRA) were completed for the bridge abutment and retaining wall works plus the GUC sheet piles and incorporated into the RSA (Appendix O) and as a standalone document²². The PWRAs followed the EA guidance²³ and concluded that risks to the key receptors, based on the pollution scenarios within the guidance, were low / very low. Groundwater and surface water monitoring was completed throughout the construction piling works, as agreed within the monitoring programme within the RSA (Appendix O). Whilst the monitoring did record concentrations of contaminants above the established trigger levels, these observations were not attributed to the piling works but rather the general variability in groundwater quality in the locale (refer to monitoring data in Appendix K).

²² CGL (2018). *Southall Western Access – Piling Works Risk Assessment for Grand Union Canal Sheet Piles*. CG/28308_PWRA GUC Sheet Piles, 05 January 2018.

²³ Environment Agency (May 2001). *Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention*. Ref: NC/99/73.

6. SOILS VERIFICATION TESTING

6.1 Introduction

As earthworks and remediation contractor, Cognition was responsible for earthworks testing to verify chemical suitability of the majority of soils, which included testing of site won soils following temporary stockpiling and treatment within the bunded lagoon, to verify chemical acceptability for reuse within the scheme. Cognition's validation report in Appendix F includes details of testing undertaken by Cognition. A material tracking summary sheet, in Appendix 3 of Cognition's report, gives the source and/or stockpile reference number and sampling information. Location plans for Zones 4, 5 and 7 of the Western Access, and for the lagoon stockpiles treated by Cognition are included in Appendix 2 of Cognition's report. The sample location plan for Zone 4 in Cognition's report has been subdivided into smaller areas, each area being given a separate reference number, which are cross referenced on a material test tracking sheet within Appendix F of the Cognition validation report. The same source and/or stockpile reference number is used for the independent testing of materials carried out by CGL under instruction from FMC. CGL also tested earthworks material outside of the Cognition work areas and produced sampling plans (in Appendix M) for the Flood Compensation Area (FCA), lagoon basal layer and stockpiles 17A, 17B and 17C. A cover soils verification test sampling plan is included in the CGL Cover Soils Report in Appendix N.

CGL undertook independent testing on materials placed and stockpiled by Cognition and FMC under instruction by FMC. No sample location plans were produced for the CGL stockpile testing for the material which had been tested and placed by Cognition, however, sample location plans were produced by CGL for material used in the earthworks which did not fall under Cognition's work remit. These location plans were for material in stockpiles 17A, 17B and 17C, the basal layer of the lagoon, Flood Compensation Area (FCA), and placed cover soils. CGL's sampling plans for the FCA, lagoon basal layer and stockpiles 17A, 17B and 17C are included in Appendix M. The cover soils testing verification sampling plan is included within the CGL Cover Soils Report in Appendix N.

CGL's raw and screened test results are presented in Appendix L for imported soil, and Appendix M for site won soils, and imported soil which was later reused elsewhere within the permanent works. Cognition's materials testing tracking sheet and raw test results for site won soils are presented alongside CGL's data in Appendix M. The data in both appendices is subdivided into subfolders for each material type to ease cross referencing. Summary tables for material volumes, source, end location and testing undertaken for each zone of fill are given on the CGL verification plan in Figure 4.

6.2 Imported Fill Materials

Approximately 11,550m³ of construction / structural fill was imported into the Western Access scheme as a whole which included;

-  450m³ of Class 6N (Thorney Wash, TW, imported from London Rock Group;
-  6,500m³ of Incinerator Bottom Ash Aggregate (IBAA) Class 6N, imported from Day Aggregates and;
-  4,600m³ of 6F5/6F2/Type 1 imported from Day Aggregates.

Chemical verification of material was both provided by the supplier, and carried out post-import, to the methods, frequencies and criteria set out in Section 3. As part of the validation for the remediation works, the placed fills used for embankment construction were sampled and chemically tested to ensure compliance with the reuse criteria for the protection of controlled waters. Cognition only carried out testing on Class 6N material imported to the LBE east GUC area of the Western Access in Zone 5. CGL/FMC's independent testing on all material imported to the LBH Western Access areas.

A verification plan showing the volumes of imported material, source and sampling quantities is presented as Figure 4. Cognition's and CGL/FMC's verification testing on imported soils is presented in Appendix L, under subfolders for each material type, and Cognition's verification report is presented as Appendix F.

6.2.1 Incinerator Bottom Ash Aggregate (IBAA - Class 6N)

Suppliers Thorney Wash and Day Aggregates provided pre-import data prior to the placement of the 6N material, see Appendix L, including their quality management protocol. Following import to the site, based on the recorded import volumes of 6,950m³, as provided by FMC, 20 samples of Class 6N (giving a sampling frequency of 1 sample per 348m³) were obtained from stockpiles by a geoenvironmental engineer from CGL and tested for screening against the import criteria. The suppliers also provided pre-import data prior to placement of the material. Of this total volume 1,580m³ of 6N was used within the LBH west of the GUC, and 5,370m³ was used within the LBE east of the GUC.

The imported IBAA materials were recorded to contain trace levels of asbestos (maximum quantity of 0.002% asbestos by weight) and concentrations of heavy metals (copper, lead and zinc) exceeding the soil import criteria outlined within the CGL RSA (Appendix O). Following review of the soils data and subsequent leachate data, it was agreed with site and the EA (email correspondence dated 15 January 2018 included in Appendix L) that the IBAA materials (classified as Class 6N) were chemically acceptable for use on site subject to certain criteria. The criteria, which were established in consultation with the Environment Agency, were broadly in line with Regulatory Position Statement

RPS 206²⁴ guidance; Using Unbound IBAA in Construction Activities (recently withdrawn and replaced with RPS 247)²⁵ though were specific to the development. It was agreed that the IBAA could be used within the bridge abutments and wing wall structures only, where it would be effectively encapsulated by the structures and, therefore, not present an unacceptable risk to human health and controlled waters. The imported IBAA was placed only behind the abutment concrete structures including the EYB, WYB and WGUC and was suitably benched into other embankment fill materials.

It was agreed that only the required amount of IBAA should be imported. Handling of the material was managed to mitigate potential risks to human health and the environment during import and placement. The following mitigation measures were introduced:

-  Material was laid and compacted on same day as importation;
-  IBAA was stockpiled a minimum of 10m from all watercourses;
-  IBAA was stockpiled on previously laid IBAA, or an impermeable liner; and
-  Stockpiled IBAA did not exceed 45 degree batters and a maximum height of 6m.

A summary of the test reports on the imported Class 6N is presented in Table 7 and the data and screened test results are included in Appendix L.

Table 7. Summary of Imported 6N Material CGL Test Data

Source	Test Certificate Ref.
Thorney Wash Class 6N	17-70131
Day Aggregates (IBAA) Class 6N	17-65606, 17-66340, 17-68217, 18-73323, 18-74149, 18-75046

6.2.2 Recycled Crush Aggregate (Class 6F5/6F2) - Imported

To support chemical compliance of imported recycled Class 6F5/6F2 aggregate, suppliers source data, included in Appendix L alongside CGL's test results, was provided by Day Aggregates. The Class 6F5/6F2 was used to construct the pile mats, haul roads and areas of hard standing during construction. A summary of the site testing on the Class 6F5/6F2 is presented in Table 8 and the results and screened data are included in Appendix L [CGL Testing - Class 6F5 Site Test Data] and [CGL Testing Screening Sheets].

Following import to the site, based on the recorded import volumes of 4,600m³, as provided by FMC, 40 samples were tested for chemical suitability, 12 tests on imported, and 28 tests on reused 6F5/6F2

²⁴ Environment Agency (withdrawn 2021). *Using Unbound Incinerator Bottom Ash Aggregate (IBAA) in construction activities: RPS 206*

²⁵ Environment Agency (2021). *Using Unbound Incinerator Bottom Ash Aggregate (IBAA) in construction activities: RPS 247*

material, giving a combined sampling frequency of 1 sample per 115m³ for the imported soils). The 12 samples on the newly imported material were obtained from stockpiles by a geoenvironmental engineer from CGL and tested for screening against the import criteria. Test results on the 22 samples tested for reuse are discussed in Section 6.2.4.

Table 8. Summary of Imported Recycled Crushed Aggregate (Class 6F5/6F2/Type 1) CGL Test Data

Source	Material Type	Test Location	End Location	Laboratory Test Report Ref.	Sample Number/Ref.
Imported - Day Aggregates	6F5/6F2	Zones 3, 4, 7 & 8 pile mats, haul roads, hardstanding / car park	Zones 4, 5 (WGUC), 7 & 8 pile mats, and zone 3, 3A, 8, 9 & 10 landscaping.	17-60426 (12 tests)	PM1, PM3, Canal Mound, Haul, Lagoon 1, Lagoon 2, EYBPPM
Imported Day Aggregates	Type 1	Stockpile	Zone 4 north west GUC embankment access steps	19-74500 (2 tests)	S1 & S2

When compared directly with the CGL import criteria, concentrations of all chemicals tested were recorded below the required import criteria except for one sample EYBPM (ES1), from the east Yeading Brook pile mat, which had a benzo(a)pyrene concentration of 5.8mg/kg, marginally above the import criteria value of 3.6mg/kg, see screened results in Appendix L [CGL Testing Screening Sheets]. As such, the pile mat from this sampled area was excavated and placed in Stockpile SP4 and subsequently encapsulated within the core of the central embankment above the existing groundwater table. The 6F5/6F2 used as pile mat material was largely left in place and incorporated into the permanent earthworks.

A single sample in Lagoon 2 ES1, report ref. 17-60426-1, recorded chrysotile asbestos however, quantification testing recorded concentrations of <0.001% chrysotile asbestos by weight which is compliant with the import criteria.

6.2.3 Type 1 - Imported

Two test results were obtained on imported Type 1 (<500m³) used as bedding to construct the access steps and ramps to the north side of WGUC embankment, adjacent to the lagoon/Minet Tip, see Table 8. The test data is presented in Appendix L [Subbase Type 1 Suppliers Data] and [CGL Testing - Subbase Type 1 Site Test Data]. The screened test results are presented in Appendix L [CGL Testing Screening Sheets].

There were exceedances of benzo(a)pyrene with values of 5.8mg/kg and 11mg/kg, above the maximum permissible concentration of 3.6mg/kg screened against the Western Access import criteria, although below the less onerous limit of 12.96mg/kg established for the reuse criteria, see screened

results in Appendix L [CGL Testing Screening Sheets]. Given the location of placement was some distance from Yeading Brook, and the concrete/paving effectively provides a semi-impermeable cover, the potential for infiltration and leaching of contaminants from the Type 1 beneath the concrete/paving was considered to be minimal, and therefore the risk to controlled waters was considered to be low.

6.2.4 Recycled Crush Aggregate (Class 6F5/6F2) - Reused

On completion of the piling works, testing on the pile mats was undertaken to assess suitability of the 6F5/6F2 within the placed pile mats, for incorporation into the embankment permanent works. Of the total volume, 2,900m³ was incorporated into the permanent works west of the GUC. The remaining 1,700m³ was transferred to the EGUC working platform. The rest of the imported aggregate was tested for reuse as landscape fill to the southwest wingwall of the GUC and to form the bund alongside Pump Lane. The lagoon 6F5/6F2 protective layer and underlying basal soils were also tested to assess suitability for use as landscape fill.

A further 28 samples were taken from placed 6F5/6F2 material in Zone 3, the haul road alongside Pump Lane, the old FMC site office and car parking area, the 'Railway Triangle' area southwest of the GUC, the lagoon protective layer, and pile mats, for reuse within the works. A summary table of CGL testing for the reuse of the recycled crushed aggregate is given in Table 9 and the test results are provided in Appendix M [CGL Testing – Reused Imported Material].

Table 9. Summary of Recycled Crushed Aggregate (Class 6F5/6F2) CGL Reuse Test Data

Source	Material Type	Test Location	End Location	Laboratory Test Report Ref.	Sample Number/Ref.
Imported - Day Aggregates and Zone 4 site won 2C	Class 4 (6F5/6F2 combined with Class 2C)	WGUC wingwall	Zone 4 landscape fill to southwest GUC wingwall	19-28000 (1 test)	WGUC SW
Imported - Day Aggregates	6F5/6F2	Zones 3, 4, 7 & 8 pile mats, haul roads.	Zones 3, 4, 7 & 8 pile mats, and zone 3, 3A, 8, 9 & 10 landscaping.	18-73323 (5 tests) 19-47039 (6 tests)	6F5 ES1 to 6F5 ES5 PLTP1, PLTP2, PLTP3
Imported - Day Aggregates	6F5/6F2	Haul roads, hardstanding / car park	Minet Tip lagoon bund wall.	19-28000 (2 tests) 19-35192 (3 tests)	HR TP1, HR TP2 C.Park ES6 to C.Park ES8
Imported- Day Aggregates	6F5/6F2	Lagoon protection layer	Disposed off site as Non-Hazardous - Cricklewood	18-22293 (8 tests) 19-36247 (3 tests and 3 leachates)	TP1-6F2 to TP8 – 6F2 TP101 to TP103 Lagoon Base

When compared directly with the CGL reuse criteria, see screened results in Appendix M [CGL Testing Screening Sheets] all but two samples recorded concentrations of all chemicals tested below the required reuse criteria. Two samples, one from the site car park hardstanding material and one from

the haul road, recorded an exceedance of benzo(a)pyrene of 36mg/kg and a marginal exceedance of 15mg/kg above the reuse criteria of 12.96mg/kg. This material was transferred to the Minet Tip and used to construct the core of the lagoon bund wall in the Minet Tip. It was considered that by encapsulation within the cohesive low permeability bund wall, that isolated contaminants within this material, would be less readily leachable and therefore present a low risk to controlled waters.

Chrysotile asbestos was also recorded in some samples, however, quantification testing recorded concentrations of <0.001% chrysotile asbestos by weight, which is compliant with the import criteria.

Further information and discussion on the reuse of the Class 6F5/6F2 is given in the CGL lagoon and stockpile 17 materials technical report²⁶, included in Appendix S. Testing was undertaken on the Class 6F5/6F2 to assess the potential for its reuse. This report concluded that, based on the available test data, the protective 6F5/6F2 lagoon capping layer met the Western Access import criteria for protection of human health and controlled waters, although one sample of eight samples retrieved from the lagoon protection layer, recorded a relatively high combined total hydrocarbon concentration (total TPH-CWG aliphatic and aromatic C10+) of 1,305mg/kg which exceeded the Atkins' RTV criteria for TPH. Further leachate testing and delineation could have been undertaken to establish the suitability of this material however, at the end of construction works, there was no suitable use for the 6F5/6F2 protective capping and it was subsequently disposed off site in 2019, as inert waste, by Elite GB Environmental Services, to Windsor Polo Club, Virginia Water / Airlinks Golf Club. Duty of Care records are included in Appendix I.

6.3 Site Won Fills

As part of the verification for the remediation works, the placed fills used for the embankment construction were sampled and chemically tested to confirm compliance with the reuse criteria for the protection of controlled waters. For cover soils risks to human health have been assessed against generic Public Open Space (POS) land use criteria developed in-house by CGL, together with those developed by Land Quality Management (LQM) and the Chartered Institute for Environmental Health (CIEH)²⁷.

Contamination screening and chemical analysis of soil samples was undertaken throughout the scheme for reused materials. Chemical verification of material was carried out to the methods, frequencies and criteria set out in Section 3. A verification plan showing the volumes of imported material, source and sampling quantities is presented as Figure 4.

²⁶ CGL (2019) *Western Access – Southall. Technical Report on Lagoon and Stockpile SP17.*

²⁷ Land Quality Management (LQM) and Chartered Institute for Environmental Health (CIEH) (2015). *The LQM/CIEH Suitable 4 Use Levels (S4ULs) for Human Health Risk Assessment.*

A summary table of CGL testing for the reuse of the site won fill is given in Table 10. The results are provided in subfolders in Appendix M for each stockpile and for material from the FCA, and the screened data is presented in Appendix M [CGL Testing Screening Sheets].

6.3.1 Pre-Treatment Verification

In total, 59 soil samples of site won fill were recovered by CGL for chemical testing. Chemical samples were recovered at source locations, stockpiles and post-placement, from the Yeading Brook embankment area, GUC embankment area and FCA. Samples were tested for the reuse criteria specified compounds (ammonia, cyanide, phenols, naphthalene benzo(a)pyrene, cadmium, chromium, lead, mercury and benzene).

Concentrations of potential contaminants recorded within most samples were below the CGL reuse criteria and, therefore, acceptable for direct reuse. Four samples recovered from the WGUC abutment excavation, stockpiled in stockpiles 4, 5 and 6, and stockpile 12 (refs. 804976, 804979, 831644 and 831645) recorded elevated concentrations of cadmium above reuse criteria (concentrations of between 41mg/kg and 230mg/kg, compared to the CGL reuse criteria of 12.05mg/kg), and one sample with elevated concentrations of lead at 1,800mg/kg above the reuse criteria of 1,050mg/kg. Whilst a reuse criteria was not specified for TPH, it was noted that two of these samples also recorded elevated concentrations of benzo(a)pyrene of 19mg/kg and 22mg/kg, above the reuse criteria of 12.96mg/kg. In addition, three samples obtained from the WGUC abutment excavation (refs. 800924, 804975, 804979) recorded combined total petroleum hydrocarbon concentrations (total TPH-CWG aliphatic and aromatic C10+). The material from the WGUC abutment excavation, was treated via stabilisation as part of Cognition's remediation works and rendered acceptable for reuse as a general fill following verification testing as presented in the Cognition validation report (presented as Appendix F).

One sample obtained from the Minet Tip bund (ref. 04977) recorded elevated concentrations of lead of at 7600mg/kg. The material from the Minet Tip bund, was subsequently segregated and disposed of to a suitably licensed waste facility.

One of three samples (ref. 860736) obtained from the Made Ground in the Flood Compensation Area recorded a marginal exceedance of benzo(a)pyrene of 14mg/kg, above the reuse criteria limit of 12.96mg/kg. This material was reused within the stabilised core of Zone 4 fill where it was effectively encapsulated and, therefore, not present an unacceptable risk to human health and controlled waters.

Testing was undertaken on the basal soils of the lagoon, formerly from Pump Lane, to confirm the potential for reuse of this material for the Western Access works. Eight samples (refs. 1114490 – 1114504 from the basal soils beneath the lagoon liner, and eight samples (refs. 1114489 -1114503, from the 6F5/6F2 protective capping laying above the liner, see Appendix M [CGL Testing – Lagoon

Basal Soils] were tested. These test results are discussed in the CGL lagoon and stockpile 17 materials letter report²⁶. This report concluded that, based on the available test data, the underlying basal soils of the lagoon did not satisfy the criteria for protection of controlled waters due to the presence of elevated concentrations of cadmium and TPH Aromatic C12-C16, and therefore was not suitable for reuse without further soil leachate testing / assessment to confirm if the material presented a potential risk to controlled waters or delineation to pinpoint and remove the impacted material.

Material from Zone 4 WGUC and the Minet Tip pile mat excavation was placed into Stockpile 17 which was split into three separate stockpiles, 17A, 17B and 17C following further investigated and delineation of contaminants. The assessment of contaminants is discussed in detail in CGL's lagoon and stockpile 17 materials technical report²⁶. The assessment confirmed Stockpiles 17A and 17C were chemically acceptable for reuse subject to riddling to remove deleterious material.

Stockpile 17B contained trace asbestos fibres and there were soil exceedances in four samples (refs. 1194579 – 1194582 in Appendix M [CGL Testing – Stockpile 17] of the reuse criteria (protective of controlled waters) for cadmium although following leachate analysis, Stockpile 17B material was approved for reuse as fill but not as cover soils (in the upper 300mm).

Only material in Stockpile 17A, approximately 2,500m³, was reused (as Class 2C and Class 4 fill) to form the landscaping mounds adjacent to Pump Lane in Zones 8 and 9. The additional material in Stockpiles 17B and 17C was surplus to requirements, and was subsequently disposed off site, along with the basal layer of the lagoon, in 2019, as non-hazardous waste by JRL Environmental Limited, to GB Railfreight Limited, Cricklewood. Duty of Care records are included in Appendix I.

Table 10. Summary of CGL Testing of Site Won Material (Pre-Treatment and/or Placement)

Source	Stockpile Ref. Number	No. of Tests and Test Location	End Location	Laboratory Test Report Ref.	Sample Reference	Lab Sample Number	Date of Movement to Stockpile	Date of Movement from Stockpile (approx)
Site wide Topsoil Zones 2, 3, 4, 5, 6, 7, 8,	1&3	16 at stockpiles SP1 and SP3	Site wide Zones 2, 3, 4, 6, 7, 8	19-26103 19-49244	TP1 - TP11 TS SP1	1139227 to 1139239 1263667 - 1263669	Aug 2017 - Sept 2017	Apr 2019 - Jul 2019
Topsoil Zone 4	2	2 at stockpile SP2	Non-Hazardous – Cricklewood	19-49244 (WAC)	TS SP2	1263670,1263671, 1263672, 1263673	Aug 2017 - Sept 2017	July 2019
Timber Zone 4	2	N/A	Woolridge Ecotec Limited	N/A	N/A	N/A	N/A	Sept 2019
Minet Tip bund	4 (segregated)	2, at source	Non-Hazardous – Cricklewood	17-58339	'BB' (blue billy) and 'BG' (brick gravel)	804974, 804977	Aug 2017 - Sept 2017	Apr 2019
Zone 4 WGUC pile mat excavation	4, 5&6	5, at source	Zone 4	17-58339-2, 17-57682	DC (dark clay), GC (granular clay) and TP101	804975, 804976, 804978, 804979, 800924	Aug 2017 - Sept 2017	Feb - Mar 2018
Zone 4 EYB and Zone 7 WYB pile mat arisings and river diversion works prior to separation to stockpile 10	7	7 at source, 3 at stockpile	Zone 3 & 3A	17-60711, 17-60408, 17-59543	WYBPM (at source) ES1 to ES3, EYBPM1 to EYBPM4 (at source), RDE ES1 to ES3 at stockpile	816866, 816867, 816868, 811760, 811761, 811762, 811763, 819189, 819190, 819191	Aug 2017 - Sept 2017	Feb - Mar 2018
Lagoon bund (from reprofiling) and Zone 4 WGUC pile mat excavation	8	None	Zone 4	None – combined and treated with stockpile 4 material	N/A	N/A	Sept 2017	Feb - Mar 2018

Source	Stockpile Ref. Number	No. of Tests and Test Location	End Location	Laboratory Test Report Ref.	Sample Reference	Lab Sample Number	Date of Movement to Stockpile	Date of Movement from Stockpile (approx)
Zone 4 WGUC pile arisings and mat excavation	9 (moved to stockpile 4)	3 at stockpile	Zone 4	17-60711	WGUC arisings	819192, 819193, 819194	Aug 2017- Sept 2017	Feb - Mar 2018
Zone 2, 8 & 9 River Diversion and Zone 7 WYB pile mat excavation	10	4 at source, 1 at stockpile	Zones 3, 3A & 7	17-61856, 17-65529	WYBPM Cropping (at source), Stockpile 10	825353, 825354, 825355, 825358 (leachate), 845629	Sept 2017	Oct 2017
Bailey Bridge excavation	11&11A	3 at stockpile	Zone 8	17-61856	RCBBS	825356, 825357, 825359 (leachate)	Sept 2017 - Oct 2017	Oct - Nov 2017
Zone 4 WGUC abutment excavation	12	5 at stockpile	Zone 4	17-65049, 17-63010	WGUCPA1 to WGUCPA4, Stockpile 12	831644, 831645, 831646, 831647 WAC 831692, 831693 842921	Oct 2017	Apr 2018
Zone 2 River Diversion and YB topsoil/subsoil strip	13	1 at stockpile	Site wide Zones 2, 3, 4, 6, 7, 8	17-65049	Stockpile 13	842922	Oct 2017	Apr 2019 - Jul 2019
Zone 2, 3 & 8 River Crane concrete liner broken out.	14	None – disposed off site.	FMC Heathrow or Dartford Depot or Old Oak Sidings, (PowerDay)	N/A	N/A	N/A	Apr 2018	Jul 2018
Zone 8 & 9 Pump Lane unclassified material from hoarding works	15	None – disposed off site.	Non-Hazardous – Cricklewood	N/A	N/A	N/A	Oct 2017	Apr 2019

Source	Stockpile Ref. Number	No. of Tests and Test Location	End Location	Laboratory Test Report Ref.	Sample Reference	Lab Sample Number	Date of Movement to Stockpile	Date of Movement from Stockpile (approx)
Zone 2 River Diversion	16	2 at source	Zone 4	17-647261	YBBA 1 and YBBA2	841158, 841159	Oct 2017	Feb - Mar 2018
Zone 4 WGUC natural material	17A	5 at stockpile	Zones 8,9 & 10	18-22014 19-47039 (asbestos ID only)	SP17A	1112517 – 1112521 1252909, 1252910	Oct 2017 - Nov 2017	Apr 2019
Zone 4 WGUC / Minet Tip pile mat excavation	17B, 17C	Disposed off site	Non-Hazardous - Cricklewood	18-22014 18-22293 19-36247 19-47039	SP17B & SP17C & Lagoon Base (below liner)	1112515, 1112516, 1112522 1114490/92/94/96/98 & 114500/02/044 1194579 – 1194582 1194586 – 1194589 1252905 - 1252908	Oct 2017 - Nov 2017	Apr 2019
Zone 2 & 8 River Crane Diversion natural arisings	18	None	Zone 4	None – combined and treated with stockpile 16 material	N/A	N/A	Oct 2017	Feb - Mar 2018
FCA natural material	FCA	8 at source	Zones 4 & 7	17-65741 17-66259 17-68111	FCTP1 FCTP2, FCTP3, FCTP5 FCTP6 ES2 FCTP7 ES5 FCTP8 ES8	846725 849604, 849605, 849607 860737 860740 860743	Oct 2017	May 2018
FCA MG		3 at source	Zones 3 & 4	17-68111	FCTP6 ES1, FCTP7 ES4, FCTP8 ES7	860736, 860739, 860742	Oct 2017	Mar 2018

6.3.2 Post-Treatment Verification

Based on a review of the Cognition validation report (presented as Appendix F) a total of 68 chemical samples were recovered from treated fill material to provide chemical verification, this correlates to a testing frequency of one sample per 445m³ of treated material and therefore within the testing frequency requirement for treated soil.

6.3.3 Cover Topsoil Verification

The majority of site won topsoil was suitable for reuse within the scheme based on the Western Access reuse criteria presented in Appendix D, and the CGL technical letter report on proposed cover soils¹⁰ presented in Appendix N. Site won topsoil has been placed on the Western Access embankments, either side of the River Crane diversion channel, across to Pump Lane, over the detention basin area, and in the reconfigured FCA. In these areas, imported topsoil from Bourne Amenity, has been placed where there is tree planting.

The majority of site won topsoil, approximately 2,700m³, from within the FCA, was stockpiled locally and reused within the FCA. The rest of the site won topsoil, around 2,770m³, was stockpiled within the lagoon complex in stockpiles SP1 and SP3. Sampling and assessment was undertaken by CGL to assess the validity and condition of the landscaping materials. CGL tested samples taken from stockpiled site won topsoil, and from their end placed location, as summarised in Table 11. A total of 33 samples of the site won reused topsoil across the scheme was tested for compliance with the Western Access reuse criteria.

The screened results for the site won topsoil are presented in Appendix M [CGL Testing Screening Sheets] and the raw test results are provided in Appendix M [CGL Testing –Landscape and Cover Soil Testing including Stockpiles 1 and 3].

The results of the chemical laboratory testing on the topsoil are discussed in a separate CGL technical letter report on proposed cover soils¹⁰ presented in Appendix N. The report concluded that, when compared with the established reuse criteria and suitable human health criteria, based on a public park land use scenario, the topsoil placed was suitable for inclusion within the scheme.

One marginal exceedance of cadmium of 15mg/kg against the reuse criteria of 12.05mg/kg was recorded in a sample of topsoil sourced from the FCA, which had been transferred to the lagoon for reuse, and asbestos fibres (chrysotile <0.001%) were also detected in the same sample. This material was deemed suitable for reuse based on the mean concentration of test results for cadmium from ten test results within the stockpiled topsoil, see Section 4.6.7.

Topsoil was placed at 300mm minimum thickness across the scheme. Further testing on the placed topsoil confirmed suitability of the materials as previously ascertained.

The imported topsoil was verified independently by Tim O'Hare Associates. Their reports, included in Appendix L confirmed that none of the five samples of placed imported topsoil tested within the LBH, exceeded the limits for the Western Access capping layer import specification, presented in Appendix D.

Imported topsoil (approximately 100m³) was placed to Pump Lane landscape area by FMC, which was verified, by CGL, to be compliant for use as cover soils based on one suppliers test data sheet provided by Bourne Amenity, included in Appendix L.

Table 11. Summary of CGL Cover Soils Testing

Source	Material Type	No. of Tests and Test Location	End Location	Laboratory Test Report Ref.	Sample Number/Ref.	Lab Sample Number
Zones 2, 3, 4, 5, 7, 8 & 9	Site Won Topsoil	15 at stockpiles SP1 and SP3	Site wide Zones 3, 4, 7, 8	19-26103 19-49243	TP1 - TP11 TS SP1-1 to TS SP1-3	1139227 – 1139239 1263667, 1263668, 1263669
SP1 and SP3	Site Won Topsoil	3 at Central Embankment (Zone 4):- North Slope South Slope	Central Embankment Zone 4	19-47039	EYBN EYBS	1252917, 1252918 1252919
SP1 and SP3	Site Won Topsoil	2 at Western Embankment (Zone 7): - South Slope	Western Embankment (Zone 7): - South Slope	19-47039 19-35192	WYBS WYB ES9	1252920 1189027
SP1 and SP3	Site Won Topsoil	3 at River Diversion (Zone 2)	River Diversion (Zone 2)	19-35192	RDE, RDW	1189019 - 1189021
FCA Zone 1 (east of River Crane)	Site Won Topsoil	6 at stockpiles in FCA 2 placed in FCA	FCA Zone 1	18-15303 19-35192	FCA SP1, FCA SP2, FCA SP3 FCA ES4, FCA ES5	1073402 – 1073407 1189022, 1189023
FCA Zone 1 (oil spill area west of River Crane)	Site Won Topsoil	3 on subsoil slope (post topsoil strip); 3 in topsoil stockpiled in FCA.	FCA Zone 1	19-30062	FCA Slope FCA stockpiles	1162081, 1162083, 1162084 1162082, 1162085, 1162086
FCA Zone 1	Site Won Topsoil	1 in stockpile transferred to lagoon	Zone 2 River Crane Diversion	19-36247	TP104 FCA TS	1194577
FCA Zone 1 (west of River Crane oil drum spillage)	Site Won Topsoil - Disposed off site	1 in stockpile in lagoon	Non-Hazardous - Cricklewood	19-36247	TP105 FCA TS Oil	1194578

6.3.4 Testing Frequency Summary

The recorded volume of 11,500m³ of treated site won material and total of 40 samples tested by both CGL and Cognition provides a sampling frequency of 1 sample per 289m³, and the recorded volume of 23,890m³ natural/untreated site won material (including topsoil) and total of 86 samples tested, provides a sampling frequency of 1 sample per 278m³. For material imported to the whole of the Western access scheme the recorded volume of 4,600m³ of recycled aggregate Class 6F5/6F2, and a total of 38 samples tested, provides a sampling frequency of 1 sample per 121m³. For imported Class N the recorded total volume of 6,950m³ of recycled aggregate Class 6F5/6F2, and Type 1 imported to the Western Access scheme, and total of 38 samples tested, provides a sampling frequency of 1 sample per 409m³. Imported topsoil to the LBH (<500m³) has been verified by supplier's test certificates.

These sampling frequencies are within the requirements of the CGL RSA (Appendix O), which required chemical analysis to be undertaken on a minimum of one sample per 500m³ for site won and imported fills.

6.4 Asbestos

During the construction works undertaken, asbestos containing materials (ACMs) were recorded in the following conditions:

-  Within imported IBAA: As discussed above in Section 6.2.1, imported IBAA soils recorded trace fibres of asbestos. Risks were sufficiently mitigated by use of a revised importation/storage and placement methodology.
-  Within imported 6F5/6F2: As discussed above in Section 6.2.2, some samples of 6F5/6F2 recorded trace fibres of ACM, with concentrations of <0.001% asbestos by weight and was therefore compliant with the import criteria.
-  Within site won fills: Risks associated with asbestos fibres in site won soils were mitigated by use of a revised importation/storage and placement methodology. All potentially ACM-impacted soils were dampened down during works, monitored for fibre release, as part of the lagoon management works by Cognition, and subsequently encapsulated within the embankment in accordance with the RSA (Appendix O) requirements.
-  Fragments at surface: Fragments of ACM were recorded at surface during certain visits. Once discovered, visible ACM fragments were hand-picked and double-bagged by specialist contractor ECON and disposed off-site as hazardous waste, as summarised in the CGL's technical report on landscape cover soils report presented in Appendix N.

6.5 Further Verification Requirements

Certain residual tasks remain that do not form part of the remediation requirements of LBH Planning Condition 21 and will need to be captured separately. The works include:

-  Some boreholes have been left operational and not decommissioned, for use in possible future works, if required. These boreholes will require eventual decommissioning.

7. ENVIRONMENTAL MONITORING AND MANAGEMENT

7.1 Emissions

Cognition undertook environmental monitoring, in accordance with their agreed remediation method statement (Appendix F). Results are presented in the Cognition report in Appendix F and summarised in Table 12 below.

Table 12. Emissions Monitoring

Emission Type	Monitoring Type	Monitoring Frequency	Threshold	Monitoring Exceeded Upper Threshold Limit?	Notes
Noise	Handheld noise meter measurement	3 times per day	10db above average ambient background of 67.2dB	No	No exceedances were encountered throughout the works
Dust	Visual inspection at monitoring locations	3 times per day	Constant visual assessment	Yes	Dust recorded on two occasions due to high winds. Works ceased, and areas were dampened down
Depositional Dust	Static dust measuring points in all working areas	Every 2 weeks per location	>200mg/m ² /day	Yes	Depositional dust marginally exceeded on two occasions, mitigated by dampening down of area
Fibres	Air pump monitoring in working zones	One per week	>0.01 fibres/cm ³	No	No exceedances were encountered throughout the works
VOCs	Observation and personal awareness	Minimum of 3 per day/ as required	1ppm	No	slight hydrocarbon observed in hydrocarbon impacted stockpile, workers aware of material content with stockpile labelling/ management and appropriate PPE worn

7.1.1 Noise and Vibration

Noise and vibration monitoring were undertaken at each required location a minimum of three times per day. Prior to commencement of works, a baseline ambient noise reading of 67.2dB was recorded. The threshold limit was set as 10dB above this baseline background reading. One recording at location 3, exceeded the noise limit threshold on 28 June 2017, at 84.1dBa. This was attributed to noise from the asphalt plant rather than site operations on the Western Access. Another marginal exceedance of 81.8dBa was recorded on the same day at location 5 along Pump Lane.

7.1.2 Dust

Dust monitoring was undertaken at each required location with the total amount of dust recorded during hourly intervals. Prior to commencement of works, a dust survey was undertaken to establish baseline levels. Elevated levels in the area of Pump Lane, due to commercial activities associated with the asphalt plant, and traffic. Away from Pump Lane, the dust levels were significantly less. A baseline total hourly dust level of $0.3\text{mg}/\text{m}^3$ was adopted for the site works based on the initial test results.

Visual dust inspections were undertaken at required locations a minimum of three times per day. Visual dust was recorded on 4th February 2018 during a period of high winds. At this time, works had ceased and the source material causing the dust was sufficiently dampened down before leaving site.

Depositional dust was measured at each required location every two weeks. On two occasions, the depositional dust marginally peaked at levels exceeding the threshold limit. On both occasions, the dust source was dampened down.

All three incidents were recorded to the site management and rectified immediately on-site (by dampening). No further incidents occurred.

7.1.3 Asbestos Control Measure and Fibre Release

An independent asbestos specialist (ECON) was used to carry out intermittent background monitoring in accordance with SoBRA guidance L143. Background air monitoring pumps were placed around targeted areas where earthworks were taking place. If airborne fibres exceeded the control limit of $0.1\text{f}/\text{cm}^3$, works were ceased and did not commence until suitable mitigation measures were implemented. This included dust suppression, material wetting and fencing off hazardous; only authorised personnel wearing suitable RPE could access the cordoned areas.

Stockpile 8 contained ACM contaminated soil and required screening to remove deleterious waste and provide uniformed grading that was geotechnically suitable and prepared for stabilisation. The material was fed into a screener hopper within a quarantined area, operators wore appropriate RPE and visually inspected output streams for visible ACM fragments as it passed along a purpose-built conveyor picking station. All identified ACM fragments were placed in bags or deposited down a chute into a sealed ACM skip; All picked asbestos was double bagged and disposed off site by ECON, a licenced contractor.

Background fibre monitoring was also undertaken near worst-case work zones where no fibres were recorded above the threshold.

7.1.4 VOCs and Odours

No odour from boreholes was observed during the monitoring rounds and so no PID readings were recorded. Very slight hydrocarbon odours were only observed on one occasion within the lagoon stockpiles. The stockpiles were immediately dampened down to mitigate the odours. All run off from lagoon stockpiles was contained by a lagoon bund wall and liner.

7.2 Environmental Management

7.2.1 Hydraulic Fluid Leak - River Channel Diversion

A hydraulic fluid spill occurred on 25th October 2017, resulting in the discharge of hydraulic fluid into ponded water within the newly cut, dry, river diversion channel and with small spills on the soils on the slope of the channel. The adjacent Yeading Brook coffer dam was in place at the time to allow construction of the river diversion and the channel was dry and the Yeading Brook was therefore not directly impacted by the leak. The hydraulic leak originated from a 360° excavator during movement. CGL was on-site during the event, which was mitigated using spill-kits in accordance with the Environmental Management Plan. Further details are provided in SVR No. 59 within Appendix H.

Spill kits were deployed to collect and control the hydraulic fluid on the ponded water surface. The visually impacted water was pumped to an IBC. During pumping, poor connections between pump pipes and the pump resulted in a secondary leak. As a result, spill kits were also deployed to the IBC pump area.

Two 1,000 litre IBCs were filled, followed by scraping of river diversion channel base and removal of visually impacted soil to the lagoon.

A single soil sample from between the diversion channel and the Yeading Brook, recovered by an Engineer from CGL, and scheduled for chemical analysis. The results recorded elevated concentrations of PAH and petroleum hydrocarbons, consistent with the hydraulic fluids spilt. However, concentrations of metals, petroleum hydrocarbons and PAHs were below the site reuse criteria and, therefore, potential risks to the Yeading Brook were considered to be low.

7.2.2 Hydraulic Fluid Leak - Lagoon

In November 2019 a hydraulic leak from site plant occurred within the lagoon after the membrane had been removed. Three samples were taken from the area of the hydraulic oil leak in the lagoon [samples S3 – S5, in report ref. 19-74500 in Appendix M [CGL Testing - Environmental Incident (Oil Spill)]]. Samples from below and to the sides of the visually affected area were tested, following removal and off site disposal of the visually impacted soil. The samples were tested for TPH by Criteria Working

Group (CWG) banding and BTEX (benzene, toluene, ethylbenzene and xylenes). The total TPH-CWG aliphatic & aromatic C10+ concentrations were between 450mg/kg and 943mg/kg, and lower carbon chains including BTEX were all below the laboratory limit of detection. Whilst there is no specific reuse criteria limit for TPH, the total TPH-CWG aliphatic & aromatic C10+ values were below the limit for imported material of 1,000mg/kg concentration. These results are considered typical of the background concentrations observed within the lagoon and confirmed the main impacted soil had been removed.

7.2.3 Yeading Brook Siltation

During CGL's site visits on 6 April 2018 and 18 April 2018 CGL observed gullies had formed at the toe of the northern embankment due to surface water run off, and had washed downslope causing some silt to wash into Yeading Brook, see SVR's 106 and 107A. CGL undertook a full round of groundwater and surface water monitoring (Round 29) on 18 April 2018. Similar siltation of the brook was observed by FMC during their daily visual inspection on 5 October 2018, which was present for approximately a week before disappearing. The surface water monitoring round undertaken on 30 October 2018 which did not record abnormal levels of contaminants within the brook.

7.2.4 Standing Water Discolouration Adjacent to Southeast Yeading Brook Bridge

Multi discolouration of a puddle of water adjacent to the southeast Yeading Brook bridge abutment wall was observed in December 2019. One test result indicated Ammoniacal Nitrogen as N of 7,900 µg/l, which was considerably higher than the typical levels of <1000 µg/l recorded in Yeading Brook. There was also an exceedance of the Environmental Quality Standard (EQS) for Total Phenols (7.7 µg/l) with a value of 42 µg/l. A slight sheen was noted at the same location during a CGL site visit in January 2020 and FMC was advised to inspect the location on a daily basis and take further action if further discolouration continued. No further discolouration was observed by FMC and the issue was closed. The test results are referenced YB Oil in report 19-78491 presented in Appendix J.

7.2.5 River Crane Channel Silt Leaching

Black, silty materials (sludge) were encountered within the redundant River Crane channel. A CGL Engineer inspected the materials and identified a sheen on the surface of the water. A sample of the waters and soils were recovered for chemical analysis and tested for a suite of potential contaminants including TPH, PAH and BTEX. The results indicated very low concentrations of TPH, PAH and BTEX, indicating that the sheen identified on the water surface was organic-based, rather than hydrocarbon-based. This was further evidenced by the elevated concentrations of organic matter within the samples

recovered. The sludge was removed by Mick George to Rushton Landfill. Duty of care records are provided in Appendix I.

7.2.6 West Grand Union Canal Excavation Water Infiltration

On 24 July 2017 CGL observed infiltration of water from the excavated face of the WGUC pile mat excavation, adjacent to the canal, onto the site in the area referred to as the 'Railway Triangle'. The ingress of water appeared to be seeping from the canal as the level of ingress was above monitored groundwater levels and because no groundwater had been encountered previously during excavation. The flow was steady and continuous, suggesting a constant head of water rather than perched water. SVR 3 for 27 July notes a sheen on the accumulated water within the excavation. This sheen was believed to be of biological origin as the sheen broke into platelets unlike hydrocarbon sheens. The corner of the excavation was plugged using natural cohesive site won material sourced from the excavation, and later, with concrete, see CGL SVR 29 dated 7 September 2017, which reduced the ingress considerably. Testing on three samples of the water confirmed suitability for discharge to Pump Lane sewer under the Thames Water discharge permit. The test reports are referenced in Table 13 and the results are presented in Appendix J.

Table 13. Rail Triangle and WGUC Abutment Excavation Tests for Thames Water Discharge Consent

Water Source	Laboratory Test Report Ref.	Sample Number/Ref.	Lab Sample Number
WGUC pile mat excavation	17-62999	Rail Triangle RT1, WGUCPM GW1 EW11, WGUCPM GW2 EW12	831594, 831596, 831597

7.2.7 West Grand Union Canal Surface Water

Visual inspections of the surface water of the GUC were undertaken on a daily basis by FMC. On 15 August 2017 an oily sheen was observed by FMC with a rise in pH levels from 8 to 9.1, see selected FMC daily surface water monitoring records in Appendix K. At that time construction works on the Western Access were concentrated on earthworks for the abutments either side of Yeading Brook, and installation of the temporary liner membrane and protective 6F5/6F2 layer within the lagoon. There was no indication that the oily sheen had originated from the site works. No testing was undertaken on the water. The sheen was inspected on a daily basis until it dissipated a couple of days later.

8. CONTROLLED WATERS MONITORING AND SAMPLING

8.1 Monitoring and Sampling Regime

A monitoring programme was identified as being required within the PCSA design phase in order to assess the potential risk to controlled waters during the material management element of the works.

In consideration of the groundwater and surface water at the site, including the Yeading Brook, River Crane and, to a lesser extent, the GUC, groundwater and surface water monitoring was required to be undertaken to assess the potential risk to these controlled waters, prior to, during and post all earthworks activities.

Groundwater trigger levels were established for adoption during construction to act as indicators of deterioration in groundwater quality, which may be as a result of the influence of the scheme construction activities. The trigger levels as given in CGL RSA (Appendix O) and presented with CGL's construction monitoring data in Appendix K, were based on either laboratory limits of detection, where baseline monitoring data were less than these limits, or were set at 20% greater than the maximum concentration for those contaminants recorded above laboratory detection limits.

Where groundwater and surface water trigger levels were breached over three consecutive monitoring rounds, the client and EA were notified, and the issues were discussed as part of the regular project meetings. Generally, breaches of trigger levels were sporadic and did not require specific further actions or contingency measures. The principal exception to this was the continued presence of elevated ammoniacal nitrogen, which was recorded in specific borehole locations from late November 2017 and was the subject of further monitoring and data assessment and review, as set out further below.

8.2 Baseline Readings

The results of baseline groundwater monitoring data undertaken by CGL and Ramboll (on behalf of BSO) were discussed at the Environment Meeting on 22 June 2017. Upon agreement with the EA, baseline groundwater monitoring was undertaken over just two rounds (as opposed to three rounds specified in the Arup Remediation Scheme report) in line with the requirements of the CGL RSA (Appendix O). CGL baseline readings were undertaken in June and July 2017 by CGL. The resultant data was used to establish trigger levels for contaminants in each borehole, further details of which are given in the CGL RSA (Appendix O) and reproduced in Appendix K. In addition, three rounds of baseline monitoring were undertaken by Ramboll in May and June 2017.

Pre-construction surface water monitoring was undertaken between 5 February 2014 and 12 January 2015 as presented in the St James West London/Arup (SJWL) DQRA²⁸. Spike readings in ammoniacal nitrogen as N concentrations in Yeading Brook were recorded on 22 April 2014, 25 November 2014 and 10 December 2014 in both the canal and Yeading Brook, up to 1100µg/l.

8.3 Construction Monitoring

CGL/FMC were required to undertake groundwater monitoring only and to review and assess the data from agreed monitoring points for the Western Access scheme as part of construction works. The data were discussed during monthly project meetings with the regulators, including the Environment Agency and issues flagged and agreed in a timely manner.

Ramboll undertook independent monitoring, at the Western Access, on behalf of BSO. Their relevant groundwater data is included for completeness but has not been assessed as part of the Western Access construction monitoring other than where necessary to support a specific issue, such as the elevated ammoniacal nitrogen concentrations / extent as discussed later in this section of the report. It is understood that Ramboll/BSO agreed with the Environment Agency that they would assess trends in groundwater quality only and agreed not to develop and assess their data against trigger levels.

Ground gas monitoring and assessment did not form part of the scope for the construction team on Western Access (i.e. FMC and CGL) based on the end use of the scheme, and in accordance with the risk assessment within the agreed Remediation Scheme Addendum (Appendix O), as gas risks were identified as being negligible to low, based on the scheme not including enclosed spaces and assuming construction and maintenance workers would undertake health and safety risk assessment and adopt appropriate mitigation measures, where necessary (for example, when accessing below ground services).

The initial frequency of monitoring was agreed with the EA at the Environment Meeting on 27 July 2017, with CGL to monitor on a monthly basis, and Ramboll monitoring bi-monthly. CGL began construction monitoring with the first two rounds of baseline monitoring in June and July 2017, on a weekly basis, and then reduced to monthly post piling, in October 2017.

Following observations of elevated ammonia in some boreholes, CGL agreed with the EA to increase the monitoring frequency to weekly visits at the Environment Meeting on 16 November 2017. CGL then continued to monitor on a weekly basis until mid-May 2018. Between May 2018 and July 2018 monitoring of these boreholes were paused whilst responsibilities for the monitoring works were

²⁸ St James West London/Arup (October 2015). *Proposed Bridge Works for Southall Gas Works Redevelopment. Ground Contamination: Detailed Quantitative Risk Assessment. Issue 2. Ref: 228263.*

reassessed. SOCOTEC carried out a single round of monitoring in July 2018, followed by CET who carried out all subsequent rounds, on a monthly basis, on behalf of FMC, up until the most recent round.

CGL commenced surface water monitoring at the request of the EA in November 2017 following identification of elevated ammoniacal nitrogen / ammonia in groundwater. This was expanded to include naphthalene at the end of 2017 as this was also noted to be elevated in groundwater. From 31 August 2018 until completion of the Western Access works, surface water monitoring was carried out on a monthly basis and testing for contaminants was broadened to the same testing suite as for groundwater.

Further discussion on the elevated concentrations of ammonia is given in Sections 8.4 to 8.6 of this report. Construction monitoring screening sheets with a construction timeline for the Western Access added, and sample monitoring location plans and relevant borehole logs are presented in Appendix K.

8.4 Groundwater

The critical controlled waters receptor at the site is the Yeading Brook surface watercourse.

Groundwater monitoring was required as part of the remediation requirements outlined in the CGL RSA (Appendix O), to verify that construction activities were not resulting in adverse effects to either the groundwater regime beneath the site or the Yeading Brook.

8.4.1 Monitoring

Monitoring of the suite of wells comprising boreholes BH1A, BH1B, BH2A, BH2B, BH3A, BH3B and BH4B commenced in June 2017 and post-construction monitoring has been completed. Monitoring of boreholes BH2A, BH2B and BH1B was stopped in May 2018 due to insufficient water within the well to sample under low flow conditions. After May 2018, monitoring results were obtained in borehole BH1B between January 2019 and July 2019, and for a single round in borehole BH2B in January 2019 when sufficient groundwater was present to obtain water samples.

The condition of the borehole wells was generally maintained well during site operations. Borehole BH2A was damaged by stockpiling operations, within the lagoon, in October 2019, and BH4B was decommissioned in error in July 2019. Both boreholes were reinstated as BH2AR and BH4BR respectively, on 25 November 2019.

A summary of the status/condition of the construction borehole monitoring wells on completion of the works in 2020 is presented in Table 14. Where possible, and required, the boreholes were decommissioned in accordance with EA/good practice guidance by removing the standpipes and

tremie grouting the boreholes to ground level. Some boreholes have been left operational for use in future works, if required. Other installations could not be properly decommissioned as they were broken, lost or damaged due to the construction works. However, it is likely the earthworks would have disturbed the shallow ground such that the upper sections of the boreholes would have collapsed and reduced potential pathways to groundwater. It is also noted that groundwater beneath the site is shallow and not confined, thereby reducing the risk associated with boreholes creating preferential pathways to shallow groundwater.

Table 14. Summary of Construction Monitoring Wells

Borehole No.	Installed by	Monitored by*	Date Last Monitored	Status
1A	CGL	FMC	20/04/20	OK
2A	CGL	FMC	17/05/18	Blocked/broken – standpipe removed by FMC September 2019 and borehole collapsed.
2AR (redrill)	CGL	FMC	20/04/20	OK – installed by CGL on 25/11/19
3A	CGL	FMC	20/04/20	OK
1B	CGL	FMC	22/07/19	OK – dry since 22/07/19
2B	CGL	FMC	29/01/19	OK – dry since 17/05/18
3B	CGL	FMC	20/04/20	OK
4B	CGL	FMC	27/06/19	Standpipe removed by FMC in error July 2019
4BR (redrill)	CGL	FMC	20/04/20	OK – installed by CGL on 25/11/19
1	Ramboll	Ramboll	10/01/18	Damaged by FMC construction works in May 2018. Installation probably later removed due to reprofiling works for the WGUC bridge works.
1R (redrill)	Ramboll	Ramboll	04/11/19	OK - installed by Ramboll May 2018
2	Ramboll	Ramboll	04/11/19	OK
3	Ramboll	Ramboll	11/01/18	Located in YB reno mattress (rock revetment) - decommissioned by CGL on 19/10/18
3R (redrill)	Ramboll	FMC	20/04/20	OK – installed by Ramboll May 2018
		Ramboll	04/11/19	
CBH1	Ramboll	Ramboll	04/10/17	Decommissioned by CGL June 2019
CBH2	Ramboll	Ramboll	04/10/17	Destroyed, not locatable.
CP30	Ian Farmer	Ramboll	01/08/17	Decommissioned by CA Blackwell due to ground improvement works August 2017
CP30b (redrill)	CA Blackwell	Ramboll	21/05/18	OK – installed by CA Blackwell September 2017

* Ramboll data only available up until November 2019.

8.4.2 Sampling/Testing

Groundwater testing was for a suite similar to that suggested in the Arup Remediation Scheme report but excluding full VOC / SVOC suites, as presented within the CGL RSA (Appendix O). Groundwater samples recovered from these boreholes were tested for a comprehensive suite of chemicals and

parameters including pH, sulphate, ammonia, phenols, cyanide (free and total), metals, PAH, TPH and BTEX.

8.4.3 Validation

Hydrocarbon sheens, odours and/or visible evidence of free product were not recorded throughout the groundwater monitoring visits. NAPL was not recorded to be present.

Sporadic breaches of the established CGL groundwater trigger levels were recorded during the monitoring. Individual breaches were anticipated as the trigger levels were adopted based on limited baseline data (two rounds of monitoring during early summer 2017). The CGL RSA (Appendix O) established that where three or more consecutive breaches of the trigger level were recorded that the project team would liaise with the EA and agree a course of action.

The groundwater quality and chemical compounds recorded and measured during each monitoring round generally show that the chemical quality of groundwater beneath the site was not significantly affected by the construction works undertaken at the site. However, during several monitoring visits, concentrations of ammonia, TPH and naphthalene were recorded in elevated concentrations, above the adopted trigger levels within groundwater monitoring wells. Ammoniacal nitrogen as N was noted to have exceeded the established trigger levels in BH1A, on eight of the twelve monitoring rounds. BH1A is located within the lagoon area, close to the Yeading Brook. As a result, ammonia, TPH and naphthalene were designated “contaminants of concern” and, as such, were tested within surface waters (Yeading Brook), see Section 8.5.

Results from the most recent groundwater monitoring, undertaken post the majority of construction, were broadly similar to those of the previous rounds though concentrations of ammoniacal nitrogen remained elevated since May 2018, with the highest concentration of >47mg/l recorded in BH3B in September 2018 over the duration of the monitoring period.

8.5 Surface Water

Surface water monitoring was required as part of the remediation requirements outlined in the CGL RSA (Appendix O), to verify that construction activities were not resulting in adverse effects to the Yeading Brook or the Grand Union Canal.

8.5.1 Monitoring

CGL commenced surface water monitoring at the request of the EA in September 2017 following identification of elevated ammoniacal nitrogen / ammonia in groundwater. This was expanded to include naphthalene at the end of 2017 as this was also noted to be elevated in groundwater.

Monitoring of surface water has been undertaken at the frequencies, and in conjunction with, groundwater monitoring for the duration of the construction period.

Surface water monitoring was undertaken initially on a weekly basis during construction at four locations from 20th September 2017 until 17th May 2018 (with the exception of Further Upstream, which was monitored from November 2017). A further two rounds of monitoring were undertaken in 2020 (with the exception of Further Upstream, which was last monitoring in April 2019). The Further Upstream Yeading Brook (FUYB) surface water sample location was located upstream of the site to provide a control base level in addition to the Upstream Yeading Brook sample location (UYB). Surface water monitoring data and a location plan are provided in Appendix K.

1. Downstream Yeading Brook (DYB);
2. Midstream Yeading Brook (MYB);
3. Upstream Yeading Brook (UYB); and
4. Further Upstream Yeading Brook (FUYB), monitoring undertaken between 8th November 2017 and 17th May 2018.

Monitoring of water quality parameters was undertaken by FMC using a multiparameter probe, recording in-situ measurements of pH, redox potential, temperature, dissolved oxygen and specific conductivity.

8.5.2 Validation

A daily visual inspection and monitoring of surface water quality in Yeading Brook and the Grand Union Canal was carried out by FMC during construction. Hydrocarbon sheens, odours and/or visible evidence of free product were not recorded or observed within the Yeading Brook throughout the works programme. Some surface water run off causing localised silt washout into the brook was noted during April and October 2018, see Section 7.2.3.

The surface water quality and chemical compounds recorded and measured during each monitoring round show that the Yeading Brook had very low concentrations of target compounds (naphthalene, TPH and ammonia), with the concentrations of these substances within surface waters not varying significantly from the pre-construction data or surface water monitoring readings presented in the SJWL DQRA.

Surface water monitoring data for Yeading Brook recorded marginally elevated concentrations of ammoniacal nitrogen. The concentrations were generally shown to decrease between the upstream

and downstream monitoring point. The upstream monitoring point is located immediately north of the lagoon. In agreement with the EA, in order to confirm that the elevated ammoniacal nitrogen concentrations in borehole BH1A located within the lagoon area, close to the Yeading Brook, were not impacting the brook, CGL undertook sampling further upstream. The upstream samples have consistently recorded higher concentrations of ammoniacal nitrogen than observed downstream, during their respective monitoring rounds, indicating water quality in the brook is not being adversely impacted by operations in the lagoon.

The observed trend was further highlighted within the Ramboll surface water monitoring results for the Yeading Brook. Typically, the highest concentrations of ammoniacal nitrogen were encountered upstream of the lagoons.

Concentrations within the surface water samples, including those obtained downstream of the active site (DYB) were within limits of the previous monitoring rounds with the exception of two anomalies above the upper limit of the established range ($1,000\mu\text{g/l}$), recorded in 16th December 2018 and 27th February 2019. The first exceedances were recorded in the upstream as well as midstream and downstream samples of Yeading Brook and was attributed to a source located upstream of the Western Access. The second occurrence was only recorded in the downstream sample and was considered to be an outlier possibly representing a localised incident from the River Crane, particularly as the majority of works had been completed by February 2019. This suggests that the elevated concentrations of ammoniacal nitrogen arise from a source upstream of the lagoon. Therefore, the elevated concentrations encountered within borehole BH1A are considered to present a low risk to surface waters.

The monitoring results suggest that the lagoon stockpiling operations and other Western Access site operations, have not increased concentrations of ammoniacal nitrogen, TPH or naphthalene within the brook, which is supported by the ground model which shows a very limited potential pathway between the lagoon and brook.

8.6 Controlled Waters Validation Summary

Despite the presence of TPH, naphthalene and ammonia exceeding baseline readings within monitoring boreholes, no significantly elevated concentrations of these compounds (TPH, naphthalene and ammonia) were recorded within the Yeading Brook surface water samples, including locations in the brook downstream of the site.

Two 'spike' anomalies of exceedances in ammonia were recorded in Yeading Brook were considered to represent localised incidents from the River Crane, rather than as a result of site works.

The cause and source of the sustained elevation of ammonia concentrations in the groundwater is inconclusive. With reference to CGL's technical report on ammoniacal nitrogen²⁹ (Appendix P), from the available data, no direct link could be established between the site activities, or from the existing ground conditions, and the elevated concentrations of ammonia recorded within the groundwater.

Based on the above, it is considered that all construction activities did not result in significant adverse effects to sensitive controlled waters receptors during the construction phase. These conclusions were agreed by the EA at the regulator's meeting on 18 December 2019 based on an earlier version (revision 1)³⁰ of CGL's technical report on ammoniacal nitrogen.

8.7 Post Construction Monitoring Strategy

A strategy for post construction monitoring was discussed and agreed with the regulators at the BSO Western Access Verification/Validation meeting on 17 October 2019. Post construction groundwater and surface water monitoring was to be undertaken over a period of twelve months, initially on a monthly basis, dropping to bi-monthly after the third month.

Boreholes were to be suitably decommissioned once post-construction monitoring of the Western Access had been completed. As a requirement, some boreholes were left functional and not decommissioned, to allow for their use in future works, if needed.

²⁹ CGL (2020). *Western Access – Southall. Technical Report on Ammoniacal Nitrogen – Revision 2. (January 2020).*

³⁰ CGL (2019). *Western Access – Southall. Technical Report on Ammoniacal Nitrogen – Revision 1. (November 2019).*

9. WASTE AND MATERIAL MANAGEMENT

9.1 Soils

All material excavated is recorded within the CGL Material Management Plan⁴ and soil management tracker (available in Appendix G) for the construction of the western, central embankments, in-fill to the former River Crane channel, FCA, detention basin and lagoon stockpile area. The material was reused following the requirements set out in the CL:AIRE Code of Practice: Definition of Waste. Where possible, fill material was placed above the established design groundwater level to minimise the potential interaction with localised shallow groundwater and potential leachate contamination to nearby controlled waters.

Site won material was stockpiled within the lagoon holding area where it was treated and/or remediated prior to reuse. The location of the lagoon is shown on the site layout plan in Figure 2 and FMC's Soil Management Strategy report in Appendix G includes stockpile layout sketches which record changes to the stockpiles and volumes at periodical intervals throughout the earthworks' construction. A plan showing the lagoon stockpiles treated by Cognition is included in Appendix 2 of Cognition's report in Appendix F.

Site won excavated Made Ground was screened and riddled to remove oversized deleterious objects and Ordinary Portland Cement (OPC) stabilised to unify and bind the material making it acceptable for use as embankment fill. A total of 12,570m³ of site won natural stony clay and sand and gravel was cut from the FCA, and 5,450m³ natural arisings from the bridge and wingwall excavations, were used as fill. The natural arisings of the Lynch Hill Gravel Member did not require chemical pre-treatment or geotechnical stabilisation and was classified as either a Class 2C or Class 1A material.

9.2 Unsuitable Material

Around 11,300m³ of soils were considered unsuitable for reuse within the scheme without screened screening and riddling to remove deleterious material, and lime/cement stabilisation due to the soil variability and relatively low strength. Approximately 2,000m³ of this material was won from the FCA, and 9,300m³ was within the stockpiled lagoon material. This included 3,900m³ of hydrocarbon impacted material which was bioremediated (Stockpile 4, 5, 6), and 250m³ of asbestos containing material (ACM) in Stockpile 8, which was handpicked to reduce visible ACM.

A small quantity of unsuitable site won topsoil (<100m³) containing deleterious material tree roots/branches from stockpile SP2 and the FCA, and hydrocarbon impacted topsoil (<10m³) from the oil drum spill area on the west bank of the River Crane, was disposed off site. Chemical and WAC test

results indicated this material to be classified as non-hazardous waste for disposal purposes, equating to EWC Code 17 05 04 (soil and stone not containing hazardous material). Timber tree stumps and branches excavated from Zone 4 and stockpiled in SP2 in the lagoon was also disposed off site by Woolridge Ecotec Limited, see Appendix I for licensed permit, to their holding area for chipping and onward movement to a green power generation plant. To reduce the risk of spreading spores of invasive species known to exist in the topsoil, the timber was jet washed prior to being disposed to a license facility for incineration. Waste Acceptance Criteria test results for material disposal are included in Appendix M [CGL Testing - Environmental Incident (Oil Spill)] and [CGL Testing - Waste Acceptance Criteria (WAC)].

9.3 Imported Material

Approximately 1, 580m³ of 6N recycled structural fill was imported to LBH, 450m³ of 6N from Thorney Wash (TW) London Rock Group, and 1,130m³ of Incinerator Bottom Ash Aggregate (IBAA) from Day Aggregates. Class 6N was used only behind abutment and retaining wingwall structures. The use of this material falls outside the scope of the DOWCOP but is included within the MMP for completeness. These materials have been chemically tested from samples collected from the source stockpiles (Ref 36 and Ref 35) and meet the import criteria for the site. Suppliers and CGL test data on the imported material is included in Appendix L.

4,600m³ of 6F5/6F2 crush/ aggregate was imported from Day Aggregates and used in the construction of the east and west Yeading Brook and WGUC temporary working platforms and temporary haul roads and hard standing areas. Of the total volume 2,900m³ was incorporated into the permanent works west of the GUC. The remaining 1,700m³ was transferred to the EGUC working platform. Under the instruction of CSP on behalf of FMC, CGL completed a geotechnical and geoenvironmental assessment of the 6F5/6F2 temporary works allowing their permanent retention into the Western Access scheme. The incorporation of the temporary works material was considered a low risk to contaminant pathways and to be within acceptable limits for use as a Class 1A fill material. Approximately 1,700m³ of surplus 6F5/6F2 used to construct temporary haul roads and hardstanding was subsequently transferred to the WGUC and placed as basal fill between the two wing walls.

9.4 Materials Management

In total, 39,870m³ of material was placed in the LBH. The volumes of each material type and distribution around the site is presented in the verification plan in Figure 3.

Table 15. Imported fills

Materials Type	Classification	Source	Volumes Imported To LBH (m ³) ¹	Total Volumes Imported (m ³)	Total No. Samples Tested ²	Testing Frequency ² 1/(m ³)	End Location
6N- TW (Thorney Wash)	6N	London Rock Group	450	450	4	1/113	Zones 4 & 7
6N – IBAA (Incinerator Bottom Ash Aggregate)	6N	Days Aggregates	1,130	6,500	16	1/407	Zones 4, 5 & 7
6F5/6F2/Type 1	6F5/6F2/ Type 1	Days Aggregates	2,900	4,600	38	1/121	Zones 3, 4, 5 & 7

¹ Total volume of imported aggregate for Western Access LBH only.

² Sample No.s and testing frequency for total volume of imported fill to LBH and LBE Western Access scheme.

Table 16. Site won fills

Materials Type	Treatment undertaken	Classification	Source Location	Volumes (m ³)	Total No. Samples Tested ¹	Testing Frequency 1/(m ³) ¹	End Location
Natural topsoil	Treatment not required	5A	FCA and west River Crane	2,700	10	1/270	FCA, west River Crane & Zone 2
Natural topsoil	Treatment not required	5A	Zones 2,3,3A,4,6,7,8,9,10	2,770	23 ¹	1/21	Zones 2,3,3A,4,6,7,8,9,10
Natural clay and gravel	Treatment not required	2C	Zones 2 (River Diversion), 3, 3A,4 & 8	5,450	18	1/303	Zones 3, 4 & 8
Made Ground (formerly 6F5,2C)	Treatment not required	4	Zone 4	200	1	1/200	Zone 4 landscaping
Natural sand and gravel	Treatment not required	1A	FCA & Pump Lane	1,350	3	1/450	Zones 3 & 8
Natural clay and gravel	Treatment not required	2C	FCA & Pump Lane	11,220	22	1/510	Zones 4, 7 & 8
Made Ground	Screened/ riddled and stabilised with OPC	7F/2C [9B]	FCA	2,000	4	1/500	Zones 3 & 4
Made Ground	Screened/ riddled and stabilised with OPC	7F/2C, 4	FCA	2,000	4	1/500	Zone 5 (LBE EGUC)
Made Ground	Screened/ riddled, bioremediated and stabilised with OPC	7F/2C [9B]	Lagoon (Combined stockpiles 4, 5, 6)	3,900	18	1/217	Zone 4
Made Ground	Screened/ riddled and stabilised with OPC	7F/2C [9B]	Lagoon (Stockpile 7)	900	2	1/450	Zone 3

Materials Type	Treatment undertaken	Classification	Source Location	Volumes (m ³)	Total No. Samples Tested ¹	Testing Frequency 1/(m ³) ¹	End Location
Made Ground	Handpicked for ACM then mixed with SP4	7F/2C [9B]	Lagoon (Stockpile 8)	250	3	1/84	Zone 4
Made Ground	Screened/ riddled and stabilised with OPC	7F/2C [9B]	Lagoon (Stockpile 16)	1,750	7	1/240	Zones 4
Made Ground	Screened/ riddled	2C, 4	Lagoon (Stockpile 17A)	2,500	5	1/500	Pump Lane Landscaping Bund Zones 8,9 & 10

¹Total number of tests on material from source or stockpile, plus additional testing on placed material.

9.5 Waste Disposal

Materials stockpiled within the lagoon were screened and riddled to remove deleterious and anthropogenic materials, a total of 9,300m³ of material stockpiled in the lagoon was treated and reused in the scheme. A total volume of around 2,050m³ of material was disposed offsite, of which 1,100m³ was fill surplus to requirements from Stockpiles 17B and 17C, 650m³ of deleterious material, and 300m³ of concrete broken out from the River Crane channel. Deleterious or non-conforming material was segregated and later disposed off-site under the appropriate duty of care. Screened material disposed off-site included the following;

-  General waste – Including general inert domestic and industrial refuse;
-  Metal – Including two stripped motorcycle frames, reinforcement bar and other metal deleterious;
-  Tyres – Waste vehicle tyres buried in the Minet Tip bund and associated underlying Made Ground;
-  Plastics – Buried rigid and microplastics buried in excavated Made Ground material including bottles, packaging and general waste; and
-  Asbestos – chrysotile cement board fragments handpicked from Stockpile 8 and disposed off-site.
-  Dredged sludge from the River Crane;

 Topsoil - containing deleterious material from the FCA west of the River Crane adjacent to Pump Lane and stockpile SP2, and hydrocarbon impacted soil from the oil drum spill on the west River Crane bank.

 Timber – tree stumps and branches.

Duty of Care records are presented in Appendix I.

10. CONCLUSIONS

On the basis of the above, including review of contractor and Client supplied information and the site support and associated records obtained by CGL, it is considered that the remediation of the site has been undertaken in general accordance with the requirements of the RSA (Appendix O). Site won materials generated during the earthworks were suitably managed and chemically verified prior to their reuse as general fill material within the scheme. Deleterious materials identified were either removed from site under suitable Duty of Care documentation, or subject to treatment and verification to render them suitable for reuse. Specific issues identified as a result of the watching brief undertaken by FMC and CGL, on behalf of BSO, were highlighted through project documentation and a strategy for addressing the issues discussed and agreed with the regulators as part of the ongoing stakeholder dialogue throughout the scheme.

This report and the associated supporting information is to be re-submitted to the Local Authority (LBH) and its consultees pursuant to Planning Condition 21 of Permission 54814/APP/2009/430.

Residual actions to be completed post main works, which fall outside the remit of this verification report, comprise:

-  Decommissioning of boreholes which have been left operational for use in future works, if required; and
-  Implementation of long-term maintenance works, where required, which are the responsibility of BSO although contractual arrangements are in place for FMC to correct certain defects as they arise.