

OVG Manchester

Remediation Strategy

BRA-BHE-XX-XX-RP-CG-0006

7 October 2020

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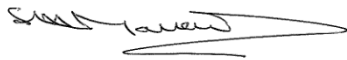
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Date **7th October 2020**

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date **7th October 2020**

Contents

1	Introduction	6
2	Site context	10
3	Contamination profile	15
4	Remediation Strategy	19
5	Remedial design and mitigation measures	24
6	Monitoring and verification	32
	References	34
	Drawings	
	Appendix A – Soil Material Suitability Criteria.	

1 Introduction

1.1 Purpose and scope of document

This report describes the Remediation Strategy for the proposed development of the OVG Manchester site (Project Bradford). It has been prepared on behalf of OVG Manchester Limited. The proposed development is for a new multi-use indoor arena, together with supporting retail and leisure facilities, back of house and support functions, public realm, cycle parking, access and associated works. As proposed, the footprint of the arena will take up the majority of the Site with some areas of soft landscaping to the south. The current scheme requires significant earthworks operations to level the site and retaining solutions will be required around the majority of the perimeter.

This report has been prepared in general accordance with the Environment Agency CLR11 Model Procedures [1] and its proposed replacement [2] (currently in draft). It has taken into account both desk-based information together with the results of various site investigations carried out for various purposes across the site.

Following this Introduction, the report describes; a summary of the site context (Chapter 2), a summary of the site contamination profile (Chapter 3), the remediation strategy (Chapter 4), the remediation design and implementation of the remediation (Chapter 5), and a plan for monitoring and verification (Chapter 6).

1.2 Summary of earthworks

The proposed earthworks for the development comprise:

- i. Grout works to fill any encountered voids associated with the mining legacy (see Coal Mining Risk Assessment [3] and Groundwater Risk Assessment [4] for more details)
- ii. Carry out a cut exercise, re-levelling of the site to between +54.1mOD (majority of the site) and +56.1mOD (north-west), generally creating a flat ground surface for the proposed development (currently the site is on an incline, with a ground level of +60.6mOD in the south, falling to +56.8mOD in the north).
- iii. Construction of an attenuation tank to the east of the site to +51.47mOD
- iv. Install retaining solutions around the majority of the perimeter of the site.
- v. Construction of temporary piling mats.

It is proposed that approximately 100, 160m³ of spoil arising from the excavation of the cut exercise will not be suitable for direct re-use and will be disposed off site, taken to suitable landfill.

1.3 Remediation – summary of need, objectives and techniques

The presence of contamination (in soils, liquids or gases) in the Made Ground and shallow groundwater across the site has the potential to impact upon human and environmental receptors both in the short term (during construction) and in the long term (during use as an arena). Multiple potential sources of contamination have been identified across the site with evidence of ground, groundwater and gaseous contamination provided by both the recent and previous ground investigations [5] and [6]. Risk assessment has identified a number of potentially significant risks associated with these sources including to people (construction workers, current / future site users and visitors). There are also risks associated with possible Unexploded Ordnance (UXO).

These potential risks are capable of mitigation by an appropriate programme of remediation. The objectives of the remediation are to mitigate the potential risks to people and the environment, associated with the ground contamination and the potential for exposure, both during construction and over the longer term.

Prior to construction, the site will be subject to significant ground alteration comprising a cut exercise to bring the site to a flattened level of +55.0mOD. This programme of earthworks will involve removal of some of the source material (Made Ground) thus reducing the potential for exposure of people to residual contamination and the generation of leachate and its migration to groundwater. However, substantial Made Ground will remain after this cut exercise, the majority of which takes place in the southern part of the site where there is the least amount of Made Ground.

The removal of below ground obstructions is subject to the proposals of the Contractor. Any areas of localised, gross or mobile contamination will be subject to excavation and treatment / removal off-site. This removal of obstructions will be managed to keep the newly open areas to a sensible minimum, thus reducing the potential for rainwater infiltration. Once the below ground obstructions/ contamination have been removed, suitable materials will be placed to reach the designed final finish level. Ground bearing across the site will be variable thicknesses, between 200mm and 400mm. The concrete slab construction does not currently incorporate any additional damp proof / gas protection measures (i.e. additional waterproof additive).

1.4 Regulatory requirements

1.4.1 Planning Conditions

This report has been prepared to address the requirements of Manchester City Council as the local planning authority with respect to land affected by contamination, set out in particular draft planning conditions. Planning permission is not yet granted. The conditions relevant to land affected by contamination are presented below for ease of reference:

***"8) a)** Notwithstanding the Geoenvironmental and Geotechnical Desk Study stamped as received by the City Council, as Local Planning Authority, on the 30th March 2020, prior to the commencement of development hereby approved, the following details shall be submitted for approval in writing by the City Council, as Local Planning Authority:*

- Provision of the calibration certificate(s) for the gas monitoring equipment to cover the entire monitoring period;*
- Submission of a remediation strategy.*

The development shall then be carried out in accordance with the approved remediation strategy.

***b)** A Completion/Verification Report shall be submitted to and approved in writing by the City Council as local planning authority, prior to the first use of the development.*

In the event that ground contamination, groundwater contamination and/or ground gas, not previously identified, are found to be present on the site at any time before the development is occupied, then development shall cease and/or the development shall not be occupied until, a report outlining what measures, if any, are required to remediate the land (the Revised Remediation Strategy) is submitted to and approved in writing by the City Council as local planning authority and the development shall be carried out in accordance with the Revised Remediation Strategy, which shall take precedence over any Remediation Strategy or earlier Revised Remediation Strategy.

Reason - To ensure that the presence of or the potential for any contaminated land and/or groundwater is detected and appropriate remedial action is taken in the interests of public safety, pursuant to policies DM1 and EN18 of the Manchester Core Strategy (2012).

"10) The Site investigation and remediation works including trial piling, grouting of coal seams and mineshaft capping and other associated works shall be carried out in accordance with The Coal Mining Risk Assessment (31st January 2020) prepared by Buro Happold Engineering and Method Statement for Proposed Grouting Works (3rd July 2020) stamped as received by the City Council, as Local Planning Authority, on the 22nd July 2020.

Upon completion of the approved intrusive site investigations and remedial works to mitigate the risk of coal mining legacy at this site, a verification report, or equivalent statement prepared by a competent person, shall be submitted for approval in writing by the City Council, as Local Planning Authority. This document shall confirm the methods and findings of the additional intrusive site investigations and the completion of the remedial works and/or mitigation necessary to demonstrate that the site has been made, safe and stable for any future development at this site.

Reason – In the interest of ensuring the works are undertaken to a suitable standard pursuant to policy EN18 of the Manchester Core Strategy (2012)."

1.4.2 Report

This report addresses Condition 8a namely the preparation of a remediation strategy and provision of all ground gas calibration certificates covering any further ground gas monitoring (calibration certificates have been provided from the programme of monitoring carried out as part of the recent ground investigation). A verification report will be required in due course to report the findings and ensure works on site are completed in line with this Remediation Strategy. The verification report will need to be suitable for discharging Condition 8b and 10 following completion of groundworks and soft landscaping.

1.5 Roles and responsibilities

The parties with responsibility for various elements of the verification activities are summarised below.

Name	Role	Description of activities	Contact information
Oak View Group	Applicant/Client	Overall responsibility for all activities related to the redevelopment	Mark Donnelly 55 New Bond Street, London, W1S 1DG 0203 640 8910 07738 892145
Turner and Townsend	Cost Consultant / Project Managers	Overall responsibility for all activities related to the redevelopment	Ross Cuming / Mark Abbott 6 th Floor. 55 Springs, Manchester, M2 2BY 0161 237 7750 07870 264974
BAM	Main Contractor	Contractor for the proposed development and provision of ground gas calibration certificates for any ground gas monitoring carried out.	Metro, 2 nd Floor 33 Trafford Road Exchange Quay 2 Salford M5 3NN 0161 877 9274
Buro Happold Ltd	Designer	Preparation of the Remediation Strategy	Francesca Gould / Rob Frost 230 Lower Bristol Road, Bath, BA2 3DQ 0122 532 0600

Name	Role	Description of activities	Contact information
			07525 766273
Provectus	Remediation Contractor	Management of spoil removal from site	Alex Clifford Regent House, Bath Avenue, Wolverhampton, WV1 4EG 0190 281 0084 07815 628197
SikaProof	Specialist Contractor	Manufacturer of external waterproof membrane and provision of ground gas calibration certificates for any ground gas monitoring carried out.	N/A

2 Site context

2.1 General

This Chapter presents a brief summary of the site context and conditions, consideration of which has enabled the definition of the remediation scheme. This summary has been prepared from source information prepared by Buro Happold [5], [7] and it is recommended that appropriate reference is made to those reports (Desk Study and Interpretative Report) for more detail.

2.2 Summary of site setting

The site is located to the north east of Manchester City Centre, within the Etihad Campus. It occupies approximately 4.5 hectares, centred on National Grid Reference SJ 86841, 98878. It is currently used as an over-spill surface level car park for those attending events associated with the Etihad Stadium. The perimeter of the site is populated with informal, dense shrubbery and trees and secured with tall mesh fence. Ashton Canal is located along the southern boundary and the River Medlock is located within a culvert to the north west. There are no existing buildings on the site.

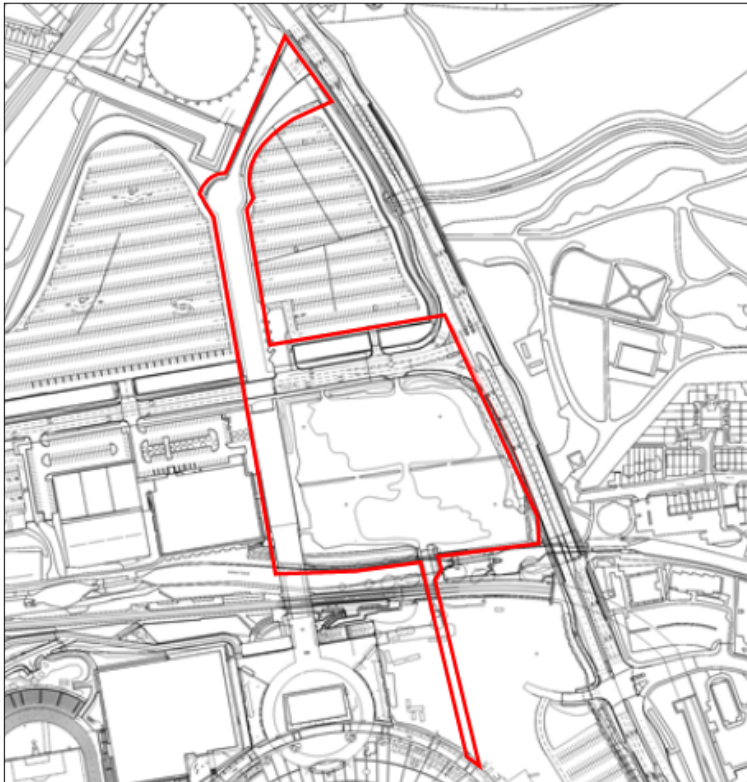


Figure 2-1 Red line boundary

The following summary of the site history has been derived from the desk study report [7] and the Coal Mining Risk Assessment [3]. Appropriate reference should be made to these reports for more detailed information.

Until the mid-1800s, the site and surrounding area was occupied by agricultural land with the River Medlock meandering through the north-west corner of the site. The Ashton canal and lock formed the southern boundary and Mill Lane the east. Victoria Gardens were located to the north and in part occupied the north of the site. By 1848, the River Medlock had been straightened and diverted further north, away from the site. Industrial works began to occupy the land south of the Canal during the early 1890s and residential development occupied the eastern part of the site.

During the early 1900s the River Medlock was culverted, Forge Lane was constructed running north/south centrally through the site and other residential roads connected onto Forge Lane from the east. The largest change at this time was the development of Bradford Road Gas Works, which included tanks, gas holders, tramways and large buildings (some within the site boundary). By the early 1930s, there was further development to these gas works on site and further development to the industrial works to the south, beyond the Canal. There were no further significant changes to the site and its surroundings until late 1970s when the majority of these works were cleared, including buildings associated with Bradford Road Gas Works. Between the late 1980s and late 1990s there were changes to the land use east of Forge Lane within the site boundary and by 1995 Mill Lane developed into Alan Turing Way.

By 2002, construction of the Etihad Stadium (formally Manchester Stadium) to the south was underway and road layouts in the surrounding area developed. A temporary BMX track occupied the site in 2009 and by 2010 the site was cleared.

2.3 Geological, hydrogeological and hydrological regimes

Geology

The 1:50 000 geological map Sheet 85 [8] and 1:10 000 geological map Sheet SJ89NE [9] together with historical and recent ground investigations [6], [10] indicate the geology to be the Pennine Upper Coal Measures of the Upper Carboniferous, overlain by Quaternary deposits. The map shows the site to be underlain by the following:

- Made Ground
- Alluvium and River Terrace Deposits (north-western area) – Soft grey clay and unconsolidated orange-brown clayey sands and gravels.
- Glacial Till – Firm becoming very stiff reddish-brown clay and silty clay with gravels and pebbles.
- Pennine Upper and Middle Coal Measures – Mudstones, siltstones and sandstones with beds of coal, fireclay and ironstone within the upper parts.

Due to the nature of the site history and the current site uses, these natural strata are overlain by variable thicknesses of Made Ground, which is locally extensive (up to 17mbgl). Incorporated within this Made Ground are many large below ground obstructions (reinforced concrete blocks) as well as hard strata (which when machine excavated during the site investigation was too hard to penetrate), for more detail refer to Constraints Plan (drawing No. BRA-BHE-XX-XX-DR-GE-0101). Much of the ground surface across the site is gravel and grass cover.

Coal seams are known to sub-crop across the site and there are two mine shafts located beneath the area proposed for development, details of these can be found within the Coal Mining Risk Assessment [3]. To summarise, known coal seams include the Bradford Four Foot, Bradford Three Quarter and Charlotte Mine (Thin B and C). A further seam sub-crops to the north east, up dip of the site, and is present beneath the site at depth due to the dip orientation of the seam (all seams generally dip south-west). The maps indicate that the strata dips between 20° (inclined strata measured underground) and 25° (inclined strata) SW. Cross sections have been produced to detail the ground profile, these have been modified slightly since the production of the interpretative report [5] and have been included within the Drawings section at the back of this report (drawing No. BRA-BHE-XX-XX-DR-GE-0201 to 0203).

Table 2-1 Encountered geological strata across the site from ground investigation information

	Description	Top of Strata (average)		Thickness (average) (m)
		m bgl	m OD	
Made Ground	Soft to firm brown black sandy gravelly CLAY. Locally sandy clayey GRAVEL and occasionally fine to coarse SAND. Constituents include ash, coal, clinker, brick, sandstone, limestone, pottery, concrete, rootlets, wood, plastic, rebar.	0 (0)	60.8 – 56.9 (59.1)	1.3 – 17.2 (8.1)
Alluvium	Soft to firm orangish brown slightly gravelly sand CLAY	7.4 – 12.6 (9.8)	52.8 – 44.8 (49.0)	0.3 – 2.0 (1.3)
River Terrace Gravels	Medium dense to very dense orangish brown slightly gravelly to gravelly clayey fine to coarse SAND	9.0 – 13.9 (10.8)	51.4 – 43.5 (48.4)	0.6 – 3.0 (1.7)
Glacial Till	Soft to very stiff brown gravelly CLAY	1.3 – 14.5 (7.8)	59.2 – 42.9 (51.6)	0.9 – 12.0 (5.6)
Coal Measures (interbedded layers of predominantly mudstone, with sandstone, siltstone and coal)	Very weak to weak grey MUDSTONE with locally thin to thickly laminations of light grey siltstone and/or fine grained sandstone Discontinuities are extremely closely to closely spaced planar smooth or undulating rough clean locally polished or clay smeared. SEATEARTH generally found below coal seams and consists of extremely weak grey MUDSTONE with gravel-sized fragments of black organic matter/fossilised plant remains and gravel-sized ironstone nodules. Very weak to moderately weak light grey fine to medium grained SANDSTONE with localised thin laminations of mudstone and/or siltstone. Discontinuities are extremely closely to medium spaced undulating rough clean. Very weak to weak grey SILTSTONE with localised thin to thick laminations of mudstone and/or sandstone. Discontinuities are very closely to medium spaced planar smooth or undulating rough clean or stained. Very weak black COAL.	11.5 – 18.0 (13.8)	48.5 – 39.9 (45.0)	Base not proven

Hydrogeology

The superficial deposits have been classified as Secondary (undifferentiated) Aquifer. Secondary (undifferentiated) Aquifer is assigned where it is not possible to attribute either category A or B to the rock type. In general, these layers have previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type. In this instance reflective of the variable nature of the Glacial Till.

The Coal Measures are classified as Secondary (A) Aquifer, defined as permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers.

There are five active groundwater abstraction located within 1km of the site. However, the site is not within a groundwater source protection zone. The abstractions are relating to the following:

- Borehole at Norton Street, Miles Platting, Manchester (611m north)
- Two boreholes at Openshaw, West Ashton, Manchester (971m south-east).

Hydrology

Ashton Canal is located along the southern boundary of the site (8m south). The canal climbs for 10.8km through 18 locks toward Ashton-under-Lyne. Lock No.9 is located adjacent to the site resulting in approximately 3.5m ground level change. According to the topographical survey the east side of Lock No. 9 (SE of the site) is at approximately +60.4mOD and west of the lock (SW of the site) the ground drops to +56.7mOD. a steep embankment up to the site is present on the west side with the site at approximately +59.0mOD.

The River Medlock is located approximately 40m to the north of the site and flows south and west toward the River Irwell in Manchester city centre. The course of the River Medlock meandered through the north-western part of the site during the late 1840s. By the early 1890s it had been diverted away from the main site area and straightened. By 1905, the River was contained within a 500m-long culvert below the former Bradford Road Gas Works, north of the main site area, see Figure 2-2 for the approximate position.

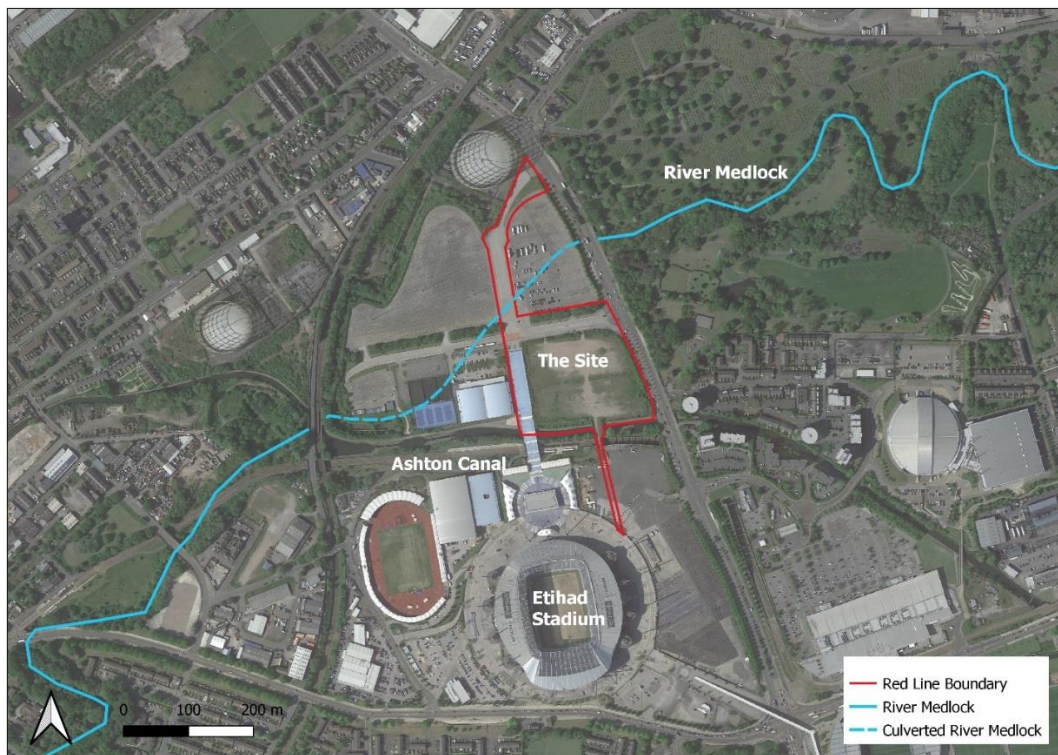


Figure 2-2 Location of River Medlock with approximate alignment of culvert (figure taken from Buro Happold Flood Risk Assessment [11])

2.4 Summary of site investigations

A recent ground investigation (February 2020) was carried out by Provectus Remediation Ltd [12]. Provectus are the appointed remediation contractor and completed trial pitting across the site in order to determine the waste characteristics of the material down to final excavation level of approximately +55.0mOD (see Section 3.1.1 for more detail).

A ground investigation was designed by Buro Happold and undertaken by Structural Soils. Intrusive works took place between September and October 2019 with post fieldwork monitoring completed by December 2019. An earlier ground investigation was carried out by May Gurney in 2010 and other intrusive works (grouting and some remediation) undertaken by BWB in 2011. All this information has been summarised and where appropriate included within the assessment summarised within the Buro Happold Interpretative Report [5].

The third party data has been accepted at face value and has not been independently verified. Buro Happold can therefore give no warranty, representation or assurance as to the accuracy or completeness of such information.

3 Contamination profile

3.1 Soils

The following information is based on previous site investigations that have informed the conceptual site model. During the previous site investigations evidence of contamination and obstructions were recorded in the form of, reinforced concrete blocks and boulders as well as ash, slag, hydrocarbon odours, oil on groundwater and evolution of gases. Perched groundwater was encountered in the Made Ground.

Assessment of the Made Ground and underlying natural strata were sub-divided into different zones based on previous remediation work and historical uses. These zones are shown in Figure 3-1 and summarised as follows:

Zone 1 Ground Level – 2.0m BGL (site-wide)

Zone 2 Over 2.0m BGL West (formerly Bradford Gas Works)

Zone 3 Over 2.0m BGL East (formerly residential use)

Zone 4 Natural Strata (site-wide)

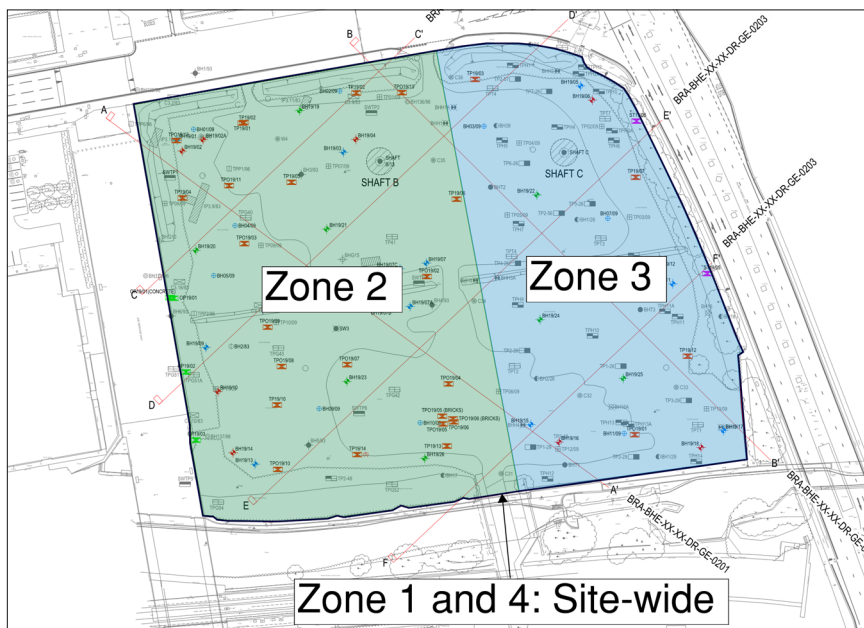


Figure 3-1 Assessment zone plan

Zone 1 - A total of 48 samples were analysed within this zone (shallow Made Ground across entire site, <2.0m bgl). All samples recorded concentrations of all inorganic and organic determinands below the relevant commercial criteria. All samples were screened for asbestos, four different samples and three separate locations identified asbestos. Three of the samples included concentrations below the hazardous threshold. One sample, TP19/01 at 2.0m bgl included a concentration of 3.62%, above the hazardous threshold (0.1%).

Zone 2 – A total of 36 samples were analysed within this zone (west of the site >2.0m bgl). All samples recorded concentrations of all inorganic and organic determinands below the relevant commercial criteria. All samples were screened for asbestos, four samples at three separate locations identified asbestos. Two samples recorded

concentrations below the limit of quantification and the other two samples were marginally above the limit for quantification but well below the hazardous threshold (0.1%).

Zone 3 – A total of 17 samples were analysed within this zone (east of the site >2.0m bgl). All samples recorded concentrations of all inorganic and organic determinands below the relevant commercial thresholds. All samples were screened for asbestos, no asbestos containing material was detected.

Zone 4 – A total of 7 samples were analysed within this zone, the natural strata beneath the Made Ground. All samples recorded concentrations of all inorganic and organic determinands below the relevant commercial criteria.

The potential health impacts were assessed as Moderate to Moderate/Low risks for construction workers, future site users, and occupiers/users of neighbouring land based on direct contact, ingestion and/or inhalation of the Made Ground.

3.1.1 Provectus Waste Characterisation

Following the ground investigation in 2019, Provectus carried out a trial pitting exercise to further determine the waste characteristics across the site [12]. A total of 48 trial pits were excavated down to the final excavation level of +55.0mOD, shown below in Figure 3-2.

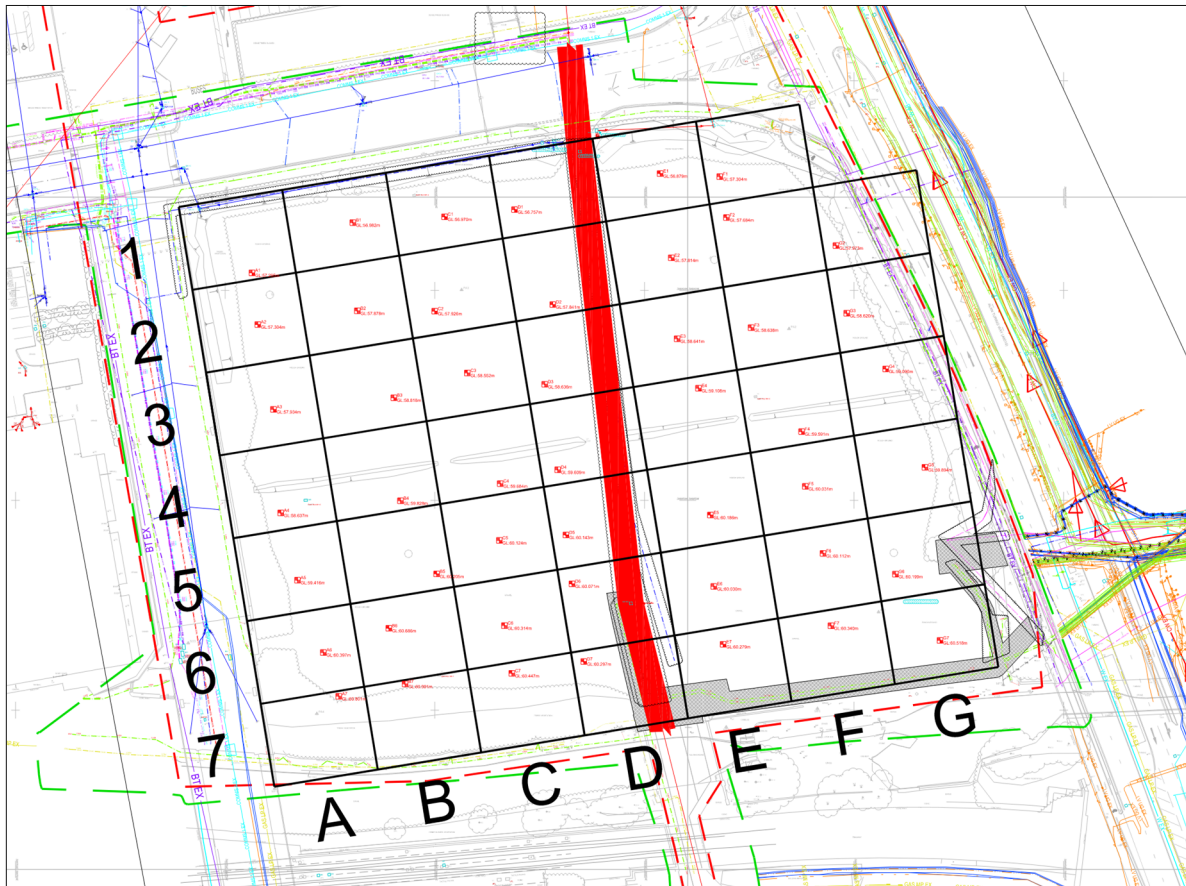


Figure 3-2 Trial pit locations from Provectus site investigation

This further investigation found the most likely hazardous substance across the site was associated with the coal tar derived hydrocarbons due to historical site use as Bradford Road Gas Works and associated coal carbonisation. The following summary has been derived from the report:

Non-Hazardous Waste found within 117 sample locations (55%), equivalent of 58,500m³

Non-Hazardous soil with LOI > 10% found within 66 sample locations (31%), equivalent of 33,000m³

Hazardous Waste found within 25 sample locations (12%), equivalent of 12,500m³

Hazardous Waste with LOI > 10% found within 4 sample locations (2%), equivalent of 2,000m³

3.1.2 Phytotoxicity in soils

All soil samples were compared to relevant phytotoxic thresholds for copper, nickel and zinc. Elevated concentrations of zinc and copper were recorded however the calculated US95 was well below the threshold. The risk to flora has been assessed as Very Low on the basis that a suitable thickness of clean imported material will be used for horticultural purposes. The criteria for suitable clean imported material are set out in Appendix A.

3.1.3 Below ground infrastructure

The data within the shallow Made Ground was assessed against particular organic determinands, which when elevated, have the potential to permeate plastic pipes and taint water supply. The assessment indicates that polyethylene (PE), poly-vinyl chloride (PVC) and copper pipes may not be appropriate for potable water supply within the Made Ground due to the elevated concentrations of TPHs and total SVOCs. Where Made Ground remains in-situ and the pipes are laid within that Made Ground, barrier pipe materials are likely to be required unless otherwise agreed with the utility company. The risk to below ground infrastructure has been assessed as Low based on the use of clean fill for all below ground service trenches. The criteria for suitable material are set out in Appendix A.

The Made Ground soils were also assessed for aggressivity against concrete in accordance with the relevant BRE guidance [13]. The details of this assessment are defined within the Buro Happold Earthworks Specification [14]. Use of suitable concrete (Design Concrete Class DC4) will be required where buried below ground to prevent degradation.

3.2 Groundwater

Perched water was recorded within the Made Ground. A total of 12 samples were taken from the perched water table and assessed against Water Supply Regulations, Environmental Quality Standards and World Health Organisations Drinking Water Standards. The analytical test results show elevated concentrations of some heavy metals and heavy end TPHs within the perched water table.

A total of four samples were taken from the groundwater within the Coal Measures (Secondary A Aquifer). The analytical test results show elevated concentrations of some heavy metals and heavy end TPHs. The underlying Secondary A Aquifer within the coal measures has not been considered as a sensitive receptor with respect to the assessment of risk at this location but does have the potential to be a pathway. It is not considered a sensitive receptor as its quality of the aquifer has already been degraded due to the mining history, the nature of the Coal Measures aquifer and the absence of local abstractions. The groundwater body itself does not appear to be flowing based on the groundwater monitoring data. The risk assessment from the interpretative report [5] assesses the risk to the culverted River Medlock via migration through permeable strata (i.e. through the Coal Measures Secondary A Aquifer) as Low.

Grout works are proposed to fill any encountered voids associated with the mining legacy. Accordingly, a Groundwater Risk Assessment in association with the grout works has been prepared [4] and should be read in conjunction with this Strategy.

3.3 Ground gas

Ground gas monitoring was undertaken on a total of 11 locations on six different monitoring occasions following the site investigation. The monitoring data is generally consistent with the nature and extent of the source (Made Ground). The Made Ground is typically about 9m thick (varies from 1.3m to 17.2m) [Made Ground thicker within the north and west of the site]. This residual Made Ground typically contained organic material including hydrocarbons, coal and rare visual sightings of oily sheen on the perched water in the monitoring installations. The maximum concentrations of methane were recorded at 8.2%, 10.1% and 10.9%, all other recorded concentrations within these installations were also elevated above the guideline threshold (1%). The maximum concentrations of carbon dioxide (in installations with elevated concentrations) were typically in the range of 1 to 8.9% with concentrations above 2.5% recorded in 4 of the 11 installations on at least one occasion. Three installations recorded concentrations of carbon dioxide elevated above 5%.

The calculated GSV for CO₂ and CH₄ (concentrations x flow rate) have been determined as Characteristic Situation 1. However, in accordance with CIRIA C665 [15] it is recommended the Characteristic Situation is increased to Characteristic Situation 2 due to the multiple elevated concentrations of CH₄ and CO₂ above the typical maximum value for CS1 (1% and 5%, respectively) and the depleted oxygen concentrations (<16%). Under the worst case scenario gas flow rates only need to increase to 0.7l/hr with the methane concentration recorded for a classification of CS2 to be triggered. Such a variation in flow though not recorded is feasible and therefore it is considered appropriate for the site to be considered CS2.

4 Remediation Strategy

4.1 Introduction

In the UK, the assessment of risk from contamination follows the source-pathway-target approach. If one of these three elements is absent it is considered that there is no plausible potential for harm. If, however, there is considered to be a linkage between any given source and any given target/receptor then a risk-based approach is used to assess the significance or impact of the potential linkage. Risks are defined as the probability of an event occurring combined with the severity of the consequence should that event occur. To assess the risk to site end-user(s) posed by a given source, the sensitivity of each receptor is considered. The potential contaminant sources relevant to this site are listed below followed by the identification of the receptors and the plausible exposure pathways that could link them. The potentially significant risks, requiring remedial design and/ or action are summarised in Section 3.

4.2 Contaminant linkages

4.2.1 Contamination Sources

Potential contamination sources from former uses of the site and neighbouring area were initially identified and described in the Desk Study report [7] and later reassessed and updated within the Interpretative Report [5]. The 'Contaminants of Concern' associated with these sources reflect the recent ground investigation information and review of historical information (summarised in the Desk Study [7]).

Table 4-1 Contaminant sources, potential pathways and sensitive receptors

Potential Source	Location	Likely Age	Potential contaminants of concern
Made Ground from previous site uses, including the former Bradford Road Gas Works	On Site	>100 years	Asbestos, some elevated heavy metals, some elevated PAHs and petroleum hydrocarbons
Ground gas generated from the underlying Made Ground			Methane, carbon dioxide, carbon monoxide and reduced oxygen
Ground gas generated from underlying coal measures	One Site	>100 years	Methane, carbon dioxide, carbon monoxide and reduced oxygen Potential for combustion of coal measures during intrusive works
Water perched within the Made ground and groundwater within the Coal Measures (Secondary A Aquifer)	On Site	>100 years	Heavy metals and petroleum hydrocarbons

4.2.2 Receptors and pathways

Off-site historic land uses are not considered potential sources of contamination due to the confined nature of the Site and the site's long industrial history which was linked to some of the nearby land uses. Therefore, such uses were excluded from the risk assessment undertaken. Site specific pathway receptor linkages that have been identified for the site are summarised in Table 4-2 with respect to the sources outlined in Table 4-1 and the anticipated future use of the site as a commercial development.

Table 4-2 Receptors and pathways

Receptor		Pathway
Human Health	Construction workers	Direct contact and dermal uptake, soil and dust ingestion during earthworks and construction
	Occupiers and users of neighbouring land	Soil and dust inhalation / ingestion during earthworks and construction
	Future site users	Direct contact and dermal uptake, soil and dust ingestion
Controlled Waters	Ashton Canal	Migration via overland flow / surface water drainage during earthworks and construction
	River Medlock	Migration via permeable strata and introduced preferential pathways
Environment	Flora	Direct contact / uptake by plant roots
Building / Services	Below ground services and structures	Direct contact / permeation of plastic pipe work by contaminants in soil and leachate. Degradation of below ground concrete. Impact to coal measures from piling works.

As described above (Section 3.2) the Secondary A aquifer in the Coal Measures is not considered to represent a sensitive receptor capable of being impacted by contamination, but rather a potential pathway between the on-site contamination and the culverted River Medlock. Grout works are proposed to fill any encountered voids associated with the mining legacy. Accordingly, a Groundwater Risk Assessment relevant to the Coal Measures Secondary A aquifer in association with the grout works has been prepared [4] and should be read in conjunction with this Strategy.

4.2.3 Potentially significant risks

The pollutant linkages (assuming no mitigation measures) listed below are relevant to; the short term (during enabling works, earthworks and construction), or to the long term (during operation as an arena and public open space).

Short term – during enabling works, earthworks and construction

1. Construction workers potentially exposed to on-site contaminants within the soils and groundwater. The assessed risk is **Moderate**.
2. Construction workers potentially exposed to hazardous ground gases within confined spaces. The assessed risk is **Moderate / Low**.
3. Occupiers / users of neighbouring land potentially exposed to dusts. The assessed risk is **Moderate / Low**.
4. There is a **Moderate** risk with regards to potential UXO at the site and combustion of the coal measures during piling works.
5. The River Medlock (in culvert) potentially exposed to migrating on site contaminants within the soils and groundwater. The assessed risk is Low.
6. Ashton Canal potentially exposed to contaminated surface water run-off. The assessed risk is Low.

Long-term – during operation

7. Future site users and occupiers / users of neighbouring land potentially exposed to hazardous ground gases within confined spaces. The assessed risks are **Moderate** and **Moderate / Low** respectively.
1. Future site users potentially exposed to contamination in soils within soft landscaped areas. The assessed risk is **Moderate / Low**.
2. Built environment (below ground infrastructure including foundations) potentially in direct contact with hazardous/ aggressive ground conditions. The assessed risk is Low.

8. Site flora potentially exposed to phytotoxic contamination via root up-take from soils in landscaped areas. The assessed risk is Low.

4.3 Remedial objectives

The overall aim of the remediation is to ensure that potential risks from land contamination at the site to construction workers / ground workers, future site users, occupier/users of neighbouring land, controlled waters, ecological systems and below ground infrastructure are appropriately mitigated. The strategy also aims to ensure that the development itself can be constructed safely without ground contamination giving rise to unacceptable risks to workers and neighbours.

The remedial objectives for the site address all of these significant contaminant linkages. The objectives can be defined in three categories;

- i) contamination related,
- ii) engineering related, and
- iii) management/ amenity related.

These objectives are set out in turn below.

4.3.1 Contamination Related Objectives

The contaminated related objectives are:

1. To ensure workers engaged in enabling works and construction of the proposed development are not exposed to concentrations of contamination in the solid, liquid or gaseous/vapour phase at concentrations that could give rise to acute risks;
2. To ensure occupiers / users of neighbouring land are not exposed to concentrations of contamination in dusts at concentration that could give rise to acute risks;
3. To ensure future site users and visitors are not exposed to concentrations of contamination that could give rise to acute or chronic risks;
4. To ensure the quality of surface waters (Ashton Canal and River Medlock) are not significantly impacted by any potentially mobile inorganic or organic contaminants in both the short and long terms;
5. To ensure soils in areas of soft landscaping meet appropriate physical and chemical criteria to enable health / growth of on-site plants; and
6. To ensure that the redeveloped site cannot be determined as 'Contaminated Land'.

4.3.2 Engineering Related Objectives

The engineering related objectives are:

1. To ensure the landform reduces rainwater infiltration and manages run off etc. in the long term and that run-off is also controlled during construction,
2. To ensure that the retaining structures on the site retain their integrity into the longer term,
3. To ensure that buildings and above ground infrastructure is protected against possible ingress and accumulation of hazardous gases and vapours;
4. To ensure that any below ground infrastructure and services are designed taking the residual contamination profile into account.

4.3.3 Management and Amenity Related Objectives

The management and amenity related objectives are:

1. To deliver the proposed development to time and budget;
2. To enable discharge of the relevant planning condition(s);
3. To minimise environmental impacts and ensure that 'nuisance' effects to occupiers / users of neighbouring land are mitigated to acceptably low; and
4. To ensure the remedial works undertaken are cost effective.

4.4 Consideration of remedial options

For remediation projects, the Model Procedures [1] advise that consideration should be given to the full range of remedial design / measures that are potentially capable of meeting the remedial objectives. Appraisal of these options should then be carried out to determine which particular remediation options are feasible and likely to be effective for the particular site and circumstances under consideration (i.e. the development proposals and relevant pollutant linkages). A systematic review and evaluation of these options would then be carried out. There are three main types of control for achieving the remedial objectives. These comprise:

1. Source control – the removal or treatment of the source(s) of contamination:
2. Pathway control
 - a. The construction of a barrier to prevent contact to contaminated materials by sensitive receptors,
 - b. The construction of a barrier to prevent the migration of contamination to sensitive receptors; and
3. Receptor control – restricting the presence/ access of sensitive receptors to the source(s) of contamination.

The criteria by which remedial actions for each of these control systems are assessed can be summarised under three headings;

- Practicality (e.g. technicality, site, time, regulatory constraints)
- Effectiveness (e.g. in achieving the remedial targets); and

Durability (e.g. remaining effective over the longer term). This project is not a "remediation project" per se, but a development project which includes as an enabling element, remediation. The development itself comprises the construction of a new multi-use indoor arena with supporting retail/ leisure facilities etc (see Section 1.1) with the majority of the Site occupied by the footprint of the arena and significant earthworks operations to level the site. Accordingly, a formal options appraisal study is not appropriate. However, within the proposed development, where appropriate, consideration has been given to the alternative remedial techniques that could be relevant to the remedial objectives and the proposed development.

4.5 Regulatory regime

4.5.1 The development industry waste code of practice

In addition to the planning conditions referred to at the beginning of this report, consideration has also been given to the requirements of waste regulation administered by the Environment Agency. Spoil from earthworks can be classified as a "waste" and thus its movement, treatment and disposal falls under the Waste Management Licensing Regulations. However, the treatment / re-use of the arisings from the site could be carried out in accordance with the development industry Waste Code of Practice (known as DoWCoP) [16] supported by a planning permission.

Adherence to this Code would require the design and implementation of a robust Materials Management Plan, signed off by a Qualified Person. The material would then not be classified as a Waste (for the purpose of licensing) and the site would not then be encumbered with a Waste Management License (with aftercare provision / or need for licence surrender). Where spoil is subject to treatment prior to re-use on site, then that would require an Environmental Permit attached to the treatment plant (and not to the land). Off-site disposal would of course require disposal to an appropriately licensed facility in accordance with Waste Management Licensing Regulations. Stockpiling may require an Environmental Permit depending upon the volumes/ nature of materials and the period of residence.

4.6 Cost benefit and sustainability

The current development proposals envisage off-site disposal of 100,160m³ spoil arisings. Following the 2019 ground investigation, Buro Happold identified the presence of hazardous soils, predominantly contaminated by hydrocarbons [5]. Based on these findings, Provectus were appointed to carry out a bioremediation trial [17] to review the potential of reducing the elevated concentrations of hydrocarbons within the soils (down to +55.0m AOD – base level of excavation) through biological treatment thus reducing concentrations of hydrocarbons to below the non-hazardous waste criteria identified in Environment Agency Guidance WM3 [18].

In December 2019, Provectus excavated approximately 20 tonnes of soil from areas of known elevated hydrocarbon concentrations. These were transported to a soil treatment facility located in Rowley Regis, Birmingham. The trial took place over a period of 12 weeks using biopile technology. The elimination rate for total petroleum hydrocarbons (TPH) within the soils following the treatment trial was 70%. This rate would allow average TPH starting concentrations of 3,300mg/kg to be deemed treatable to a non-hazardous concentration of <1,000mg/kg within a 12 week period.

Where spoil is deemed hazardous as a result of elevated TPH concentration across the site, this material can be taken to an off-site treatment facility. By using a treatment facility, the material can be bioremediated to reduce the TPH concentrations therefore removing the requirement of paying higher rates of landfill tax (potentially Hazardous Waste) significantly reducing the off-site disposal costs and also allow for potential re-use of that material.

5 Remedial design and mitigation measures

5.1 Implementation Plan

The programme of works is defined by the Principal Contractor (BAM), this will be described within their Remedial Method Statement and CEMP. The following sections of this chapter describe the principles of the enabling works and earthworks, the measures to protect people and the environment necessary to ensure their construction, including how unforeseen contamination will be managed.

5.2 Earthworks

5.2.1 Made Ground

Substantial volumes of Made Ground arisings will be derived from the enabling works and earthworks (approximately 101,000m³). There is limited opportunity for the re-use of such materials on site due to both the nature of the ground and the design requirements of the arena. Much of these arisings will therefore be subject to off-site treatment / disposal at appropriately licensed facility, managed by the Remediation Contractor, Provectus.

The majority of Made Ground from the site is likely to be classified as Non-Hazardous Waste, with more impacted material (elevated hydrocarbon concentrations) and/or material containing visible ACM, likely to be classified as Hazardous Waste and requiring segregation for separate disposal / treatment accordingly. In line with current good practice, where appropriate and in agreement with the receiving facility, these waste streams will be separated on excavation while confirmatory testing is carried out. This will ensure correct classification and disposal / treatment of any hazardous materials. It is the earthworks contractor's responsibility, in association with the operator and / or owner of the landfill to classify and record any such materials for disposal in line with current regulation and guidance. Waste classification and landfill Waste Acceptance Criteria (WAC) leachate testing should be undertaken prior to disposal to landfill to meet the requirements of the disposal facilities licence. Any Made Ground (fill) material considered for re-use on site (e.g. as sub soil or fill) will meet the criteria set out in Appendix A.

During the works, the risks of potential asbestos containing material becoming airborne will be mitigated by on-site controls such as dust suppression and appropriate PPE/RPE. If 'pickable' asbestos fragments are identified, they will be picked by competent and trained personnel, removed, double bagged and placed into a clearly labelled covered skip, prior to off-site disposal to an appropriately licensed facility by a competent and licenced contractor. This will be defined in the Contractors Method Statement.

5.2.2 Natural Strata

Some of the cut exercise being carried out across the site as well as other deep excavations (i.e. piling) will result in spoil arisings of natural material (clay from the Glacial Till). This material, provided it has not been impacted by contamination, will be classified as Inert and potentially suitable for re-use either on or off site (subject to physical / geotechnical suitability). The properties of any such potentially contaminated natural soil materials would be proven chemically and physically to ensure appropriate re-use or disposal. Testing would be carried out on representative samples at an approximate frequency of one sample per 250m³ or a minimum of five samples per source area.

5.3 Protection of human health

The following text provides the written method statement for meeting the remedial objectives set out above, taking into account the proposed development as an arena with public open space. The receptors are addressed in the order of pollutant linkages above in Table 4-2.

5.3.1 Construction workers

During the enabling works, earthworks and construction there is a potential for construction workers to be exposed to contamination via direct contact and dust inhalation (including asbestos fibres) from contaminated soils and groundwater as well as potential asphyxiation within enclosed spaces from hazardous ground gases. Such risks will be mitigated by a combination of the measures set out below. The measures comprise:

- i. Avoiding below ground excavations / earthworks not required for development purposes;
- ii. Ensuring awareness of the potential for contamination in the construction workforce engaged in any below ground works by the provision of briefing and site induction including description of the potential for and the nature of potential contaminants and setting out the provisions being implemented on site;
- iii. Ensuring awareness of the potential for Unexploded Ordnance (UXO) or combustion of the underlying coal measures in the workforce engaged in any below ground works (specially piling or basement works) by the provision of liaison with specialist consultants or relevant authorities;
- iv. The implementation of an appropriate health, safety and hygiene regime. This would include:
 - Providing an appropriate level of Personal Protective Equipment (PPE) and ensuring this is worn at all times;
 - Ensuring that supplementary PPE that may be necessary (e.g. vapour masks) are immediately available to be used if required;
 - Ensuring exposure time within any enclosed spaces during construction is relatively limited and implementation of standard good practice;
 - Ensuring a good standard of hygiene with the consumption of food and drink permitted only in designated areas. Smoking will not be permitted on site.
- v. Ensuring good construction practice (including appropriate mitigation) is followed during excavation and any below ground works to prevent the generation and migration of dusts created by below ground works and other construction activities. These measures shall be set out in a Construction Environmental Management Plan (CEMP) and Foundation Work Risk Assessment (FWRA) which will be submitted with the planning application and include use of dust suppression measures (e.g. damping down dust, avoiding the dropping of spoil from height, sheeting all lorries, sheeting any areas of soil stockpile etc.).
- vi. The preparation and implementation of plans and provisions for unforeseen contamination (see Section 5.7)

5.3.2 Occupiers and users of neighbouring land

The potential for dust inhalation (including asbestos fibres) by occupiers / users of neighbouring land during the development will be mitigated by ensuring standard construction practice. This shall prevent the generation and the migration of dusts created by enabling works, earthworks and other construction activities. These measures shall be set out in a CEMP and include use of dust suppression measures (e.g. damping down dust, avoiding the dropping of spoil from height, sheeting all lorries, sheeting any areas of soil stockpile etc.). The limited potential for ground gas to migrate to neighbouring enclosed spaces will be mitigated by implementation of suitable ventilation surrounding the site (i.e. areas of soft landscaping).

5.3.3 Future site users – ground gas protection

The potential for ground gas to migrate into enclosed spaces within the proposed development will be mitigated by implementation of suitable ground gas protection measures within the base of the structure. The characteristic situation has been classed as CS2. The proposed development incorporates a gas protection system which comprises a reinforced basement slab with minimal penetrations and cracking control with a gas protection and tanking membrane. All service entries and penetrations of the slab will be sealed using “top hats” and gas resistant tape as appropriate. The proposed ground bearing slab structure will have a variable thickness between 200mm and 400mm. The gas protection and tanking membrane (a bonded membrane) will be placed on top of the concrete blinding and beneath the slab (See drawing BRA-BHE-XX-GF-DR-S-5051) and will be installed by an approved contractor (a qualified and experienced installer) and verified, all in accordance with CIRIA C735 [19]. Currently the proposed membrane will be SikaProof A-08, this or similar shall be used, see the text below. All inspection records of the membrane installation will need to be retained by the Contractor and be made available for verification purposes.

In accordance with the relevant British Standard [20], the gas protection measures score required for the type of building on site (with a gas regime classified as CS2) is 1.5 points.

The reinforced basement slab merits 1.5 points and the membrane (with penetrations sealed) merits 2 points (provided installation is verified in accordance with CIRIA C735 [19]). The proposed gas protection system therefore meets and outperforms the minimum “score” required by the British Standard.

The technical details of these gas protection measures will be confirmed by the Contractor in their detailed design. The following information has been summarised from the SikaProof Specification [21].

SikaProof A-08 is an embossed polyolefin FPO sheet membrane for pre-applied fully bonded below ground waterproofing of reinforced concrete structures. Membrane thickness 0.8mm. SikaProof A-08 is cold-applied without heat or open flames to prepared substrates or onto formwork before fixing reinforcement and concrete placement. The membrane has self adhesive longitudinal strips for bonding overlap joints and is laminated with unique sealant and a non-woven fleece backing layer with creates a bond with cast concrete.

SikaProof A-08 may only be used by experienced professionals. It can be used as a methane and carbon dioxide resistant membrane when installed as a waterproofing membrane fully bonded to concrete according to BS8485:2015+A1 2019 [20].

SikaProof A-08 membrane must be applied on a sufficiently stable substrate to avoid movement during the construction works. Substrate surface must be smooth, uniform and clean. Large gaps and voids (> 12-15mm) must be filled before membrane installation. Substrate can be damp or slightly wet, ponding water must be avoided. Suitable membrane fixing substrates include: concrete blinding, formwork, rigid thermal insulation, plywood sheets / forms. All overlap and transverse joints must be bonded and sealed either with self-adhesive strips lengthways on the edge of the membrane sheet or using SikaProof ExTape-150 on the outside face and SikaProof Tape-150 A on the inside face and all transverse joints.

An inspection will be carried out by SikaProof personnel and subsequent approval of correct installation of membrane prior to placement of the concrete slab.

5.3.4 Future site users – direct contact with Made Ground

The proposed cut exercise across the majority of the site will remove a large volume of the Made Ground (source), particularly across the southern part of the site, where soft landscaping is proposed, effectively isolating future site users from the underlying geology (including residual contamination in the Made Ground) and reducing the potential for direct contact. To the north, much of the Made Ground will remain in-situ. However, the large majority of this area of the site will be capped by the hardstanding of the development and/or the proposed public realm design, mitigating the potential for direct contact.

Substantial soft landscaped areas are proposed as part of the development, which have the potential to be constructed on existing site soils, including contaminated Made Ground (predominantly within the south of the site). Where such areas of soft landscaping are proposed an appropriate thickness of subsoil/topsoil will be provided for horticultural/landscaping reasons, and also acting as a cap over the underlying Made Ground. Due to the nature of materials on site it is unlikely that site-won materials will be suitable for reuse in soft landscaped areas (unless treated). Accordingly, clean suitable soils will be imported and placed to a minimum thickness of 600mm (see Appendix A). This soil cover will therefore provide a suitable medium for the flora but will also form a barrier between people on site and the underlying residual Made Ground and mitigate the potential for the generation of contaminated dust during the operational phase.

5.4 Protection to surrounding controlled waters

The potential risks to controlled waters have been assessed as Low (for both the River Medlock and Ashton Canal). This reflects the nature and extent of residual contamination perched within the Made Ground soils, sitting above the lower permeability Glacial Till, and the potential for migration of this contamination during enabling works and earthworks.

The River Medlock is located within a culvert 24m to the north-west of the site. The culvert soffit is approximately 4.5m below the ground surface (based on sections provided by Atkins to the EA in 2008) and the approximate level of the River is +41.7mOD. The culvert is 500m long, with openings located approximately 120m north within Philips Park and 370m west. There is a plausible pathway for the contaminants present within the water perched in the Made Ground on site to migrate away from site in the direction of the River Medlock. However, the river is located within a culvert, the groundwater perched in the Made Ground is a discontinuous water body, with limited potential for substantial lateral movement / replenishment. Therefore, it is most unlikely that contamination will be able to penetrate this boundary and impact the water quality of the River. The Secondary A aquifer is located between +37.0mOD and +39.0mOD within the Coal Measures, this is substantially lower than the River Medlock. It is most unlikely that there is hydraulic continuity between the culverted River and the groundwater in the Coal Measures aquifer. There does not appear to be any discernible pattern relating to groundwater flow direction on the site and there is no evidence that groundwater flow is in the direction of the River or to other surface water features.

Ashton Canal is located adjacent to the site along the southern boundary. The canal climbs for 10.8km through 18 locks toward Ashton-under-Lyne. Lock No.9 is located adjacent to the site resulting in approximately 3.5m ground level change. According to the topographical survey the east side of Lock No. 9 (SE of the site) is at approximately +60.4mOD and west of the lock (SW of the site) the ground drops to +56.7mOD. This level is well above the groundwater in the Coal Measures and also above the perched groundwater in the Made Ground. It is understood to be lined by clay. On this basis it is considered most unlikely that groundwater contamination will be able to penetrate this boundary and impact the water quality of the Canal. However, there is a potential for the accidental discharge of any uncontrolled run-off in the vicinity of the Canal to impact upon its water quality. Accordingly, measures will be put in place to ensure that this potential is not realised (see below).

The following measures will be implemented as standard good practice during enabling works and earthworks to ensure any potential risks to controlled waters are mitigated:

- i. Restricting the area of open excavation at any one time to reduce the potential for infiltration. Any dewatering of such excavation;
- ii. Removal of source material (any gross contamination encountered as part of the excavation / removal of below ground obstructions) reducing the potential for future leaching of contamination from impacted soils to shallow groundwater;
- iii. Prevention of uncontrolled run off during earthworks, including the provision of an appropriate cut-off/ barrier in the vicinity of the Canal bund as necessary. Appropriately managed dewatering during excavations to mitigate risks to receptors. These measures to be defined within the Construction Code of Practice (CCoP) and/ or Environmental Management Plan (CEMP).

As discussed above, grouting works are proposed as part of the site remedial measures to fill any below ground voids associated with the known coal mining legacy. A groundwater risk assessment has been produced in line with this proposed work and has been included within Appendix B. The Contractor carrying out the grouting works will be responsible for a compiling a completion report (suitable for submission under Draft Planning Condition 10) which will form evidence for the overall verification report (Draft Planning Condition 8b).

5.5 Protection of future flora placed in landscaped areas

There are some substantial areas of soft landscaping that will be constructed on existing site soils (predominantly to the south of the site between the arena structure and Ashton Canal and to the east of the site along Alan Turing Way). Details of the landscaping can be found in drawing No. BRA-POP-ZZ-ZZ-DR-L-8100. As described above, there is potential for elevated concentrations of some determinands, which exceed the phytotoxicity thresholds, to impact plants via root uptake. In these areas an appropriate thickness of subsoil and topsoil will be required primarily for horticultural/landscaping reasons, but also acting as a cap on the underlying Made Ground thus providing protection to human health via direct contact. More detail on landscaping criteria is detailed below in Section 5.9.

5.6 Protection of below ground infrastructure

Below Ground Concrete

The potential for aggressive attack on below ground concrete will be mitigated by designing the below ground concrete in accordance with the BRE guidance [13]. The classification of the Design Chemical (DC) class is DC4 for the basement slab and piles, DC3 for the pile caps with consideration to DC4 to allow for easier construction using all the same design class. This is detailed within the Earthworks Specification [14].

Water Supply Pipework

The potential for contaminant permeation of water supply pipework in the ground will be mitigated by designing the below ground water supply pipework in the ground to take account of the Water UK guidance [22] and to meet the requirements of the water utility provider [23].

5.7 UXO and Piling within Coal Measures

Although not a contaminated land risk, the risks from Unexploded Ordnance (UXO) and risks associated with piling within the coal measures will need to be addressed by the Contractor. The recommendations within the detailed UXO assessment [24] should be followed:

- Personnel involved with intrusive work are given an ordnance awareness briefing prior to any work commencing, this shall inform staff of how to identify UXO, the associated risks, relevant working procedures and contingency measures.
- A competent Explosives Ordnance Disposal (EOD) Engineer shall be present during large scale excavations.

The piling should follow Coal Authority guidance [25] and appropriate permits / licences will be required before these works are undertaken.

5.8 Unforeseen contamination

The site investigations indicate variably impacted materials with a potential to encounter relatively localised more grossly contaminated materials. The potential risks related to any such localised/ gross or otherwise unforeseen contamination will be mitigated by the following management regime:

- i. A 'watching brief' will be held by the Engineer to involve periodic inspection, appropriately recorded in a site diary. This will supplement daily records maintained by the Contractor;
- ii. The Contractor's tool box talk will alert the construction workforce to the potential for such unforeseen contamination. Encountering any such unforeseen contamination will require immediate cessation of excavation and notification of the Contractor's Site Manager and the Engineer;
- iii. In the event of any such unforeseen contamination being encountered an appropriately qualified environmental specialist from the Engineer will be contacted and will visit the site as soon as practicable (but within a maximum of 24 hours) to determine the need for and scope of any remedial action. Proposals for any such action (investigation, analysis, modelling, monitoring and remedial action if appropriate) will be discussed and agreed with the Local Authority (and Environment Agency if appropriate) prior to implementation; and

Any such action will be appropriately recorded and included in the Verification Report (see Chapter 6)

5.9 Landscaping

5.9.1 General

The latest available plans illustrating the areas of soft landscaping are shown in drawing No. BRA-POP-ZZ-ZZ-DR-L-8100. The majority of soft landscaped areas will be positioned at the south of the site between the arena structure and Ashton Canal in the form of a wildflower garden, shrub and understory planting. A line of trees and shrubs within concrete planters are proposed along the eastern boundary of the site alongside Alan Turing Way as well as occasional concrete planters along the northern boundary, adjacent to Sportcity Way.

Where areas of soft landscaping are to be laid on top of existing site materials a marker layer will be required. This is a highly visible layer (i.e. colourful geotextile) which shall act as a visual barrier separating the existing materials from the clean imported material above.

All topsoil to be used as part of the landscaped areas of the development must comply with the physical, biological and chemical parameters set out in this specification, see Appendix A. Made Ground unsuitable as a sub soil (i.e. not complying with the physical and chemical parameters set out in this specification) will not be re-used on site in landscaped areas. For imported soils within the planters, the horticultural specification will define the thickness requirement, for areas where landscaping is underlain by existing Made Ground a minimum thickness of 600mm of clean material suitable for the protection of human health will be required. This is in addition to any suitability requirements set out by the landscape architect.

5.9.2 Re-use / imported material

Due to the nature of materials on site it is likely that site-won materials will not be suitable for re-use as topsoil. Accordingly, clean suitable topsoil will be imported from off-site. It is anticipated that some Made Ground arisings may be suitable as sub soil, or may require treatment prior to such use, or may be suitable for re-use beneath building footprints and / or areas of hardstanding. All topsoil will comply with British Standard 3882:2015 [26] as a multipurpose soil (as set out in Table 1 of the standard) and should be a clay loam as defined in Figure 1 of the standard (summarised here in Appendix A). The soil is to have a defined granular or blocky structure and be free from non-soil material i.e. brick, other building materials, wastes, hydrocarbons, plant matter, roots and rhizomes of perennial weeds and any other foreign matter or material of substance that would render the topsoil unsuitable for use.

For the protection of human health imported topsoil and sub soil (including any fill materials suitable for re-use as a sub soil) will comply with the parameters set out in Appendix A. In addition to the requirements from the British Standard the horticultural specialist will set out a specification for any additional parameters relating to soil quality and suitability for use from a landscaping perspective. Any soils re-used beneath areas of buildings or hardstanding will also comply with the relevant parameters set out in Appendix A.

5.9.3 Sampling and testing regime

All topsoil and sub soil material imported from off-site sources can be tested at source and prior to import to ensure conformity prior to transport to site and placement but will also be tested in-situ for verification purposes. In-situ testing will be carried out on representative samples at a frequency of one sample per 250m³ for each material type, or a minimum of five samples per source (whichever is greater). This data will supplement any data provided by the topsoil supplier. The depth of the samples will be dependent upon the thickness of the sub soil / topsoil at that location but typically samples would be taken at 0-150mm; 200-350mm; and 400-550mm – commensurate with the nature of the material, its homogeneity and the overall frequency of 1 sample per 250m³.

If in-situ testing shows that some areas of topsoil fail the criteria (i.e. average concentrations exceed thresholds set out in Appendix A) the contractor will be required to either carry out further testing to demonstrate compliance or to excavate and remove the non-compliant soils and replace them with fresh imported topsoil with further sampling of the fresh imported material to confirm suitability. Non-compliant material will be determined on the basis of the average values (mean or US⁹⁵ as appropriate) for each batch/source of topsoil. Exceedance of this average would either result in rejection of that material and its removal and replacement by compliant material or in further testing to confirm non-compliance and/or delineate any particular contaminant 'hotspot'. The further testing would be at a frequency, spacing and depth specific to reflect the location specific circumstances. The potential for non-compliance will be reduced by the contractor obtaining data from the supplier prior to importation.

6 Monitoring and verification

6.1 Monitoring objective

Monitoring of the works as they proceed will be carried out in order to;

- Record the works as they are undertaken,
- Record any impact on surface water, groundwater or air quality,
- Record any nuisance (noise or dust)
- Record and check placement of the ground gas membrane across the building footprint,
- Record any unexpected contamination encountered during the works, together with any remedial action undertaken in agreement with the local authority,
- Provide confirmation of successful implementation of the Remediation Strategy, and
- Enable completion of a Verification Report.

6.2 Verification plan

The Verification activities will be carried out by an appropriately competent and qualified organisation, independent of the contractor. The proposed scope of works for the verification programme will comprise;

- Collation of all relevant information available from contractors' reports, drawings and records. This will include data on the grouting works, re-use of suitable soil materials, on source removal, on the waste management of spoil (contaminated and uncontaminated natural soils), management of groundwater;
- Collation of all relevant permits and licences required for the ground works / foundation works;
- Provision of the grout works completion report, to include all groundwater level monitoring as specified within the Groundwater Risk Assessment [4];
- Periodic inspection and recording of works undertaken at site to be carried out by an appropriately competent and qualified person independent of the contractor. This activity will span the whole period of the enabling works and earthworks (and include landscaping) with the frequency of inspection varying to suit the complexity and type of activity underway, but on average at between 2 and 4 weekly intervals.
- Observation, inspection and recording of health, safety, hygiene and environmental management;
- Management of the soil sampling and testing necessary to demonstrate compliance with the agreed Criteria. Testing would be carried out on representative samples at the agreed spacing and frequency;
- Chemical analysis of soils and groundwater will be carried out by an appropriate specialist laboratory (with MCERTS/UKAS accreditation for relevant determinands). The chemical analytical suite will reflect the contaminants of concern on the site, be subject to agreement with the local authority and the Environment Agency but will also reflect the determinands defined in Appendix A,
- Management of the environmental monitoring programmes (groundwater, air quality, noise),
- Verification of the installation of the gas protection measures in accordance with CIRIA C735 [19],
- Immediate response to any unexpected contamination being encountered (when the process described in Section 5.8 will be undertaken),
- Continuing review all of this data and assessment of compliance with the agreed remediation strategy,
- Liaison with the local authority, and
- Preparation of the Verification Report at the conclusion of below ground and landscaping works detailing how the work has been carried out in accordance with the approved remediation scheme

Once the contractors Remediation Method Statement, Construction Code of Conduct and Environmental Management Plan are available, a detailed plan of these verification activities will be set out. This will identify the names and contact details of the relevant parties involved and define their roles and responsibilities. It will define the period and frequency of site inspections, the period and frequency of monitoring (air, dust and groundwater). It will identify the laboratories undertaking the chemical and geotechnical testing, and the specialists carrying out monitoring. The detailed plan will identify all of the activities that will be necessary to demonstrate achievement of the remedial objectives of the works. It will be suitable for submission to the Local Authority as confirmation of this plan.

6.3 Recording

The verification data will be obtained, managed and stored by the contractor with a copy also retained by the organisation responsible for the management of the activities and the preparation of the report. All chemical and geotechnical data will be obtained, retained and made available in AGS format. The data will also be saved in an appropriate electronic format.

6.4 Verification Report

The overall objective of verification activity is to demonstrate that the remedial works have been carried out in accordance with the agreed plan and that the works have not given rise to any unacceptable impacts upon people or the environment. The verification activities will also provide evidence that:

- Planning/permit/licence conditions have been met; and
- Environmental management goals have been met.

The verification report will be prepared on completion of the works and will comply with relevant Environment Agency guidance [27]. The object of the report is to provide authoritative documentary evidence of the remedial works. The report will describe the site, the remediation objectives, the techniques or processes employed and the verification/monitoring data in succinct text supported by as built drawings, figures, photographs etc. The source data will accompany this text as appendices to the main report.

The contents of the Verification Report are anticipated to comprise;

1. Introduction
2. Background to the site and the enabling works/earthworks
3. Description of the conceptual site model
4. Planned Remedial Actions
5. Summary of Verification Plan
6. Reports of the verification activities
 - Earthworks and spoil re-use
 - Earthworks and off-site treatment/disposal
 - Drainage
 - Management of risks to the environment and human health
 - Gas protection measures
 - Management of unforeseen contamination
7. Monitoring data [air, groundwater, noise]
8. Conclusions

Supporting Appendices: Drawings; Contractor's Method and H&S Statements; Contractors data; Site Inspection records (inc. photographic record); Monitoring data.

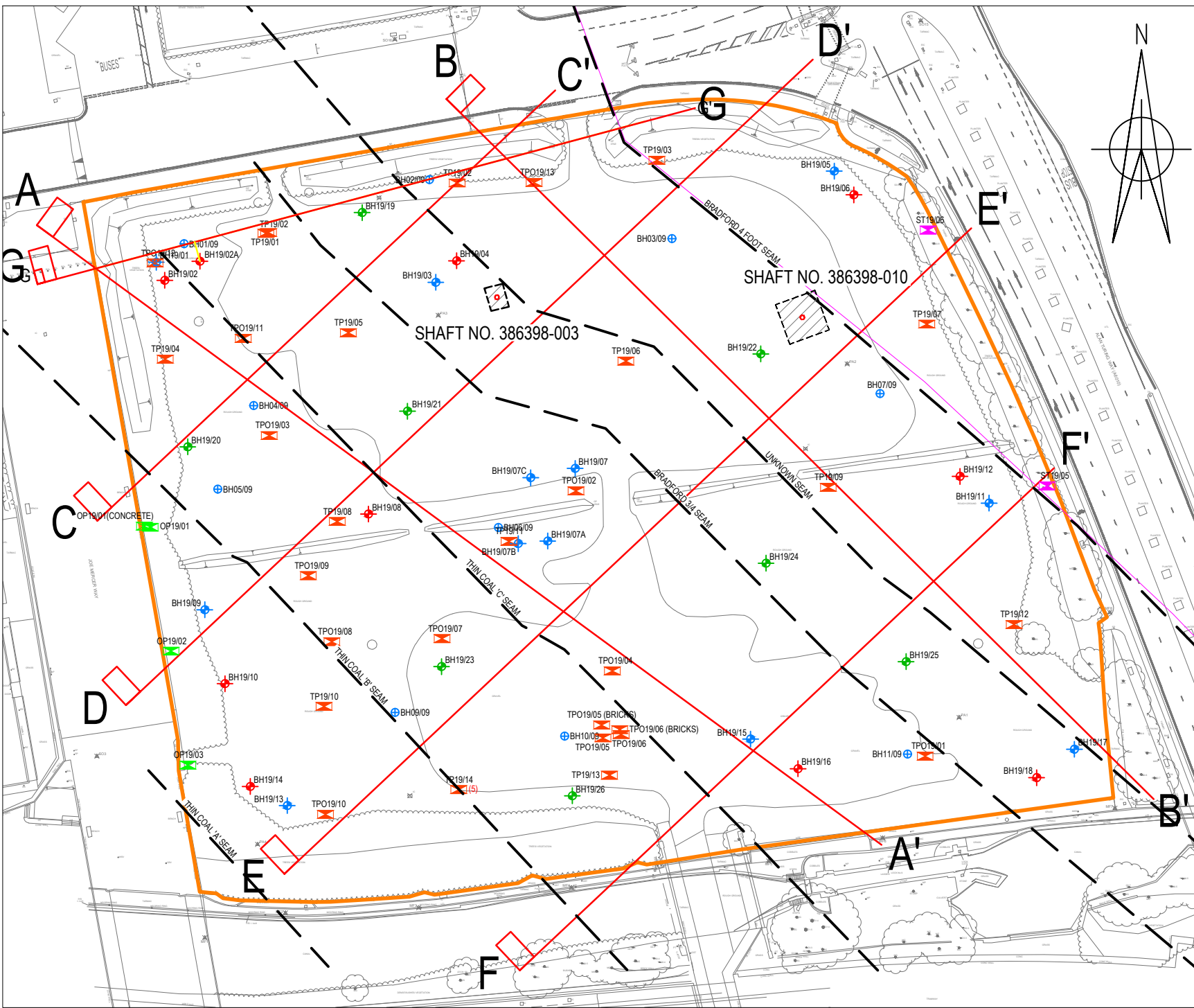
References

- [1] Environment Agency, Model Procedures for the Management of Land Contamination - Contaminated Land Report 11 (CLR11), 2004.
- [2] H M Government, <https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks>, 2019.
- [3] Buro Happold Ltd, BRA-BHE-XX-XX-RP-CG-0005 P03 Coal Mining Risk Assessment, 2020.
- [4] Buro Happold, "Groundwater Risk Assessment - Project Bradford," 2020.
- [5] Buro Happold Ltd, BRA-BHE-XX-XX-RP-CG-0004 P04 Geotechnical and Geoenvironmental Interpretative Report, 2020.
- [6] May Gurney Geotechnical, "Site Investigation Report No. SI1565 R01," 2010.
- [7] Buro Happold Ltd, BRA-BHE-XX-XX-RP-CG-0001 Geoenvironmental and Geotechnical Desk Study, 2019.
- [8] British Geological Survey , England and Wales Sheet 85. Bedrock and Superficial Deposits, 2011.
- [9] British Geological Survey, 1:10,000 BGS Map Sheet SJ89NE.
- [10] Structural Soils Ltd, "Project Bradford Ground Investigation Factual Report," 2020.
- [11] Buro Happold Ltd, BRA-BHE-XX-XX-RP-CW-0131 Rev 03 Flood Risk Assessment, 2020.
- [12] Provectus Remediation Ltd, "10114/R002 Project Bradford Waste Classification Report," 2020.
- [13] British Research Establishment Report, "Special Digest 1: Concrete in aggressive ground (Third Edition)," 2005.
- [14] Buro Happold Ltd, BRA-BHE-XX-XX-SP-CG-0003 Specification for Earthworks, 2020.
- [15] CIRIA, C665 - Assessing risks posed by hazardous ground gases to buildings, 2007.
- [16] CL:AIRE, The Definition of Waste: Development Industry Code of Practice. Version 2, 2011.
- [17] Provectus Remediation Ltd, "10114/R001 Project Bradford Bioremediation Treatability Trial," 2020.
- [18] Environment Agency, Technical Guidance WM3: Waste Classification - Guidance on the classification and assessment of waste, 2018.
- [19] CIRIA, "Good practice on the testing and verification of protection systems for buildings against hazardous ground gases (C735)," 2014.
- [20] The British Standards Institution, BS8485:2015+A1:2019 - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, 2019.

- [21] SikaProof A-08, "Product Data Sheet - FPO Sheet membrane for pre-applied fully bonded below ground waterproofing," 2019.
- [22] Water UK, Contaminated Land Assessment Guidance, 2014.
- [23] United Utilities, "Supplmentary guidance for the selection of water pipes in land potentially affected by contamination".
- [24] BAE Sytems Environmental, "X10208-R3-1 Risk Assessment for German Air-dropped UXO, Project Bradford," 2020.
- [25] Coal Authority, "Guidance on managing the risk of hazardous gases when drilling or piling near coal," Coal Authority, 2019.
- [26] British Standards Institute, Specification for topsoil 3882:2015, 2015.
- [27] Environment Agency, Verification of remediation of land contamination. SC 030114/R1., 2010.
- [28] Health & Safety Executive, Managing and working with asbestos L143, 2013.

Drawings

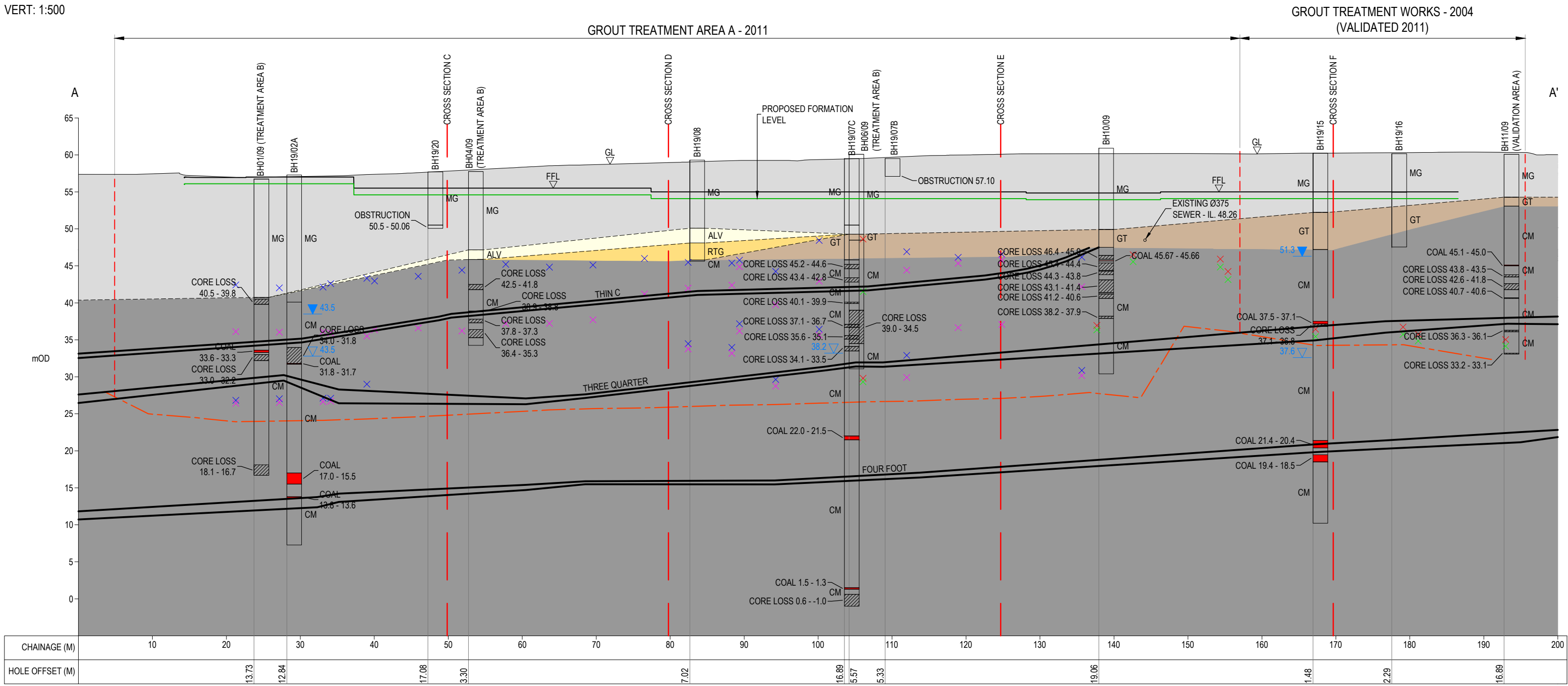
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BRA-BHE-XX-XX-DR-GE-0202	Geological Cross Section
BRA-BHE-XX-XX-DR-GE-0203	Geological Cross Section
BRA-BHE-XX-GF-DR-S-5051	Level Ground Floor Details
BRA-POP-ZZ-ZZ-DR-L-8100	Landscape Site Plan



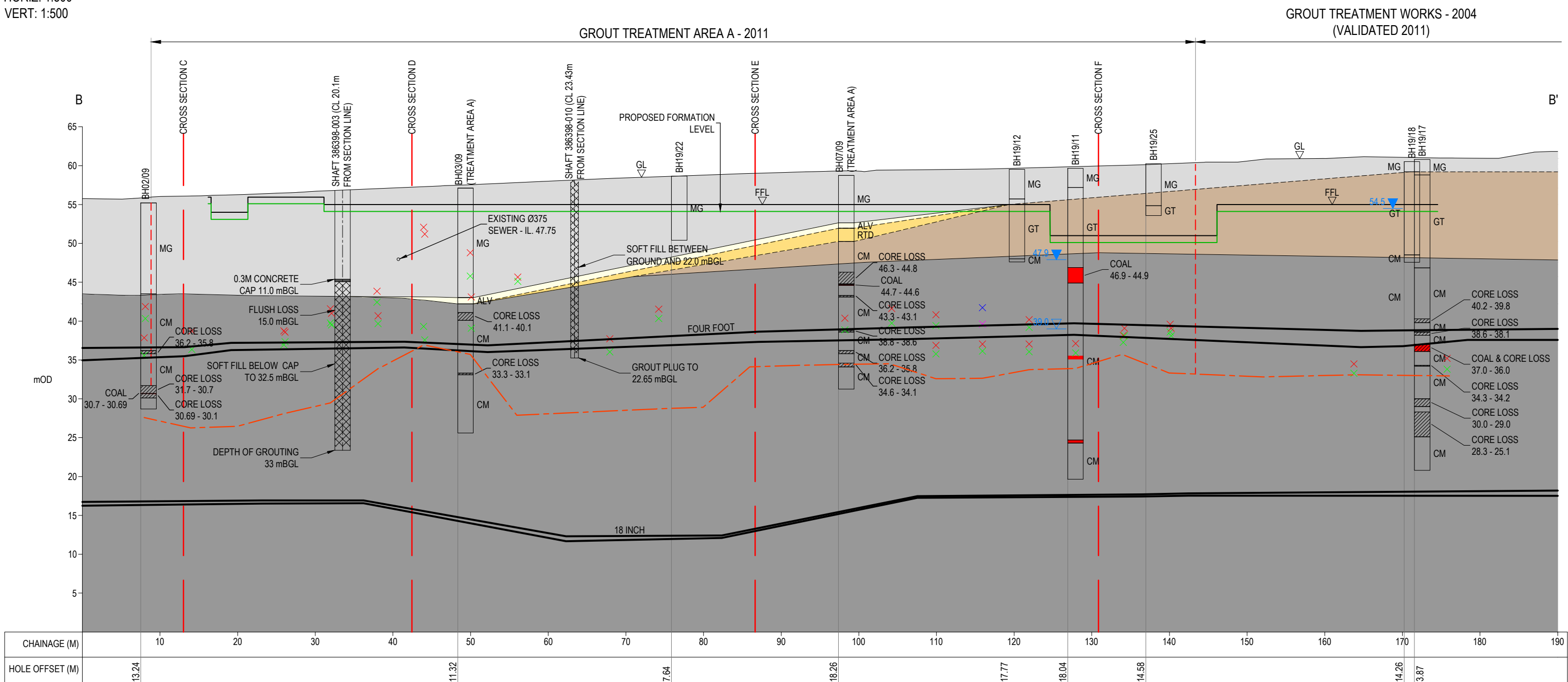
- INFERRED COAL SEAM
- MG MADE GROUND
- ALV ALLUVIUM
- RTG RIVER TERRACE DEPOSITS
- GT GLACIAL TILL
- CM COAL MEASURES
- COAL SEAM FROM GROUND INVESTIGATION DATA
- ASSUMED ZONE OF CORE LOSS
- 47.1 GROUNDWATER - PERCHED (MADE GROUND/GLACIAL TILL) mOD
- 37.9 GROUNDWATER - SECONDARY A AQUIFER (COAL MEASURES) mOD
- DRILL & GROUT LEVELS
- TOP OF COAL SEAM
- BASE OF COAL SEAM
- TOP OF SHALE & COAL ZONE
- BASE OF SHALE & COAL ZONE
- BASE OF DRILL & GROUT TREATMENT
- NOTE

HOLES MARKED TREATMENT AREAS A & B WERE LOCATED WITHIN TREATMENT AREAS FROM THE 2011 BWB REPORT. WITHIN THESE AREAS GLACIAL TILL WAS ENCOUNTERED AT APPROX. 11 mBGL AND 14 mBGL FOLLOWED BY GREY MUDSTONE OF THE COAL MEASURES.

SECTION A - A'
SCALES
HORIZ. 1:500
VERT. 1:500



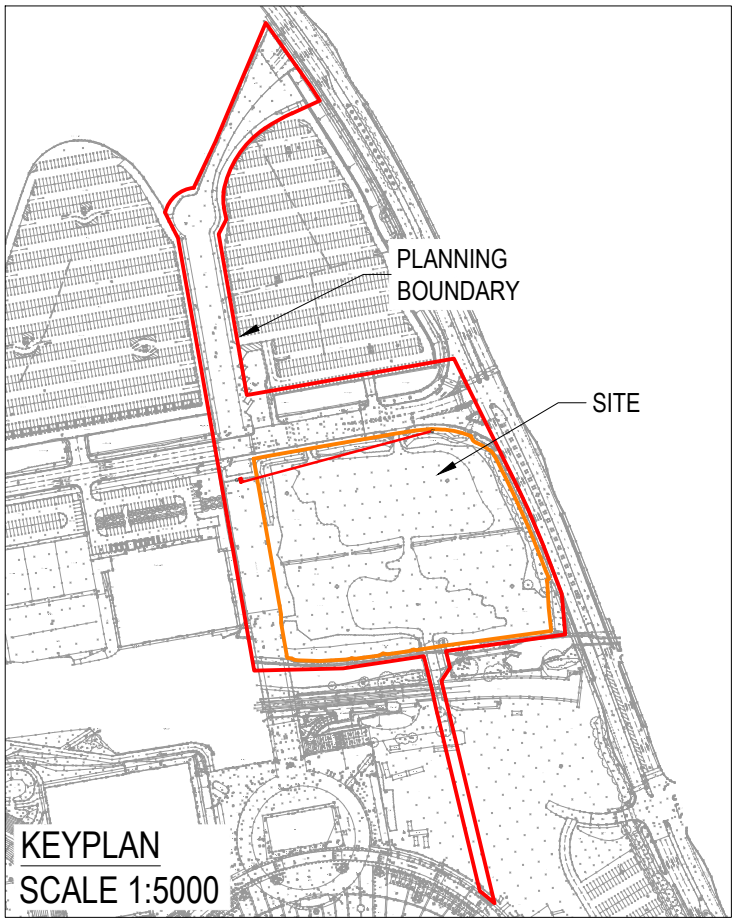
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SCALES
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Notes
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P05 PLANNING	28.08.20	NG	AKS
P04 PLANNING	24.06.20	NG	FG
P03 PLANNING	31.01.20	NG	FG
P02 DRAFT FOR PLANNING	20.12.19	NG	FG
P01 DRAFT STAGE 3	27.11.19	NG	FG
Rev Description	Date	Dm	Ch'd

PLANNING

Status of drawing

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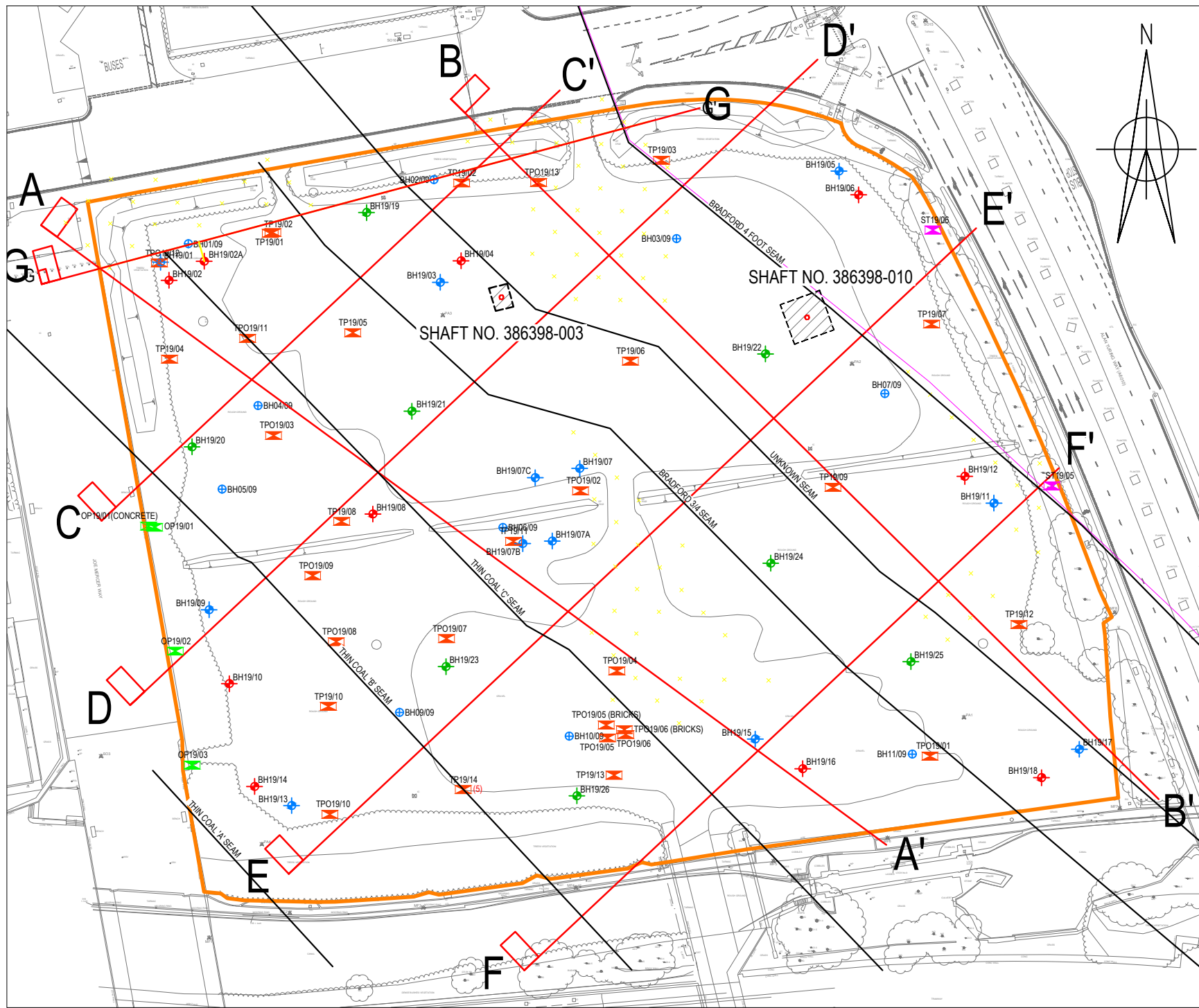
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Architect **POPULOUS**
Project **OVG MANCHESTER**
Drg Title **GEOLOGICAL CROSS SECTIONS
SHEET 1**

Scales@A1 1:500
Drawn by NG
Checked by FG

Job No. **0042841**
Date **NOV 2019**
Rev **P05**

Drawing No. **BRA-BHE-XX-XX-DR-GE-0201**



- INFERRED COAL SEAM
- MG MADE GROUND
- ALV ALLUVIUM
- RTG RIVER TERRACE DEPOSITS
- GT GLACIAL TILL
- CM COAL MEASURES
- COAL SEAM FROM GROUND INVESTIGATION DATA
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DRILL & GROUT LEVELS

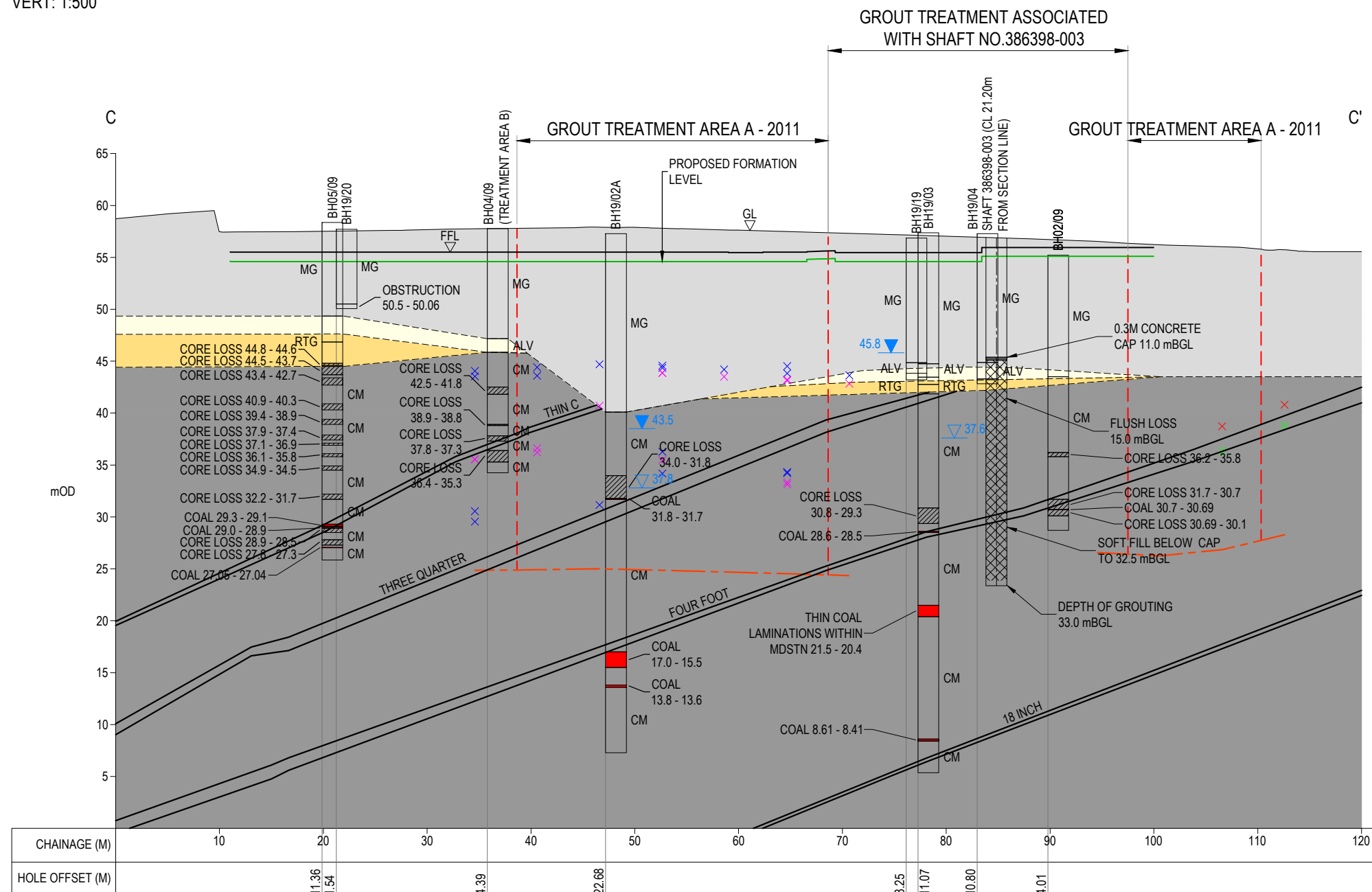
- TOP OF COAL SEAM
- BASE OF COAL SEAM
- TOP OF SHALE & COAL ZONE
- BASE OF SHALE & COAL ZONE
- BASE OF DRILL & GROUT TREATMENT

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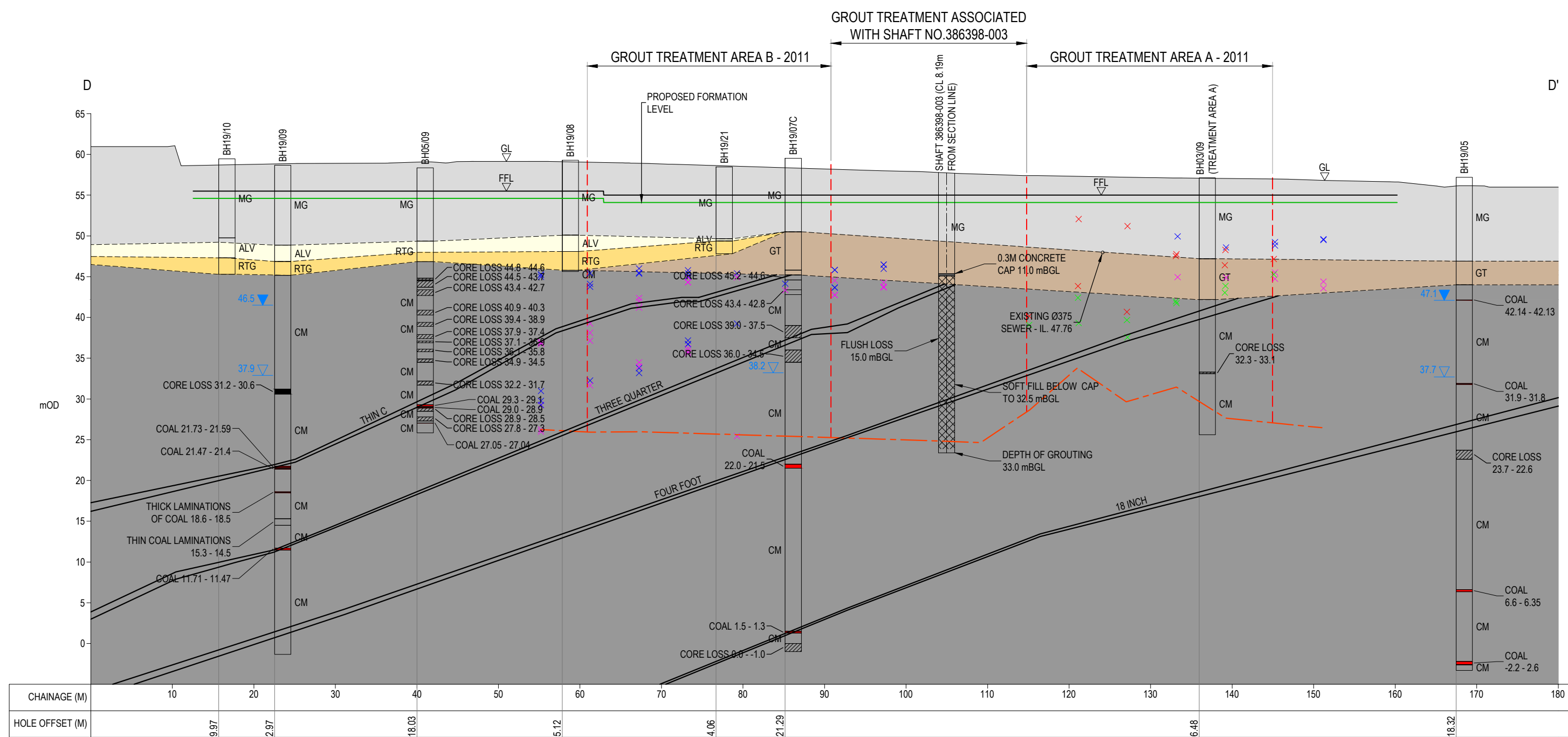
SECTION C - C'

SCALES
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VERT. 1:500



SECTION D - D'

SCALES
HORIZ. 1:500
VERT. 1:500



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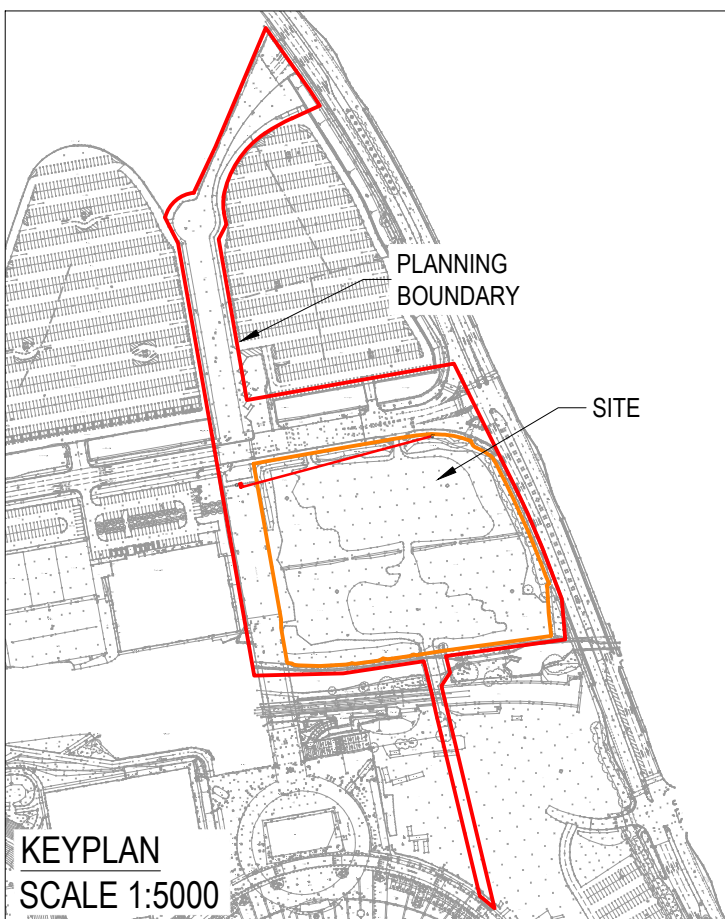
CONSTRUCTION.

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Notes

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KEYPLAN
SCALE 1:5000

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P04 PLANNING	24.06.20	NG	FG	
P03 PLANNING	31.01.20	NG	FG	
P02 DRAFT FOR PLANNING	20.12.19	NG	FG	
P01 DRAFT STAGE 3	27.11.19	NG	FG	
Rev	Description	Date	Dm	Ch'd

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Drg Title

GEOLOGICAL CROSS SECTIONS
SHEET 2

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Checked by FG

Job No.

0042841

Date

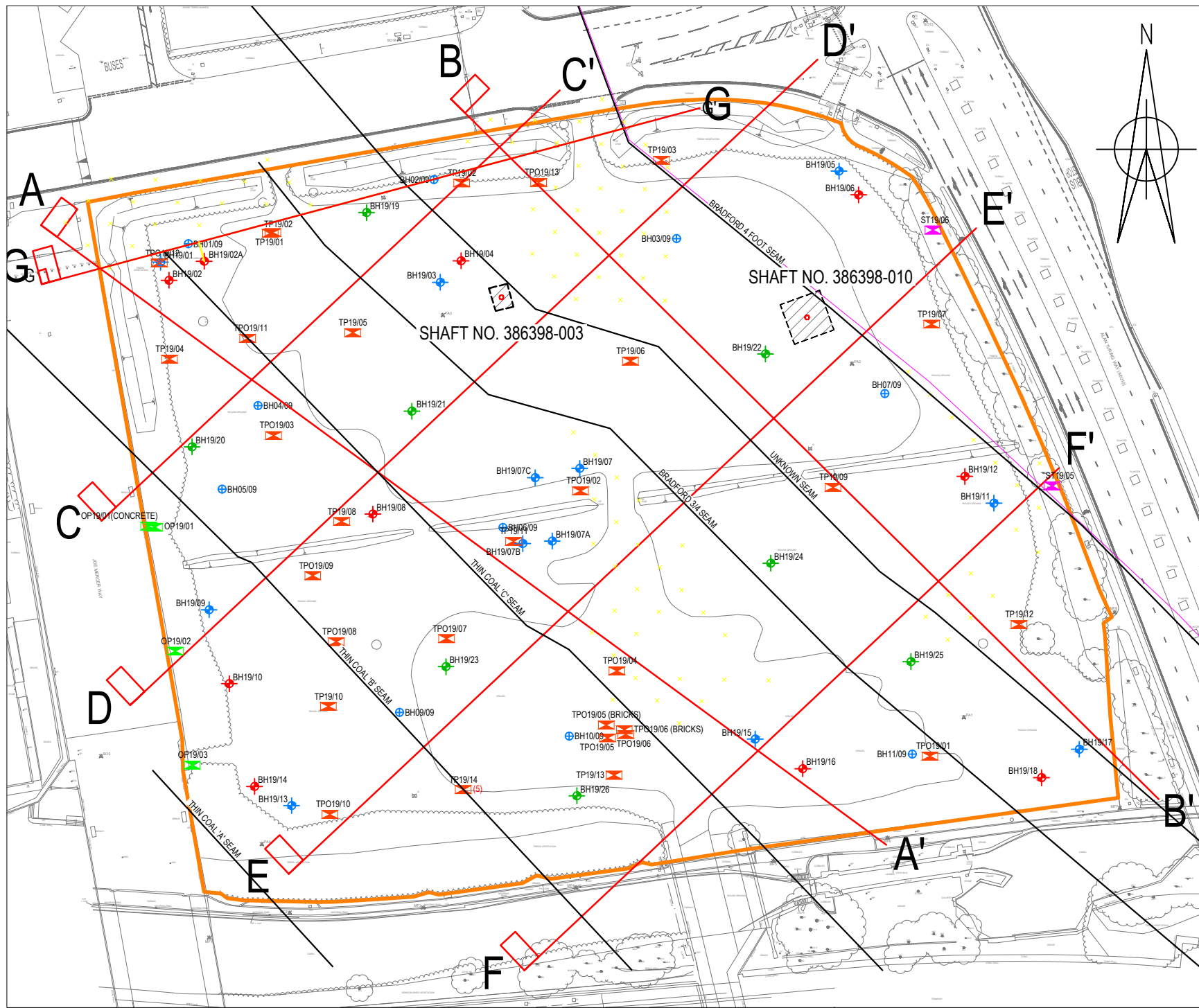
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Rev

P05

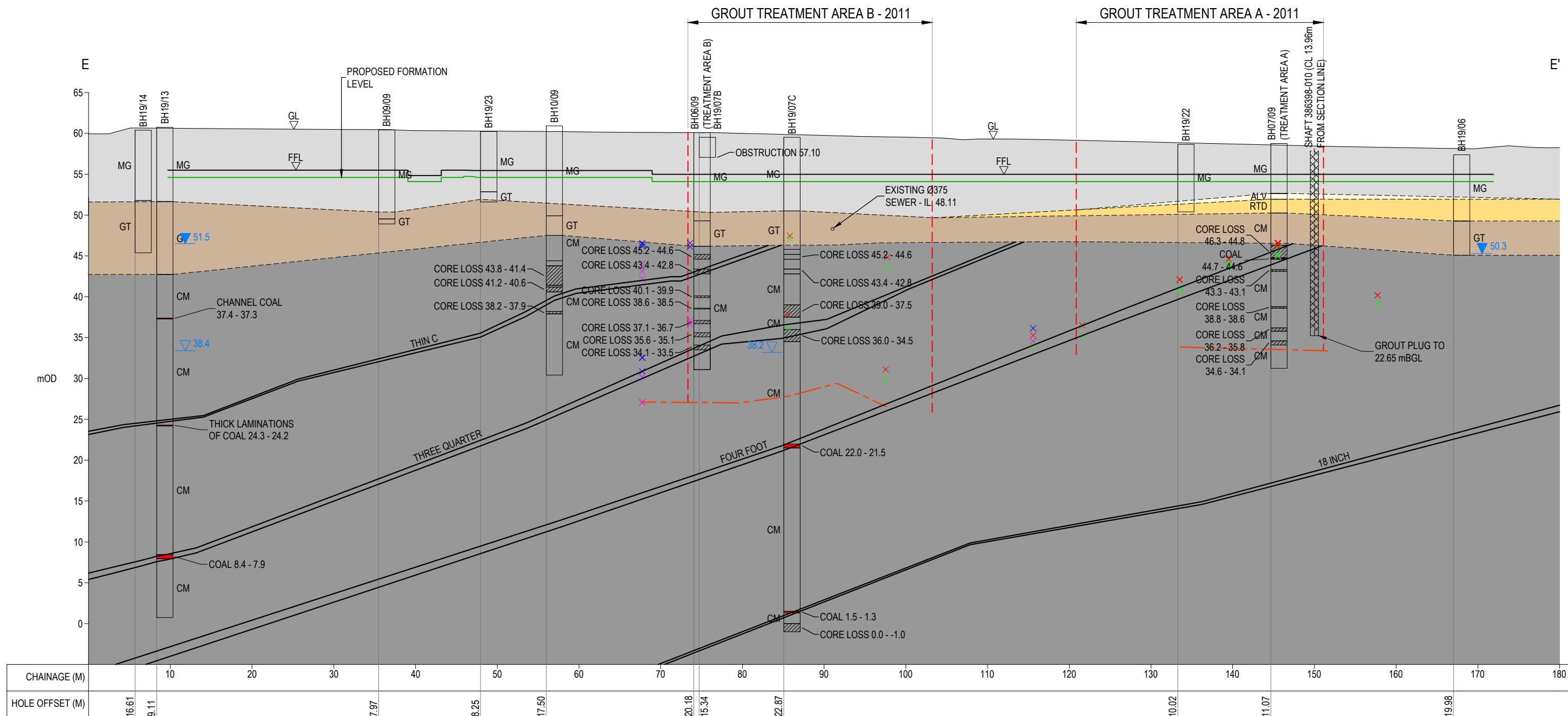
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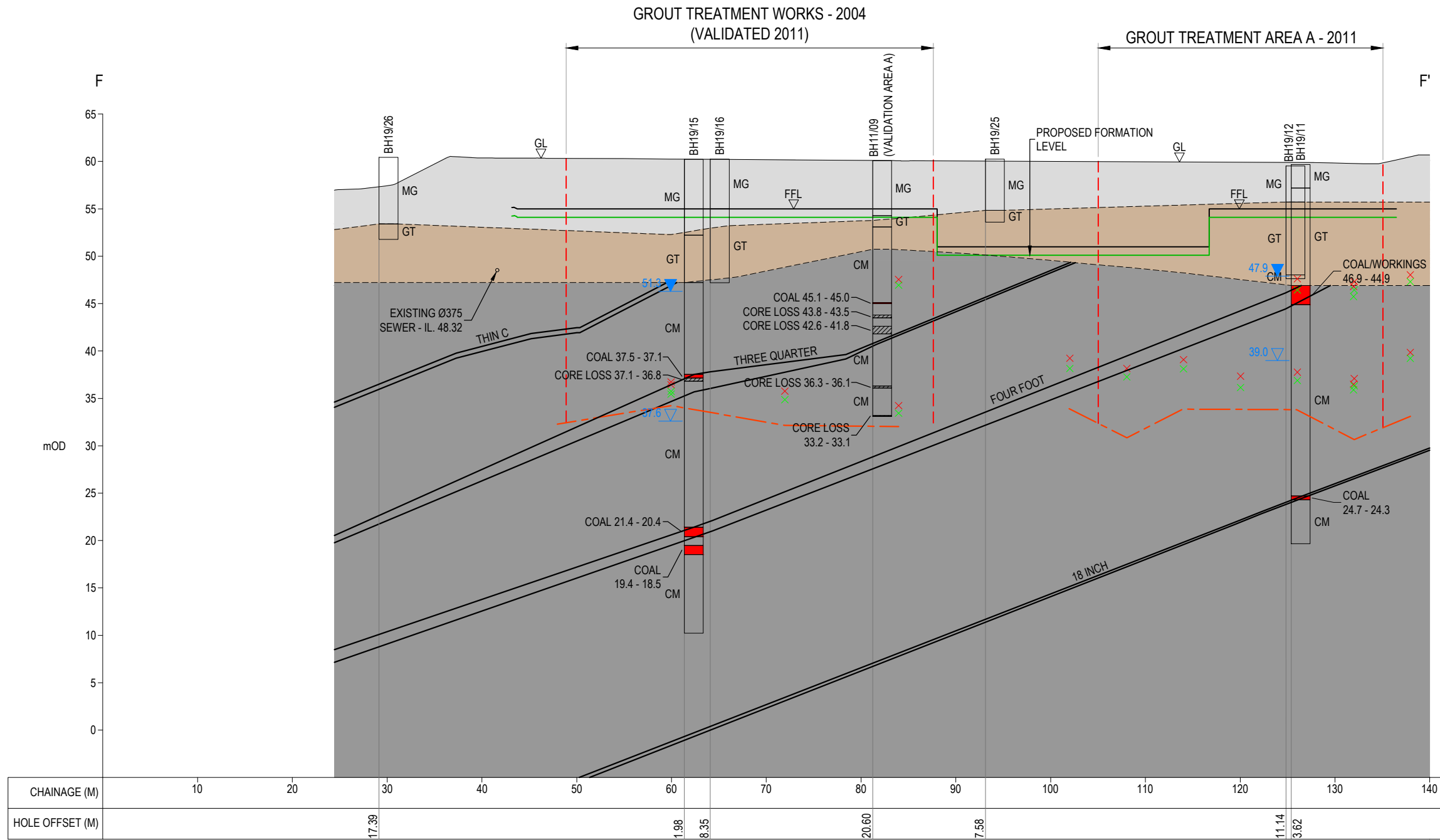


- INFERRED COAL SEAM
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SECTION E - E'
SCALES
HORIZ. 1:500
VERT. 1:500



SECTION F - F'
SCALES
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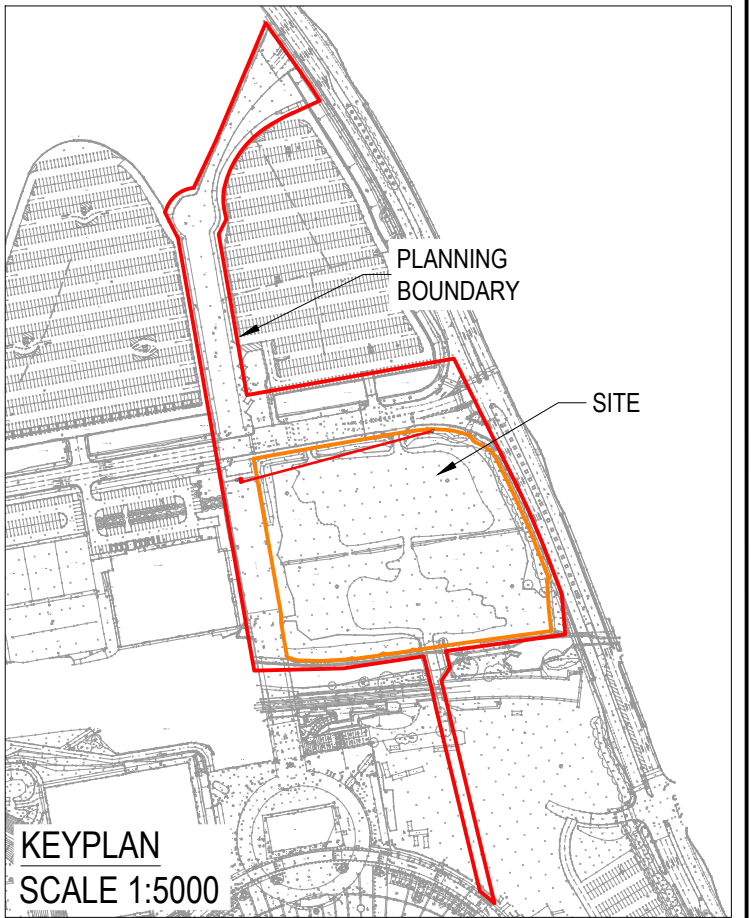
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P01 DRAFT STAGE 3	27.11.19	NG	FG	
Rev	Description	Date	Dm	Ch'd

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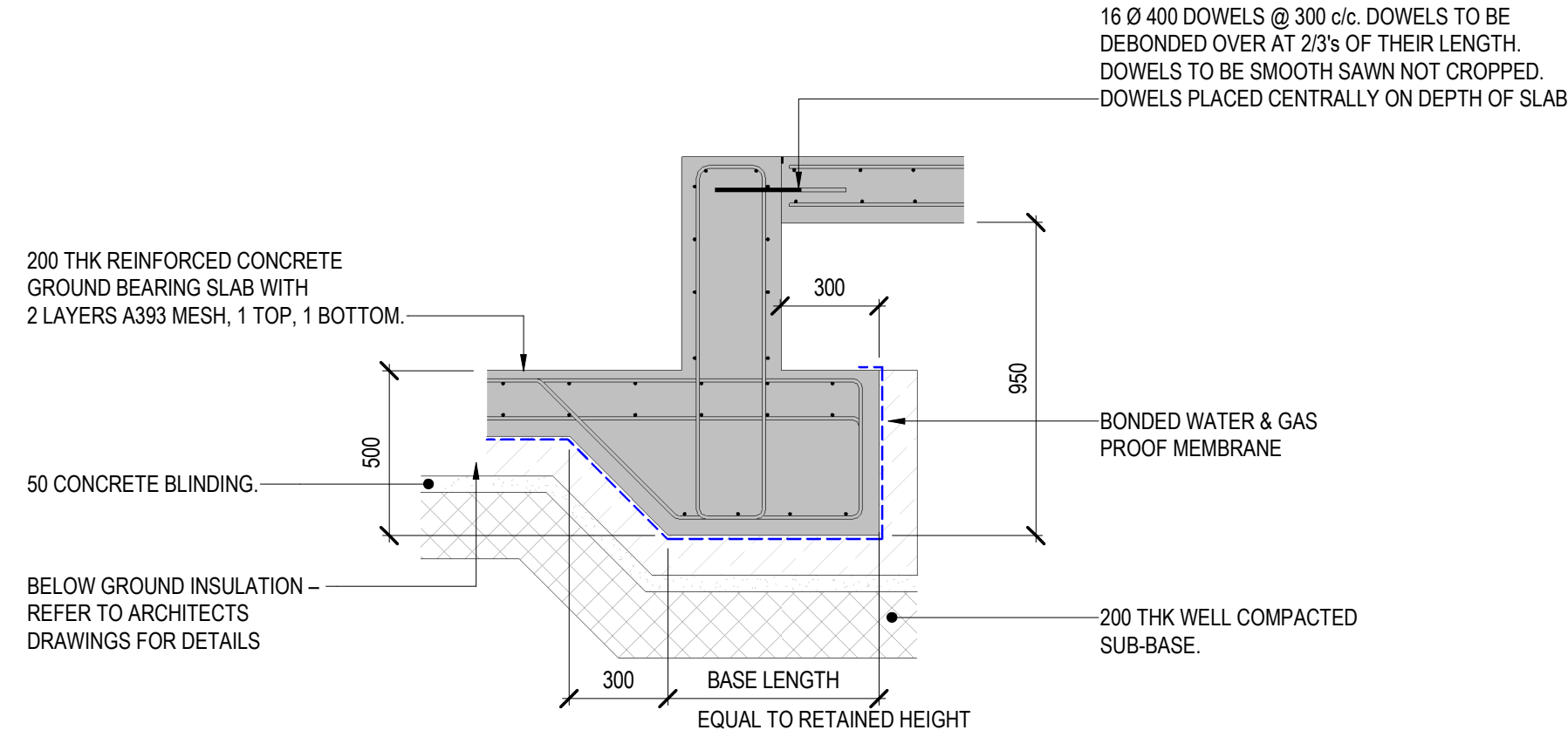
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Project **OVG MANCHESTER**
Drg Title **GEOLOGICAL CROSS SECTIONS
SHEET 3**

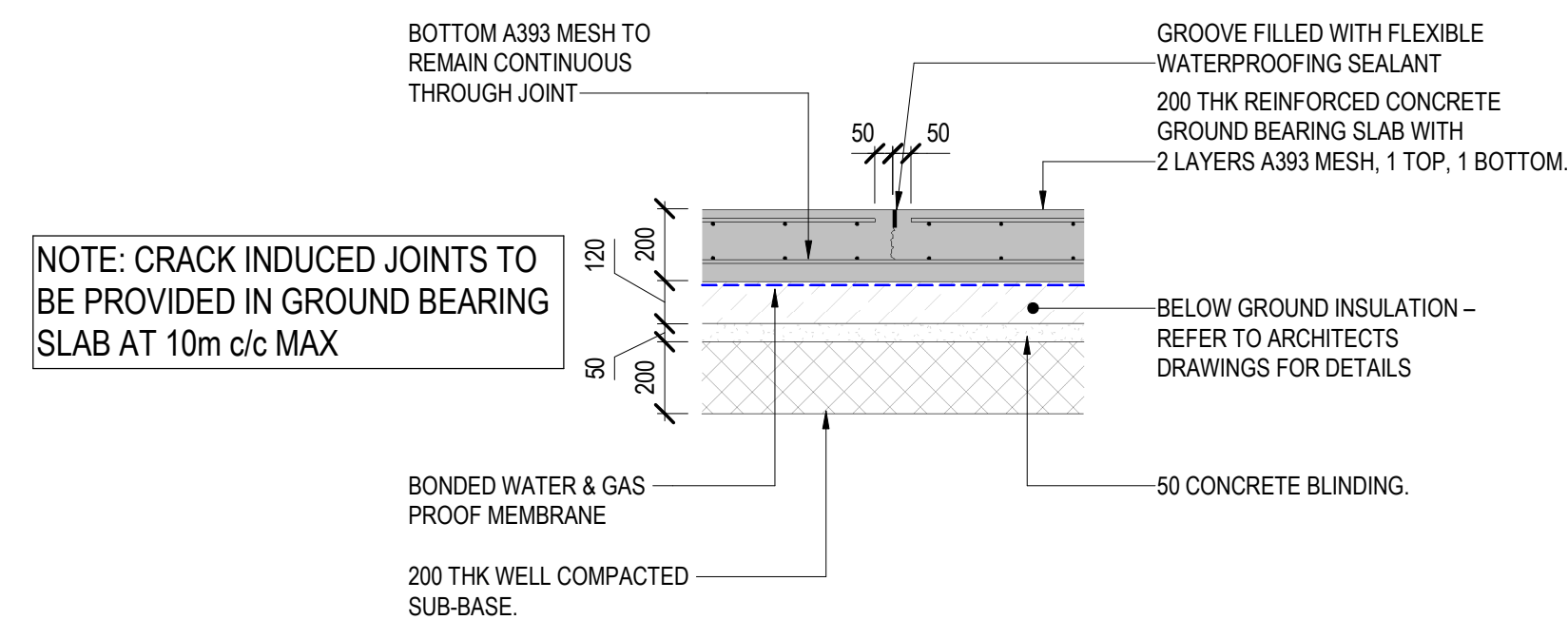
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Rev **P05**

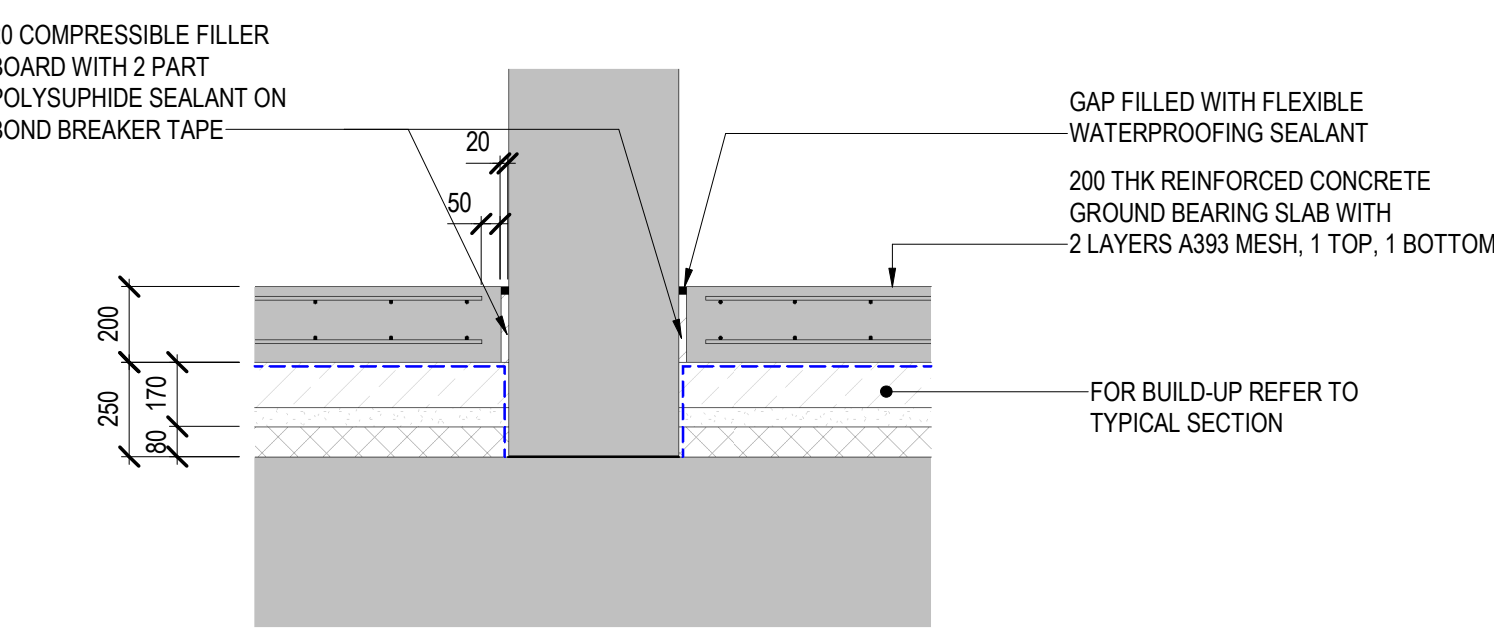
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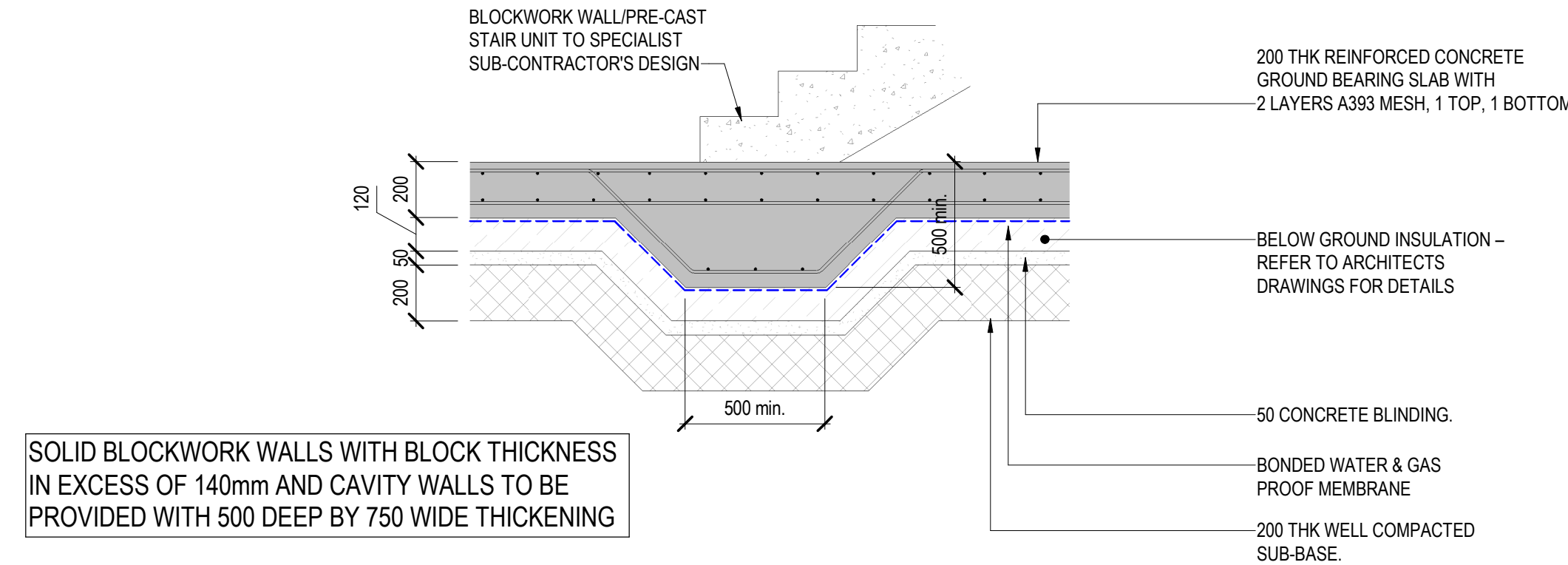
TYPICAL STEP <500
SCALE 1:20



TYPICAL SLAB EXPANSION / MOVEMENT JOINT (EJ/MJ)
SCALE 1:20

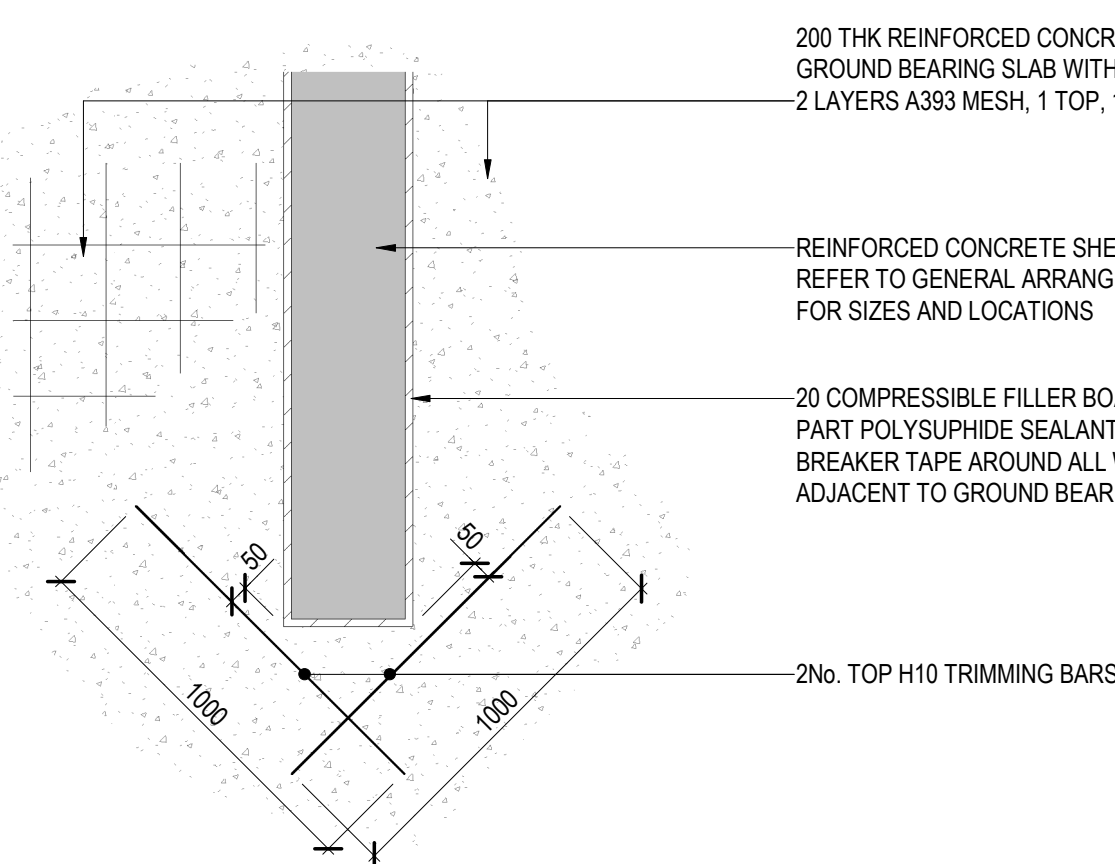


**TYPICAL PLAN ON STEEL
COLUMNS AT GROUND FLOOR**
SCALE 1 : 20

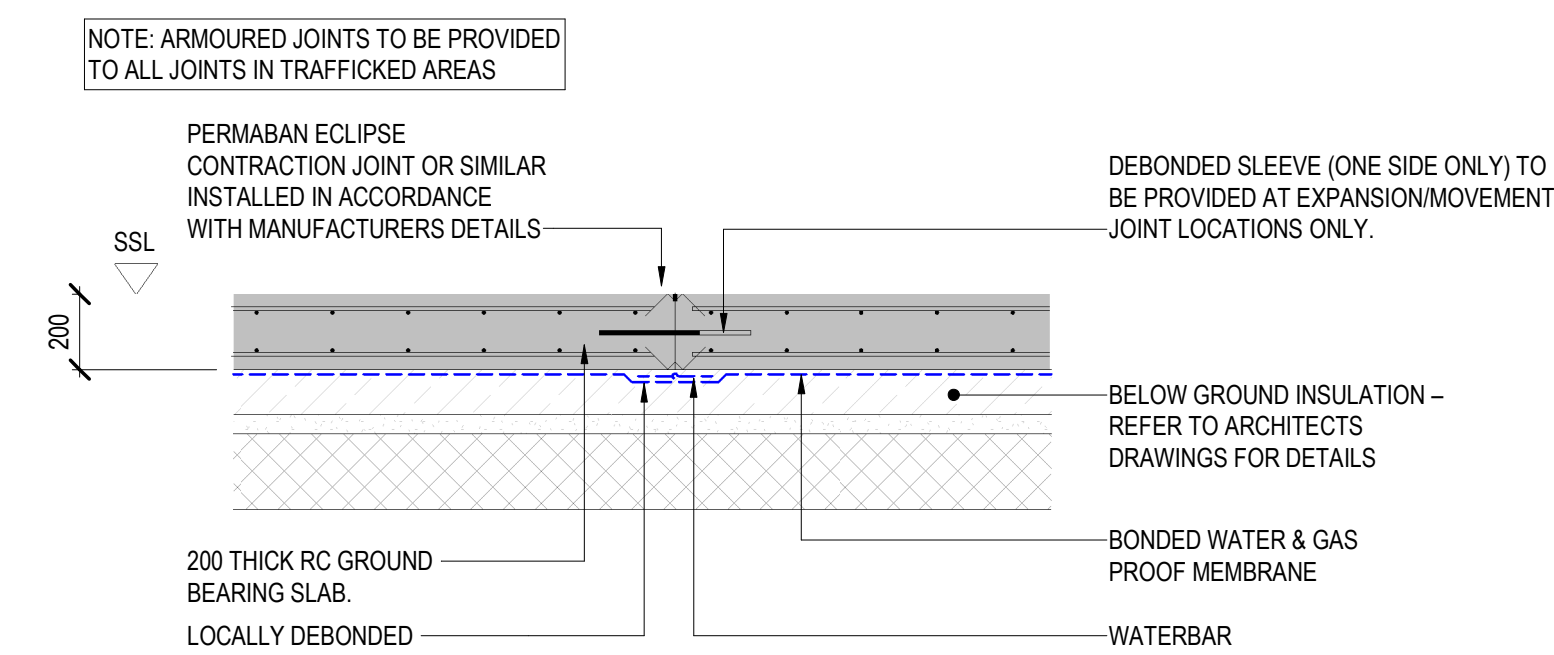


**TYPICAL SECTION THROUGH STAIR AND INTERNAL
MASONRY SLAB THICKENING IN 200 THK GROUND
BEARING SLAB**

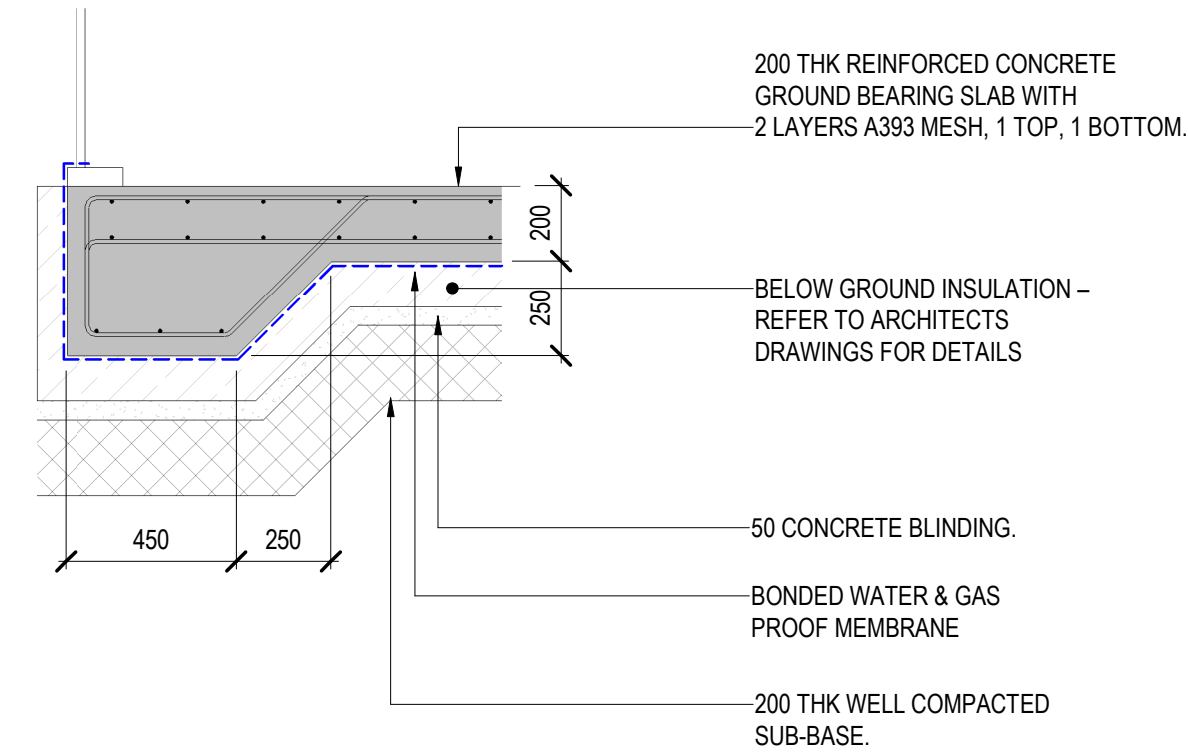
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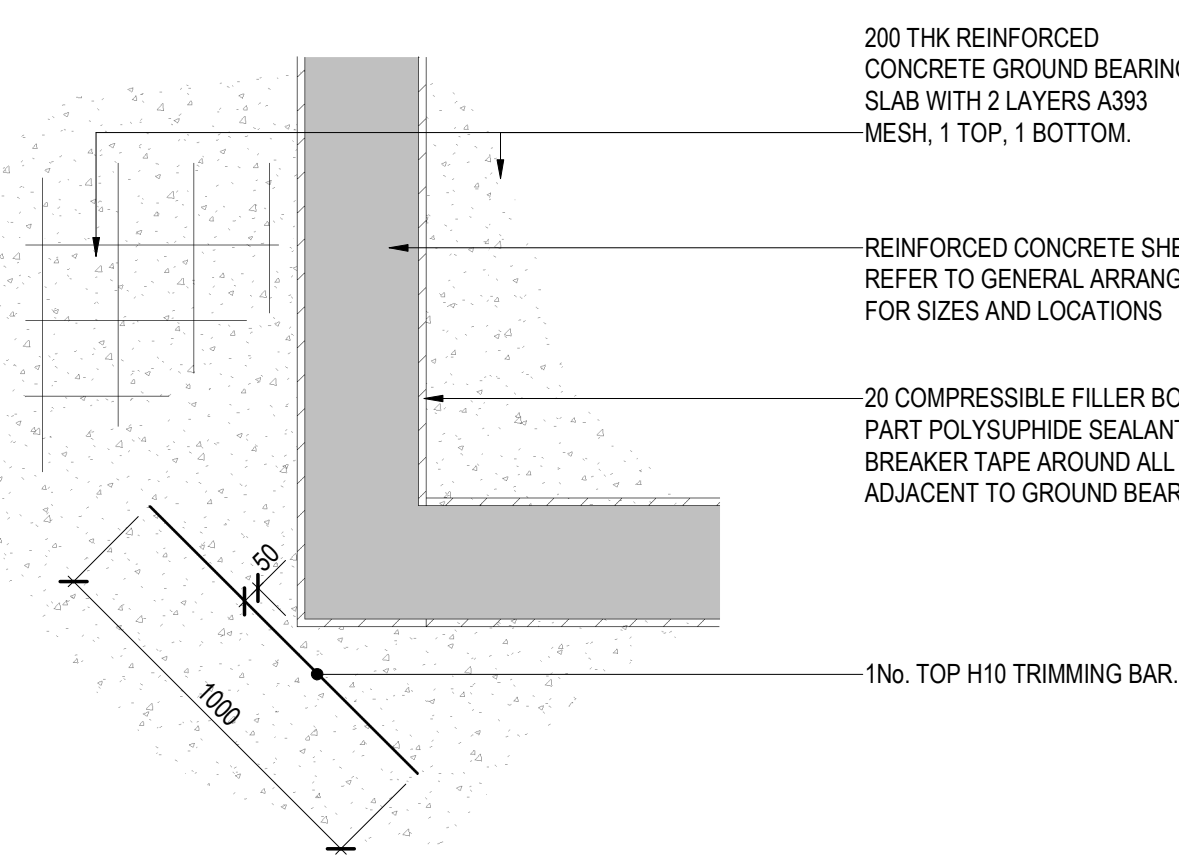
**TYPICAL PLAN ON END OF RC
WALL AT GROUND FLOOR**
SCALE 1 : 20



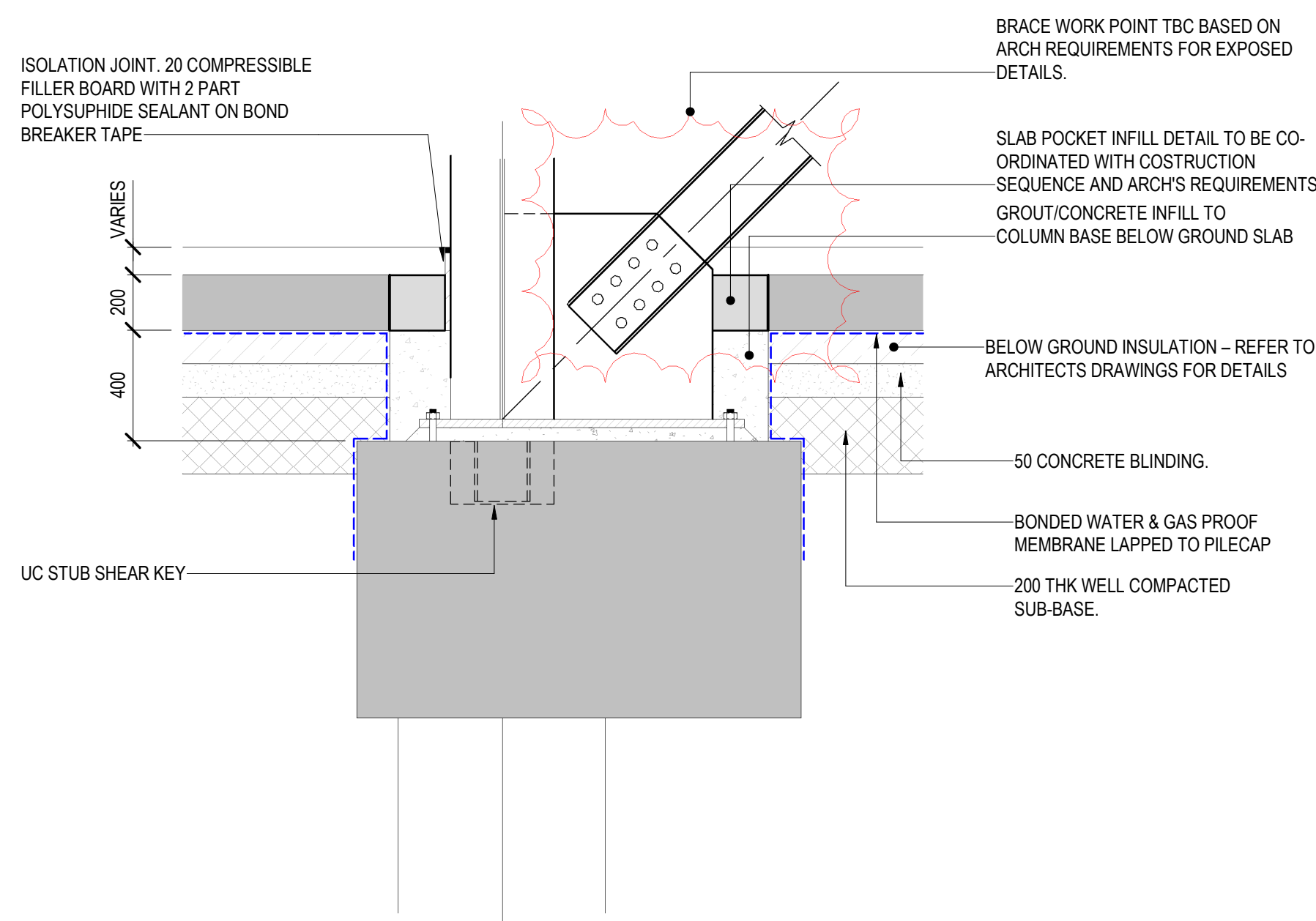
TYPICAL SLAB TIED CONSTRUCTION JOINT (ARMOURED) DETAIL (TCJ)



TYPICAL SECTION THROUGH GROUND BEARING SLAB EDGE
THICKENING IN 200 THK GROUND BEARING SLAB



**TYPICAL PLAN ON CORNER OF RO
WALL AT GROUND FLOOR**
SCALE 1:20



TYPICAL SECTION THROUGH STEEL
COLUMNS AT GROUND FLOOR
SCALE 1:20

TYPICAL SECTION THROUGH BRACED
COLUMNS AT GROUND FLOOR
SCALE 1 : 20

Notes

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH GENERAL NOTES ON SHEET 00-XX-001-0-001.

2. REFERENCE SHOULD BE MADE TO THE BASIS OF DESIGN REPORT, INFORMATION IN SUPPORT OF COSTING REPORT AND STRUCTURAL SPECIFICATIONS FOR KEY INFORMATION INCLUDING:

- A. LOADING ALLOWANCES
- B. REINFORCEMENT RATES
- C. MATERIAL SPECIFICATIONS
- D. COSTING NOTES FOR STRUCTURAL ELEMENTS FOR CONCRETE, STEELWORK AND FOUNDATIONS
- E. INFORMATION FOR FASTENERS, CONCRETE ELEMENTS TO THE BOWL AND RAKER STEELWORK

3. FOR INFORMATION ON PERIMETER RETAINING STRUCTURES, BASEMENT WATERPROOFING AND SITE CONSTRAINTS, REFER TO THE FOUNDATION PLAN, TYPICAL SECTIONS AND COSTING REPORT.

4. REFER TO LATEST GEOTECHNICAL INFORMATION REGARDING THE SITE GEOLOGY AND GROUND CONDITIONS

5. DESIGN AND EMBEDDED RETAINING WALLS ARE ALL TO CONTRACTOR SPECIES. DESIGNS ARE DRAWN AS BODIN. REFER TO THE PILE SECTION B/BIE-XXX-SS-0010 FOR FURTHER DETAILS

6. ALL FOUNDATIONS TO BE CAST ON 50mm LEAN MIX BLINDING CONCRETE

7. ALL FOUNDATIONS REQUIRE BODIN WATERPROOFING AND GAS MEMBRANE. REFER TO THE WATERPROOFING SPECIFICATION FOR EMBEDDED DETAILS

8. ALL CONSTRUCTION JOINTS WITHIN THE PERIMETER CONCRETE WALLS TO BE PROVIDED WITH HYDROPHILIC STRIPS AND WATER BARS. CONSTRUCTION JOINTS TO BE PROVIDED AT APPROX. 10m CENTRES. REFER TO DRAWING S-5011 FOR FURTHER DETAILS

9. NOMINAL COVER TO REINFORCEMENT AS FOLLOWS:
75mm - BASE
50mm - SIDES AND TOP

10. GROUND CLASSIFICATION FOR BELOW-GROUND CONCRETE IS DC-4. REFER TO PILING AND CONCRETE SPECIFICATIONS FOR FURTHER DETAILS

ISSUED FOR STAGE 4A
TENDER



OVG
INTERNATIONAL

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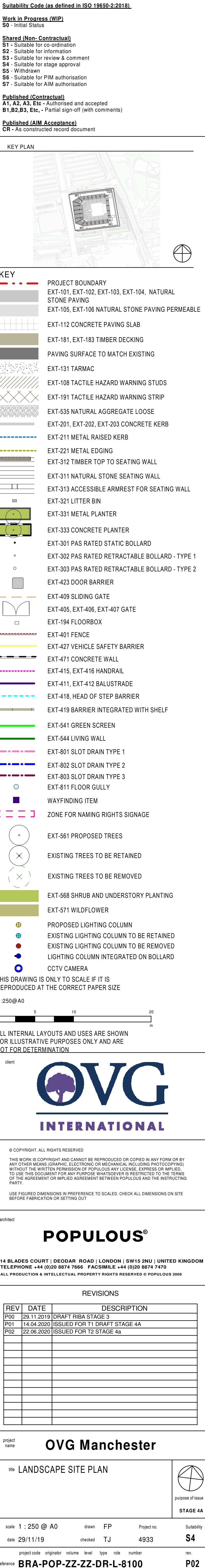
OVG MANCHESTER

100 LEVEL GR
DETAILS
SHEET 1

purpose of issue

STAGE 4A

scale	1 : 20 @ A0	drawn	Author	Job no.	Suitability		
date	11/19/19	checked	Checker	0042841	S2		
project code	originator	volume	level	type	rate	number	rev.
reference	BRA-BHE-XX-GF-DR-S-5051						P04



Appendix A – Soil Material Suitability Criteria.

General

All material that is re-used or that is imported into site, including geotechnical fill, topsoil and subsoil for landscaping, is required to meet the parameters set out in this specification. It is not anticipated that any topsoil/subsoil that is presently on site will be retained due to its chemical and physical composition. If any material is to be retained and reused, it should be stripped and stored in stockpiles which are separate from other stockpiled soils. Topsoil must not be stockpiled for longer than two years, after two years the stockpile is to be excavated, reconditioned and formed into a new stockpile.

Topsoil and Subsoil Specification

All topsoil and subsoil to be used as part of the landscaping areas (imported or site derived) must comply with the physical, biological and chemical parameters set out in the following sections. All topsoil must comply with British Standard 3882:2015 (Ref 3) as a multipurpose soil (as set out in Table 1 of that Standard). The soil should be a clay loam as defined in BS3882:2015. The soil is to have a defined granular or blocky structure and be free from non-soil material i.e. brick, other building materials, wastes, hydrocarbons, plant matter, roots and rhizomes of perennial weeds and any other foreign matter or material or substance that would render the topsoil unsuitable for use. Topsoil must also contain sufficient nutrients that it allows plant growth as detailed in Table 2.

Table 1 Physical Parameters

Determinand	Unit	Sub soil	Topsoil
Clay (less than 0.002mm)	%	5 - 40	5 – 27
Silt (0.002 - 0.06mm)	%	5 - 60	5 -45
Sand (0.06 - 2.00mm)	%	20 – 65	50 - 90
Max. Stone Content (2 - 50mm)	% by weight	<50	<35
Max. Stone Size in any dimension	mm	75	30

Table 2 Soil Quality Parameters (suitability as a growing medium related)

Determinand	Unit	Concentration
pH value	pH units	5.0 - 8.0
Electrical Conductivity (1:2.5 extract)	µS/cm	100 to 1500
Organic Matter	%	4.0 – 15.0
Total Nitrogen	%	>0.2
Extractable Phosphorus	mg/l	>26
Extractable Potassium	mg/l	>240
Extractable Magnesium	mg/l	>50

Chemical (contamination related) Parameters

Table 3 below details the chemical compounds that require testing for each sample and also details the maximum permissible average concentration of those compounds (i.e. the US⁹⁵ average value). In the first instance the values have been derived from the LQM Suitable for Use Levels (S4UL) (Ref 1) or the phytotoxic values (Ref 3) and with lead C4SL values have been used (Ref 2). Imported topsoils and the majority of the soils to be re-used (following appropriate treatment) must comply with residential [without plant uptake] thresholds. Materials immediately below any hardstanding and/or below the "marker layer" must comply with the commercial thresholds shown in square brackets (e.g. Arsenic [640]).

Table 3 - Chemical (contamination related) Parameters

Determinand	Concentration (mg/kg)	Determinand	Concentration (mg/kg)
Arsenic	40 ² [640]	Cadmium	85 ¹ [410]
Chromium (total)	910 ¹ [8600]	Lead	310 ² [2330]
Mercury	56 ¹ [58]	Selenium	430 ¹ [12,000]
Boron	11000 ¹ [240,000]	Copper	200 ³ [68,000]
Nickel	40 ¹ [980]	Zinc	300 ³ [730,000]
Naphthalene	2.3 ¹ [190]	Benzo[a]anthracene	11 ¹ [170]
Acenaphthylene	2900 ¹ [83,000]	Chrysene	30 ¹ [350]
Acenaphthene	3000 ¹ [84,000]	Benzo[b]fluoranthene	3.9 ¹ [44]
Fluorene	2800 ¹ [63,000]	Benzo[k]fluoranthene	110 ¹ [1,200]
Phenanthrene	1300 ¹ [22,000]	Benzo[a]pyrene	3.2 ¹ [35]
Anthracene	31000 ¹ [520,000]	Indeno[123-cd]pyrene	45 ¹ [500]
Fluoranthene	1500 ¹ [23,000]	Dibenzo[ah]anthracene	0.31 ¹ [3.5]
Pyrene	3700 ¹ [54,000]	Benzo[ghi]perylene	360 ¹ [3,900]
TPH aliphatic >C5-C6	42 ¹ [3,200]	TPH aromatic >C5-C7	370 ¹ [26,000]
TPH aliphatic >C6-C8	100 ¹ [7,800]	TPH aromatic >C7-C8	860 ¹ [56,000]
TPH aliphatic >C8-C10	27 ¹ [2,000]	TPH aromatic >C8-C10	47 ¹ [3,500]
TPH aliphatic >C10-C12	130 ¹ [9,700]	TPH aromatic >C10-C12	250 ¹ [16,000]
TPH aliphatic >C12-C16	1100 ¹ [59,000]	TPH aromatic >C12-C16	1800 ¹ [36,000]

Determinand	Concentration (mg/kg)	Determinand	Concentration (mg/kg)
TPH aliphatic >C16-C35	65000 ¹ [1,600,000]	TPH aromatic >C16-C21	1900 ¹ [28,000]
Free cyanide	760 ¹ [16,000]	TPH aromatic >C21-C35	1900 ¹ [28,000]
Benzene	0.38 ¹ [27]	Toluene	880 ¹ [869]
Ethylbenzene	83 ¹ [518]	Xylene	79 ¹ [576]
		Asbestos	No detectable fibres above trace levels*

¹ Value derived from LQM Suitable for Use Levels (Ref 1)

² Value derived from Category 4 Screening Levels (Ref. 2)

³ Value derived from British Standard BS3882:2007 (Ref 3)

* Trace levels defined as occasional sporadic occurrence typically at concentrations less than the limit of quantification (<0.001%).

Appendix References

1. LQM/CIEH. 2015. The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham.
2. Department for Environment, Food and Rural Affairs. SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document. March 2014
3. British Standards Institution. BS3882:2015. Specification for topsoil and requirements for use. 2015

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