SANDON QUARRY NORTHERN VOID RESTORATION

Environmental Permit Application

Hydrogeological Risk Assessment

Prepared for: Brett Aggregates Limited

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CONTENTS

TABLES

APPENDICES

DRAWINGS

1.0 INTRODUCTION

Brett Aggregates Limited (BAL) has instructed SLR Consulting Limited (SLR) to prepare a bespoke Environmental Permit (EP) application to authorise the deposit of waste for recovery in the restoration of the Northern Void, Sandon Quarry, Sandon, Chelmsford, Essex, CM2 7RL, hereafter referred to as 'the Site'.

1.1 Site History

Planning permission for the extraction of sand and gravel in the Northern Quarry area was granted in 1955 (ref. CHR/252/55). Sand and gravel was extracted from the 1960s through into the 1980s. In the 1980s, the western part of the Northern Quarry area was restored under a Control of Pollution Act licence ref. 118/85 using excavated natural materials arising solely from the A12 construction site. Completion of restoration of the Northern Quarry area was then delayed by an extension of the quarry's operating life granted by planning permission ref. CHL/14/84 in 1985, since when no restoration activities have taken place. However, the southern and western A12 (T) slopes of the northern void have experienced significant stability issues.

In 2018, planning permission for the restoration of the Northern Quarry void was granted by Essex County Council (ECC) (ref. ESS/08/16/CHL). Since then BAL have been working to address pre-commencement conditions in the Site's planning permission regarding stability and undertaking preparatory works. This has included undertaking Site investigation, monitoring, preparing risk assessments and developing detailed methodologies for the delivery of the slope stabilisation (which have subsequently been submitted to ECC and approved, with the Environment Agency (EA) as a consultee) and restoration scheme.

1.1.1 Stability

Historically, the southern and western A12 (T) slopes of the northern void have experienced stability issues. Geotechnical appraisals and water level monitoring of the Site have been undertaken since 2016.

In July 2020, a series of tension cracks in the north-western area of the northern void were identified by BAL personnel during routine visual inspections of the western A12(T) slope. In December 2020 it was reported by site personnel that the lower part of the slope had slipped by approximately 300mm, along the line of the tension cracks initially observed in July 2020. On the 27th December 2020 further slippage of the slope in the order of 1m was recorded by Site personnel.

The ongoing stability issues at the Site, including the December 2020 slope movements, can be partially attributed to excess porewater pressures forming in the western slope following increased pumping to draw the water level in the void down.

In February 2021, an Emergency Earthworks Remedial Strategy comprising the construction, using waste, of a berm for access and a buttress to support the slope was designed by SLR. Discussions were held between the EA and BAL throughout May and June 2021 regarding the instability events and, in July 2021, a Local Enforcement Position (LEP) (ref. AH/EAWML102405) was granted by the EA for the emergency earthworks. Copies of the request for the LEP and the LEP letter are enclosed as Appendix B and Appendix C, respectively.

Construction of the berm and emergency buttress commenced in November 2021 following a delay obtaining permission from the ECC in relation to certain conditions in planning permission ref. ESS/08/16/CHL.

1.2 Site Location

Centred on national grid reference TL 74747 04347, the northern void of Sandon Quarry is located within a predominantly agricultural landscape approximately 170m to the southeast of the village of Sandon, Essex. The A12 trunk road (T) is situated approximately 10m to the west of the Site. Access to the Site can be gained from

the A1114 on a slip road at the junction of the A1114 with Molrams Lane and Church Street. The Site is surrounded by a network of minor roads connecting the villages of Sandon to the north-west of the Site, Butts Green to the south-east and Howe Green to the south with properties present on the roads between the main villages. There are several residential properties located within the area surrounding the Site. The closest properties are located approximately 120m to the north-west of the Site and beyond the A12(T).

The Site is a former sand and gravel pit within the Northern Area of the Sandon Quarry complex. It comprises a deep void, approximately 5m Above Ordnance Datum (AOD) at its lowest point and up to approximately 32mAOD at its crest, with steep slopes at the edges.

Sandon Quarry Southern Void is located immediately to the south of the Site and has been undergoing restoration since 2016.

1.3 Objectives

This report presents the conceptual site model (CSM) developed for the Site and assesses the risk to the hydrogeological regime posed by the proposed restoration of the Site using inert waste material.

The objectives of the assessment are to demonstrate that the Site will be compliant with Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations 2016 (as amended) and the Inert Waste Guidance (2020). These Regulations require that certain substances (Hazardous Substances) are not discharged to groundwater such that they are discernible, and that the discharge of other substances (Non-Hazardous Pollutants) is limited *"so as to prevent pollution"*.

2.0 CONCEPTUAL HYDROGEOLOGICAL SITE MODEL

The conceptual hydrogeological site model is based on the source-pathway-receptor linkages. The conceptual model is shown in Drawing HRA2 and key elements of the hydrogeological model are discussed in further detail within the following sections below:

- waste source;
- aquifer characteristics;
- groundwater flow and quality;
- groundwater quality;
- licensed groundwater abstractions; and
- Source Protection Zones.

2.1 Waste Source

2.1.1 Site Design and Construction

This EP application seeks to authorise the use of suitable imported inert waste materials as a replacement for non-waste construction material, in stabilising the quarry slopes including that adjacent to the A12(T), and the restoration of the quarry void to agricultural and nature conservation uses with new public rights of way. The proposed restoration of the land is illustrated in the 2012 'Restoration Proposals' drawing ref. 1910/005/K.

The void will be restored using inert waste for which treatment is not technically possible. The majority of the area will be restored to a species rich grazed grassland with shallow pools and areas of exposed substrate interspersed throughout to provide habitat for invertebrate species relevant to the void's current designation as

a Local Wildlife Site (LWS). The restored landform will comprise a gentle slope from approximately 32mAOD in the south to approximately 25mAOD in the north.

Given stabilities issues at the Site - as described in the Non-Technical Summary (SLR ref. 416.09886.00050/NTS) - the site will be restored in a partially dewatered state and involve subaqueous placement of the attenuation layer and fill until above the water level. The level of water within the void will be maintained at 14.5-15mAOD unless operational safety reasons require it to be drawn down to a minimum of 9mAOD.

Key points regarding the proposed Northern Void restoration are as follows:

- Due to the stability risks to the A12 and quarry slopes, the quarry void will be filled in a phased and partially dewatered manner to within 300-400mm of the pre-settlement contour levels. The infilling will be undertaken over 12 phases which can be summarised as outlined below. The phasing scheme has been designed in accordance with the requirements of Condition 10 of planning permission ESS/08/16/CHL.
    - Phases 1 through to 9 involve the creation of berms within the quarry void and then infilling the voids between the berms to achieve a level platform at 17mAOD, above the water level within the void. The phasing has been designed to provide stability to the quarry side slopes in order of priority. Phase 1 comprises the emergency earthworks to be completed under the LEP (ref. AH/EAWML102405).
    - Phase 10 involves the creation of a buttress to the full height of the former quarry in the north-eastern corner.
    - Phase 11 involves the creation of a buttress to the full height of the former quarry in the south-eastern corner.
    - Phase 12 involves the placement of fill to within 300-400mm of the pre-settlement contour levels.
- Following completion of fill material placement, a layer of fine clay and sand approximately 300-400mm thick will be sourced from any remaining on-Site material (following restoration of the plant site) and imported waste. It will be spread to provide a suitable substrate which will be sown with species rich chalk grassland. Shallow ponds and areas of sandy substrate will be created in line with approved details
- Including 67,000m^3 of waste material to be placed under the LEP, volumetric calculations based on the current topography and proposed restoration contours estimate that approximately 846,737m^3 material will be required to complete the scheme. This equates to approximately 1,608,800 tonnes based on a conversion factor of 1.9 tonnes per m^3.

Waste will be deposited at a maximum rate of up to 300,000 tonnes per annum for use in restoration of the void. Restoration of the northern quarry void is anticipated to be completed in approximately 8.5 years.

2.1.2 Basal and Side Slope Attenuation Barriers

Given the stability issues at the Site, BAL have assessed the feasibility of dewatering the Site to enable engineering of the attenuation layer and placement of fill in dry conditions.

A Stability Assessment undertaken in August 2021[1] to address Condition 10 of planning permission ref. ESS/08/16/CHL found that drawing the water down rapidly would reduce the stability of the slope in the short term. Drawing down the water at a slower rate would take longer than is practical to enable restoration of the Site within the 10 years following commencement as required by the Site's planning permission. A safe rate of

[1] SLR Consulting Ltd – Sandon Quarry Northern Void Stability Assessment ref. 403.09886.00012 (August 2021)

dewatering and timescale has not been determined due to the impracticalities, however, by way of example, a reduction of 200mm/month to 5mAOD would take approximately 4 years with the works estimated to take approximately 8.5 years thereafter. It should be noted that a reduction of 200mm/month to 9mAOD could not be proven to achieve a necessary factor of safety and therefore the dewatering rate would need to be slower than 200mm/month. Complete dewatering of the void is therefore not a viable option.

Given the August 2021 Stability Assessment found the western slope to be marginally stable based on the current pumping regime, BAL propose to maintain the current pumping regime and water level within the void between 14.5 and 15mAOD with sub-aqueous placement of fill, until the fill is above water level.

If, however, for operational safety reasons, the water level in the void needs to be lowered, BAL will implement a marginal increase in the pumping rate, to gradually drawn down to a minimum of 9mAOD subject to continuous stability monitoring. If it is possible to draw the water down to this level without further stability issues occurring, sub aqueous placement of inert fill will commence until the fill is above the water level.

Dewatering will be undertaken in accordance with the requirements of BAL's existing discharge consent ref. PR2NF/10173B.

A 1m attenuation layer with a permeability no greater than 1 x 10^{-7} m/s will be provided along the base and sidewall of the Site as illustrated on Drawing EP6. The attenuation layer will be constructed using low risk inert, suitably cohesive waste materials with a pollution potential less than or equal to the background quality of the surrounding geology and water.

Below the water level, the attenuation layer will be formed by end tipping of the material. Self-compaction will be achieved by the weight of overlying fill placed and operating plant running on berms and the platform once above water level.

Construction of the attenuation layer will be undertaken in accordance with a Construction Quality Assurance (CQA) plan. The CQA Plan will detail the chemical and geotechnical requirements of the attenuation layer, placement procedures, Site records, supervision and CQA validation requirements.

2.1.3 Waste Quality and Priority Contaminants

Strict waste acceptance procedures will be implemented to ensure that only suitable inert wastes are accepted at the Site, and no contaminated materials will be accepted. The inert waste source term has been assessed based on inert WAC limits as outlined within section 2.1.2 of the Landfill Directive 2003/33/EC. The exception to this will be for the parameters sulphate, selenium, total dissolved solids, fluoride and antimony which will have a WAC of 3 x inert WAC limits due to the naturally elevated concentrations of these substances found within clays. The WAC which will apply at the Site are therefore presented in Table 2-1 and Table 2-2.

Table 2-1
WAC Leaching limits

Component	L/S = 10 l/kg (mg/kg dry substance)
Arsenic	0.5
Barium	20
Cadmium	0.4
Chromium (Total)	10.5
Copper	2

Component	L/S = 10 l/kg (mg/kg dry substance)
Mercury	0.01
Molybdenum	0.5
Nickel	0.4
Lead	0.5
Antimony	0.18
Selenium	0.3
Zinc	4
Chloride	800
Fluoride	30
Sulphate	3,000*
Phenol	1
DOC**	500
TDS***	12,000

* if the waste does not meet these values for sulphate, it may still be considered as complying with the acceptance criteria if the leaching does not exceed either of the following values: 1,500mg/l as C_0 at L/S = 0.1l/kg and 6000mg/kg at L/S = 10l/kg.

** If the waste does not meet these values for DOC at its own pH value, it may alternatively be tested at L/S = 10 l/kg and a pH between 7,5 and 8,0. The waste may be considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 500 mg/kg.

*** The values for total dissolved solids (TDS) can be used alternatively to the values for sulphate and chloride.

Table 2-2
WAC Limits for Total Content of Organic Contaminants

Parameter	Value (mg/kg)
TOC (total organic carbon)	30 000 (*)
BTEX compounds (benzene, toluene, ethyl benzene & xylenes)	6
Polychlorinated biphenyls (PCBs) (7 congeners)	1
Mineral oil (C10 to C40)	500
PAHs (Polycyclic aromatic hydrocarbons) (Total of 17)	100

* In the case of soils, a higher limit value may be admitted by the competent authority, provided the DOC value of 500 mg/kg is achieved at L/S = 10 l/kg, either at the soil's own pH or at a pH value between 7,5 and 8,0.

EA guidance *'Testing for Disposal to Landfill*[2]*'* clarifies: *"While limits are set for these tests in the Council Decision annex, the Environmental Permitting Regulations, schedule 10 state that the L:S 10 l/kg test must be used."*. It is therefore proposed that the L:S 10l/kg WAC limits will be used for determining priority contaminants.

[2] Environment Agency (2013). *Waste Sampling and Testing for Disposal to Landfill*. Ref. EBPRI 11507B Final

2.2 Pathways

The following sources of information have been consulted to characterise the geology and hydrogeology:

- British Geological Survey (BGS) online mapping (www.bgs.ac.uk/data/mapViewers/home.html) for details of geology, borehole logs and groundwater classifications;
- Environment Agency Website (www.environment-agency.gov.uk) for details on licensed abstractions and Water Framework Directive classifications for groundwater, rivers and coast;
- National Soils Resource Institute Website for details on soils (https://www.landis.org.uk/soilscapes/);
- Natural England Website for details on groundwater and surface water dependent designated sites, aquifer classifications, groundwater vulnerability and source protection zones (http://www.natureonthemap.naturalengland.org.uk);
- information request from Chelmsford City Council for details of private water supplies;
- previous assessments of the Sandon voids as follows:
    - Sandon Quarry Southern Void Environmental Permit Application: ESID (2015)[3]
    - Sandon Waste Management facility planning application: Environmental Statement (1998)[4]
    - Sandon Quarry Northern Quarry Void: Hydrogeological/Hydrological Impact Assessment (2015)[5]
    - Sandon Quarry Northern Quarry Void: Stability Risk Assessment (2015)[6]
    - Sandon Quarry Southern Void: Hydrogeological Risk Assessment (2015)[7]
    - Sandon Quarry Northern Void; Groundwater Modelling Report (2021)[8] ;and
- site investigations undertaken in 1997, 2015 and 2020 including borehole logs, groundwater levels and permeability testing. Relevant borehole logs are included as Appendix 01.

2.2.1 Geology

Soils

The Cranfield Soilscapes online soil map viewer[9] indicates that the natural soils at the Site were predominantly '*Freely draining slightly acid loamy soils'* which drain to local groundwater and rivers. Site investigation found top-soils with a thickness of approximately 0.2m around the perimeter of the quarry void.

Superficial Deposits

The wider Sandon Quarry site was described in the Sandon Quarry South ESID[3] as located on a northeast-southwest orientated buried channel (paleochannel) of sand and gravel (River Terrace Gravels). This paleochannel is further described as being highly variable in thickness and cutting into the surface of the London Clay. The Drift geology comprises units of sand and gravel with thin, intercalated clays and silts. The BGS

[3] *Sandon Quarry Southern Void Environmental Permit Application, Environmental Setting and Installation Design, SLR Ref: 412-01009-00120, August 2015*
[4] *Sandon Waste Management Facility Planning Application Environmental Statement, Appendix K – Hydrogeological Report, MJCA, January 1998*
[5] MJCA (Dec 2015) *Hydrogeological and hydrological impact assessment including a flood risk assessment for the restoration of the northern void at sandon quarry, Essex,* Ref: BGL/SA/JRC/2847/01
[6] MJCA (Dec 2015) *Stability risk assessment for the northern quarry void to support planning application for the restoration of the northern quarry void, Ref: BGL/SA/DFR/3190/01/SRA*
[7] SLR Consulting Ltd (Apr 2015) *Sandon Quarry Southern Void Environmental Permit (EP) Variation Application: Hydrogeological Risk Assessment, SLR Ref: 412.01009.00120*
[8] SLR Consulting Ltd (August 2021) *Sandon Quarry Northern Void; Groundwater Modelling Report, SLR Ref: 403.09886.00012*
[9] Cranfield Soil and Agrifood Institute Soilscapes Online Soil Map Viewer (Accessed 29/11/21) http://www.landis.org.uk/soilscapes/

geological map indicates that the main buried channel extends approximately 200m south of the northern void, 300m to the west of the northern void and over 1km to the northeast of the northern void. Appendix K of the 1998 ES[4] also refers to a narrow southern part of the channel south of the southern void, approximately 120m wide.

The River Terrace deposits are overlain by a variety of other superficial deposits across the modelled area. The northern void is largely surrounded by older manmade fill as follows:

- western site boundary – spoil from the construction of the A12;
- northern site boundary – historic landfilling; and
- southern site boundary – causeway formed historically with infill, then Sandon Southern Void landfill and Hall Lane Landill further south.

Along the eastern site boundary lies Alluvium beneath the eastern arm of nearby Sandon Brook, and glaciofluvial and glaciolacustrine deposits across the slope of the hillside to the north-east.

The superficial deposits in the vicinity of the Site are presented in Drawing HRA1. The geological sequence identified is summarised in Table 2-3 below.

Table 2-3
Summary of Geology

Age	Strata	Description	Thickness
Anthropocene	Made Ground / Fill	Mixture of reworked sands and gravels, silts and clays	0 – 20m
Quaternary	Glaciofluvial Deposits	Mid-Pleistocene Sand and Gravel	0 – 3m
	Glaciolacustrine Deposits	Mid-Pleistocene Clay and Silt	0 – 3m
	Head	Poorly sorted and poorly stratified hillwash of clays, sands and gravels	0 – 5m
	Alluvium	Fluvial clay, silt, sand and gravel	1.2 – 5.2m
	River Terrace Deposits	Greyish-brown sand and gravel	2 – 25m
Paleogene	London Clay	Blue-grey stiff grey CLAY	Up to 150m

Bedrock Geology

The superficial sands and gravels are underlain by London Clay bedrock which outcrops at the surface to the south-east, south and south-west of the northern void as well as across a small area to the north of the village of Sandon.

The approximate base of the sand and gravels (top of the London Clay) is presented in Drawing HRA1; this demonstrates that the paleochannel extends in a north-easterly direction from the northern void for a distance of approximately 2.5km. The paleochannel is at its deepest in the vicinity of the northern void with a minimum elevation of approximately -10mAOD, becoming progressively shallower as it extends approximately 2km to the

north. To the south of the southern void the base of the paleochannel rises steeply to where the London Clay outcrops, approximately 400m to the south and south-west.

2.2.2 Hydrogeology

Aquifer Characteristics

The Magic Map service[10] classifies the River Terrace Deposits as a Secondary A Aquifer, described 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. These are generally aquifers formerly classified as minor aquifers"*

The London Clay is classified as Un-Productive Strata, described as:

> *"rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow".*

Rainfall Infiltration

Rainfall data have been provided by the Environment Agency for a rain gauge located in Chelmsford, approximately 2.5km to the north-west of the Site. The gauge provides daily rainfall for the period August 2011 to March 2021. Long-term average (1981 – 2010) rainfall data have also been obtained from the Met Office for Writtle, approximately 7km north-west of the Site. Average monthly rainfall from both sources is summarised in Table 2-4.

Potential Evapotranspiration (PET) data have been obtained from MAFF Technical Bulletin 34[11], area 33E. The recorded PET and calculated effective rainfall (based on Met Office Long-Term averages) are summarised in Table 2-4. The monitoring data indicate that PET exceeds average rainfall between April and September and the bulk of recharge will typically occur over the winter period between October and February each year

Table 2-4
Average Monthly Total and Effective Rainfall and Potential Evapotranspiration

Source	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall at Chelmsford (EA) 2011 - 2021	58.38	33.88	33.56	34.22	40.87	48.22	50.38	55.74	40.94	65.40	51.32	64.36	577.26
Rainfall at Writtle (Met Office) 1981 - 2010	53.20	39.20	40.20	41.60	48.70	49.90	44.30	51.70	48.60	64.10	58.00	52.30	591.80
PET	3.0	10.0	32.0	57.0	84.0	98.0	98.0	80.0	51.0	21.0	5.0	1.0	540
Effective Rainfall at Writtle	50.2	29.2	8.2	0.0	0.0	0.0	0.0	0.0	0.0	43.1	53.5	51.3	235.5

[10] https://magic.defra.gov.uk
[11] MAFF (Dec 1975) *Technical Bulletin 34: Climate Change and Drainage*

Recharge rates are likely to be relatively high where River Terrace and glaciofluvial deposits are present at the surface with lower recharge rates into Alluvium, Head and Glaciolacustrine deposits.

Groundwater Levels and Flow

Groundwater levels across both the northern and southern voids have long been impacted by groundwater management, particularly from the southern void. Groundwater levels were historically maintained towards the base of the southern void at an elevation of c.4mAOD. It is unknown when pumping at the Site commenced, however a 1998 hydrogeological report on Sandon Quarry[12] indicated a water level at the time of -4mAOD in the southern void in December 1997 (no information is available on the water level in the northern void at this point).

A topographical survey completed on 13th December 2010 indicated a water level in the southern void of 3.59mAOD and in the northern void at 8.52mAOD. Pumping from the southern void was gradually reduced until ceasing in 2017 and water levels in the northern void had rebounded to an elevation of c.15.80mAOD by late 2017. Since 2017 groundwater levels have been managed by pumping from the northern void.

Groundwater levels have been regularly monitored at fifteen perimeter boreholes from January 2014 to October 2021. Most of these monitor the sands and gravels, although several have been installed within areas of backfill and made ground. Borehole locations are shown on Drawing HRA1 which also shows groundwater level contours for May 2021, a time-series graph illustrating groundwater levels in all boreholes is presented as Appendix 02, and groundwater level data are summarised in Table 2-5 for the monitoring period 2019-2021, when more recently installed boreholes are also available.

Table 2-5
Summary of Groundwater Level Data 2019-2021

Borehole ID	Horizon Monitored	Date Range		Groundwater Level (mAOD)				
				Count	Min	Mean	Max	Range (m)
BH01 (1997)	Shallow sand	28/02/19	17/08/21	10	21.27	22.16	23.67	2.40
BH01/17	Historic fill	04/01/19	26/10/21	11	17.19	17.88	19.05	1.86
BH07	Shallow sand	28/02/19	17/08/21	11	21.69	22.27	23.09	1.40
BH1/97	Gravel	28/02/19	26/10/21	17	16.88	17.94	19.05	2.17
BH12R	Sand	28/02/19	17/08/21	11	25.42	26.04	26.42	1.00
BH14	Sand and overlying fill	02/01/19	30/11/21	291[a]	13.94	15.47	17.03	3.09
BH15	Sand and overlying fill	02/01/19	30/11/21	292[a]	13.98	15.51	16.25	2.27
BH16	2m sand layer in clay	28/02/19	26/10/21	17	18.16	19.29	21.22	3.06
2020-02	Historic fill	23/03/21	26/10/21	8	17.89	18.89	20.42	2.53
2020-03	Sand	05/02/21	26/10/21	9	12.92	14.26	14.95	2.03
2020-05	Gravel	05/07/21	30/11/21	51	16.28	16.88	17.32	1.04
2020-06	Historic fill	05/07/21	30/11/21	49	15.46	16.17	16.89	1.43
BH6/97R	Sand and gravel	28/02/19	17/08/21	11	15.40	15.77	16.24	0.84
BH06A	0.4m sand layer in silt	28/02/19	26/10/21	17	21.14	21.80	22.86	1.72

[a] – monitored more frequently for stability reasons

[12] MJ Carter Associates (Jan 1998) *A hydrogeological report on Sandon Quarry*, Ref: BGL/SA/HC/998/04

A review of the groundwater level data indicates the following:

- from 2014 – 2017 there was a rising trend in groundwater levels associated with the reduction and cessation of pumping from the southern void;
- between November 2017 and June 2021, when pumping from the northern void typically ranged from 600-900 m3/day, groundwater levels have shown a slight declining trend close to the northern void, where lake water levels declined from 15.6mAOD in late 2017 to c.14mAOD in the summer of 2021.
- groundwater levels within the sand and gravel aquifer in the general vicinity of the Site since 2019 have ranged from 26.42 mAOD at BH12R in the south to 16.88 mAOD in the north;
- groundwater levels within the sand and gravel aquifer adjacent to the dewatered quarry void had fallen to 14.6mAOD by the summer of 2021, but there has been significant variation of several metres depending on occasional variations in the rate of pumping from the northern void;
- a seasonal variation of up to 2-3m is evident in groundwater levels in the general vicinity of the Site; and
- groundwater flow across the Site is broadly towards the north.

Aquifer Properties

Permeability testing was completed by SLR as part of the 2020 Ground Investigation, and results of the permeability testing were presented within the Ground Investigation Report included within Appendix 01 of the overarching *'submission to discharge condition 10 of planning consent ESS/08/16/CHL'* report.

Testing for permeability of the fill around the western edge of the northern void confirmed low permeabilities of less than 0.01 m/day, indicating that there are not likely to be significant groundwater inflows where there is thick fill. The general applicability of this order of magnitude of permeability for the fill was confirmed by MODFLOW modelling[13] carried out by SLR.

Testing of the sands and gravels was completed in five of the perimeter boreholes along the western boundary of the Site. Borehole locations as presented on Drawing HRA1. The test results as summarised in Table 2-6 indicate that the permeability of the sands and gravels is relatively high, at between 1m/day and 11m/day. The applicability of this range of permeability was also confirmed by MODFLOW modelling carried out by SLR.

Table 2-6
Permeability Test Results at Boreholes Installed in Sand and Gravel

Borehole	BH1/97	BH16	BH15	2020-05	2020-03
Ground Level (mAOD)	+25.97	+26.34	+28.34	+31.02	+16.38
Slotted Casing (mAOD)	-4 to +8	+2 to +25	-1 to +27	+7 to +12	-1.3 to +11.9
Summary of Geology (Elevation (mAOD)	Sand: +21 to +26 Silt: +10 to +21 Gravel: -4 to +10	Clayey Fill: +22 to +26 Clay: +6 to +22 Sand: +4 to +6 Clay: +2 to +4	Clayey Fill: +8 to +28 Sand: -1 to +8	Fill: +12.5 to +31 Gravel: +7 to +12.5	Fill: +12.5 to +16.4 Sand: -1.3 to +12.5
Rest Water Level (mAOD)	17.29	18.18	14.96	16.80	15.17
Permeability (m/day)	5 – 11	1 – 8 [a]	1 – 1.5 [a]	2 - 9	2 – 9

[13] Sandon Quarry Northern Void: Groundwater Modelling Report, August 2021, SLR Ref: 403.09886.00012

Borehole	BH1/97	BH16	BH15	2020-05	2020-03
[a] - results analysed assuming that all flows are in sand or gravel horizons only					

2.2.3 Groundwater Quality

Groundwater quality has been sampled on a quarterly basis at six boreholes monitoring the deeper sand aquifer, and also from the dewatering discharge. Recent results are presented below in Tables 2-7 to 2-9, with data shaded if Drinking Water Standards (DWS) have been exceeded, and key groundwater chemographs are presented in Appendix 03.

Groundwater quality is generally within the relevant DWS, apart from:

- elevated sulphate concentrations which are likely to be due to elevated concentrations in older historic fill surrounding the site. More recent concentrations have remained below the 2013 maximum of 1290 mg/l at BH14. Concentrations in down-gradient borehole BH1/97 have generally exceeded or approached DWS, possibly influenced by older historic fill;
- concentrations of iron and manganese have exceeded DWS, potentially due to redox variations; and
- at borehole BH6/97R concentrations of nickel have exceeded DWS (and arsenic has approached DWS) , which is likely to be due to sorption onto manganese oxide nodules in the silt horizon present within this borehole;
- nickel, lead and PAHs have also been elevated at boreholes influenced by older historic fill.

Table 2-7
Summary of Routine Determinands in Groundwater Quality 2018-2021

Sample Point	Summary Stats 2018 Onwards	Alkalinity as CaCO3	Ammoniacal Nitrogen as N	BOD	Chloride	COD (Total)	Conductivity	pH	Sulphate as SO4	Total Organic Carbon	Total Oxidised Nitrogen
		mg/l	mg/l	mg/l	mg/l	mg/l	us/cm	pH units	mg/l	mg/l	mg/l
	UK DWS	-	0.39	-	250	-	2500	6.5 - 9.5	250	-	-
BH1/97	Count	15	15	15	15	15	15	15	15	15	15
	Detects	15	12	10	15	12	15	15	15	15	0
	Min	196.0	<0.06	<1	68.5	<11	1020	7.0	228.0	3.0	<0.7
	Mean	284.1	0.091	1.3	75.7	17.0	1075	7.4	236.8	3.5	-
	Max	340.0	0.12	3.0	79.4	33.0	1170	7.8	261.0	4.9	<0.7
BH12R	Count	11	11	11	11	11	11	11	11	11	11
	Detects	11	0	7	11	10	11	11	11	11	10
	Min	75.0	<0.06	<1	4.9	<11	263	7.0	31.5	6.7	<0.7
	Mean	96.9	-	1.7	13.6	31.7	370	7.3	72.0	11.0	3.09
	Max	121.0	<0.06	4.0	23.9	59.0	480	7.9	129.0	16.8	6.80
BH14	Count	17	17	17	17	17	17	17	17	17	17
	Detects	17	13	11	17	15	17	17	17	17	0
	Min	202.0	<0.06	<1	135.0	<11	1750	6.9	394.0	1.9	<0.7
	Mean	347.7	0.10	1.6	228.5	38.2	1870	7.3	487.8	2.5	-
	Max	586.0	0.17	5.0	312.0	345.0	2040	7.7	601.0	3.9	<0.7
BH15	Count	17	17	17	17	17	17	17	17	17	17
	Detects	17	14	14	17	17	17	17	17	17	0
	Min	324.0	<0.06	<1	49.3	68	1610	6.8	586.0	3.1	<0.7
	Mean	435.1	0.26	4.1	68.3	125.8	1925	7.0	821.9	4.1	-

Sample Point	Summary Stats 2018 Onwards	Alkalinity as CaCO3	Ammoniacal Nitrogen as N	BOD	Chloride	COD (Total)	Conductivity	pH	Sulphate as SO4	Total Organic Carbon	Total Oxidised Nitrogen
		mg/l	mg/l	mg/l	mg/l	mg/l	us/cm	pH units	mg/l	mg/l	mg/l
	UK DWS	-	0.39	-	250	-	2500	6.5 - 9.5	250	-	-
	Max	549.0	0.54	24.0	165.0	316.0	2370	7.5	1210.0	6.1	<0.7
BH16	Count	15	15	15	15	15	15	15	15	15	15
	Detects	15	12	11	15	15	15	15	15	15	0
	Min	404.0	<0.06	<1	26.4	19	1090	7.0	195.0	4.6	<0.7
	Mean	1885.7	0.081	5.6	42.2	362.3	1143	7.2	223.6	6.1	-
	Max	6040.0	0.12	41.0	47.4	1080.0	1280	7.5	241.0	9.7	<0.7
BH6-97R	Count	15	15	15	15	15	15	15	15	15	15
	Detects	15	15	9	15	13	15	15	15	15	0
	Min	201.0	0.14	<1	36.1	<11	819	6.9	182.0	6.0	<0.7
	Mean	279.9	0.23	2.1	46.4	24.9	996	7.4	245.9	7.1	-
	Max	358.0	0.38	7.0	54.3	57.0	1250	7.8	404.0	8.7	<0.7
Northern Void Dewatering Discharge	Count	16	20	20	20	20	20	20	16	16	20
	Detects	16	1	8	20	16	20	20	16	16	1
	Min	149	<0.06	<1	63.7	<11	1090	7.9	361.0	3.7	<0.7
	Mean	202.4	0.033	1.2	69.0	16.5	1287	8.1	494.1	4.5	0.4
	Max	273	0.080	4	72.9	45.0	1400	8.3	558.0	5.3	1.2

Table Notes:

- Metals are dissolved (filtered)
- Averages have been calculated using half the detection limit for that monitoring round in the case of non-detects
- Averages have not been calculated where half of monitoring rounds were non-detects.

Table 2-8
Summary of Dissolved Metals in Groundwater Quality 2018-2021

Sample Point	Summary Stats 2018 Onwards	As	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Mn	Hg	Ni	K	Se	Na	Zn
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	UK DWS	0.01	0.005	-	0.05	2	0.2	0.01	-	0.05	0.001	0.02	-	0.01	200	-
BH1/97	Count	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
	Detects	8	0	15	1	0	5	2	15	15	0	7	15	0	15	0
	Min	<0.001	<.0006	173.0	<0.002	<0.009	<0.23	<0.006	16.2	0.35	<.00001	<0.003	6.45	<0.0008	36.1	<0.018
	Mean	.00055	-	188.1	-	-	-	-	17.7	0.39	-	-	7.38	-	40.0	-
	Max	0.0010	<.0006	200.0	0.011	<0.009	2.87	0.020	18.9	0.43	<0.0002	0.043	8.43	<0.0012	42.1	<0.018
BH12R	Count	1	11	11	11	11	11	11	11	11	1	11	11	1	11	11
	Detects	1	0	11	0	3	0	0	11	10	0	11	11	0	11	0
	Min	0.0020	<.0006	30.7	<0.002	<0.009	<0.23	<0.006	5.2	<0.007	<.00001	0.0030	8.33	<0.0012	6.8	<0.018
	Mean	0.0020	-	45.4	-	-	-	-	8.2	0.021	-	0.0048	15.45	-	10.8	-
	Max	0.0020	<.0006	61.2	<0.002	0.012	<0.23	<0.006	12.9	0.047	<.00001	0.0070	26.50	<0.0012	13.2	<0.018
BH14	Count	4	17	17	17	17	17	17	17	17	4	17	17	4	17	17
	Detects	1	0	17	1	0	4	3	17	17	4	17	17	0	17	0
	Min	<.0002	<.0006	317.0	<0.002	<0.009	<0.23	<0.006	25	0.69	0.00001	0.0070	10.20	<0.0008	53.8	<0.018
	Mean	-	-	343.7	-	-	-	-	27.5	0.80	4.75E-05	0.015	12.98	-	83.0	-
	Max	<0.001	<.0006	366.0	0.0090	<0.009	0.90	0.021	30	0.93	.00008	0.044	15.50	<.0012	122.0	<0.018
BH15	Count	4	17	17	17	17	17	17	17	17	4	17	17	4	17	17
	Detects	2	1	17	1	0	0	2	17	17	2	17	17	0	17	3

Sample Point	Summary Stats 2018 Onwards	As	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Mn	Hg	Ni	K	Se	Na	Zn
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
	UK DWS	0.01	0.005	-	0.05	2	0.2	0.01	-	0.05	0.001	0.02	-	0.01	200	-
	Min	<0.001	<.0006	296.0	<0.002	<0.009	<0.23	<0.006	33.6	1.55	<.00001	0.022	13.00	<0.0008	38.8	<0.018
	Mean	.00060	-	412.8	-	-	-	-	45.7	2.53	.00004	0.049	18.02	-	46.9	-
	Max	<0.001	.00060	574.0	0.011	<0.009	<0.23	0.019	65.1	3.77	.00013	0.074	24.30	<0.0012	72.5	0.024
BH16	Count	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
	Detects	10	0	15	2	0	1	1	15	15	0	12	15	0	15	0
	Min	<0.001	<.0006	216.0	<0.002	<0.009	<0.23	<0.006	20.9	0.17	<.00001	<0.003	3.68	<0.0008	20.6	<0.018
	Mean	.00080	-	233.3	-	-	-	-	23.7	0.64	-	0.0072	4.94	-	24.7	-
	Max	0.0019	<.0006	245.0	0.011	<0.009	0.37	0.0080	25.2	3.01	<.0002	0.049	6.80	<0.0012	26.0	<0.018
BH6-97R	Count	4	15	15	15	15	15	15	15	15	4	15	15	4	15	15
	Detects	4	0	15	1	0	8	1	15	15	1	15	15	0	15	0
	Min	0.0014	<.0006	137.0	<0.002	<0.009	<0.23	<0.006	13.5	0.42	<.00001	0.030	12.10	<0.0008	26.6	<0.018
	Mean	0.0037	-	174.5	-	-	2.08	-	18.3	0.54	-	0.064	16.59	-	33.5	-
	Max	0.0090	<.0006	242.0	0.0030	<0.009	9.80	0.0060	27.5	0.82	.00001	0.091	27.40	<0.0012	43.9	<0.018
Northern Void Dewatering Discharge	Count	1	16	16	16	16	16	16	16	16	Not Analysed	16	16	1	16	16
	Detects	1	0	16	0	0	1	0	16	16		11	16	0	16	0
	Min	.00065	<.0006	173.0	<0.002	<0.009	<0.23	<0.006	26.7	0.021		<.003	9.64	<0.0006	36.8	<0.018
	Mean	.00065	-	231.9	-	-	-	-	30.0	0.13		.0030	11.1	-	41.0	-
	Max	.00065	<.0006	270.0	<0.002	<0.009	0.25	<0.006	33.2	0.37		.0040	12.3	<0.0006	45.0	<0.018

Table Notes: Metals are dissolved (filtered);
Averages have been calculated using half the detection limit for that monitoring round in the case of non-detects, but have not been calculated where over half of monitoring rounds were non-detects.

Table 2-9
Summary of PAHs Detected in Groundwater 2018-2021

Sample Point	Summary Stats 2018 Onwards	Benzo(b)fluoranthene	Benzo(ghi)perylene	Benzo(k)fluoranthene	Fluoranthene	Naphthalene	Phenanthrene	Pyrene	Total PAH
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
	UK DWS	-	-	-	-	-	-	-	0.10
BH1/97	Count	15	15	15	15	15	15	15	15
	Detects	0	0	1	0	0	0	0	1
	Min	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Max	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
	Max Detect	-	-	0.011	-	-	-	-	0.011
BH12R	Count	1	1	1	1	1	1	1	1
	Detects	0	0	0	0	0	0	0	0
	Min	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Max	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Max Detect	-	-	-	-	-	-	-	-
BH14	Count	4	4	4	4	4	4	4	4
	Detects	0	0	1	0	1	0	0	2
	Min	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Max	<0.01	<0.01	0.012	<0.01	0.027	<0.01	<0.01	0.027
	Max Detect	-	-	0.012	-	0.027	-	-	0.027
BH15	Count	4	4	4	4	4	4	4	4
	Detects	1	0	1	4	0	2	4	4
	Min	<0.01	<0.01	<0.01	0.016	<0.01	<0.01	0.015	0.032
	Max	0.11	<0.1	0.13	0.12	<0.1	<0.1	0.11	0.47

Sample Point	Summary Stats 2018 Onwards	Benzo(b)fluoranthene	Benzo(ghi)perylene	Benzo(k)fluoranthene	Fluoranthene	Naphthalene	Phenanthrene	Pyrene	Total PAH
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
	UK DWS	-	-	-	-	-	-	-	0.10
	Max Detect	0.11	-	0.13	0.12	-	0.030	0.11	0.47
BH16	Count	15	15	15	15	15	15	15	15
	Detects	0	1	0	0	0	0	1	1
	Min	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Max	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Max Detect	-	0.012	-	-	-	-	0.023	0.035
BH6-97R	Count	4	4	4	4	4	4	4	4
	Detects	0	0	1	0	2	0	0	3
	Min	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Max	<0.01	<0.01	0.012	<0.01	0.015	<0.01	<0.01	0.015
	Max Detect	-	-	0.012	-	0.015	-	-	0.015

2.3 Receptors

2.3.1 Abstractions and Source Protection Zones

Online mapping[14] confirms that the proposed development is not located within a groundwater Source Protection Zone (SPZ) and that there are no licensed groundwater or surface water abstractions within a 2km radius of the Site.

Chelmsford City Council has confirmed[15] that there no private water supplies within 2km of the Site.

2.3.2 Surface Water

Surface water potential receptors at or immediately adjacent to the Site are:

- the eastern arm of Sandon Brook – flowing northwards near the eastern boundary of the Site (40m from the quarry void at the closest point, where the channel elevation is approximately[16] 25 mAOD). The eastern arm is underlain by alluvial silty clay 1.4 – 5.2m thick; and
- the western arm of the Sandon Brook – flowing north-eastwards near the northern boundary of the Site (50m from the quarry void at the closest point, where the channel elevation is approximately 23 mAOD. The western arm is underlain by alluvial clay/silt 1.2 – 3.3m thick.

The two channels merge around 400m to the northeast of the quarry immediately upstream of Woodhill Road, the combined channel being referred to as Sandon Brook. Flow within Sandon Brook is monitored by the Environment Agency at Sandon Bridge (NGR 52 TL 755 055 approximately 500m north of the confluence) where average flow is 0.30 m^3/sec (c. 26,000m3 /day) with a Q95 of 0.033 m^3/sec.

Water is currently pumped from Sandon Quarry and discharged to Sandon Brook (Eastern arm) under Discharge Consent PR2NF/E10173, which authorises the discharge of up to 2,500m^3/day of groundwater into the Sandon Brook at Grid Reference TL 7485 0421. Although historically this discharge occurred from the Southern Void, the current discharge occurs from the Northern Void to manage water levels.

Given the significant thickness of low permeability alluvium beneath both arms of the Sandon Brook, the brook Is not considered to be a receptor for any contamination migrating from the waste into groundwater adjacent to the Site.

2.3.3 Ecological Sites

The MAGIC map website and an EA Habitats and Conservation screening assessment confirms that there are none of the following ecological sites located within 2km of the Site boundary;

- Sites of Special Scientific Interest (SSSI);
- Special Area of Conservation (SAC);
- Special Protection Areas (SPA); and
- RAMSAR.
- Area of Outstanding Natural Beauty;
- Local Nature Reserve;

[14] https://magic.defra.gov.uk and https:/www.arcgis.com/home/webmap
[15] Email from Tim Savage (Chelmsford City Council) dated 3rd December 20921
[16] Based on EA 2017 Flood Model for Sandon Brook

- National Nature Reserve; and
- National Parks

Designated Ancient Woodlands (as detailed in the ESSD) 1.4km north-east of the Site are not likely to be groundwater dependent.

2.3.4 Receptor Locations for Modelling

The primary receptors assumed for this assessment are in accordance with those required by Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations, 2016, these are as follows:

- for Hazardous Substance the receptor is assumed to be the groundwater within the River Terrace gravel aquifer downgradient of the Site taking account of immediate dilution in the aquifer[17] but without any dispersion or attenuation in the aquifer pathway; and
- for Non-Hazardous Pollutants the receptor has been assumed to be the groundwater within the River Terrace gravel aquifer at the down-gradient Site boundary (down-gradient boreholes in the gravel).

For the purposes of defining receptors, the compliance points are taken to be at the down-gradient Site boundaries. It is noted that there may be other, physical receptors further away from the down-gradient Site boundary. Compliance with the Regulations at the points defined above will ensure that other receptors are adequately protected.

2.4 Priority Contaminants & Environmental Assessment Limits

To assess the risk posed from the Site, first Environmental Assessment Limits (EALs) must be assessed. These have been set for all substances included in WAC testing based on the requirements of the Environmental Permitting Regulations 2016 (as amended) whereby no discernible release of Hazardous Substances is permitted, and the release of Non-Hazardous Pollutants is sufficiently limited as to avoid pollution. The EALs have therefore been set as follows:

- for Hazardous Substances, the EALs shall be the minimum reporting values (MRV's) as defined in the current EA HRA guidance[18] (also taking account of UKTAG Limits of Quantification[19]) unless current background groundwater quality exceeds the specific limit;
- for Non-Hazardous Pollutants the EALs have been set mid-way between average background groundwater quality and the DWS.

While waste deposition commenced in November 2021 under the LEP, the data presented in Tables 2-7 to 2-9, which covers January 2018 to August 2021, give an indication of background groundwater quality. However, it is noted that local groundwater quality at BH14 and BH15 is likely to be impacted by in excess of 20m thickness of overlying historic waste, and at BH6/97R by nearby alluvial clay, hence where concentrations of some substances

[17] UK Government, *Groundwater Protection Technical Guidance*, Available at: https://www.gov.uk/government/publications/groundwater-protection-technical-guidance/groundwater-protection-technical-guidance (Accessed 22/07/2020)

[18] UK Government, *Hazardous Substances to Groundwater: Minimum Reporting Values* Guidance, Available at: https://www.gov.uk/government/publications/values-for-groundwater-risk-assessments/hazardous-substances-to-groundwater-minimum-reporting-values (Accessed 22/07/2020)

[19] Limit of Quantification from UK Technical Advisory Group (UKTAG) on the Water Framework Directive (September 2016): Technical Report in Groundwater Hazardous Substances [https://www.wfduk.org/resources/groundwater-hazardous-substances-standards]

at these boreholes significantly exceed typical concentrations at other boreholes, those substances have been excluded from the overall means in Table 2-10.

In Table 2-10 below, the Site's proposed WAC leaching limits as presented in Table 2-1 converted to mg/l have been assessed against respective UK DWS and background groundwater quality to determine which substances pose the highest risk to the groundwater receptor for inorganic substances.

Table 2-10 Inorganic Inert Waste Quality Risk Factors

Substance	3xIWAC Limit L/S = 10 l/kg	Conversion to mg/l (L/S=10 value x 0.3)	Hazardous or Non-Haz[2]	UK DWS (mg/l)	MRV / LOQ / Detection Limit	Average GW quality (mg/l)	Proposed EAL	Risk Factor[1]
Arsenic	1.5	0.15	Haz	0.01	0.005[(b)]	0.0009[(h)]	0.005[(c)]	30
Barium	60	6	Non-Haz	1.30[(a)]	Non-Haz	-	0.65[(h)]	9.2
Cadmium	0.12	0.012	Non-Haz	0.005	Non-Haz	<0.0006	0.0025[(d)]	4.8
Cr (Total)	1.5	0.15	Non-Haz	0.05	Non-Haz	<0.002	0.025[(d)]	6.0
Copper	6.0	0.6	Non-Haz	2.0	Non-Haz	<0.009	1.0[(d)]	0.6
Mercury	0.03	0.003	Haz	0.001	0.00001[(e)]	<0.00001[(g)]	0.00001[(c)]	300
Molybdenum	1.5	0.15	Non-Haz	0.07[(a)]	Non-Haz	-	0.035[(h)]	4.3
Nickel	1.2	0.12	Non-Haz	0.02	Non-Haz	0.006[(g,h)]	0.013[(d)]	9.2
Lead	1.5	0.15	Haz	0.01	0.0002[(b)]	<0.006	0.0002[(c)]	750
Antimony	0.18	0.018	Non-Haz	0.005	Non-Haz	-	0.0025[(h)]	7.2
Selenium	0.3	0.03	Non-Haz	0.01	Non-Haz	<0.001	0.005[(d)]	6.0
Zinc	12	1.2	Non-Haz	-	Non-Haz	<0.018	-	-
Chloride	2400	240	Non-Haz	250	Non-Haz	45[(g)]	148[(d)]	1.6
Fluoride	30	3	Non-Haz	1.5	Non-Haz	-	0.75[(h)]	4.0
Sulphate	6000[(f)]	600	Non-Haz	250	Non-Haz	195[(g)]	223[(d)]	2.7
DOC	500	50	N/A	-	-	5.7[(i)]	-	-
TDS	12000	1200	N/A	-	-	-	-	-

[1] Risk factor calculated as assumed max waste quality divided by EAL; [2] As classified by JAGDAG 2018; [(a)] No DWS therefore WHO Limit used; [(b)] UKTAG Limit of Quantification; [(c)] EAL set at the respective MRV / LOQ; [(d)] EAL set mid-way between DWS and mean background groundwater quality; [(e)] EA defined MRV; [(f)] if the waste does not WORD MISSING 1000 mg/kg at L/S = 10l/kg, for sulphate, it may still be considered as complying with the acceptance criteria if the leaching does not exceed 6000mg/kg at L/S = 10l/kg; [(g)] Excluding higher concentrations at boreholes BH14 and BH15 potentially influenced by historic fill in these boreholes; [(h)] Excluding borehole BH6/97R where dissolved arsenic and nickel concentrations are locally significantly higher; [(i)] Using Total Organic Carbon as a substitute for Dissolved Organic Carbon; [(j)] half of DWS; [(k)] maximum upgradient baseline excluding boreholes BH14 and BH15 (which are potentially influenced by historic fill in these boreholes) of 404 mg/l at BH6/97R in February 2021

Based on the risk factors as outlined in Table 2-10 it is considered that Hazardous Substances arsenic, mercury and lead pose the highest risk to groundwater from the Site. The risk from Non-Hazardous inorganics is relatively low due to the low concentrations of the IWAC limits. Nonetheless fluoride and sulphate should be modelled as the highest risk major ions and nickel as the highest risk Non-Hazardous metal.

An assessment of organic substances is outlined in Table 2-11. Risk factors have been derived by comparing the MRVs with maximum leachable values for each individual determinand, which were back-calculated from IWAC solid waste limits using the EA P20 Remedial Targets Worksheet with input parameters such as typical porosity and bulk density of inert waste, and substance-specific Henry's Law constant and soil-water partition coefficients.

Table 2-11
Organics Results for Proposed Inert Waste Stream

Suite	Speciated Substance	IWAC Limit Solid Ratio (mg/kg)	Max Leachable (mg/l)	Haz / Non-Haz	MRV (mg/l)	Max Background Groundwater Quality (mg/l)	Risk Factor
BTEX	Benzene	6.0[a]	1.26	Hazardous	0.001 [e]	Not monitored	1260
	Toluene		0.464	Hazardous	0.004 [e]		116
	Ethylbenzene		0.218	Hazardous	0.001 [f]		218
	Xylene		0.218	Hazardous	0.003 [e]		72.7
PAHs	Acenaphthene	100[b]	0.141	Hazardous	0.00001 [f]	<0.00001	14100
	Acenaphthylene		0.397	Undefined	-	<0.00001	-
	Anthracene		0.0339	Hazardous	0.00001 [g]	<0.00001	3390
	Benzo(a)anthracene		0.0129	Undefined	-	<0.00001	-
	Benzo(a)pyrene		0.00776	Hazardous	0.00001 [h]	<0.00001	776
	Benzo(b)fluoranthene		0.00955	Hazardous	0.0001 [h]	0.00011	95.5
	Benzo(g, h, i) perylene		0.0024	Hazardous	0.0001 [h]	0.000012	24
	Benzo(k)fluoranthene		0.00676	Hazardous	0.0001 [h]	0.00013	67.6
	Chrysene		0.0182	Undefined	-	<0.00001	-
	Dibenzo(a,h)anthracene		0.00537	Undefined	-	<0.00001	-
	Fluoranthene		0.0549	Hazardous	0.00001 [f]	0.00012	5490
	Fluorene		0.0724	Undefined	-	<0.00001	-
	Indeno(1,2,3-cd) pyrene		0.0115	Hazardous	0.0001 [h]	<0.00001	115
	Naphthalene		1.52	Non-Haz	-	0.000027	-
	Phenanthrene		0.0436	Undefined	-	0.000030	-
	Pyrene		0.0616	Undefined	-	0.00011	-
Mineral Oil C10 – C40	Aliphatics >C10-C12	500[c]	Not assessed further as low risk (EA TPH Guidance 2009)			Not monitored	-
	Aliphatics >C12-C16						-
	Aliphatics >C16-C21						-
	Aliphatics >C21-C35						-
	Aromatics >C10-C12		1.99	Hazardous	0.01[d]		199
	Aromatics >C12-C16		0.997	Hazardous	0.01[d]		99.7
	Aromatics >C16-C21						-

Suite	Speciated Substance	IWAC Limit Solid Ratio (mg/kg)	Max Leachable (mg/l)	Haz / Non-Haz	MRV (mg/l)	Max Background Groundwater Quality (mg/l)	Risk Factor
	Aromatics >C21-C35		Not assessed further as low risk (EA TPH Guidance 2009)				-

(a) Speciated max leachable concentrations back-calculated using remedial target worksheet based on typical porosity & bulk density of inert waste and substance specific Henry's Law and soil water partition coefficients (assuming any one speciated substance <33% of the Total BTEX (i.e. 2.0mg/kg)
(b) Speciated max leachable concentrations back-calculated using remedial target worksheet based on typical porosity & bulk density of inert waste and substance specific Henry's Law and soil water partition coefficients (assuming any one speciated substance <20% of the Total PAH (i.e. 20mg/kg)
(c) Speciated max leachable concentrations back-calculated using remedial target worksheet based on typical porosity & bulk density of inert waste and substance specific Henry's Law and soil water partition coefficients (assuming any one speciated substance <20% of Total Mineral Oil (i.e. 100mg/kg)
(d) Target value in EA TPH Guidance 2009
(e) MRV from EA website
(f) MRV based on typical detection limit for groundwater e.g. in site samples
(g) Limit of Quantification from UK Technical Advisory Group (UKTAG) on the Water Framework Directive (September 2016): Technical Report in Groundwater Hazardous Substances [https://www.wfduk.org/resources/groundwater-hazardous-substances-standards]
(h) Drinking Water Standard

The highest risk BTEX, PAH and Mineral Oil substances should be included within the key determinands to be assessed as listed below. Two PAHs have been selected, benzo(a)pyrene as the highest risk PAH which has a Drinking Water Standard, and acenaphthene as the highest risk PAH compared with MRV. The proposed EALs for these substances are the MRVs specified in Table 2-11 above.

The following key determinands are proposed:

Hazardous Substances:

- arsenic;
- lead;
- mercury
- acenaphthene;
- benzene;
- benzo(a)pyrene; and
- aromatic C10-C12.

Non-Hazardous Pollutants:

- fluoride;
- nickel; and
- sulphate.

2.5 Summary of Hydrogeological Site Conceptual Model

The Site's hydrogeological conceptual model is summarised in Table 2-12.

Table 2-12
Summary of Hydrogeological Site Conceptual Model

Linkage	Site Details
Source	The void created by extraction of River Terrace Deposits is to be restored with inert wastes. Given the nature of the waste streams no leachate collection system or artificial sealing liner is required. The waste placed within the void will meet the WAC limits as specified in Table 2-1. Due to the nature of the adjacent River Terrace Deposits aquifer there is a requirement for an artificial basal and sidewall attenuation layer, which will be constructed using inert, suitably cohesive waste materials with a low pollution potential and a permeability equivalent to 1 metre at 1 x 10^{-7}m/s. Due to the stability risks to the A12 and quarry slopes, the quarry void will be filled in a phased and partially dewatered manner.
Pathway	Any potential leachate generated by infiltration into the inert waste will migrate through the artificially established basal and sidewall attenuation layer and into the adjacent groundwater. Attenuation of potential contaminants will take place within the attenuation layer.
Receptor	In order to comply with Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations, 2016, the following are considered appropriate receptors: • for Hazardous Substances the receptor is assumed to be the groundwater within the River Terrace Deposits aquifer at the Site, taking account of immediate dilution in the aquifer but without any dispersion or attenuation in the aquifer pathway; and • for Non-Hazardous Pollutants the receptor has been assumed to be the groundwater at the down-gradient Site boundary (down-gradient boreholes) within the River Terrace Deposits aquifer.
Compliance Points	For the purposes of defining receptors, the compliance points are taken to be at the down-gradient Site boundaries. It is noted that there may be other, physical receptors further away from the down-gradient Site boundary. Compliance with the Regulations at the points defined above will ensure that other receptors are adequately protected.

3.0 HYDROGEOLOGICAL RISK ASSESSMENT

3.1 Nature of the Hydrogeological Risk Assessment

As set out within current HRA technical guidance[20], the *"appropriate complexity of assessment for a site should be determined from the potential risks presented by the site, which are linked to the nature of potential hazards, the sensitivity of the surrounding environment, degree of uncertainty and likelihood of a risk being realised."*

Given the nature of the Site and its environmental setting in a Secondary A Aquifer, it is considered appropriate to carry out a detailed quantitative assessment.

The Site will accept inert waste, which is defined as follows;

(a) it does not undergo any significant physical, chemical or biological transformations;

(b) it does not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm to human health; and

(c) total leachability, pollutant content and the ecotoxicity of its leachate are insignificant and, in particular, do not endanger the quality of any surface water or groundwater.

Based on this definition of inert waste, the Site should not produce any leachate that could result in any significant discharge of Hazardous Substances or Non-Hazardous Pollutants throughout the lifecycle of the Site.

Therefore, with regard to this inert waste stream, the Site:

- presents a negligible risk to groundwater and surface water quality;
- falls outside the Environmental Permitting Regulations 2016 (Schedule 22 Groundwater Activities); and
- does not require environmental management systems (artificial sealing liner, leachate management or other engineering and management structures), or the consideration of the degradation of such systems.

However, notwithstanding the above, it is considered that a quantitative risk assessment is required given that the EPR Inert Waste Guidance[21] 2020 states that a quantitative risk assessment is likely to be necessary for inert waste where the receiving environment is particularly sensitive, for example (as at Sandon) in a Secondary A aquifer near a brook.

In order to assess the risk to the environment, it is considered appropriate to assess the potential worst-case leachate quality that could potentially be generated from the Site.

3.2 The Proposed Assessment Scenario

3.2.1 Lifecycle Phases

It is recognised that the HRA must assess the proposed development's compliance with the requirements of Schedule 22 of the Environmental Permitting Regulations 2016 (as amended), throughout the lifecycle of the operation i.e. from the start of the operational phases until the point at which the waste no longer poses an unacceptable environmental risk.

[20] EA and DEFRA (February 2016) *Landfill developments: groundwater risk assessment for leachate guidance*, Available at: https://www.gov.uk/guidance/landfill-developments-groundwater-risk-assessment-for-leachate (Accessed 22/07/2020)
[21] Environment Agency (July 2009): *Environmental Permitting Regulations: Inert Waste Guidance*

Based on the hydrogeological conceptual site model, as outlined within Section 2.0, there are three scenarios to assess:

- Early filling during ongoing partial dewatering – it is proposed to maintain reduced groundwater levels for several years until waste is filled to approximately 17 mAOD across all of the Site, except the sump to be retained in the south-western corner of the quarry void. During this period, any contaminants migrating out through the landfill sidewall or base would then be drawn through the aquifer towards the dewatering sump in the south-western corner of the Site. This scenario has been included in the quantitative modelling using RAM3 software as discussed for the post-restoration scenario below;
- Later filling after cessation of dewatering – during this period groundwater levels would rise around the waste, but the slow build-up of moisture in the cohesive waste would rise more slowly, hence there would be potential diffusive migration of contaminants within the inert fill through the sidewall and base into the aquifer. This has been assessed quantitatively using the EA Diffusion Model; and
- Post-Restoration – in the long term moisture levels within the cohesive waste could potentially rise higher than groundwater levels, with a steady state water balance developing in which infiltration into the waste is matched by advective migration out through the sidewall and base. As this would be a sub water table scenario, this has been assessed quantitatively using RAM3 software.

As a conservative approach the quantitative assessments have been run using worst case assumptions with regards to potential source term, attenuation layer and aquifer characteristics.

3.2.2 Accidents and their Consequences

With respect to the deposition of potentially contaminated wastes, it is considered that the risks and potential consequences of such accidents are extremely low for the following reasons:

- all waste deliveries will be pre-arranged and come from known sources to ensure no contaminated material is delivered in accordance with Brett Aggregates waste acceptance procedures BA40;
- if deemed necessary, characterisation testing will be undertaken to demonstrate that the waste will not give rise to polluting leachate, prior to the acceptance of waste at the Site;
- verification testing will be undertaken as necessary to ensure the continued acceptability of the waste source;
- visual inspection will be undertaken of every waste load deposited at the Site; and
- in the event of suspicion regarding the acceptability of the waste once on site, waste rejection including quarantine procedures will be enforced.

In the unlikely event of contaminants from a rogue load being deposited at the Site, attenuation processes will occur within the waste body, and most organic Hazardous Substances are very likely to be degraded and retarded during migration through the surrounding inert wastes within the waste mass and the artificially emplaced attenuation layer. Other processes such as volatilisation can also be expected for volatile and semi-volatile organic substances resulting in a mass loss of contaminant from the waste.

Details of accidental occurrences at the Site that could present a potential risk to groundwater quality adjacent to the Site are provided in Table 3-1 below.

Table 3-1
Qualitative Assessment of Accidents and Mitigation

Accidental Occurrence	Risk to Groundwater	Likelihood of Occurrence	Mitigation and Corrective Measures
Deposition of non-inert wastes.	Generation of leachate containing Hazardous Substances or Non-Hazardous Pollutants.	Low – due to the essential and technical precautions.	Any unaccaeptable wastes entering the site will be immediately rejected or moved to a suitable quarantine area prior to removal from site by the customer.
Spillage of fuels from vehicles.	Release of hydrocarbons (Hazardous Substances) into the ground and migration to groundwater.	Low – no fuel is stored within the permitted boundary. A traffic system and speed limit will be imposed at the Site to reduce both the risk of accidents and the likelihood of spillage occurring.	Any spillage will be cleaned up immediately and any resulting contaminated soils removed to a suitable installation.

3.3 Numerical Modelling

3.3.1 Model Parameterisation

The nature of all of the input parameters used, together with the appropriate probability distributions used to describe them are presented in the following:

- Drawing HRA2: provides an indication of the Site conceptual model;
- Appendix 04: presents the detailed diffusion parameterisation; and
- Appendix 06: presents the detailed RAM3 parameterisation.

Parameter values were determined from information directly measured at Site wherever possible. If no Site data were available, conservative parameter values were taken from authoritative sources or after previous SLR experience at similar sites.

3.3.2 Assessment Methodology

In order to represent worst case conditions and assess the most sensitive determinands, risk factors were used to choose suitable determinands which pose the greatest risk of causing either pollution to the aquifer or a derogation of groundwater quality. As detailed within Section 2.0 the following determinands have been modelled:

- Hazardous Substances: arsenic, lead, mercury, benzene, acenaphthene, benzo(a)pyrene and aromatic C10-C12; and
- Non-Hazardous Pollutants: fluoride, nickel and sulphate.

As detailed in Section 3.2 above, the fate of Hazardous Substances and Non-Hazardous Pollutants has been considered using diffusion and RAM3 modelling developed by SLR for the Site, including the following assumptions:

- the sidewall attenuation layer is engineered to a thickness of 1m and a maximum permeability of $1x10^{-7}$m/s, although given the clayey nature of the inert waste to be used for the attenuation layer, the actual permeability is likely to be significantly lower i.e. allowing less contaminant migration;
- the source term has been set at single value concentrations based on the Inert WAC limit for the modelled organic substances and as a conservative worst case to allow for the possibility of rogue loads at 3 x IWAC for all modelled inorganic substances except arsenic, which is slightly more sensitive and has been modelled at 2 x IWAC. In reality most results will be well below the modelled WAC, hence a more realistic approach would consider a range of concentrations rather than all waste being exactly at those limits;
- seepage of infiltration through the waste has been modelled at 120 mm/yr which is half of the effective rainfall for this area, which is considered a very conservative approach as given the clayey nature of the waste the actual infiltration is likely to be significantly less; and
- attenuation of Hazardous Substances has been included within the attenuation layer only.

3.4 Assessment Results

The predicted discharge from the development has been assessed against EALs presented in Table 2-10 and MRVs / EALs presented in Table 2-11 to determine whether the Site complies with the requirements of Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations 2016. The diffusion model results are presented in Appendix 05, the RAM3 model results in Appendix 07, and electronic versions of the models in Appendix 08.

3.4.1 Hazardous Substances

Hazardous Substances have been assessed against their respective EALs in down-gradient groundwater following immediate localised dilution but prior to any attenuation or dispersion. The model results summarised in Table 3-2 below indicate that predicted resultant concentrations are below EALs, even with a source term at single values of 3 x IWAC for lead and mercury, 2 x IWAC for arsenic and IWAC for Hazardous organics.

Table 3-2
Hazardous Substances - Maximum Model Predicted Concentrations

Determinand (mg/l)	EAL / MRV	Resultant Concentration	
		Diffusion Model (Max)	RAM3 Model (95%ile)
Arsenic	0.005	$<1 \times 10^{-9}$	4.24×10^{-3}
Lead	0.0002	$<1 \times 10^{-9}$	1.33×10^{-4}
Mercury	0.00001	$<1 \times 10^{-9}$	7.36×10^{-6}
Acenaphthene	0.00001	$<1 \times 10^{-9}$	$<1 \times 10^{-9}$
Aromatic C10-C12	0.01	$<1 \times 10^{-9}$	$<1 \times 10^{-9}$
Benzene	0.001	$<1 \times 10^{-9}$	4.38×10^{-5}

Determinand (mg/l)	EAL / MRV	Resultant Concentration	
		Diffusion Model (Max)	RAM3 Model (95%ile)
Benzo(a)pyrene	0.00001	$<1 \times 10^{-9}$	$<1 \times 10^{-9}$

3.4.2 Non-Hazardous Pollutants

Non-Hazardous Pollutants have been assessed against their respective EALs in down-gradient groundwater following immediate localised dilution. The model results summarised in Table 3-3 below indicate that predicted resultant concentrations are below EALs, even with a source term at single values of 6000 mg/l for sulphate and 3 x IWAC for fluoride and nickel.

Table 3-3
Non-Hazardous Pollutants – Maximum Model Predicted Concentrations

Determinand (mg/l)	Max Groundwater Background Concentration	EAL	Maximum Resultant Concentration	
			Diffusion Model (Max)	RAM3 Model (95%ile)
Fluoride	Not analysed	0.75	$<1 \times 10^{-9}$	0.52
Nickel	0.091[a]	0.013	$<1 \times 10^{-9}$	3.52×10^{-4}
Sulphate	404[a]	223	$<1 \times 10^{-9}$	135.7

a- Excluding boreholes BH14 and BH15 as impacted by historic fill
b-

Table 3-2 and Table 3-3 demonstrate that the predicted resultant concentrations at the respective compliance points are lower than the appropriate EALs. It is therefore considered that the modelling has shown that the discharge of Hazardous Substances and Non-Hazardous Pollutants will be sufficiently limited so as to avoid pollution.

3.5 Assessment Conclusions

The modelling results demonstrate that the proposed importation of inert waste at Sandon North Quarry will remain compliant with the Environmental Permitting Regulations 2016 (as amended) , assuming that a 1m thick attenuation layer is installed with a maximum permeability of 1×10^{-7} m/s.

3.6 Review of Technical Precautions

Essential and technical precautions are those measures required to ensure that the Site complies with Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations 2016 (as amended). Essential and technical precautions typically include both restrictions on waste types and the engineering and other environmental management measures. Given the proposed classification as inert waste, the Site will not require leachate management. However, the following essential and technical precautions are proposed:

- a basal and sidewall attenuation layer at least 1 metre thick with a maximum permeability of 1×10^{-7} m/s;
- all waste deliveries will be pre-arranged and come from known sources;
- all wastes will be subjected to stringent waste acceptance criteria and waste acceptance procedures;
- environmental monitoring, as specified in Section 4.0, will be undertaken.

3.7 Hydrogeological Completion Criteria

Due to the nature of the waste it is concluded that the Site will be complete (that is, the Site no longer has the potential to cause damage to or deterioration of the environment and risk to human health) with respect to hydrogeology immediately after the completion of restoration works and/or definite closure of the Site.

4.0 REQUISITE SURVEILLANCE

The Environmental Permitting Regulations 2016 (as amended), require that "*requisite surveillance*" is undertaken where disposal of substances potentially giving rise to Hazardous Substances or Non-Hazardous Pollutants has been authorised by the EA. Therefore, environmental monitoring will be undertaken to provide assurance that the Site is not resulting in any detrimental effects on water quality.

4.1 Leachate Monitoring

WAC testing will be completed on selected wastes prior to deposition at the Site. There is no requirement for leachate monitoring.

4.2 Groundwater Monitoring

The monitoring of groundwater quality around the perimeter of the Site will be carried out using the existing network of monitoring boreholes. It is proposed that ongoing groundwater level and quality monitoring is undertaken from at least one up-gradient and two down-gradient boreholes within the River Terrace Deposits sand and gravel aquifer. Given the potential influence of historic fill on the perimeter up-gradient boreholes, it is also proposed to include two boreholes several hundred metres up-gradient of the Site to give a better indication of natural background groundwater quality.

Groundwater level monitoring indicates that groundwater flow is broadly towards the north across the Site. It is therefore proposed that the following Site boreholes are used for groundwater quality monitoring purposes going forward:

- Up-Gradient Perimeter: BH2020-05, BH14, BH15
- Up-gradient Offsite: BH6/97, BH12R
- Down-Gradient: BH16, BH1/97 and Dewatering Discharge (while operational)

The proposed monitoring schedule is outlined in Table 4-1 below, and monitoring locations on Drawing HRA1. The proposed schedule is based on current EA guidance and the results of this HRA.

Table 4-1
Proposed Groundwater Monitoring Schedule

Groundwater Monitoring Locations	Monitoring Frequency	Measurement and Analytical Suite
Up-gradient: BH2020-05, BH14, BH15, BH6/97, BH12R Down-gradient: BH16, BH1/97, Dewatering Discharge (while operational)	Quarterly	Groundwater level (mAOD), electrical conductivity, chloride, ammoniacal nitrogen, pH, fluoride, nickel, sulphate, lead, arsenic.
	Annual	Total alkalinity, magnesium, potassium, calcium, sodium, chromium, copper, iron, selenium, manganese, zinc, cyanide, mercury, BTEX (benzene, toluene, ethylbenzene & xylene), acenaphthene, benzo(a)pyrene, total PAHs, Aromatic C10-C12, well base (mAOD).
Note: all metals to be analysed as filtered/dissolved		

4.3 Surface Water Monitoring

The risk of any impact due to restoration of the Site on water quality in the Sandon Brook is considered to be relatively low due to the intervening low permeability alluvium on which the Rive Nene is likely to be perched. Furthermore, the location of the groundwater monitoring wells means that these provide early identification of any release which could impact the surface water down-gradient of the Site.

Discharge Consent PR2NF/E10173 authorises the discharge of groundwater from quarry dewatering, with the following restrictions on water quality:

- 'the discharge shall contain no more than 30 mg/l suspended solids';
- 'the discharge shall contain no visible oil or grease'.

The above water quality restrictions are considered to remain applicable, and no additional surface water compliance limits are considered necessary in the permit for inert restoration.

The proposed ongoing surface water monitoring schedule in the Sandon Brook upstream and downstream of the discharge location is presented in Table 4-2. This should be discontinued after cessation of the dewatering discharge.

Table 4-2
Proposed Surface Water Monitoring Schedule

Surface Water Monitoring Points	Monitoring Frequency	Parameters
SWA, SWB To be discontinued when dewatering discharge ceases.	Quarterly	Ammoniacal Nitrogen, chloride, suspended solids, visual oil and grease, pH, electrical conductivity, sulphate

4.4 Control Levels and Compliance Limits

4.4.1 Groundwater

The HRA has demonstrated that the Site will limit the release of both Hazardous Substances and Non-Hazardous Pollutants. However, it is appropriate to set appropriate control levels and compliance limits for suitable representative determinands. Based on the above assessment it is considered appropriate to use the following determinands for compliance monitoring:

- Arsenic: representative of Hazardous Substance in inert waste with relatively low background concentrations; and
- Sulphate: conservative determinand which can potentially provide an early indicator of leachate leakage.

Control levels and compliance limits have been set for each of the determinands above for the proposed compliance boreholes within the sand and gravel aquifer.

The control levels and compliance limits have been set as follows:

- Arsenic: the compliance limit has been set at the EAL, and no control level has been set as arsenic is a Hazardous Substance; and

- Sulphate: it is considered appropriate to set the compliance limit at the maximum upgradient concentration (excluding boreholes BH14 and BH15 impacted by historic fill) which exceeds the EAL. Borehole-specific control levels have been set at mean borehole specific baseline + 2 x standard deviations.

The proposed groundwater compliance limits and control levels are provided in Table 4-3 below.

Table 4-3
Proposed Groundwater Compliance Limits and Control Levels

BHID	Determinand	Proposed Compliance Limit (mg/l)	Proposed Control Level (mg/l)
BH1/97 & BH16	Arsenic	0.005	-
BH1/97	Sulphate	404	255
BH16			248

5.0 CONCLUSIONS

5.1 Compliance with Schedule 10 of the Environmental Permitting Regulations, 2016

The results of this risk assessment have established the following:

- the proposed operation will only accept inert waste streams, therefore there is no significant contaminant source and leachate management is not required;
- a sidewall and basal attenuation barrier with a minimum thickness of 1 metre and a maximum permeability of 1 x 10^{-7}m/s will be provided;
- the modelling undertaken has demonstrated that the proposed waste deposit will not result in the release of Hazardous Substances, and the release of Non-Hazardous Pollutants will be sufficiently limited as to avoid pollution of the River Terrace Deposits aquifer;
- essential and technical precautions have been outlined;
- requisite surveillance, which includes the monitoring of groundwater around the Site has been detailed to ensure the installation remains in compliance with the Environmental Permitting Regulations 2016 (as amended).
- control levels /compliance limits have been set in order to ensure the adequate protection of ground and surface water resources; and
- the Site should comply with the relevant requirements of the Schedule 10 of the Environmental Permit Regulations 2016 (as amended).

5.2 Compliance with Schedule 22 of the Environmental Permitting Regulations 2016

The results of this risk assessment have established the following:

- the proposed development poses a potential hazard to groundwater quality. Consequently, it falls within the scope of Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations 2016 (as amended);
- this assessment has outlined the CSM that must be developed for waste deposit operations;
- the proposed technical precautions will prevent the discernible discharge of Hazardous Substances to groundwater throughout the Site lifecycle;
- the proposed technical precautions will limit the introduction of Non-Hazardous Pollutants into groundwater so as to avoid pollution throughout the Site lifecycle; and
- the following essential and technical precautions have been identified as part of the HRA:
    - WAC limits for the site which below those assessed on a precautionary basis and bearing in mind the potential for rogue loads;
    - a risk-based programme of groundwater and the implementation of control levels and compliance limits have been outlined.

The Site therefore complies with the relevant requirements of the Schedule 22 (Groundwater Activities) of the Environmental Permitting Regulations 2016 (as amended).

APPENDICES

APPENDIX 01

Borehole Logs

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 1/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 1 of 4

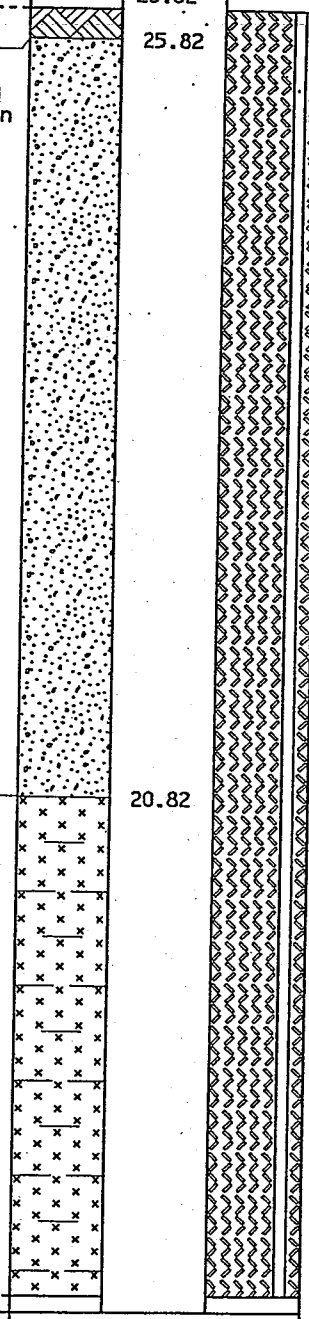
SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
0.20 - 0.80	B		
1.10 - 1.60	B		
1.30 - 1.75	CPT		50/115
2.80 - 3.25	CPT		50/150
3.10 - 3.60	B		
4.30 - 4.75	CPT		11
5.20	D		
5.40 - 5.85	U100		
5.85	D		
6.00 - 6.50	B		
7.20 - 7.65	U100		
7.65	D		

STRATA

Depth (Thickness)	Description	Level (m AOD)
0.00		26.02
0.20	Light brown slightly clayey silty sandy TOPSOIL with occasional fine chalk gravel	25.82
(5.00)	Very dense light brown fine, medium and coarse SAND and medium to coarse subrounded flint GRAVEL and occasional cobbles and thin soft clay bands	
	Medium dense at 4.30m	
5.20	Soft light brownish grey to grey slightly clayey SILT	20.82
(4.80)		

Legend / Installation



GROUNDWATER

Date	AM PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
03/11	PM	11.00	7.60	DRY			
04/11	AM	11.00	7.60	DRY			
04/11	PM	15.80		DAMP			
04/11	PM	22.50	22.50	18.10			
05/11	AM	22.50	22.50	14.90			
05/11	PM	30.50	30.50	14.90			
17/11	PM	30.50		15.04			

REMARKS / INSTALLATIONS

Gravel backfill from 30.50m to 30.00m. 90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 30.00m bgl to 18.00m bgl and continued plain to ground level. Gravel surround continued to 16.30m. Bentonite seal to ground level. Raised steel headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	30.50

Start date: 03/11/97
Finish date: 06/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 1/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 2 of 4

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
8.70 - 9.15	U100		
9.15	D		
10.00	D		
10.20-10.65	U100		
10.65	D		
11.50-12.00	B		
13.20-13.65	U100		
13.65	D		
14.00-14.50	B		
14.50-14.95	U100		
14.95	D		
15.80-16.50	B		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)	Installation
8.50			17.52	
	Soft light brownish grey to grey slightly clayey SILT			
10.00			16.02	
	Firm dark grey CLAY			
(1.00)				
11.00			15.02	
	Loose grey slightly clayey sandy SILT becoming more sandy with depth			
(4.80)				
15.80			10.22	
	Very dense orangish brown fine silty SAND and fine, medium and coarse subrounded flint GRAVEL with occasional flint cobbles			

GROUNDWATER

Date	AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
03/11	PM	11.00	7.60	DRY			
04/11	AM	11.00	7.60	DRY			
04/11	PM	15.80		DAMP			
04/11	PM	22.50	22.50	18.10			
05/11	AM	22.50	22.50	14.90			
05/11	PM	30.50	30.50	14.90			
17/11	PM	30.50		15.04			

REMARKS / INSTALLATIONS

Gravel backfill from 30.50m to 30.00m. 90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 30.00m bgl to 18.00m bgl and continued plain to ground level. Gravel surround continued to 16.30m. Bentonite seal to ground level. Raised steel headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	30.50

Start date: 03/11/97
Finish date: 06/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Project no.: BGL/SA/DGR/089/01
Location: SANDON, CHELMSFORD
Client: BRETT WASTE MANAGEMENT LIMITED
Contractor: FOUNDATION & EXPLORATION SERVICES
Borehole No.: 1/97
Coordinates:
Sheet 3 of 4

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
17.50	CPT		50/200
17.80-18.30	B		
19.80-20.30	B		
20.50-20.95	CPT		50/255
21.80-22.50	B		
23.80-24.25	CPT		26
23.80-24.30	B		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)	Installation
17.00	Very dense orangish brown fine silty SAND and fine, medium and coarse subrounded flint GRAVEL with occasional flint cobbles		9.02	
(14.70)				

GROUNDWATER

Date	AM/PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
03/11	PM	11.00	7.60	DRY			
04/11	AM	11.00	7.60	DRY			
04/11	PM	15.80		DAMP			
04/11	PM	22.50	22.50	18.10			
05/11	AM	22.50	22.50	14.90			
5/11	PM	30.50	30.50	14.90			
17/11	PM	30.50		15.04			

REMARKS / INSTALLATIONS

Gravel backfill from 30.50m to 30.00m. 90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 30.00m bgl to 18.00m bgl and continued plain to ground level. Gravel surround continued to 16.30m. Bentonite seal to ground level. Raised steel headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	30.50

Start date: 03/11/97
Finish date: 06/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 1/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 4 of 4

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
25.80-26.30	B		
27.80-28.30	B		
29.80-30.50	B		

STRATA

Depth (Thick-ness)	Description	Legend	Level (m AOD)	Installation
25.50	Very dense orangish brown fine silty SAND and fine, medium and coarse subrounded flint GRAVEL with occasional flint cobbles		0.52	
30.50	(Glacial deposits)		-4.48	
	Base of Borehole			

GROUNDWATER

Date	AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
03/11	PM	11.00	7.60	DRY			
04/11	AM	11.00	7.60	DRY			
04/11	PM	15.80		DAMP			
04/11	PM	22.50	22.50	18.10			
05/11	AM	22.50	22.50	14.90			
05/11	PM	30.50	30.50	14.90			
17/11	PM	30.50		15.04			

REMARKS / INSTALLATIONS

Gravel backfill from 30.50m to 30.00m. 90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 30.00m bgl to 18.00m bgl and continued plain to ground level. Gravel surround continued to 16.30m. Bentonite seal to ground level. Raised steel headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	30.50

Start date: 03/11/97
Finish date: 06/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates

BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Project no.: BGL/SA/DGR/089/01
Location: SANDON, CHELMSFORD

Client: BRETT WASTE MANAGEMENT LIMITED
Contractor: FOUNDATION & EXPLORATION SERVICES

Borehole No.: 3/97
Coordinates:
Sheet 1 of 3

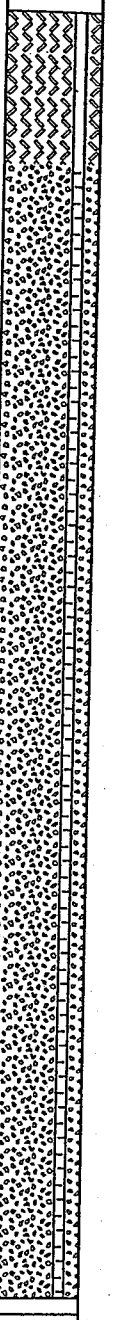
SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
0.00 - 0.60	B		
0.60 - 1.20	B		
1.20 - 1.65	U100		
1.65	D		
1.70 - 2.15	SPT		12
2.60 - 3.10	B		
4.60 - 5.10	B		
6.20 - 6.65	CPT		13
5.40 - 6.00	B		
6.60	D		
6.60 - 7.10	B		
8.00 - 8.45	SPT		30

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)
0.00			31.94
(0.60)	Light brown TOPSOIL with some medium flint gravel		
0.60			31.34
(4.80)	MADE GROUND: Soft to firm brown silty very sandy clay with some medium flint gravel Thin band of silty medium grained sand		
5.40			26.54
(1.20)	Loose to medium dense orange fine to medium SAND and medium to coarse GRAVEL with occasional flint cobbles		
6.60			25.34
(1.40)	Soft brownish orange silty very sandy CLAY		
8.00			23.94
	Medium dense orangish brown clayey SAND		

Installation



GROUNDWATER

Date	AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
07/11	PM	15.00	15.00	10.80			
10/11	AM	15.00	15.00	12.00			
10/11	PM	23.00	22.30	DRY			
14/11	AM	23.00		DRY			
17/11	PM	23.00		DRY			
18/11	AM	23.00		DRY			

REMARKS / INSTALLATIONS

Gravel backfill from 23.00m bgl to 21.00m bgl. 90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 23.00m bgl to 1.00m bgl and continued plain to ground level. Bentonite seal from 1.00m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	23.00

Start date: 07/11/97
Finish date: 10/11/97

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 3/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 2 of 3

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
8.60 - 9.10	B		
9.50 -10.00	B		
9.60 -10.05	SPT		6
11.10-11.45	CPT		24
11.50-12.00	B		
13.50-14.00	B		
14.10	CPT		50/285
15.50-16.00	B		
16.70	D		
16.70-17.20	B		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)	Installation
8.50			23.44	
(1.50)	Medium dense orangish brown clayey SAND			
9.50			22.44	
	Loose orangish brown clayey SAND with occasional medium flint gravel			
	Medium dense below 11.10m			
(7.20)				
	Very dense below 14.10m			
16.70			15.24	
	Firm slightly silty brown CLAY with some fine to medium subrounded gravel			

GROUNDWATER

Date	AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
07/11	PM	15.00	15.00	10.80			
10/11	AM	15.00	15.00	12.00			
10/11	PM	23.00	22.30	DRY			
14/11	AM	23.00		DRY			
17/11	PM	23.00		DRY			
18/11	AM	23.00		DRY			

REMARKS / INSTALLATIONS

Gravel backfill from 23.00m bgl to 21.00m bgl. 90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 23.00m bgl to 1.00m bgl and continued plain to ground level. Bentonite seal from 1.00m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	23.00

Start date: 07/11/97
Finish date: 10/11/97

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 3/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 3 of 3

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
17.70-18.15	CPT		27
18.70-19.20	B		
20.70-21.15	CPT		34
20.70-21.20	B		
21.90	D		
22.30-22.70	U100		
22.75	D		
22.90-23.00	B		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)
17.00			14.94
(1.00)	Firm slightly silty brown CLAY with some fine to medium subrounded gravel		
17.70			14.24
	Medium dense fine to coarse SAND and medium to coarse subrounded GRAVEL		
(4.20)			
21.90	(Glacial deposits)		10.04
	Firm to stiff brownish grey CLAY becoming stiffer grey clay with depth		
(1.10)			
23.00	(London Clay)		8.94
	Base of Borehole		

Installation: 14.94 / 14.24 / 10.04 / 8.94

GROUNDWATER

Date AM PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
07/11 PM	15.00	15.00	10.80			
10/11 AM	15.00	15.00	12.00			
10/11 PM	23.00	22.30	DRY			
14/11 AM	23.00		DRY			
17/11 PM	23.00		DRY			
18/11 AM	23.00		DRY			

REMARKS / INSTALLATIONS

Gravel backfill from 23.00m bgl to 21.00m bgl. 90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 23.00m bgl to 1.00m bgl and continued plain to ground level. Bentonite seal from 1.00m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	23.00

Start date: 07/11/97
Finish date: 10/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

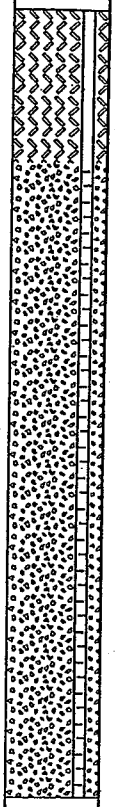
Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 6/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 1 of 1

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
0.00 - 0.35	B		
0.35 - 1.20	B		
1.20	CPT		50/205
2.40 - 3.00	B		
2.70	CPT		50/200
4.20	D		
4.60 - 5.05	U100		
5.05	D		
4.20 - 5.00	B		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)
0.00			26.21
0.10 (0.25)	Light brown sandy TOPSOIL		26.11
0.35	Brown sandy SUBSOIL with much medium to coarse flint gravel		25.86
	Very dense medium to coarse SAND and medium flint GRAVEL		
(3.85)			
4.20	(Glacial deposits)		22.01
	Firm to stiff grey CLAY		
(1.00)			
5.20	(London Clay) Base of Borehole		21.01

Installation: 

GROUNDWATER

Date AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
11/11 PM	5.20	4.60	DRY			
14/11 AM	5.20		3.38			
17/11 PM	5.20		4.54			
18/11 AM	5.20		4.77			

REMARKS / INSTALLATIONS

90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 5.20m bgl to 1.00m bgl and continued plain to ground level. Bentonite seal from 1.00m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	5.20

Start date: 11/11/97
Finish date: 11/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Project no.: BGL/SA/DGR/089/01
Location: SANDON, CHELMSFORD
Client: BRETT WASTE MANAGEMENT LIMITED
Contractor: FOUNDATION & EXPLORATION SERVICES
Borehole No.: 7/97
Coordinates:
Sheet 1 of 2

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
1.20 - 1.65	SPT		15
2.60	D		
2.70 - 3.20	B		
2.70 - 3.15	SPT		27
4.20 - 4.65	SPT		14
4.70 - 5.20	B		
5.70 - 6.15	SPT		15
6.70 - 7.20	B		
7.20 - 7.55	SPT		50/215
8.00 - 8.50	B		

STRATA

Depth (Thickness)	Description	Level (m AOD)
0.00		36.27
0.20	Grey clayey TOPSOIL with a little fine to coarse gravel (drillers description)	36.07
(2.40)	Firm brown CLAY with some orangish brown and grey mottling	
2.60	Medium dense brown to orangish brown slightly clayey fine to coarse SAND	33.67
(5.30)		
7.90	Very dense below 7.20m	28.37
	Medium dense to dense orangish brown medium to coarse SAND and medium to coarse GRAVEL with many cobbles	

Legend

Installation: 90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 16.00m bgl to 1.00m bgl and continued plain to ground level. Gravel surround continued to 0.90m bgl. Bentonite seal from 0.90m bgl to ground level. Raised headworks concreted in at ground level

GROUNDWATER

Date	AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
11/11	PM	1.20		DRY			
12/11	AM	1.20		DRY			
12/11	PM	15.40	15.00	11.90			
14/11	AM	16.00		14.53			
17/11	PM	16.00		13.99			
18/11	AM	16.00		13.58			

REMARKS / INSTALLATIONS

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	16.00

Start date: 11/11/97
Finish date: 13/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 7/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 2 of 2

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
9.00 - 9.45	CPT		34
10.00-10.50	B		
10.50-10.95	CPT		36
11.00-11.50	B		
13.00-13.50	B		
13.00-13.45	CPT		37
13.80	D		
14.00-14.50	B		
14.90	D		
15.40-15.85	U100		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)	Installation
8.50			27.77	
	Medium dense to dense orangish brown medium to coarse SAND and medium to coarse GRAVEL with many cobbles			
(5.90)				
13.80			22.47	
	Dense grey clayey fine to coarse SAND and GRAVEL with some cobbles and a little brown very sandy clay			
(1.10)				
14.90	(Glacial deposits)		21.37	
	Stiff grey CLAY			
(1.10)				
16.00	(London Clay)		20.27	
	Base of Borehole			

GROUNDWATER

Date AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
11/11 PM	1.20		DRY			
12/11 AM	1.20		DRY			
12/11 PM	15.40	15.00	11.90			
14/11 AM	16.00		14.53			
17/11 PM	16.00		13.99			
18/11 AM	16.00		13.58			

REMARKS / INSTALLATIONS

90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 16.00m bgl to 1.00m bgl and continued plain to ground level. Gravel surround continued to 0.90m bgl. Bentonite seal from 0.90m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	16.00

Start date: 11/11/97
Finish date: 13/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Project no.: BGL/SA/DGR/089/01
Location: SANDON, CHELMSFORD
Client: BRETT WASTE MANAGEMENT LIMITED
Contractor: FOUNDATION & EXPLORATION SERVICES
Borehole No.: 8/97
Coordinates:
Sheet 1 of 3

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
0.00 - 1.20	B		
1.30	CPT		39
2.00 - 2.50	B		
2.90 - 3.30	CPT		18
3.30	D		
3.30 - 3.80	B		
3.70 - 4.15	U100		
4.15	D	▽	
4.40 - 5.00	B		
4.80 - 5.25	CPT		26
6.10	D		
6.10 - 6.60	B		
6.60 - 7.05	U100		
7.05	D		
7.00 - 7.60	B		
7.60 - 7.95	U100		
7.95	D		
8.00 - 8.60	B		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)	Installation
0.00			-3.87	
	Dense medium to coarse SAND and fine to coarse flint GRAVEL			
(3.30)				
3.30			-7.17	
	Very stiff grey CLAY with medium chalk gravel			
(0.60)				
3.90			-7.77	
	Medium dense silty SAND and medium flint GRAVEL			
(0.50)				
4.40			-8.27	
	Medium dense medium to coarse SAND and fine to coarse subrounded GRAVEL			
(1.70)				
6.10			-9.97	
	(Glacial deposits)			
	Very stiff dark grey CLAY			

GROUNDWATER

Date	AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
12/11	AM	4.40	3.70		4.40	0.75	
12/11	PM	20.20	6.60	DRY			
14/11	AM	20.20		DRY			
17/11	PM	20.20		20.04			
18/11	AM	20.20		20.00			

REMARKS / INSTALLATIONS

19mm diameter PVC pipe with piezometer tip installed from 20.20m bgl to ground level. Piezometer sand surround from 20.20m bgl to 18.20m bgl. Gravel surround from 18.20m bgl to 9.10m bgl. Bentonite seal from 9.10m bgl to 6.10m bgl. Backfill from 6.10m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	20.20

Start date: 12/11/97
Finish date: 12/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

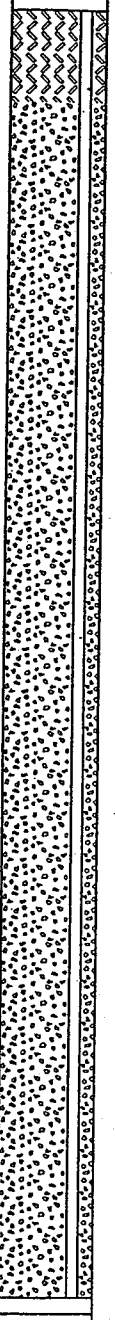
Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 8/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 2 of 3

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
8.60 - 9.05	U100		
9.05	D		
9.00 - 9.50	B		
9.60 -10.05	U100		
10.05	D		
11.00-11.50	B		
11.60-12.05	U100		
12.05	D		
13.00-13.50	B		
13.60-14.05	U100		
14.05	D		
15.00-15.50	B		
15.60-16.05	U100		
16.05	D		
17.00-17.50	B		

STRATA

Depth (Thick-ness)	Description	Legend	Level (m AOD)	Installation
8.50	Very stiff dark grey CLAY		-12.37	
(14.10)				



GROUNDWATER

Date AM/PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
12/11 AM	4.40	3.70		4.40	0.75	
12/11 PM	20.20	6.60	DRY			
14/11 AM	20.20		DRY			
17/11 PM	20.20		20.04			
18/11 AM	20.20		20.00			

REMARKS / INSTALLATIONS

19mm diameter PVC pipe with piezometer tip installed from 20.20m bgl to ground level. Piezometer sand surround from 20.20m bgl to 18.20m bgl. Gravel surround from 18.20m bgl to 9.10m bgl. Bentonite seal from 9.10m bgl to 6.10m bgl. Backfill from 6.10m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	20.20

Start date: 12/11/97
Finish date: 12/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 8/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 3 of 3

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
17.60-18.05	U100		
18.05	D		
19.00-19.50	B		
19.60-20.05	U100		
20.05	D		

STRATA

Depth (Thick-ness)	Description	Legend	Level (m AOD)	Installation
17.00	Very stiff dark grey CLAY		-20.87	
20.20	(London Clay) Base of Borehole		-24.07	

GROUNDWATER

Date	AM/PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
12/11	AM	4.40	3.70		4.40	0.75	
12/11	PM	20.20	6.60	DRY			
14/11	AM	20.20		DRY			
17/11	PM	20.20		20.04			
18/11	AM	20.20		20.00			

REMARKS / INSTALLATIONS

19mm diameter PVC pipe with piezometer tip installed from 20.20m bgl to ground level. Piezometer sand surround from 20.20m bgl to 18.20m bgl. Gravel surround from 18.20m bgl to 9.10m bgl. Bentonite seal from 9.10m bgl to 6.10m bgl. Backfill from 6.10m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	20.20

Start date: 12/11/97
Finish date: 12/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Project no.: BGL/SA/DGR/089/01
Location: SANDON, CHELMSFORD
Client: BRETT WASTE MANAGEMENT LIMITED
Contractor: FOUNDATION & EXPLORATION SERVICES
Borehole No.: 9/97
Coordinates:
Sheet 1 of 4

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
0.00 - 1.20	B		
1.30 - 1.80	B		
1.50 - 1.95	CPT		19
3.00 - 3.45	CPT		14
3.30 - 3.80	B		
3.80	D		
3.90 - 4.40	B		
4.50 - 4.95	CPT		19
5.90 - 6.40	B		
6.00 - 6.45	CPT		11
7.60 - 8.00	CPT		11
7.90 - 8.40	B		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)
0.00			8.61
	Medium dense orangish brown clayey SAND and medium flint GRAVEL		
(3.80)			
3.80			4.81
3.90	Firm grey silty CLAY		4.71
	Medium dense grey medium to coarse SAND and medium flint GRAVEL		

Installation: 19mm diameter PVC pipe with piezometer tip installed from 32.50m bgl to ground level. Piezometer sand surround from 32.50m bgl to 30.50m bgl. Gravel surround from 30.50m bgl to 19.70m bgl. Bentonite seal from 19.70m bgl to 16.70m bgl. Backfill from 16.70m bgl to ground level. Raised headworks concreted in at ground level

GROUNDWATER

Date	AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
13/11	PM	17.50	17.00	DRY			
14/11	AM	17.50	17.00	6.60			
14/11	PM	24.50	18.00	SEEP			

REMARKS / INSTALLATIONS

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	32.50

Start date: 13/11/97
Finish date: 14/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 9/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 2 of 4

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
9.30 - 9.75	CPT		11
9.90 -10.40	B		
11.00-11.40	CPT		11
11.90-12.40	B		
13.90-14.40	B		
14.20-14.65	CPT		39
15.90-16.40	B		
16.70	D		
16.70	D		
16.70-17.20	B		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)	Installation
8.50	Medium dense grey medium to coarse SAND and medium flint GRAVEL		0.11	
(12.80)				
16.70	(Glacial deposits) Stiff grey CLAY with medium flint gravel in		-8.09	

GROUNDWATER

Date	AM/PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
13/11	PM	17.50	17.00	DRY			
14/11	AM	17.50	17.00	6.60			
14/11	PM	24.50	18.00	SEEP			

REMARKS / INSTALLATIONS

19mm diameter PVC pipe with piezometer tip installed from 32.50m bgl to ground level. Piezometer sand surround from 32.50m bgl to 30.50m bgl. Gravel surround from 30.50m bgl to 19.70m bgl. Bentonite seal from 19.70m bgl to 16.70m bgl. Backfill from 16.70m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	32.50

Start date: 13/11/97
Finish date: 14/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres.

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 9/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 3 of 4

SAMPLING / STRATA

Depth	Sample type	Depth to water	S.P.T 'N'	Depth (Thick-ness)	Description	Legend	Level (m AOD)	Installation
				17.00			-8.39	
17.00-17.45	U100				Stiff grey CLAY with medium flint gravel in upper horizons			
17.00	D							
17.50	B							
18.00-18.50	U100							
18.00-18.50	B							
18.50-18.95	U100							
18.95	D							
19.00-19.50	B							
19.50-19.95	U100							
19.95	D							
20.00-20.50	B							
20.50-20.95	U100							
20.95	D							
21.00-21.50	B							
21.50-21.95	U100							
21.95	D							
22.00-22.50	B							
22.50-22.95	U100							
22.95	D							
23.00-23.50	B							
23.50-23.95	U100							
23.95	D							
24.00-24.50	B							
24.50-24.95	U100			(15.80)				
24.95	D							
25.00-25.50	B							
25.50-25.95	U100							

GROUNDWATER

Date AM/PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
13/11 PM	17.50	17.00	DRY			
14/11 AM	17.50	17.00	6.60			
14/11 PM	24.50	18.00	SEEP			

REMARKS / INSTALLATIONS

19mm diameter PVC pipe with piezometer tip installed from 32.50m bgl to ground level. Piezometer sand surround from 32.50m bgl to 30.50m bgl. Gravel surround from 30.50m bgl to 19.70m bgl. Bentonite seal from 19.70m bgl to 16.70m bgl. Backfill from 16.70m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	32.50

Start date: 13/11/97
Finish date: 14/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Project no.: BGL/SA/DGR/089/01
Location: SANDON, CHELMSFORD
Client: BRETT WASTE MANAGEMENT LIMITED
Contractor: FOUNDATION & EXPLORATION SERVICES
Borehole No.: 9/97
Coordinates:
Sheet 4 of 4

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
25.95	D		
26.00-26.50	B		
26.50-26.95	U100		
26.95	D		
27.50-28.00	B		
28.50-28.95	U100		
28.95	D		
29.50-30.00	B		
30.50-30.95	U100		
30.95	D		
31.50-32.00	B		
32.00-32.45	U100		
32.45	D		

STRATA

Depth (Thick-ness)	Description	Legend	Level (m AOD)	Installation
25.50	Stiff grey CLAY with medium flint gravel in upper horizons		-16.89	
32.50	(London Clay) Base of Borehole		-23.89	

GROUNDWATER

Date	AM/PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
13/11	PM	17.50	17.00	DRY			
14/11	AM	17.50	17.00	6.60			
14/11	PM	24.50	18.00	SEEP			

REMARKS / INSTALLATIONS

19mm diameter PVC pipe with piezometer tip installed from 32.50m bgl to ground level. Piezometer sand surround from 32.50m bgl to 30.50m bgl. Gravel surround from 30.50m bgl to 19.70m bgl. Bentonite seal from 19.70m bgl to 16.70m bgl. Backfill from 16.70m bgl to ground level. Raised headworks concreted in at ground level

Logged by: D GRIFFITHS-RICHARDS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	32.50

Start date: 13/11/97
Finish date: 14/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

M. J. Carter Associates — BOREHOLE DRILLING RECORD

Project: SANDON QUARRY
Client: BRETT WASTE MANAGEMENT LIMITED
Borehole No.: 10/97
Project no.: BGL/SA/DGR/089/01
Coordinates:
Location: SANDON, CHELMSFORD
Contractor: FOUNDATION & EXPLORATION SERVICES
Sheet 1 of 1

SAMPLING

Depth	Sample type	Depth to water	S.P.T 'N'
0.00 - 0.40	B		
0.40 - 1.20	B		
1.20 - 1.65	U100		
1.65	D		
1.90 - 2.35	CPT		5
1.60 - 2.10	B		
3.40 - 3.85	CPT		4
3.60 - 4.10	B		
4.40	D		
4.40 - 4.90	B		
5.00 - 5.45	U100		
5.45	D		

STRATA

Depth (Thickness)	Description	Legend	Level (m AOD)	Installation
0.00			23.52	
	Dark brown clayey TOPSOIL with some gravel			
(0.40)				
0.40			23.12	
	Firm brownish grey CLAY with occasional gravel			
(0.80)				
1.20			22.32	
	Loose dark grey clayey SAND and GRAVEL			
(3.20)				
4.40	(Glacial deposits)		19.12	
	Firm grey CLAY			
(1.10)				
5.50	(London Clay)		18.02	
	Base of Borehole			

GROUNDWATER

Date	AM / PM	Depth of hole	Depth of casing	Depth to water	Depth struck	Depth after 20 mins	Depth sealed
17/11	AM	5.50	4.60	DRY			
18/11	AM	5.50		2.02			

REMARKS / INSTALLATIONS

90mm diameter HDPE pipe installed slotted and wrapped with gravel surround from 5.50m bgl to 1.00m bgl and continued plain to ground level. Bentonite seal from 1.00m bgl to ground level. Raised headworks concreted in at ground level

Logged by: C BETTS

DRILLING

Plant: DANDO 150
Crew: D ALLAN

Type and Dia.	Depth
LIGHT CABLE PERCUSSIVE TOOL 150mm	5.50

Start date: 17/11/97
Finish date: 17/11/97

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres

Site:- SANDON QUARRY

Job Number:- H0663

Machine Type:- DANDO 150

Date:- 11.7.97.

Number 1

Sheet 1 of 2

C.J. associates

Sampling Details	Depth m	Penetration Tests [mm] 75 75 75 75 75 75	Boring Details	Depth m	Thickness m	Legend	Description of Strata	Datum m O.D
D1	0.50							
D2	1.00							
S(c) B1	1.50	1 1 2 3 3 3	N = 11		(3.500)		Firm to stiff brown and grey silty, sandy CLAY/clayey SAND, with gravel and organic traces, becoming predominantly grey below 2.50m. (Driller noted Made Ground – small fragments of concrete)	
D3	2.50							
S(c) B2	3.00	1 – 1 2 2 1	N = 6					
D4	3.50			3.50				
D5	4.00				(1.300)		Fine medium and coarse flinty GRAVEL, in a brown coarse sandy matrix. Occasional rounded gravels.	
D6	4.80			4.80				
U1	5.50		44b					
D7	6.00							
D8	6.50							
U2	7.00		44b					
D9	7.50				(5.200)		Firm to stiff grey silty CLAY, with occasional fine to medium chalk gravel.	
D10	8.00							
U3	8.50		24b					
D11	9.00							
D12	9.50							
U4	10.00		27b	10.00				

Client ASPINWALL & CO

Remarks

150mm dia casing installed to 6.00m depth.
Water added to assist drilling from 3.50 to 4.80m depth.
Standpipe installed at 4.60m depth

Chiselling

From	To	Time
[m]	[m]	[hours]

Water Level Observations During Boring

Date	Time	Depth in metres Hole	Casing	Water	Remarks
					DRY

Site:– SANDON QUARRY

Job Number:– H0663

Machine Type:– DANDO 150

Date:– 11.7.97.

Number 1

Sheet 2 of 2

C.J. associates

Sampling Details	Depth m	Penetration Tests [mm] 75	75	75	75	75	75	Boring Details	Depth m	Thickness m	Legend	Description of Strata	Datum m O.D
									10.00				
D13	10.50												
D14	11.20												
U5	12.10							26b					
D15	12.60												
D16	13.30									(7.000)		Firm to stiff friable, grey silty CLAY.	
S(c) D17	14.10	2	2	5	5	6	7	N = 23					
D18	15.50											Becoming very stiff.	
D19	16.00												
U6	16.50							44b					
D20	17.00								17.00			END OF BOREHOLE	

Client ASPINWALL & CO

Remarks

Chiselling

From [m]	To [m]	Time [hours]

Water Level Observations During Boring

Date	Time	Depth in metres Hole	Casing	Water	Remarks

Site	SANDON QUARRY
Job No	H0663
Date	16.7.977
Borehole	1
Client	ASPINWALL & CO

KING ROAD AVENUE
AVONMOUTH
BRISTOL BS11 9HG

TEL: (0117) 982 1473
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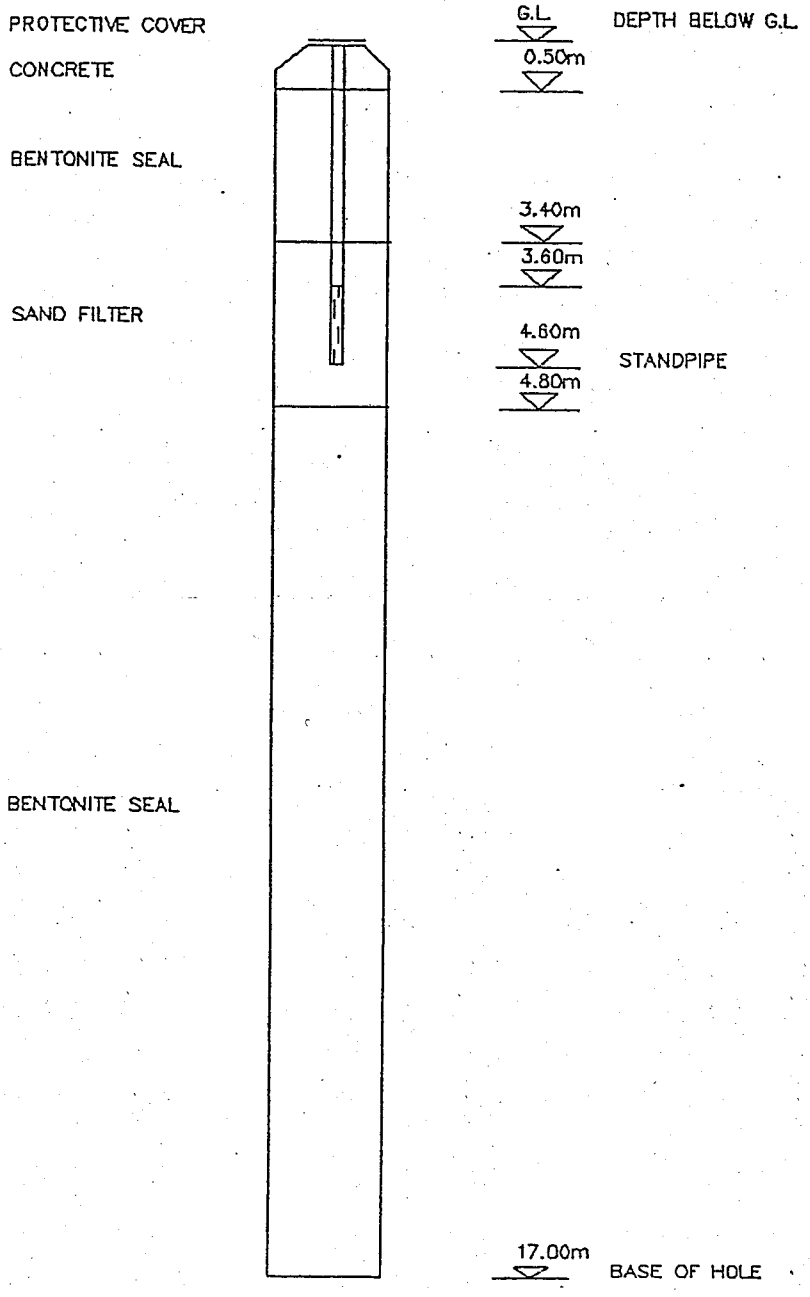
C.J. associates



Shell and Auger Borehole Log Sheet

Site:- SANDON QUARRY

Job Number:- H0663

Machine Type:- PILCON 150

Date:- 7.7.97.

Number 3

Sheet 1 of 2

C.J. associates

Sampling Details	Depth m	Penetration Tests [mm] 75 75 75 75 75 75	Boring Details	Depth m	Thickness m	Legend	Description of Strata	Datum m O.D
				0.20	(0.200)		Turf over TOPSOIL	
D1	0.70				(0.800)		Firm grey and brown silty CLAY, with fine to medium chalky gravel, roots and organic traces.	
D2	1.20			1.00				
S(c)	1.50	2 2 1 2 2 3	N = 8					
D3	2.50				(2.700)		Stiff friable dark brown and grey, silty sandy CLAY, with frequent fine to medium flinty gravel and occasional small cobbles.	
S(c)	3.00	1 – 1 1 1 2	N = 5					
D4	3.50			3.70				
D5	4.00							
S(c)	4.50	1 – 1 2 1 2	N = 6					
D6	5.50							
U7	6.00		20b 90%r		(5.100)		Firm light brown silty sandy CLAY, with occasional fine gravel and organic traces.	
D8	7.00							
S(c)	7.50	1 – 2 2 2 2	N = 8					
D9 S(c)	8.80	2 3 4 4 5 6	N = 19	8.80				
B10 B10a	9.50				(1.700)		Medium dense yellowish-brown fine to medium SAND, with occasional fine gravel. (Continued.....)	

Client ASPINWALL & CO

Remarks

150mm dia casing installed to 14.00m depth.
Standpipe installed at 12.00m depth.

Chiselling

From (m)	To (m)	Time (hours)

Water Level Observations During Boring

Date	Time	Depth in metres Hole	Casing	Water	Remarks
		12.00	12.00	–	SEEPAGE

Shell and Auger Borehole Log Sheet

Site:– SANDON QUARRY

Job Number:– H0663

Machine Type:– PILCON 150

Date:– 7.7.97.

Number 3

Sheet 2 of 2

C.J. associates

Sampling Details	Depth m	Penetration Tests [mm] 75 75 75 75 75 75	Boring Details	Depth m	Thickness m	Legend	Description of Strata	Datum m O.D
							(....cont.)	
S(c)	10.50	1 2 1 2 1 2	N = 6	10.50				
D11	11.50				(1.700)		Soft to firm grey and brown, silty, sandy CLAY, becoming predominantly grey with increasing depth.	
U12	12.00		49b 20%r					
				12.20				
D13	13.00							
S14	13.50	2 3 5 6 7 8	N = 26					
B15	14.30						Firm to stiff grey silty CLAY.	
					(5.250)			
U16	15.30		82b 60%r					
D17	15.75						Becoming very stiff.	
D18	16.50							
S19	17.00	8 10 11 13 15 17	N > 50					
				17.45			END OF BOREHOLE	

Client ASPINWALL & CO

Remarks

Chiselling

From [m]	To [m]	Time [hours]

Water Level Observations During Boring

Date	Time	Depth in metres Hole	Casing	Water	Remarks

Site	SANDON QUARRY
Job No	H0663
Date	8.7.97.
Borehole	3
Client	ASPINWALL & CO

KING ROAD AVENUE
AVONMOUTH
BRISTOL BS11 9HG

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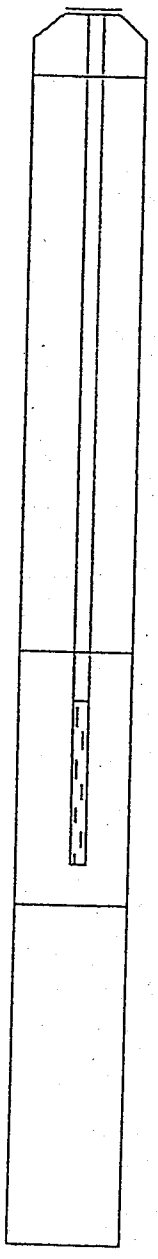
C.J. associates



Site:– SANDON QUARRY

Job Number:– H0663

Machine Type:– PILCON 150

Date:– 9.7.97.

Number 6

Sheet 1 of 1

C.J. associates

Sampling Details	Depth m	Penetration Tests [mm] 75 75 75 75 75 75	Boring Details	Depth m	Thickness m	Legend	Description of Strata	Datum m O.D
D1	0.80				(1.700)		Firm brown silty sandy CLAY, with frequent fine gravels.	
S(c)	1.50	2 3 2 2 3 3	N = 10					
B2	1.70			1.70				
U3	2.00		27b 95%r					
D4	3.20				(2.400)		Firm grey silty CLAY, with frequent fine medium and coarse flinty gravels below 3.00m.	
S(c)	3.50	2 5 6 8 10 14	N = 38					
B5	4.10			4.10				
D6	4.70			4.50	(0.400)		Dense fine to medium flint GRAVEL with occasional cobbles, in a brown coarse sand matrix.	
U7	5.00		27b 65%r					
D8	5.50				(2.050)		Firm to stiff grey silty CLAY.	
D9	5.80							
U10	6.10		58b 100%					
				6.55			END OF BOREHOLE	

Client ASPINWALL & CO

Remarks

150mm dia casing installed to 5.00m depth.
Standpipe installed at 4.50m depth.

Chiselling

From [m]	To [m]	Time [hours]
4.10	4.40	0.75

Water Level Observations During Boring

Date	Time	Depth in metres Hole	Casing	Water	Remarks
		4.50	4.50	–	SLIGHT SEEPAGE

STANDPIPE INSTALLATION

Site	SANDON QUARRY
Job No	H0663
Date	9.7.97.
Borehole	6
Client	ASPINWALL & CO

KING ROAD AVENUE
AVONMOUTH
BRISTOL BS11 9HG

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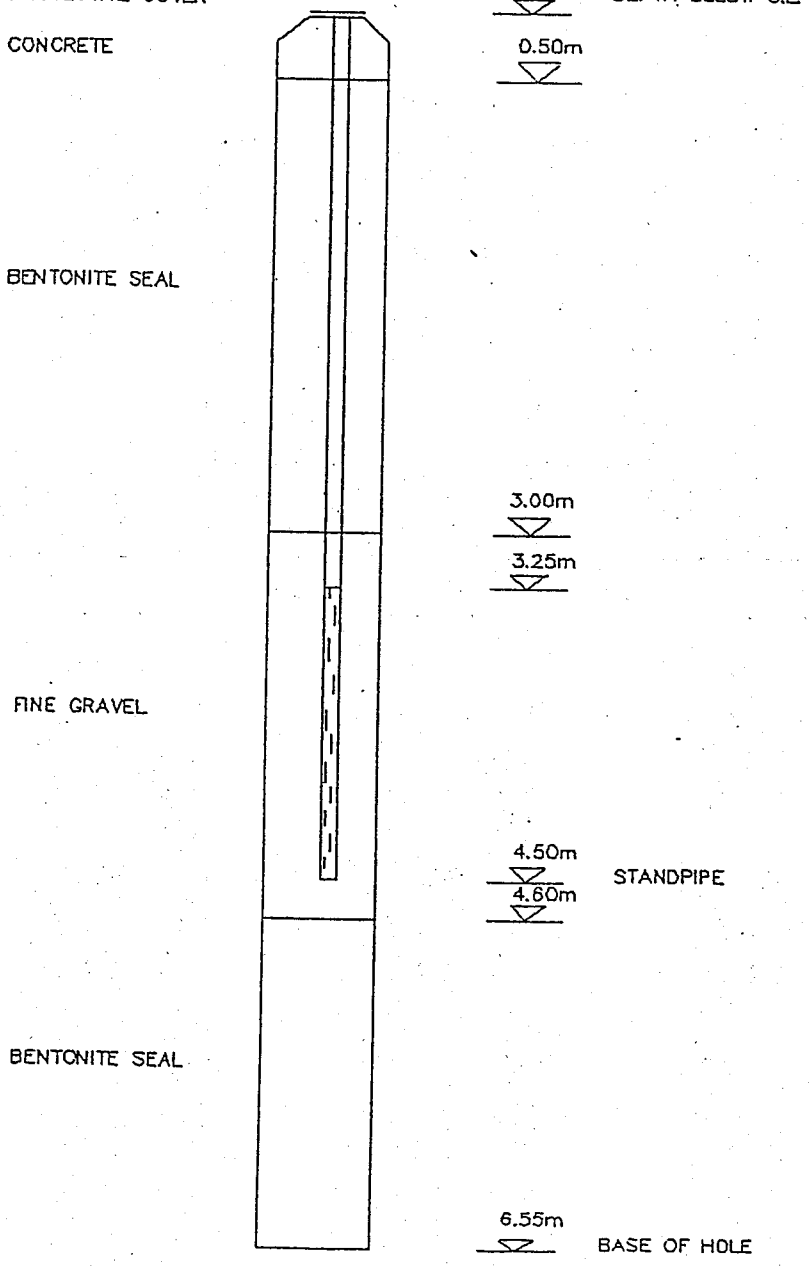
C.J. associates



Site:- SANDON QUARRY

Job Number:- H0663

Machine Type:- PILCON 150

Date:- 8.7.97.

Number 7

Sheet 1 of 1

C.J. associates

Sampling Details	Depth m	Penetration Tests [mm] 75 75 75 75 75 75	Boring Details	Depth m	Thickness m	Legend	Description of Strata	Datum m O.D
				0.20	(0.200)		TOPSOIL	
D1	0.50				(1.000)		Firm brown and grey silty sandy CLAY, with frequent rootlets and chalk gravel.	
D2	1.30			1.20				
S(c)	1.40	10 14 17 20 – –	N > 50	1.40	(0.200)		Firm light brown silty sandy CLAY, with frequent fine medium and coarse flinty gravel.	
B3 B4	1.70				(1.800)		Dense fine medium and coarse flinty GRAVEL, in a brown coarse sand matrix.	
S(c)	3.00	3 4 3 2 1 1	N = 7	3.20				
B5	3.50							
U6	4.00		20b 90%r				Firm grey silty CLAY.	
D7	4.45				(2.300)			
D8	4.80							
U9	5.00		49b 60%r				Becoming very stiff.	
D10	5.45			5.50			END OF BOREHOLE	

Client ASPINWALL & CO

Remarks

150mm dia casing installed to 4.50m depth.
Water added to assist drilling throughout.
Standpipe installed at 3.10m depth.

Chiselling From [m]	To [m]	Time [hours]

Water Level Observations During Boring

Date	Time	Depth in metres Hole	Casing	Water	Remarks
					DRY

STANDPIPE INSTALLATION

Site	SANDON QUARRY
Job No	H0663
Date	8.7.97.
Borehole	7
Client	ASPINWALL & CO

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AVONMOUTH
BRISTOL BS11 9HG

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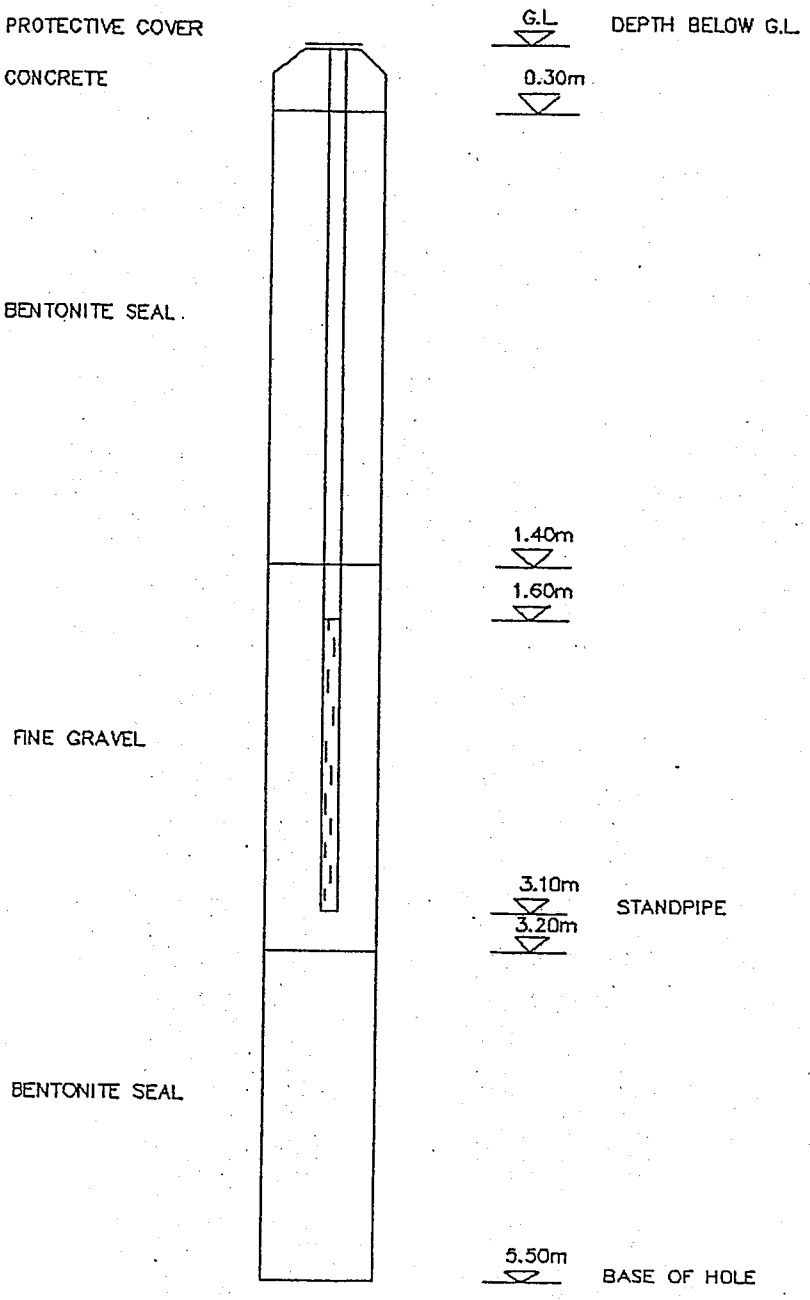
FAX:(0117) 982 8200

C.J. associates



BOREHOLE LOG

BOREHOLE No. **BH14**

Client: **BRETT**

Project No:	Date:	Ground Level:	Co-ordinates:
Sandon Quarry	12/06/13		

Project: **SANDON QUARRY**

Sheet: 1 of 2

SAMPLES & TESTS						Water	STRATA				Instrument/ Backfill
Depth	Type No	HS(ppm)	HV(kPa)	PP(kPa)	SPT-N		Reduced Level	Legend (Thick-ness)	Depth	DESCRIPTION	
									(1.00) 1.00	MADE GROUND: Brown gravelly sandy CLAY. Gravel is fine to coarse sub angular to rounded quartzite rare fine chalk and brick gravel. Concrete cobble. Sand is medium to coarse. Clay is soft to firm reworked mixed material.	
									(1.70) 2.70	MADE GROUND: Pale brown sandy CLAY. Clay is soft, sand is medium. Rare flint gravel.	
									(3.80) 6.50	MADE GROUND: Soft brown/grey mottled CLAY. Rare fine quartzite and chalk? gravel. Mixed reworked clay. Brick fragemnts observed at 6.1m	
									(1.00) 7.50	MADE GROUND: Brown/yellow/grey mottled sandy CLAY. Sand is medium to coarse.	
									(7.60)	MADE GROUND: Firm to stiff brown/grey mottled CLAY. Rare fine quartzite and chalk? gravel. Mixed reworked clay. Visual evidence of hydrocarbon impact between 13 - 13.5m, weathered diesel odour.	

Boring Progress and Water Observations				Casing		Chiselling			Water Added		General Remarks
Date	Time	Depth	Water Dpt	Depth	Dia. mm	From	To	Hours	From	To	Hand dug trial pit to 1.2m

All dimensions in metres Scale 1:93.75	Contractor : EDL Plant:Dando 2000	Method: Cable Percussion Hole Size200mm reducing to 150mm	Logged By: SMJ	Approved By:

SLR Consulting Ltd., 19 Hollingworth Court, ME14 5PP, Tel: 01622 609 242, Fax:

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930

BOREHOLE LOG

BOREHOLE No. **BH14**

Client: **BRETT**

Project No:	Date:	Ground Level:	Co-ordinates:
Sandon Quarry	12/06/13		

Project: **SANDON QUARRY**

Sheet: 2 of 2

SAMPLES & TESTS							STRATA				
Depth	Type No	HS(ppm)	HV(kPa)	PP(kPa)	SPT-N	Water	Reduced Level	Legend (Thick-ness)	Depth	DESCRIPTION	Instrument/ Backfill
									15.10	MADE GROUND: Yellow medium clayey medium to coarse SAND. Mottled grey clay.	
16									(2.90)		
17											
18									18.00	MADE GROUND: Brown gravelly sandy firm CLAY. Gravel is fine to coarse angular to sub rounded quartzite and chalk. Sand is medium.	
									(0.90)		
19									18.90	MADE GROUND: Grey/ brown gravelly sandy firm CLAY. Gravel is fine to coarse angular to sub rounded quartzite and chalk. Sand is medium.	
20									(2.70)		
21											
22									21.60	MADE GROUND: Pale grey medium to coarse clayey SAND.	
									(1.90)		
23									23.50	MADE GROUND: Grey very fine slightly clayey SILT. Brick fragment observed at 26.4m	
24											
25									(3.30)		
26											
									26.80	Stiff grey CLAY. Rare fine to medium quartzite gravel.	
27									(2.20)		
28											
29									29.00	Borehole complete at 29.00m	

Boring Progress and Water Observations				Casing		Chiselling			Water Added		General Remarks
Date	Time	Depth	Water Dpt	Depth	Dia. mm	From	To	Hours	From	To	Hand dug trial pit to 1.2m

All dimensions in metres Scale 1:93.75	Contractor : EDL Plant:Dando 2000	Method: Cable Percussion Hole Size200mm reducing to 150mm	Logged By: SMJ	Approved By:

SLR Consulting Ltd., 19 Hollingworth Court, ME14 5PP, Tel: 01622 609 242, Fax:

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930

BOREHOLE LOG

BOREHOLE No. **BH15**

Client: **BRETT AGGREGATES**

Project No:	Date:	Ground Level:	Co-ordinates:
409.01009.00139	21/08/15	28.34maOD	E574742.657 N204201.646

Project: **SANDON QUARRY**

Sheet: 1 of 3

SAMPLES & TESTS							STRATA				
Depth	Type No	HS(ppm)	HV(kPa)	PP(kPa)	SPT-N	Water	Reduced Level	Legend (Thick-ness)	Depth	DESCRIPTION	Instrument/ Backfill
							27.74		(0.60) 0.60	MADE GROUND: Brown to orange round to angular GRAVEL and occasional cobbles of mixed lithologies.	
							23.84		(3.90) 4.50	MADE GROUND: Stiff dark grey CLAY.	
							22.14		(1.70) 6.20	MADE GROUND: Loose orange clayey silty fine to coarse gravelly SAND. Gravel was sub-rounded to angular of mixed lithologies.	
							19.84		(2.30) 8.50	MADE GROUND: Grey clayey silty SAND and GRAVEL. Gravel was round to angular of mixed lithologies.	
										MADE GROUND: Greyish green fine to coarse sandy gravelly CLAY. Gravel was sub-rounded to angular of mixed lithologies.	

Boring Progress and Water Observations				Casing		Chiselling			Water Added		General Remarks
Date	Time	Depth	Water Dpt	Depth	Dia. mm	From	To	Hours	From	To	1. Hand-dug pit to 1.2m 2. Cable percussion drilling ended at 29m.

All dimensions in metres	Contractor : Endeavour Drilling	Method: Cable Percussion	Logged By:	Approved By:
Scale 1:62.5	Plant: Dando 3000	Hole Size: 150mm	NA	SJ

SLR Consulting, , , Tel: , Fax:

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930

BOREHOLE LOG

BOREHOLE No. **BH15**

Client: **BRETT AGGREGATES**

Project No:	Date:	Ground Level:	Co-ordinates:
409.01009.00139	21/08/15	28.34maOD	E574742.657 N204201.646

Project: **SANDON QUARRY**

Sheet: 2 of 3

SAMPLES & TESTS							STRATA				
Depth	Type No	HS(ppm)	HV(kPa)	PP(kPa)	SPT-N	Water	Reduced Level	Legend (Thick-ness)	Depth	DESCRIPTION	Instrument/ Backfill
									(4.50)	MADE GROUND: Greyish green fine to coarse sandy gravelly CLAY. Gravel was sub-rounded to angular of mixed lithologies. *(continued)*	
										12.00 ...water-logged strata	
							15.34		13.00		
									(7.50)	MADE GROUND: Soft to firm greyish green to orange silty sandy CLAY. Occasional gravel and cobbles of mixed lithology including flint and chert. Lens of soft to firm CLAY throughout depth.	

Boring Progress and Water Observations				Casing		Chiselling			Water Added		General Remarks
Date	Time	Depth	Water Dpt	Depth	Dia. mm	From	To	Hours	From	To	1. Hand-dug pit to 1.2m 2. Cable percussion drilling ended at 29m.

All dimensions in metres	Contractor : Endeavour Drilling	Method: Cable Percussion	Logged By:	Approved By:
Scale 1:62.5	Plant: Dando 3000	Hole Size: 150mm	NA	SJ

SLR Consulting, , , Tel: , Fax:

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930

BOREHOLE LOG

BOREHOLE No. **BH15**

Client: **BRETT AGGREGATES**

Project No:	Date:	Ground Level:	Co-ordinates:
409.01009.00139	21/08/15	28.34maOD	E574742.657 N204201.646

Project: **SANDON QUARRY**

Sheet: 3 of 3

SAMPLES & TESTS							STRATA				
Depth	Type No	HS(ppm)	HV(kPa)	PP(kPa)	SPT-N	Water	Reduced Level	Legend (Thick-ness)	Depth	DESCRIPTION	Instrument/ Backfill
						1	7.84		20.50		
										Orange to brown fine to coarse SAND and rounded to angular GRAVEL of mixed lithology including occasional flint cobbles (GLACIAL DRIFT).	
										20.50 ...water strike	
									(9.30)		
							-1.46		29.80		
										Borehole complete at 29.80m	

Boring Progress and Water Observations				Casing		Chiselling			Water Added		General Remarks
Date	Time	Depth	Water Dpt	Depth	Dia. mm	From	To	Hours	From	To	1. Hand-dug pit to 1.2m 2. Cable percussion drilling ended at 29m.

All dimensions in metres	Contractor : Endeavour Drilling	Method: Cable Percussion	Logged By:	Approved By:
Scale 1:62.5	Plant: Dando 3000	Hole Size: 150mm	NA	SJ

SLR Consulting, , , Tel: , Fax:

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930

BOREHOLE LOG

BOREHOLE No. **BH16**

Client: **BRETT AGGREGATES**

Project No:	Date:	Ground Level:	Co-ordinates:
409.01009.00139	19/08/15	26.34maOD	E204201.646 N204544.923

Project: **SANDON QUARRY**

Sheet: 1 of 3

SAMPLES & TESTS							STRATA				
Depth	Type No	HS(ppm)	HV(kPa)	PP(kPa)	SPT-N	Water	Reduced Level	Legend (Thick-ness)	Depth	DESCRIPTION	Instrument/ Backfill
							25.44		(0.90) 0.90	MADE GROUND: Brown clayey silty sandy GRAVEL. Gravel was sub-rounded to angular of mixed lithologies. Sand was fine to coarse.	
							21.84		(3.60) 4.50	MADE GROUND: Soft dark brown fine to medium sandy CLAY with occasional gravel of concrete, brick and flint.	
									(7.00)	Firm to stiff dark grey gravelly CLAY. Gravel was angular to sub-angular chalk (GLACIAL DRIFT).	

Boring Progress and Water Observations				Casing		Chiselling			Water Added		General Remarks
Date	Time	Depth	Water Dpt	Depth	Dia. mm	From	To	Hours	From	To	1. Hand-dug pit to 1.2m 2. Cable percussion drilling ended at 24m.

All dimensions in metres	Contractor : Endeavour Drilling	Method: Cable Percussion	Logged By:	Approved By:
Scale 1:62.5	Plant: Dando 3000	Hole Size: 150mm	NA	SJ

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LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930

BOREHOLE LOG

BOREHOLE No. **BH16**

Client: **BRETT AGGREGATES**

Project No:	Date:	Ground Level:	Co-ordinates:
409.01009.00139	19/08/15	26.34maOD	E204201.646 N204544.923

Project: **SANDON QUARRY**

Sheet: 2 of 3

SAMPLES & TESTS							STRATA				
Depth	Type No	HS(ppm)	HV(kPa)	PP(kPa)	SPT-N	Water	Reduced Level	Legend (Thick-ness)	Depth	DESCRIPTION	Instrument/ Backfill
										Firm to stiff dark grey gravelly CLAY. Gravel was angular to sub-angular chalk (GLACIAL DRIFT). *(continued)*	
						1	14.84		11.50		
										Soft to firm grey silty sandy CLAY. Sand was fine (GLACIAL DRIFT). 11.50 ...water strike at 11.5m	
									(8.80)		

Boring Progress and Water Observations				Casing		Chiselling			Water Added		General Remarks
Date	Time	Depth	Water Dpt	Depth	Dia. mm	From	To	Hours	From	To	1. Hand-dug pit to 1.2m 2. Cable percussion drilling ended at 24m.

All dimensions in metres	Contractor : Endeavour Drilling	Method: Cable Percussion	Logged By:	Approved By:
Scale 1:62.5	Plant: Dando 3000	Hole Size: 150mm	NA	SJ

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LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930

BOREHOLE LOG

BOREHOLE No. **BH16**

Client: **BRETT AGGREGATES**

Project No:	Date:	Ground Level:	Co-ordinates:
409.01009.00139	19/08/15	26.34maOD	E204201.646 N204544.923

Project: **SANDON QUARRY**

Sheet: 3 of 3

SAMPLES & TESTS							STRATA				
Depth	Type No	HS(ppm)	HV(kPa)	PP(kPa)	SPT-N	Water	Reduced Level	Legend (Thick-ness)	Depth	DESCRIPTION	Instrument/ Backfill
							6.04		20.30	Soft to firm grey silty sandy CLAY. Sand was fine (GLACIAL DRIFT). *(continued)*	
										Grey clayey silty fine to coarse SAND (GLACIAL DRIFT).	
									(2.20)		
							3.84		22.50		
										Soft to firm grey silty sandy gravelly CLAY. Gravel was sub-rounded to angular of mixed lithologies with occasional cobbles of flint and chert. Sand was fine (GLACIAL DRIFT).	
									(1.00)		
							2.84		23.50		
										Stiff dark grey silty sandy gravelly CLAY. Gravel was sub-rounded to angular chalk (GLACIAL DRIFT).	
									(0.50)		
							2.34		24.00		
										Borehole complete at 24.00m	

21 22 23 24 25 26 27 28 29

Boring Progress and Water Observations				Casing		Chiselling			Water Added		General Remarks
Date	Time	Depth	Water Dpt	Depth	Dia. mm	From	To	Hours	From	To	1. Hand-dug pit to 1.2m 2. Cable percussion drilling ended at 24m.

All dimensions in metres	Contractor : Endeavour Drilling	Method: Cable Percussion	Logged By:	Approved By:
Scale 1:62.5	Plant: Dando 3000	Hole Size: 150mm	NA	SJ

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LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930

BOREHOLE LOG

BOREHOLE No
BH2020-02

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	28/09/2020		

Project:
Sandon Northern Void SI

Sheet
1 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument / Backfill
								0.05	Soft brown slightly sandy CLAY with frequent rootlets.	
1		SPT	N=6	6				(1.75)	Soft to firm brown slightly sandy gravelly CLAY. Sand is fine. Gravel is angular fine to medium of flint, chert and brick, subrounded fine to medium of quartz and rounded fine to medium of chalk. [REWORKED]	
								1.80		
2.00 - 2.70 2	B							(1.15)	Firm grey gravelly very silty CLAY. Gravel is subangular fine to medium of flint. [REWORKED]	
		SPT	N=11	11				2.95		
3								3.30	Orangish brown gravelly medium SAND. Gravel is subangular fine of flint and brick. [FILL/ REWORKED]	
								(1.00)	Soft grey mottled brown slightly gravelly silty CLAY. Gravel is angular fine of brick, subangular fine of flint. [FILL/REWORKED]	
4								4.30		
								(0.75)	Brown mottled dark grey slightly clayey very gravelly medium to coarse SAND. Gravel is angular fine to coarse of brick and concrete, subangular fine to medium of flint and chert. [FILL/ REWORKED]	
5								5.05		
								5.40	Soft grey mottled brown slightly gravelly silty CLAY. Gravel is subangular fine of flint. Frequent wood and one metal nail. [FILL/REWORKED]	
		SPT	N=5	5					Firm orangish brown slightly silty slightly gravelly CLAY. Gravel is subangular fine to medium of flint. [REWORKED]	

Borehole Continued on Next Page

Boring Progress and Water Observations

Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt
28/09/2020	06:00	2.70			
29/09/2020	06:00	22.10	22.10		5.53
30/09/2020	06:00	29.00	26.55		16.02

Chiselling

From	To	Hours

Water Added

From	To
8.70	26.55

General Remarks

1. Drilled by Geotechnical Engineering Limited.
2. Scanned with C.A.T. and 1.2m hand-dug inspection pit completed.
3. Installed with 50mm standpipe piezometer to 13.5m depth upon completion.
4. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Dynamic (windowless) sampler	Logged By:	Approved By:
Scale 1:40	Plant: Pioneer - P21	Hole Size: 170mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No **BH2020-02**

Client: **Brett Aggregates Ltd**

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	28/09/2020		

Project: **Sandon Northern Void SI**

Sheet 2 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
6.20 - 6.90	B							(1.60)	Firm orangish brown slightly silty slightly gravelly CLAY. Gravel is subangular fine to medium of flint. [REWORKED]	
								7.00		
								7.30	Firm dark grey slightly gravelly silty CLAY. Gravel is subangular fine to medium of flint. [REWORKED]	
								(1.40)	Firm orangish brown slightly gravelly silty CLAY. Gravel is angular fine of flint. [REWORKED]	
		SPT	N=9	9				8.70		
								(1.40)	Firm greyish brown slightly gravelly very sandy CLAY. Gravel is rounded fine to medium of quartz, subangular fine to medium of flint. Sand is medium to coarse. Occasional wood. [REWORKED]	
								10.10		
10.50 - 11.10	B							(1.70)	Light greyish brown slightly gravelly medium SAND. Gravel is subangular fine to medium of flint and chert. [REWORKED]	
									11.35 : decreasing gravel content.	
		SPT	N=8	8				11.80		
									Soft to firm orangish brown mottled grey slightly	
									Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling		
From	To	Hours

Water Added	
From	To
8.70	26.55

General Remarks

1. Drilled by Geotechnical Engineering Limited.
2. Scanned with C.A.T. and 1.2m hand-dug inspection pit completed.
3. Installed with 50mm standpipe piezometer to 13.5m depth upon completion.
4. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Dynamic (windowless) sampler	Logged By:	Approved By:
Scale 1:40	Plant: Pioneer - P21	Hole Size: 170mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-02

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	28/09/2020		

Project:
Sandon Northern Void SI

Sheet
3 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
								12.15	sandy gravelly CLAY. Sand is medium to coarse. Gravel is subangular fine to medium of flint. Rare wood. [REWORKED]	
								12.30	Light greyish brown slightly gravelly medium SAND. Gravel is subangular fine of flint. [REWORKED]	
								12.60	Soft dark grey mottled brown silty CLAY. Frequent wood and organic staining. [REWORKED]	
13									Firm light brownish grey SILT.	
14										
14.60 - 15.40	B	SPT	N=34	34				(4.40)		
15										
16									*16.10 - 17.00 : slightly clayey.*	
17								17.00		
								(0.60)	Firm grey very sandy SILT.	
		SPT	N=26	26				17.60		
									Medium dense grey slightly silty fine SAND.	
									Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To
			8.70	26.55

General Remarks

1. Drilled by Geotechnical Engineering Limited.
2. Scanned with C.A.T. and 1.2m hand-dug inspection pit completed.
3. Installed with 50mm standpipe piezometer to 13.5m depth upon completion.
4. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Dynamic (windowless) sampler	Logged By:	Approved By:
Scale 1:40	Plant: Pioneer - P21	Hole Size: 170mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No **BH2020-02**

Client: **Brett Aggregates Ltd**

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	28/09/2020		

Project: **Sandon Northern Void SI**

Sheet 4 of 5

SAMPLES & TESTS					Water	STRATA				Instrument Backfill
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	
								(0.85) 18.45	Medium dense grey slightly silty fine SAND.	
								(0.95) 19.40	Soft light brownish grey slightly clayey SILT.	
19.40 - 20.20	B							(0.85) 20.25	Light brownish grey medium SAND.	
		SPT	N=31	31				(0.35) 20.60	Firm light brownish grey slightly sandy SILT. Sand is fine.	
								(1.75) 22.35	Medium dense light greyish brown slightly silty fine to medium SAND. *21.70 - 22.10 : medium sand.*	
								(0.15) 22.50	Firm brownish grey slightly sandy SILT.	
								(0.50) 23.00	Soft light brownish grey slightly clayey SILT. *22.98 - 23.00 : subrounded fine gravel of chalk.*	
								(0.30) 23.30	Light brownish grey medium SAND.	
		SPT	N=26	26				(0.70) 24.00	Firm light brownish grey very silty CLAY with frequent pockets of grey medium sand.	
									Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To
			8.70	26.55

General Remarks

1. Drilled by Geotechnical Engineering Limited.
2. Scanned with C.A.T. and 1.2m hand-dug inspection pit completed.
3. Installed with 50mm standpipe piezometer to 13.5m depth upon completion.
4. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Dynamic (windowless) sampler	Logged By:	Approved By:
Scale 1:40	Plant: Pioneer - P21	Hole Size: 170mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-02

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	28/09/2020		

Project:
Sandon Northern Void SI

Sheet
5 of 5

SAMPLES & TESTS					Water	STRATA				Instrument Backfill
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	
								(1.50)	Soft to firm light brownish grey slightly sandy clayey SILT.	
25								25.50	*25.25 - 25.30 : subangular fine to medium gravel of flint, subrounded medium of quartz.*	
								(0.55)	Firm to stiff dark grey slightly gravelly CLAY. Gravel is subangular fine to medium of chalk.	
26								26.05		
								26.45	Soft to firm light brownish grey SILT.	
		SPT	N=35	35					Stiff brownish grey silty CLAY with occasional shell fragments.	
27										
								(2.55)		
28										
		SPT	N=32	32						
29								29.00		
									Borehole Complete at 29.00m	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling		
From	To	Hours

Water Added	
From	To
8.70	26.55

General Remarks

1. Drilled by Geotechnical Engineering Limited.
2. Scanned with C.A.T. and 1.2m hand-dug inspection pit completed.
3. Installed with 50mm standpipe piezometer to 13.5m depth upon completion.
4. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Dynamic (windowless) sampler	Logged By:	Approved By:
Scale 1:40	Plant: Pioneer - P21	Hole Size: 170mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-03

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	24/09/2020		

Project:
Sandon Northern Void SI

Sheet
1 of 4

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
								(1.10)	Firm brown sandy gravelly CLAY. Sand is medium to coarse. Gravel is subangular fine to coarse of flint and brick. Occasional subangular cobbles of flint. [FILL/REWORKED]	
1		SPT	N=8	8				1.10		
								1.50	Firm brown mottled grey silty gravelly CLAY. Gravel is subangular fine to medium of flint. [REWORKED]	
								1.70	Firm brown sandy gravelly CLAY. Sand is medium to coarse. Gravel is subangular fine to coarse of flint and brick. Occasional subangular cobbles of flint. [FILL/REWORKED]	
								1.95	Soft brownish grey slightly gravelly silty CLAY. Gravel is subrounded fine to medium of quartz, angular fine to medium of brick. [FILL/REWORKED]	
2								2.20	Soft to firm greyish brown silty CLAY.	
								2.60	Very soft to soft silty gravelly CLAY. Gravel is subangular fine to medium of flint. [REWORKED]	
								2.70	Brown medium to coarse SAND. [REWORKED]	
								(0.50)	Soft grey mottled brown slightly gravelly silty CLAY. Gravel is angular fine of flint. [REWORKED]	
3								3.20		
3.40 - 3.90	B							3.40	Brown slightly gravelly medium SAND. Gravel is subangular fine to medium of flint. [REWORKED]	
								(0.50)	Firm grey silty CLAY. [REWORKED]	
								3.90		
4		SPT	N=4	4				(0.60)	Loose greyish brown gravelly medium to coarse SAND. Gravel is subangular fine to medium of flint.	
								4.50		
								4.80	Greyish brown medium to coarse SAND.	
								4.95	Greyish brown slightly silty fine SAND.	
5.00 - 5.50	B							(1.15)	Grey slightly gravelly medium SAND.	
5										
									Borehole Continued on Next Page	

Boring Progress and Water Observations

Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt
24/09/2020	05:00	11.50	11.50		2.94
25/09/2020	03:00	20.00	19.15		6.55

Chiselling

From	To	Hours

Water Added

From	To
4.00	19.15

General Remarks

1. Drilled by Geotechnical Engineering Limited.
2. Scanned with C.A.T. and 1.2m hand-dug inspection pit completed.
3. Installed with 50mm standpipe piezometer to 18.5m depth upon completion.
4. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Dynamic (windowless) sampler	Logged By:	Approved By:
Scale 1:40	Plant: Pioneer - P21	Hole Size: 140mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-03

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	24/09/2020		

Project:
Sandon Northern Void SI

Sheet
2 of 4

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
								6.10	Grey slightly gravelly medium SAND.	
								6.25	Grey slightly silty fine SAND.	
7		SPT	N=21	21				(1.75)	Medium dense grey very gravelly fine to coarse SAND. Gravel is subangular fine to medium of flint and chert, subrounded fine to medium of quartz.	
7.50 - 8.00	B									
8								8.00		
								(1.20)	Grey slightly silty medium SAND.	
9								9.20		
								(0.60)	Grey very gravelly fine to coarse SAND. Gravel is subangular fine to medium of flint and chert, subrounded fine to medium of quartz.	
								9.80		
10		SPT	N=23	23				(1.25)	Medium dense grey slightly silty medium to coarse SAND.	
11								11.05		
								(1.05)	Grey very sandy subangular fine to medium GRAVEL of flint and chert, subrounded fine to medium of quartz. Sand is medium to coarse.	
									Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling		
From	To	Hours

Water Added	
From	To
4.00	19.15

General Remarks

1. Drilled by Geotechnical Engineering Limited.
2. Scanned with C.A.T. and 1.2m hand-dug inspection pit completed.
3. Installed with 50mm standpipe piezometer to 18.5m depth upon completion.
4. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Dynamic (windowless) sampler	Logged By:	Approved By:
Scale 1:40	Plant: Pioneer - P21	Hole Size: 140mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-03

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	24/09/2020		

Project:
Sandon Northern Void SI

Sheet
3 of 4

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
								12.10	Grey very sandy subangular fine to medium GRAVEL of flint and chert, subrounded fine to medium of quartz. Sand is medium to coarse.	
								(0.80)	Grey medium to coarse SAND.	
								12.90		
13		SPT	N=24	24					Medium dense grey silty fine SAND.	
								13.30		
								(0.70)	Grey medium SAND. *13.50 - 13.55 : grey silt.*	
14								14.00		
								14.10	Grey silty fine SAND.	
14.20 - 15.20	B							(1.20)	Grey slightly gravelly slightly sandy SILT. Gravel is subangular medium of flint. Sand is medium.	
15								15.30		
								(0.55)	Grey slightly gravelly coarse SAND. Gravel is subangular fine of flint and chert.	
								15.85		
16		SPT	N=32	32				(0.70)	Firm grey SILT.	
								16.55		
16.70 - 17.60	B							(1.10)	Grey gravelly medium to coarse SAND. Gravel is subangular fine to medium of flint and chert, subrounded fine to medium of quartz.	
17								17.65		
									Stiff grey silty CLAY.	
									Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To
			4.00	19.15

General Remarks

1. Drilled by Geotechnical Engineering Limited.
2. Scanned with C.A.T. and 1.2m hand-dug inspection pit completed.
3. Installed with 50mm standpipe piezometer to 18.5m depth upon completion.
4. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Dynamic (windowless) sampler	Logged By:	Approved By:
Scale 1:40	Plant: Pioneer - P21	Hole Size: 140mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-03

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	24/09/2020		

Project:
Sandon Northern Void SI

Sheet
4 of 4

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
19		SPT	N=34	34				(2.35)	Stiff grey silty CLAY.	
20								20.00	Borehole Complete at 20.00m	
21										
22										
23										

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To
			4.00	19.15

General Remarks

1. Drilled by Geotechnical Engineering Limited.
2. Scanned with C.A.T. and 1.2m hand-dug inspection pit completed.
3. Installed with 50mm standpipe piezometer to 18.5m depth upon completion.
4. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Dynamic (windowless) sampler	Logged By:	Approved By:
Scale 1:40	Plant: Pioneer - P21	Hole Size: 140mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-04

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	02/09/2020		

Project:
Sandon Northern Void SI

Sheet
1 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
0									Firm orangish brown silty gravelly very sandy CLAY. Gravel is angular fine to coarse of flint and concrete. Sand is medium. [FILL/REWORKED]	
1								(2.20)		
2								2.20	Firm orangish brown mottled grey slightly sandy silty CLAY. Sand is medium to coarse. Rare wood. [FILL/REWORKED]	
3		SPT	N=9	9						
4								(4.80)		
5										
		SPT	N=12						Borehole Continued on Next Page	

Boring Progress and Water Observations

Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt
02/09/2020	05:30	7.50	7.50		
03/09/2020	05:00	24.80	24.00		
04/09/2020	03:00	26.00	24.00		

Chiselling

From	To	Hours

Water Added

From	To

General Remarks

1. Drilled by Endeavour Drilling. Borehole abandoned and backfilled with grout/ arisings.
2. Redrilled by GEL approx. 5m South of original location and installed with an inclinometer to full depth.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 200mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-04

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	02/09/2020		

Project:
Sandon Northern Void SI

Sheet
2 of 5

SAMPLES & TESTS					Water	STRATA				Instrument
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Backfill
				12				7.00	Firm orangish brown mottled grey slightly sandy silty CLAY. Sand is medium to coarse. Rare wood. [FILL/REWORKED]	
7								(0.50)	Stiff grey mottled greyish brown slightly gravelly silty CLAY. Gravel is angular fine of flint. [REWORKED]	
								7.50	Firm to stiff brown gravelly very sandy CLAY. Gravel is rounded medium of quartz, subangular medium of flint and chert. Sand is medium to coarse. Rare wood. [REWORKED]	
8										
9		SPT	N=23	23				(3.00)		
10								10.50	Medium dense brown slightly gravelly very silty medium SAND. Gravel is subrounded medium of quartz. [REWORKED]	
11										
		SPT	N=14						Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling. Borehole abandoned and backfilled with grout/ arisings.
2. Redrilled by GEL approx. 5m South of original location and installed with an inclinometer to full depth.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 200mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-04

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	02/09/2020		

Project:
Sandon Northern Void SI

Sheet
3 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
12.50 - 13.00	B								Medium dense brown slightly gravelly very silty medium SAND. Gravel is subrounded medium of quartz. [REWORKED]	
15		SPT	N=11	11				(7.00)		
17.50									Soft brown sandy SILT. Sand is fine to medium. [REWORKED?]	
17		SPT	N=36						Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling. Borehole abandoned and backfilled with grout/ arisings.
2. Redrilled by GEL approx. 5m South of original location and installed with an inclinometer to full depth.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 200mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-04

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	02/09/2020		

Project:
Sandon Northern Void SI

Sheet
4 of 5

SAMPLES & TESTS					Water	STRATA				Instrument Backfill
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	
19									Soft brown sandy SILT. Sand is fine to medium. [REWORKED?]	
20										
21		SPT	N=39	39				(6.00)		
22										
23								23.50	Stiff to very stiff bluish grey silty CLAY.	
									Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling. Borehole abandoned and backfilled with grout/ arisings.
2. Redrilled by GEL approx. 5m South of original location and installed with an inclinometer to full depth.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 200mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-04

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	02/09/2020		

Project:
Sandon Northern Void SI

Sheet
5 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
25								(2.50)	Stiff to very stiff bluish grey silty CLAY.	
26		SPT	N=46	46				26.00	Borehole Complete at 26.00m	
27										
28										
29										

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling. Borehole abandoned and backfilled with grout/ arisings.
2. Redrilled by GEL approx. 5m South of original location and installed with an inclinometer to full depth.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 200mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-05

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	26/08/2020		

Project:
Sandon Northern Void SI

Sheet
1 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
0.70 - 1.20	B							(0.70) 0.70	Firm brown slightly sandy gravelly CLAY. Gravel is subangular fine to medium of flint, rounded fine to medium of quartz. [REWORKED]	
								(0.50) 1.20	Orangish brown slightly clayey slightly gravelly medium SAND. Gravel is subangular fine to medium of flint, subrounded fine to medium of quartz. Rare metal. [FILL/REWORKED]	
								(0.50) 1.70	Firm dark orangish brown mottled grey slightly gravelly silty CLAY. Gravel is angular fine of flint. [REWORKED]	
		SPT	N=7	7				(2.80) 4.50	Firm bluish grey slightly gravelly CLAY. Gravel is angular fine of flint, angular medium of brick. Occasional wood and organic staining. [FILL/ REWORKED]	
4.50 - 5.00	B								Soft to firm brown gravelly very sandy CLAY. Sand is medium to coarse. Gravel is angular fine to medium flint and chert, subrounded fine to medium of quartz. [REWORKED]	
		SPT	N=26							

Borehole Continued on Next Page

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt
26/08/2020	05:00	15.00	15.00		
27/08/2020	05:00	21.50	21.50		
28/08/2020	03:00	26.00	24.00		

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling.
2. Installed with 50mm standpipe piezometer upon completion.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 250mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-05

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	26/08/2020		

Project:
Sandon Northern Void SI

Sheet
2 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
7										
7.50 - 8.00	B								*7.20 - 7.50 : very stiff bluish grey silty clay.*	
8										
								(6.50)		
9		SPT	N=15	15						
10										
10.50 - 11.00	B									
11								11.00	Soft to firm dark grey slightly gravelly silty CLAY. Gravel is angular fine of flint. [REWORKED]	
		SPT	N=24	26					Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling.
2. Installed with 50mm standpipe piezometer upon completion.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 250mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-05

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	26/08/2020		

Project:
Sandon Northern Void SI

Sheet
3 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
								(2.40)	Soft to firm dark grey slightly gravelly silty CLAY. Gravel is angular fine of flint. [REWORKED]	
								13.40		
13.50 - 14.00	B							(5.10)	Soft grey SILT. [REWORKED?]	
		SPT	N=11	11						
16.50 - 17.00	B								*17.30 - 18.50 : becoming gravelly. Gravel is subangular fine to coarse of flint.*	
		SPT	N=12	24						

Borehole Continued on Next Page

Boring Progress and Water Observations						Chiselling			Water Added		General Remarks
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt	From	To	Hours	From	To	1. Drilled by Endeavour Drilling. 2. Installed with 50mm standpipe piezometer upon completion. 3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 250mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-05

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	26/08/2020		

Project:
Sandon Northern Void SI

Sheet
4 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
				12				18.50	Soft grey SILT. [REWORKED?]	
19									Medium dense brown sandy fine to coarse subangular GRAVEL of flint and chert, subrounded fine to coarse of quartz. Sand is coarse.	
19.50 - 20.00	B									
20										
21		SPT	N=11	11				(4.90)		
22										
23								23.40	Light brown slightly silty medium to coarse SAND.	
		SPT	N=30					(0.60) 24.00		
									Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling.
2. Installed with 50mm standpipe piezometer upon completion.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 250mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-05

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	26/08/2020		

Project:
Sandon Northern Void SI

Sheet
5 of 5

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
25								(2.00)	Very stiff bluish grey silty CLAY.	
26								26.00	Borehole Complete at 26.00m	
27										
28										
29										

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling.
2. Installed with 50mm standpipe piezometer upon completion.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 250mm	SW	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-06

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	13/08/2020		

Project:
Sandon Northern Void SI

Sheet
1 of 4

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
									Soft light brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine of sandstone, mudstone, coal, flint and quartz with occasional rootlets. [REWORKED]	
1.50	B							(3.20)		
		SPT	N=8	8				3.20		
									Soft light yellowish brown slightly gravelly silty sandy CLAY. Gravel is subrounded medium to coarse of sandstone. [REWORKED]	
4.50	B								*4.50 - 9.20 : becoming firm.*	
		SPT	N=10							
									Borehole Continued on Next Page	

Boring Progress and Water Observations

Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt
13/08/2020	05:00	14.00	10.00		
14/08/2020	04:00	22.50	22.50		

Chiselling

From	To	Hours

Water Added

From	To

General Remarks

1. Drilled by Endeavour Drilling.
2. Installed with 50mm standpipe piezometer upon completion.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 200mm	AK	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No **BH2020-06**

Client: **Brett Aggregates Ltd**

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	13/08/2020		

Project: **Sandon Northern Void SI**

Sheet 2 of 4

SAMPLES & TESTS					Water	STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
7.50	B							(6.00)	*7.50 - 9.20 : decrease in gravel content.*	
		SPT	N=20	20				9.20	Medium dense subangular to subrounded fine to coarse sandy GRAVEL of flint and quartz.	
10.50	B									
		SPT	N=49						Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling.
2. Installed with 50mm standpipe piezometer upon completion.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 200mm	AK	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-06

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	13/08/2020		

Project:
Sandon Northern Void SI

Sheet
3 of 4

SAMPLES & TESTS						STRATA				
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40	Water	Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Instrument Backfill
					4 9				*12.00 - 16.50 : becoming dense.*	
13										
13.50	B									
14								(7.30)		
15		SPT	N=46	46					*15.00 - 16.50 : gravels becoming finer.*	
16										
16.50	B							16.50	Medium dense grey very gravelly fine to coarse SAND. Gravel is subrounded to subangular fine to medium of flint.	
17								(2.50)		
		SPT	N=15						Borehole Continued on Next Page	

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

1. Drilled by Endeavour Drilling.
2. Installed with 50mm standpipe piezometer upon completion.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 200mm	AK	

LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

BOREHOLE LOG

BOREHOLE No
BH2020-06

Client:
Brett Aggregates Ltd

Project No:	Date:	Ground Level:	Co-ordinates:
403.09886.00012	13/08/2020		

Project:
Sandon Northern Void SI

Sheet
4 of 4

SAMPLES & TESTS					Water	STRATA				Instrument Backfill
Depth	Type No	Test Type	Test Result	SPT N Value 10 20 30 40		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	
				15				19.00	Medium dense grey very gravelly fine to coarse SAND. Gravel is subrounded to subangular fine to medium of flint.	
19										
19.50	B							(2.50)	Soft brownish grey silty sandy gravelly CLAY. Gravel is subrounded to subangular fine to coarse of flint.	
20										
21		SPT	N=23	23				21.50		
								(1.00)	Stiff to very stiff dark grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine of flint.	
22								22.50		
22.30	B								Borehole Complete at 22.50m	
23										

Boring Progress and Water Observations					
Date	Time	Depth	Casing Dpt	Casing Dia	Water Dpt

Chiselling			Water Added	
From	To	Hours	From	To

General Remarks

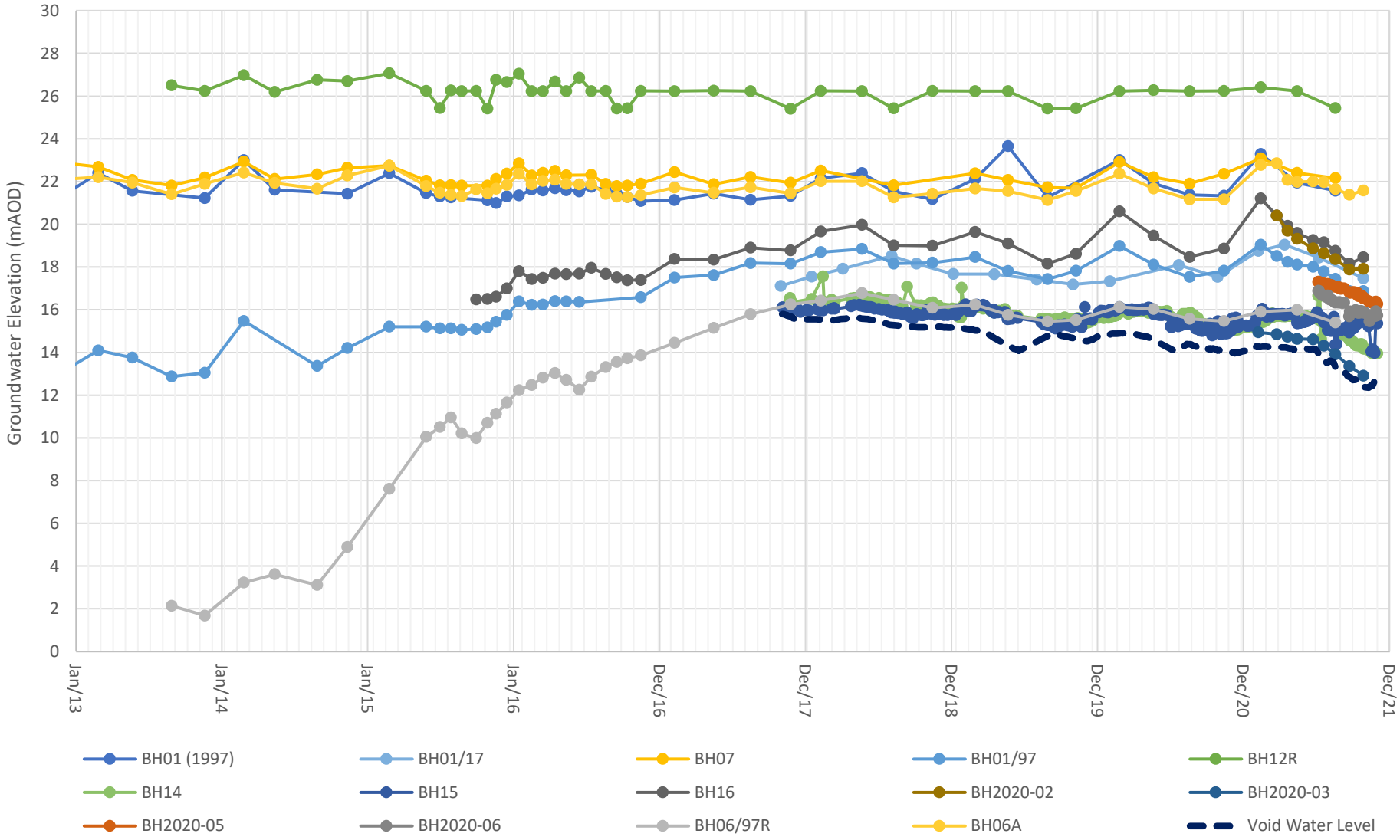
1. Drilled by Endeavour Drilling.
2. Installed with 50mm standpipe piezometer upon completion.
3. Relative density and strength descriptions based on field tests and observations.

All dimensions in metres	Contractor: Endeavour/GEL	Method: Cable percussion (shell and auger)	Logged By:	Approved By:
Scale 1:40	Plant: Dando 2500	Hole Size: 200mm	AK	

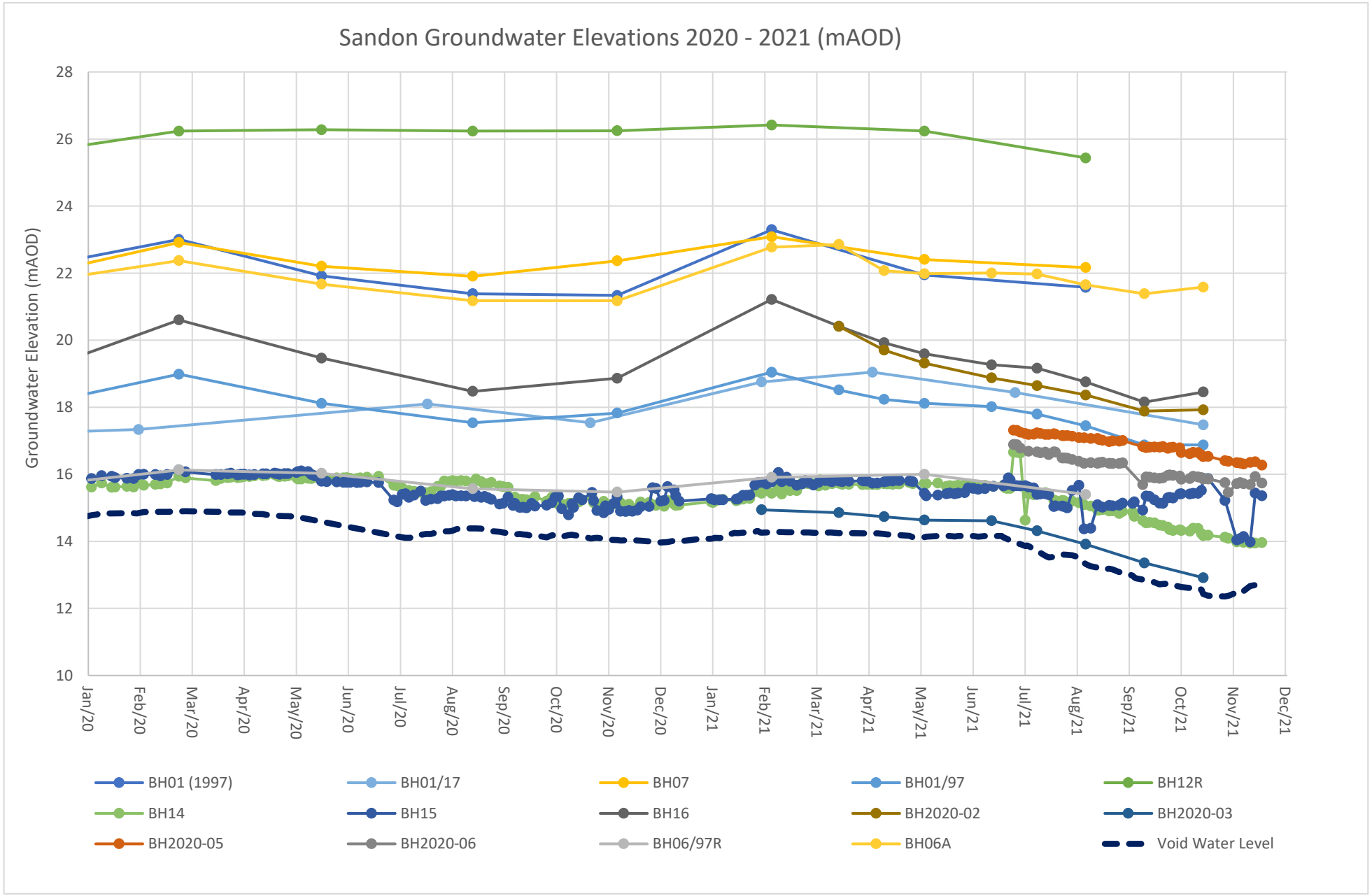
LOGGING HAS BEEN CARRIED OUT IN ACCORDANCE WITH BS5930:2015

APPENDIX 02

Groundwater Hydrographs

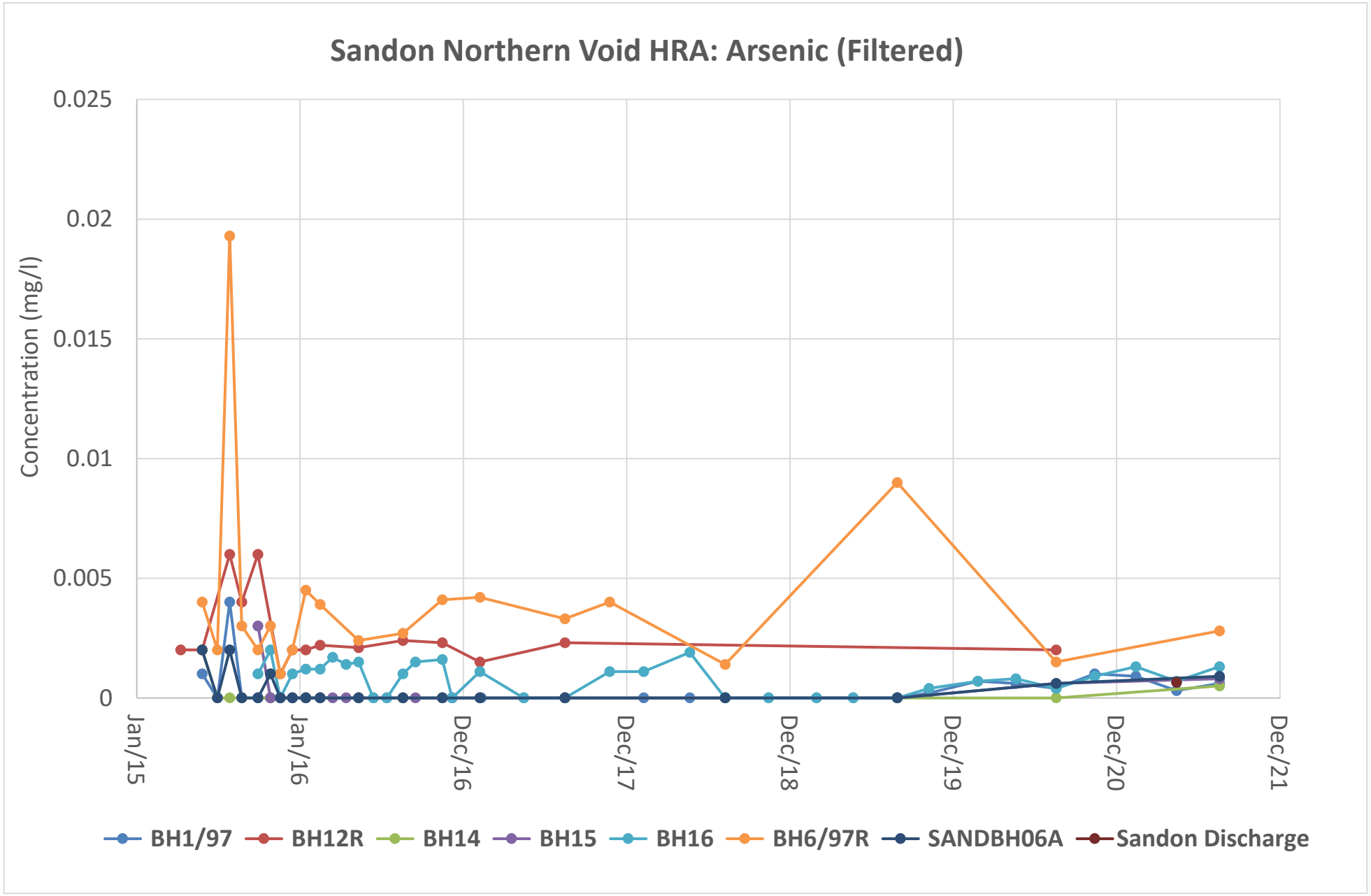


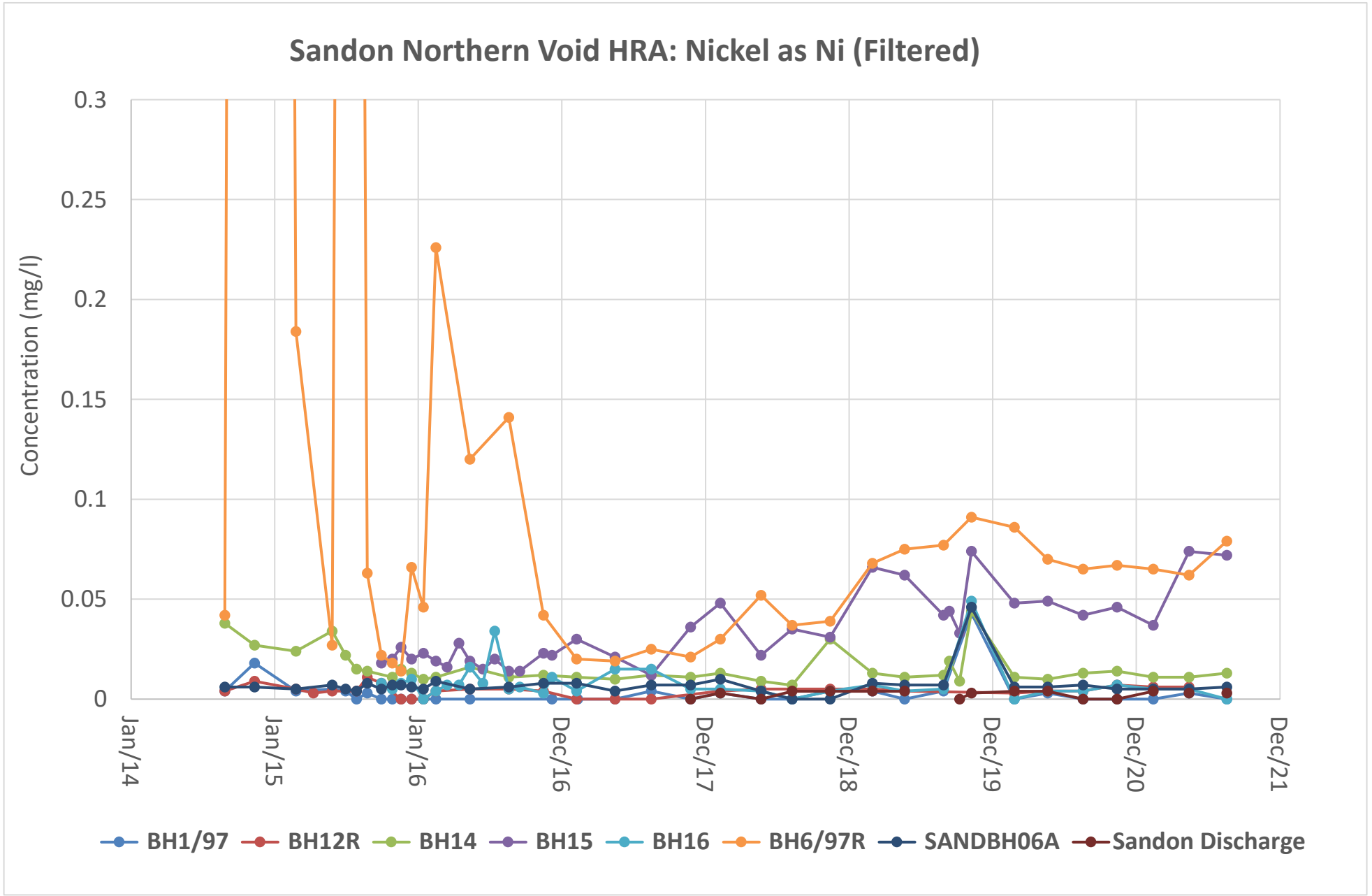
2020-2021 groundwater levels presented in more detail on next page

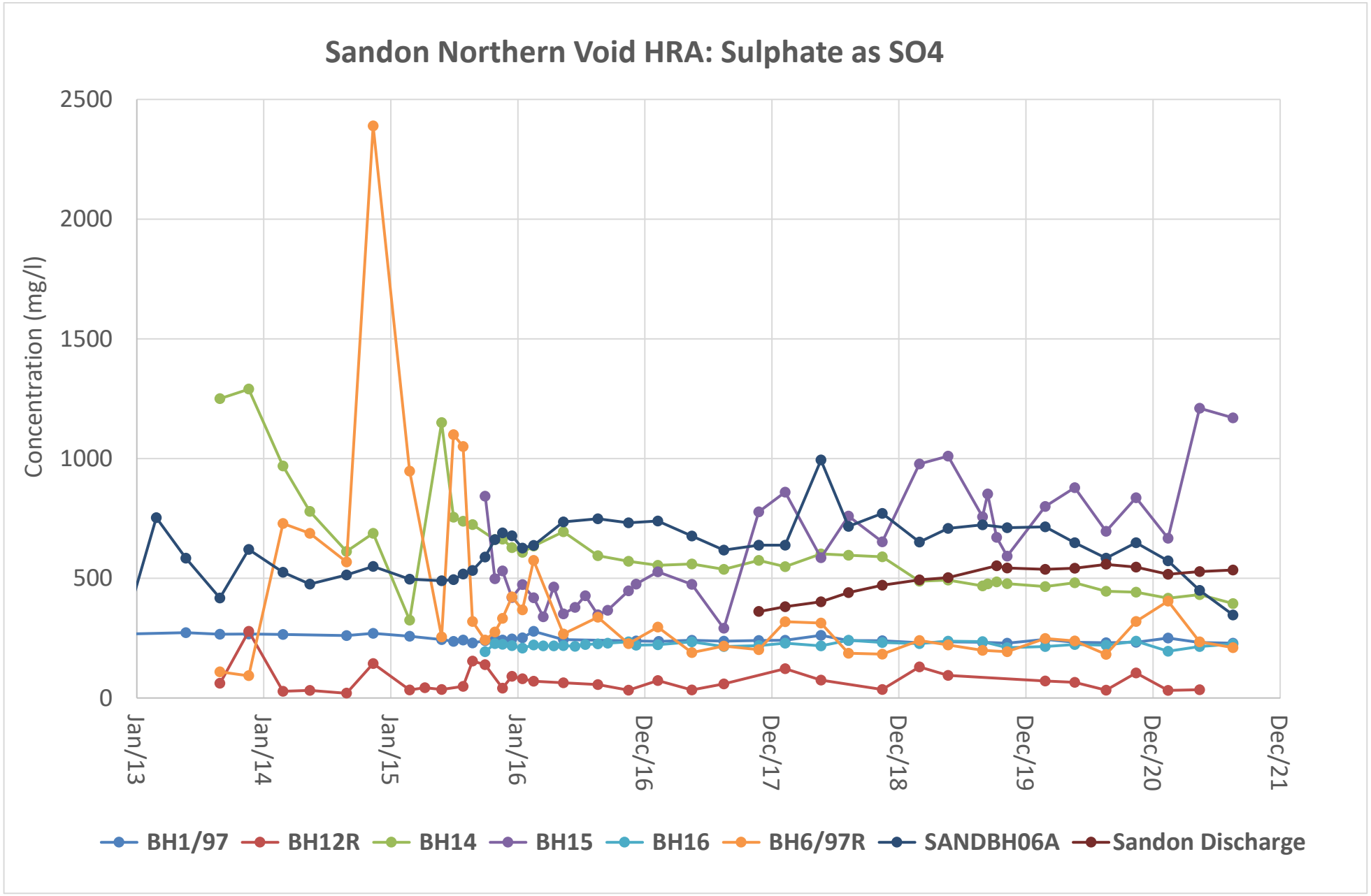

Sandon Groundwater Elevations 2020 - 2021 (mAOD)
Groundwater Elevation (mAOD)
28
26
24
22
20
18
16
14
12
10
Jan/20
Feb/20
Mar/20
Apr/20
May/20
Jun/20
Jul/20
Aug/20
Sep/20
Oct/20
Nov/20
Dec/20
Jan/21
Feb/21
Mar/21
Apr/21
May/21
Jun/21
Jul/21
Aug/21
Sep/21
Oct/21
Nov/21
Dec/21
BH01 (1997)
BH01/17
BH07
BH01/97
BH12R
BH14
BH15
BH16
BH2020-02
BH2020-03
BH2020-05
BH2020-06
BH06/97R
BH06A
Void Water Level

APPENDIX 03

Groundwater Quality Chemographs


Sandon Northern Void HRA: Arsenic (Filtered)
Concentration (mg/l)
0.025
0.02
0.015
0.01
0.005
0
Jan/15
Jan/16
Dec/16
Dec/17
Dec/18
Dec/19
Dec/20
Dec/21
BH1/97
BH12R
BH14
BH15
BH16
BH6/97R
SANDBH06A
Sandon Discharge


Sandon Northern Void HRA: Nickel as Ni (Filtered)
Concentration (mg/l)
0.3
0.25
0.2
0.15
0.1
0.05
0
Jan/14
Jan/15
Jan/16
Dec/16
Dec/17
Dec/18
Dec/19
Dec/20
Dec/21
BH1/97
BH12R
BH14
BH15
BH16
BH6/97R
SANDBH06A
Sandon Discharge


Sandon Northern Void HRA: Sulphate as SO4
Concentration (mg/l)
2500
2000
1500
1000
500
0
Jan/13
Jan/14
Jan/15
Jan/16
Dec/16
Dec/17
Dec/18
Dec/19
Dec/20
Dec/21
BH1/97
BH12R
BH14
BH15
BH16
BH6/97R
SANDBH06A
Sandon Discharge

APPENDIX 04

RAM3 Model Parameterisation

Site Layout Source / Inert Waste Source

Item		Value/Description	Source of Data
Infiltration to site (mm/year)		120	Based on approximately 50% of effective rainfall forming recharge through low permeability inert material
Area of Top of Waste (m^2)		74,000	Site volume calculations
Nominal Waste Thickness (m)		11.5	Void Volume / Area of Top of Waste
Waste porosity		0.30	Typical values for cohesive inert waste
Waste Water filled porosity		0.05	
Waste dry bulk density (kg/m^3)		1500	
Waste FoC		0.01	
Contaminant Source	Arsenic (mg/l)	0.1	Derived in mg/l from 2 X Inert WAC limits outlined in mg/kg within the Landfill Directive council decision annex 2003/33/EC
	Fluoride (mg/l)	3.0	Derived in mg/l from 3 X Inert WAC limits outlined in mg/kg within the Landfill Directive council decision annex 2003/33/EC
	Lead (mg/l)	0.15	
	Mercury (mg/l)	0.003	
	Nickel (mg/l)	0.12	
	Sulphate (mg/l)	600	Sulphate may still be considered as complying with the acceptance criteria if the leaching does not exceed either of the following values: 1,500mg/l as C0 at L/S = 0.1l/kg and 6000mg/kg at L/S = 10l/kg.
	Acenaphthene (mg/kg)	20	Assumes 20% of the total PAH WAC limit of 100mg/kg is Benzo(a)pyrene

Item		Value/Description	Source of Data
	Benzene (mg/kg)	2	Assumes 33% of the total BTEX WAC limit of 6mg/kg is benzene
	Benzo(a)pyrene (mg/kg)	20	Assumes 20% of the total PAH WAC limit of 100mg/kg is Benzo(a)pyrene
	Aromatic C10 – C12 (mg/kg)	100	Assumes 20% of the Total Mineral Oil (C10-C40) WAC limit of 500mg/kg in Aromatic C10-C12
Free Water Diffusion Coefficients (m^2/s)	Arsenic	$3.52x10^{-10}$	https://www.dgtresearch.com/diffusion-coefficients/
	Fluoride	$1.48x10^{-9}$	Buffle et.al
	Lead	$9.45x10^{-10}$	Buffle et.al[22]
	Mercury	$2.00x10^{-09}$	Supplementary information for the derivation of SGV for mercury, Science Report SC050021
	Nickel	$7.05x10^{-10}$	Salmon P. S., Howells W. S., Mills R. The dynamics of water molecules in ionic solution: J. Phys. C: Solid State. Phys., 1987, 20, 5727-5747.
	Sulphate	$1.07x10^{-10}$	Buffle et.al
	Acenaphthene	$5.16E^{-10}$	Assumed similar to naphthalene
	Benzene	$6.64X10^{-10}$	Compilation of Data for Priority Organic pollutants for Derivation of Soil Guideline Values Science report SC050021/SR7
	Benzo(a)pyrene	$3.67X10^{-10}$	
	Aromatic C10 – C12	$5.16E^{-10}$	EA Compilation of Data for Priority Organic pollutants[23] - value for naphthalene used as representative of most conservative of Aromatic C10-C12 band
Contaminant Solubility (mg/l)	Acenaphthene	3.9	Handbook of Aqueous Solubility Data, Yalkowsky et al, 2010
	Benzene	1780	

[22] Buffle, Zhang & Startchev (1994) *Metal flux and dynamic specification at (bio)interfaces. Part I: Critical evaluation and compilation of physico-chemical parameters for complexes with simple ligands and fluvic/humic substances*

[23] Environment Agency (Nov 2008) *Compilation of Data for priority organic pollutants for derivation of soil guideline values*, Ref: SC050021/SR7

Item		Value/Description	Source of Data
	Benzo(a)pyrene	0.0038	Compilation of Data for Priority Organic pollutants for Derivation of Soil Guideline Values Science report SC050021/SR7
	Aromatic C10 – C12	25.0	CL:AIRE Petroleum Hydrocarbons in Groundwater[24]
Henrys Law Constant (dimensionless)	Acenaphthene	0.0049	EA 2003 Review of Fate and Transport of Selected Contaminants
	Benzene	0.182	
	Benzo(a)pyrene	0.000019	
	Aromatic C10 – C12	0.14	TPHCWG 1999

Hydrogeological Units

Item		Value	Source of Data
Attenuation Layer (Selected Cohesive Waste)	Unit Thickness (m)	1.0	Based on proposed thickness
	Hydraulic Conductivity (m/s)	$1x10^{-7}$	Proposed specification
	Hydraulic Gradient (m/m)	1.0676	Maximum potential head across sidewall of site given the effective infiltration into the waste of 120mm/year. $Q = KiA$ Where: Q = Infiltration In = Seepage out of Sidewall K = max conductivity ($1x10^{-7}$m/s) I = hydraulic gradient A = area of sidewall in contact with aquifer (3,000m^2). Silt-covered basal area (22,000 m^2) excluded to derive conservative worst case gradient
	Porosity	Min: 0.34 Max: 0.61	Based on range for silt and clay from ConSIM helpfile
	Bulk Density (kg/m^3)	Min: 1800 Max: 2400	Based on typical range for clay from ConSim helpfile
	FoC	Min: 0.01 Max: 0.1	Based on typical range for clay from ConSim Helpfile

[24] CL:AIRE (2017) *Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies*

Item		Value	Source of Data
River Terrace Deposits	Unit Thickness (m)	15-25	Estimated typical post-dewatering thickness of groundwater flow path including beneath quarried voids and to north of site
	Aquifer Width (m)	300	Equal to width of site (width where base of paleochannel is 10mAOD or lower)
	Hydraulic Conductivity (m/s)	Min: 0.00001 Max: 0.00006	Based on slug test results from site boreholes installed within the Sands and Gravels
	Hydraulic Gradient (m/m)	Min: 0.004 Max: 0.01	Based on potential range for groundwater rebounding after dewatering
	Porosity	Min: 0.24 Max: 0.46	Based on range for sands and gravels from ConSIM helpfile
	Bulk Density (kg/m^3)	Min: 1360 Max: 2190	Based on typical range for sands and gravels from ConSim helpfile
	FoC	Min: 0.00017 Max: 0.00125	Based on range for glacio-fluvial sands from ConSim helpfile

Attenuation Parameters

Item		Value	Source of Data
Arsenic Partition Coefficient (l/kg)	Attenuation Layer	Min: 25 Max: 250	Based on LandSim default
	River Terrace Deposits	0	Assumed 0 as worst case
Fluoride Partition Coefficient (l/kg)	Attenuation Layer	0.8	Based on ConSim Helpfile value for glacial till as representative of clayey overburden
	River Terrace Deposits	0	Assumed 0 as worst case
Lead Partition Coefficient (l/kg)	Attenuation Layer	Min: 990 ML: 1600 Max: 27000	Based on range for Loam from ConSim helpfile
	River Terrace Deposits	0	Assumed 0 as worst case
Mercury Partition Coefficient (l/kg)	Attenuation Layer	1500	ConSim Helpfile for Loam
	River Terrace Deposits	0	Assumed 0 as worst case
Nickel Partition Coefficient (l/kg)	Attenuation Layer	300	ConSim Helpfile for Loam
	River Terrace Deposits	Min 20 Max: 800	LandSim default range

Item		Value	Source of Data
Sulphate Partition Coefficient (l/kg)	Attenuation Layer	0	Assumed 0 as worst case
	River Terrace Deposits	0	Assumed 0 as worst case
Acenaphthene (Koc) (l/kg)	Attenuation Layer (no Koc modelled in Aquifer)	7079	EA 2003 Review of Fate and Transport of Selected Contaminants
Benzene (Koc) (l/kg)	Attenuation Layer (no Koc modelled in Aquifer)	68	Compilation of Data for Priority Organic pollutants SC050021/SR7
Benzo(a)pyrene (Koc) (l/kg)	Attenuation Layer (no Koc modelled in Aquifer)	128,825	
Aromatic C10 – C12 (Koc) (l/kg)	Attenuation Layer (no Koc modelled in Aquifer)	2510	EA R&D Report P2-228
Acenaphthene Half Life (Days)	Attenuation Layer (no half-life used in Aquifer)	Min: 12.3 Max: 102	Based on range of aerobic half-life from Howard et.al Handbook of Environmental Degradation Rates Naphthalene used as representative of Aromatic C10-C12
Benzene Half Life (Days)	Attenuation Layer (no half-life used in Aquifer)	Min: 5 Max: 15	
Benzo(a)pyrene Half Life (Days)	Attenuation Layer (no half-life used in Aquifer)	Min: 57 Max: 529.25	
Aromatic C10 – C12 Half Life (days)	Attenuation Layer (no half-life used in Aquifer)	Min: 0.5 Max: 20	

APPENDIX 05

RAM3 Model Results

BREAKTHROUGH Probabilistic Results **10000 Monte Carlo iterations**

Site Name: "Sandon North"

Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, Sand & Gravel, Down-Gradient Borehole

95 th Percentile Concentrations in mg/L in Down-Gradient Borehole

Compared with EAL target concentration in mg/L

	5.000E-03	7.500E-01	2.000E-04	1.000E-05	1.300E-02	2.230E+02

Time(years)	Species1 Arsenic	Species2 Fluoride	Species3 Lead	Species4 Mercury	Species5 Nickel	Species6 Sulphate
1	7.572E-24	1.617E-02	0.000E+00	0.000E+00	0.000E+00	1.357E+02
5	1.291E-06	4.896E-01	0.000E+00	0.000E+00	0.000E+00	1.284E+02
10	5.927E-04	5.164E-01	0.000E+00	2.159E-39	4.240E-33	4.540E+01
20	4.244E-03	1.270E-01	1.607E-34	6.374E-28	6.736E-25	5.632E+00
30	4.136E-03	1.709E-02	5.952E-31	4.862E-25	5.547E-20	6.987E-01
40	3.333E-03	2.156E-03	1.340E-26	1.454E-22	5.809E-17	8.669E-02
50	2.849E-03	2.683E-04	8.421E-24	3.680E-21	1.824E-13	1.075E-02
75	2.121E-03	1.456E-06	8.823E-19	8.788E-15	5.402E-09	5.768E-05
100	1.653E-03	8.338E-09	2.247E-14	6.869E-12	7.023E-07	0.000E+00
150	9.428E-04	0.000E+00	3.558E-10	4.266E-09	5.012E-05	0.000E+00
250	1.964E-04	0.000E+00	5.475E-07	4.544E-07	3.520E-04	0.000E+00
500	2.282E-06	0.000E+00	5.554E-05	5.937E-06	2.856E-04	0.000E+00
750	2.745E-08	0.000E+00	1.268E-04	7.361E-06	2.135E-04	0.000E+00
1000	3.405E-10	0.000E+00	1.333E-04	5.385E-06	1.664E-04	0.000E+00
2000	0.000E+00	8.427E-12	8.866E-05	5.330E-07	8.964E-05	7.520E-09
3000	0.000E+00	1.957E-11	6.369E-05	3.880E-08	6.389E-05	1.016E-08
5000	0.000E+00	2.584E-11	4.211E-05	2.100E-10	2.776E-05	9.013E-09
10000	1.522E-13	2.238E-11	2.096E-05	3.232E-15	7.414E-07	5.633E-09
15000	2.097E-13	1.753E-11	9.707E-06	0.000E+00	1.557E-08	4.011E-09
20000	2.096E-13	1.411E-11	4.011E-06	0.000E+00	3.358E-10	3.108E-09

Pollutant Linkage: Inert Waste, Attenuation Layer, Sand & Gravel, Down-Gradient Borehole

5 th Percentile Remedial Target Concentrations in mg/L in Inert Waste

Time(years)	Species1 Arsenic	Species2 Fluoride	Species3 Lead	Species4 Mercury	Species5 Nickel	Species6 Sulphate
1	6.547E+19	1.389E+02	1.000E+40	1.000E+40	1.000E+40	9.857E+02
5	3.761E+02	4.595E+00	1.000E+40	1.000E+40	1.000E+40	1.042E+03
10	8.371E-01	4.357E+00	1.000E+40	1.389E+31	3.633E+29	2.946E+03
20	1.177E-01	1.771E+01	1.845E+29	4.702E+19	2.305E+21	2.375E+04
30	1.208E-01	1.315E+02	4.984E+25	6.168E+16	2.806E+16	1.914E+05
40	1.498E-01	1.043E+03	2.154E+21	2.058E+14	2.682E+13	1.543E+06
50	1.753E-01	8.384E+03	3.503E+18	8.135E+12	8.151E+09	1.244E+07
75	2.358E-01	1.545E+06	3.245E+13	3.413E+06	2.870E+05	2.317E+09
100	3.023E-01	2.697E+08	1.327E+09	4.363E+03	2.201E+03	1.000E+40
150	5.302E-01	1.000E+40	8.311E+04	7.032E+00	3.112E+01	1.000E+40
250	2.546E+00	1.000E+40	5.463E+01	6.596E-02	4.422E+00	1.000E+40
500	2.190E+02	1.000E+40	5.384E-01	5.053E-03	5.453E+00	1.000E+40
750	1.814E+04	1.000E+40	2.353E-01	4.076E-03	7.307E+00	1.000E+40
1000	1.467E+06	1.000E+40	2.246E-01	5.570E-03	9.375E+00	1.000E+40
2000	1.000E+40	2.670E+11	3.382E-01	5.626E-02	1.739E+01	1.778E+13
3000	1.000E+40	1.150E+11	4.710E-01	7.731E-01	2.439E+01	1.316E+13
5000	1.000E+40	8.708E+10	7.113E-01	1.427E+02	5.592E+01	1.481E+13
10000	3.282E+09	1.005E+11	1.431E+00	9.282E+06	2.093E+03	2.375E+13
15000	2.385E+09	1.283E+11	3.088E+00	1.000E+40	9.972E+04	3.335E+13
20000	2.384E+09	1.595E+11	7.480E+00	1.000E+40	4.641E+06	4.304E+13

Compared with source concentrations in mg/L

	1.000E-01	3.000E+00	1.500E-01	3.000E-03	1.200E-01	6.000E+02

Pollutant Linkage: Inert Waste, Attenuation Layer, Sand & Gravel, Down-Gradient Borehole

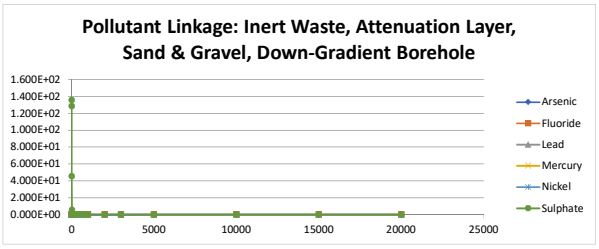
5 th Percentile Dilution Factor

2.270E+00

Pollutant Linkage: Inert Waste, Attenuation Layer, Sand & Gravel, Down-Gradient Borehole

5 th Percentile Attenuation Factor

Time(years)	Species1 Arsenic	Species2 Fluoride	Species3 Lead	Species4 Mercury	Species5 Nickel	Species6 Sulphate
1	2.299E+21	2.260E+01	1.000E+40	1.000E+40	1.000E+40	1.125E+00
5	1.605E+04	1.631E+00	1.000E+40	1.000E+40	1.000E+40	2.034E+00
10	3.499E+01	2.442E+00	1.000E+40	3.257E+35	4.882E+30	5.765E+00
20	5.035E+00	1.024E+01	2.306E+32	1.304E+24	2.916E+22	4.647E+01
30	6.397E+00	7.598E+01	4.929E+28	2.049E+21	3.434E+17	3.746E+02
40	8.469E+00	6.039E+02	2.474E+24	4.577E+18	3.208E+14	3.019E+03
50	1.062E+01	4.853E+03	3.804E+21	2.927E+17	1.059E+11	2.434E+04
75	1.616E+01	8.944E+05	3.466E+16	7.635E+10	3.791E+06	4.538E+06
100	2.180E+01	1.559E+08	1.389E+12	9.930E+07	3.069E+04	1.000E+40
150	3.333E+01	1.000E+40	8.426E+07	1.711E+05	4.420E+02	1.000E+40
250	1.267E+02	1.000E+40	5.640E+04	1.782E+03	5.395E+01	1.000E+40
500	9.803E+03	1.000E+40	5.859E+02	1.699E+02	8.628E+01	1.000E+40
750	8.283E+05	1.000E+40	2.423E+02	1.706E+02	1.362E+02	1.000E+40
1000	6.668E+07	1.000E+40	2.496E+02	2.289E+02	1.901E+02	1.000E+40
2000	1.000E+40	4.509E+10	4.662E+02	1.823E+03	4.204E+02	2.220E+10
3000	1.000E+40	2.713E+10	6.946E+02	2.268E+04	6.727E+02	2.109E+10
5000	1.000E+40	2.993E+10	1.149E+03	3.775E+06	1.704E+03	2.680E+10
10000	1.370E+11	4.734E+10	2.300E+03	2.601E+11	6.503E+04	4.520E+10
15000	1.138E+11	6.633E+10	3.856E+03	1.000E+40	3.037E+06	6.441E+10
20000	1.231E+11	8.549E+10	8.681E+03	1.000E+40	1.379E+08	8.369E+10



BREAKTHROUGH Probabilistic Results 10000

Site Name: "Sandon North"

Level3

Pollutant Linkage: Inert Waste, Attenuation Layer, Sand & Gravel, Down-Gradient Bore

95 th Percentile Concentrations in mg/L in Down-Gradient Borehole

Compared with EAL target concentration in mg/L

	1.000E-05	1.000E-03	1.000E-05	1.000E-02
Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyrene**	**Aromatic C10-C12**
1	0.000E+00	4.382E-05	0.000E+00	2.470E-39
5	0.000E+00	1.902E-05	0.000E+00	1.194E-32
10	0.000E+00	6.698E-06	0.000E+00	4.204E-33
20	0.000E+00	8.310E-07	0.000E+00	5.216E-34
30	0.000E+00	1.031E-07	0.000E+00	6.471E-35
50	0.000E+00	1.587E-09	0.000E+00	9.961E-37
75	0.000E+00	8.446E-12	0.000E+00	5.376E-39
100	0.000E+00	0.000E+00	0.000E+00	0.000E+00
150	0.000E+00	0.000E+00	0.000E+00	0.000E+00
250	0.000E+00	0.000E+00	0.000E+00	0.000E+00
500	0.000E+00	0.000E+00	0.000E+00	0.000E+00
750	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1000	0.000E+00	0.000E+00	0.000E+00	0.000E+00
1500	0.000E+00	1.502E-15	0.000E+00	0.000E+00
2500	0.000E+00	2.508E-15	0.000E+00	0.000E+00
5000	0.000E+00	1.913E-15	0.000E+00	0.000E+00
7500	0.000E+00	1.430E-15	0.000E+00	0.000E+00
10000	0.000E+00	1.132E-15	0.000E+00	0.000E+00
15000	0.000E+00	7.924E-16	0.000E+00	0.000E+00
20000	0.000E+00	6.105E-16	0.000E+00	0.000E+00

Pollutant Linkage: Inert Waste, Attenuation Layer, Sand & Gravel, Down-Gradient Bore

5 th Percentile Remedial Target Concentrations in mg/kg in Inert Waste

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyrene**	**Aromatic C10-C12**
1	1.000E+40	2.155E+02	1.000E+40	1.000E+40
5	1.000E+40	4.965E+02	1.000E+40	1.000E+40
10	1.000E+40	1.410E+03	1.000E+40	1.000E+40
20	1.000E+40	1.000E+40	1.000E+40	1.000E+40
30	1.000E+40	1.000E+40	1.000E+40	1.000E+40
50	1.000E+40	1.000E+40	1.000E+40	1.000E+40
75	1.000E+40	1.000E+40	1.000E+40	1.000E+40
100	1.000E+40	1.000E+40	1.000E+40	1.000E+40
150	1.000E+40	1.000E+40	1.000E+40	1.000E+40
250	1.000E+40	1.000E+40	1.000E+40	1.000E+40
500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
750	1.000E+40	1.000E+40	1.000E+40	1.000E+40

1000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
1500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
2500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
5000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
7500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
10000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
15000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
20000	1.000E+40	1.000E+40	1.000E+40	1.000E+40

Compared with source concentrations in mg/kg

2.000E+01	2.000E+00	2.000E+01	1.000E+02

Pollutant Linkage: Inert Waste, Attenuation Layer, Sand & Gravel, Down-Gradient Bore

5 th Percentile Dilution Factor

2.260E+00

Pollutant Linkage: Inert Waste, Attenuation Layer, Sand & Gravel, Down-Gradient Bore

5 th Percentile Attenuation Factor

Time(years)	Species1	Species2	Species3	Species4
	Acenaphthene	**Benzene**	**Benzo(a)pyrene**	**Aromatic C10-C12**
1	1.000E+40	1.479E+04	1.000E+40	2.617E+35
5	1.000E+40	3.408E+04	1.000E+40	5.585E+28
10	1.000E+40	9.674E+04	1.000E+40	1.586E+29
20	1.000E+40	7.798E+05	1.000E+40	1.278E+30
30	1.000E+40	6.285E+06	1.000E+40	1.030E+31
50	1.000E+40	4.084E+08	1.000E+40	6.693E+32
75	1.000E+40	7.672E+10	1.000E+40	1.239E+35
100	1.000E+40	1.000E+40	1.000E+40	1.000E+40
150	1.000E+40	1.000E+40	1.000E+40	1.000E+40
250	1.000E+40	1.000E+40	1.000E+40	1.000E+40
500	1.000E+40	1.000E+40	1.000E+40	1.000E+40
750	1.000E+40	1.000E+40	1.000E+40	1.000E+40
1000	1.000E+40	1.000E+40	1.000E+40	1.000E+40
1500	1.000E+40	4.395E+14	1.000E+40	1.000E+40
2500	1.000E+40	2.601E+14	1.000E+40	1.000E+40
5000	1.000E+40	3.417E+14	1.000E+40	1.000E+40
7500	1.000E+40	4.575E+14	1.000E+40	1.000E+40
10000	1.000E+40	5.764E+14	1.000E+40	1.000E+40
15000	1.000E+40	8.217E+14	1.000E+40	1.000E+40
20000	1.000E+40	1.068E+15	1.000E+40	1.000E+40

APPENDIX 06

Diffusion Model Parameterisation

Table A
Landfill Source & Containment Lining System

Parameter	Modelled Values	Derivation
Conceptual Model of Landfill Construction	2 – Flux through base and sidewalls of the landfill	Conservative worst case as flux through base will be restricted by thick silt cover on current lakebed
Basal Width Perpendicular to Groundwater Flow (m)	110	Based on quarry base
Basal Length Parallel to Groundwater Flow (m)	200	Based on quarry base
Elevation of Base of Landfill (maOD)	6.0	Average basal elevation from site surveys.
Elevation of Base of Aquifer (maOD)	-6.0 (i.e. below mAOD)	Average basal elevation based on site boreholes.
Leachate Head Inside Landfill (maOD)	17.9	Assumed worst case value (with a limited inward gradient) in correlation with predicted adjacent groundwater levels.
Groundwater Head outside Landfill (maOD)	18	Assumed adjacent recovering groundwater levels based on site monitoring data.
Liner Thickness (m)	1.0	Assumed engineered lining system will be 1 metre.
Liner Hydraulic Conductivity (m/s)	1×10^{-7}	Proposed specification
Liner Average Pore Radius (m)	1×10^{-5}	Typical value used in EA Diffusion Model Manual as conservative worst case
Liner Effective Porosity (fraction)	0.4	Most likely value from Tellam & Lloyd (1981).
Liner Dry Bulk Density (kg/m3)	2000	Mid-range value for clay using CONSIM helpfile.
Liner Tortuosity	5	Mid-range value from Freeze and Cherry (1979).
Geomembrane Present	No	Absent

Table B
Leachate Quality Data

Parameter	Modelled Values	Derivation
Acenaphthene (mg/l)	0.141	Maximum leachable concentrations in HRA Table 2-11
Aromatic C10-C12 (mg/l)	1.99	
Benzene (mg/l)	1.26	
Benzo(a)pyrene (mg/l)	0.00776	
Arsenic (mg/l)	0.1	Derived in mg/l from 2 X Inert WAC limit outlined in mg/kg within the Landfill

		Directive council decision annex 2003/33/EC
Fluoride (mg/l)	3	Derived in mg/l from 3 X Inert WAC limits outlined in mg/kg within the Landfill Directive council decision annex 2003/33/EC
Lead (mg/l)	0.15	
Mercury (mg/l)	0.003	
Nickel (mg/l)	0.12	
Sulphate (mg/l)	600	Sulphate may still be considered as complying with the acceptance criteria if the leaching does not exceed either of the following values: 1,500mg/l as C0 at L/S = 0.1l/kg and 6000mg/kg at L/S = 10l/kg.

Table C
Free Solution Diffusion Coefficients, Retardation and Half Lives

Parameter	Modelled Values	Derivation
Diffusion Coefficient Acenaphthene (m^2/s)	5.16×10^{-10}	Assumed similar to naphthalene (see below derivation for Aromatic C10-C12).
Diffusion Coefficient Aromatic C10-C12 (m^2/s)	5.16×10^{-10}	EA Compilation of Data for Priority Organic Pollutants - value for naphthalene used as representative of most conservative of Aromatic C10-C12 band.
Diffusion Coefficient Benzene (m^2/s)	6.64×10^{-10}	Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values Science report SC050021/SR7
Diffusion Coefficient Benzo(a)pyrene (m^2/s)	3.67×10^{-10}	
Diffusion Coefficient Arsenic (m^2/s)	3.52×10^{-10}	https://www.dgtresearch.com/diffusion-coefficients/
Diffusion Coefficient Fluoride (m^2/s)	1.48×10^{-9}	Value from Buffle et.al (1994) Metal flux and dynamic specification at (bio)interfaces
Diffusion Coefficient Lead (m^2/s)	9.45×10^{-10}	
Diffusion Coefficient Mercury (m^2/s)	2.00×10^{-9}	Supplementary information for the derivation of SGV for mercury, Science Report SC050021
Diffusion Coefficient Nickel (m^2/s)	7.05×10^{-10}	Salmon P. S., Howells W. S., Mills R. The dynamics of water molecules in ionic solution: J. Phys. C: Solid State. Phys., 1987, 20, 5727-5747
Diffusion Coefficient Sulphate (m^2/s)	1.07×10^{-10}	Value from Buffle et.al (1994) Metal flux and dynamic specification at (bio)interfaces
Acenaphthene Half Life (days)	102	Based on range of aerobic halflife from Howard et.al Handbook of Environmental Degradation Rates. Naphthalene used as representative of Aromatic C10-C12
Aromatic C10-C12 Half Life (days)	20	
Benzene Half Life (days)	15	
Benzo(a)pyrene Half Life (days)	529.25	
Fraction of Organic Carbon (fraction)	0.01	Lower end (worst case) value in ConSim range for clay.
Acenaphthene (Koc) (l/kg)	7079	EA 2003 Review of Fate and Transport of Selected Contaminants
Aromatic C10-C12 (Koc) (l/kg)	2510	EA R&D Report P2-228

Benzene (Koc) (l/kg)	68	Compilation of Data for Priority Organic pollutants SC050021/SR7
Benzo(a)pyrene (Koc) (l/kg)	128,825	
Arsenic (Kd) (l/kg)	25	LandSim default lower value
Fluoride (Kd) (l/kg)	0.8	Based on ConSim Helpfile value for glacial till as representative of clayey overburden
Lead (Kd) (l/kg)	990	Based on lowest value for Loam from ConSim helpfile
Nickel (Kd) (l/kg)	20	LandSim default lower value
Mercury (Kd) (l/kg)	1500	ConSim Helpfile for Loam
Sulphate (Kd) (l/kg)	0	Assumed zero as worst case

Table D
Geosphere Parameters for River Terrace Deposits

Parameter	Modelled Values	Derivation
Hydraulic Conductivity (m/s)	0.00001	Minimum value from site slug tests as a worst case
Regional Gradient	0.004	Based on potential minimum for groundwater rebounding after dewatering as worst case
Downgradient distance of compliance point from landfill (m)	70 Single Value	Approximate distance to compliance point BH1/97 from edge of landfill

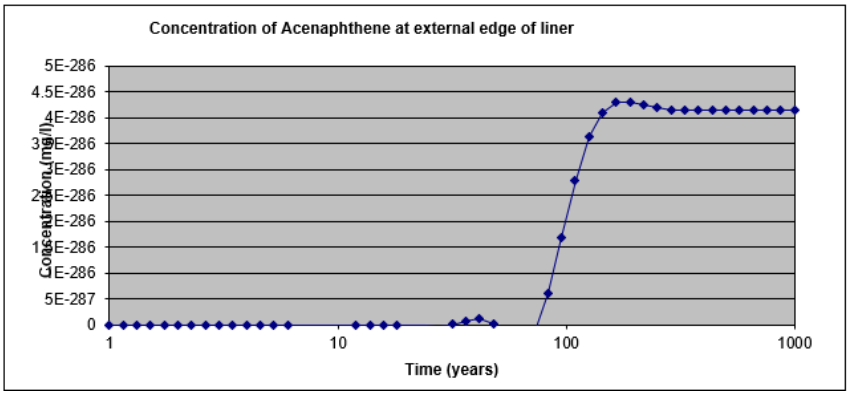
APPENDIX 07

Diffusion Model Results

Sandon North Diffusion Modelling - Results

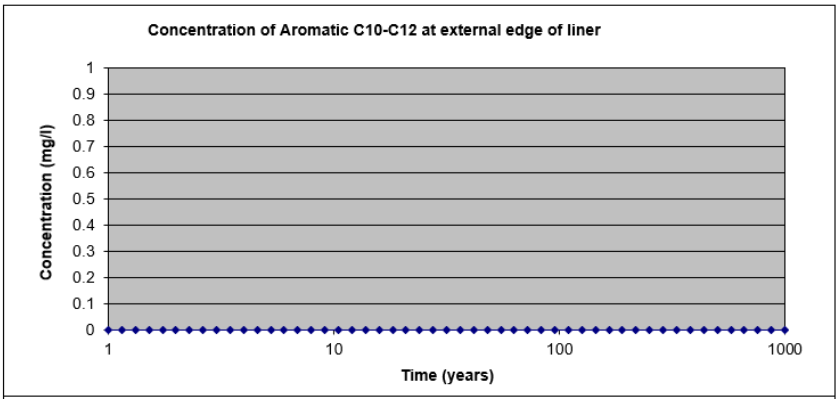
Acenaphthene

CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	4.3029E-286	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years



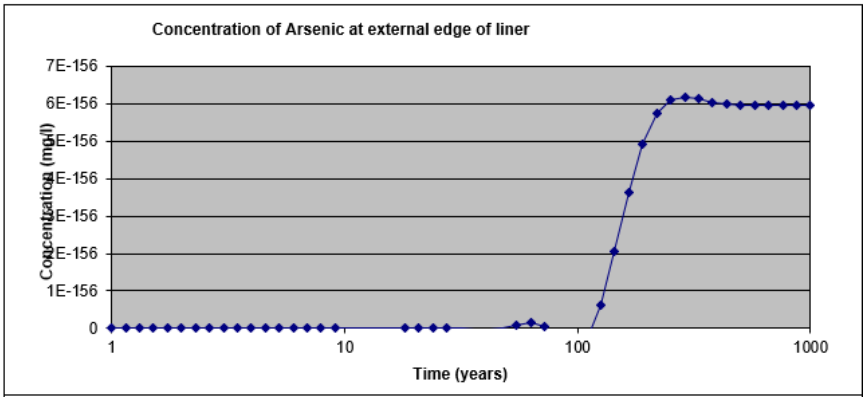
Aromatic C10-C12

CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	0	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years



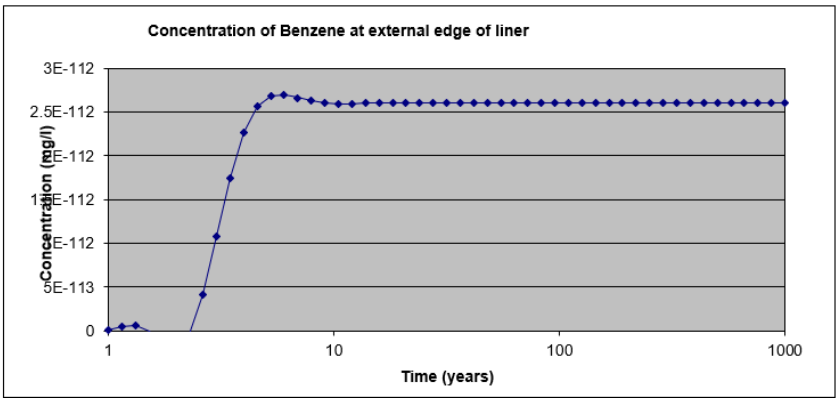
Arsenic

CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	6.1855E-156	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years



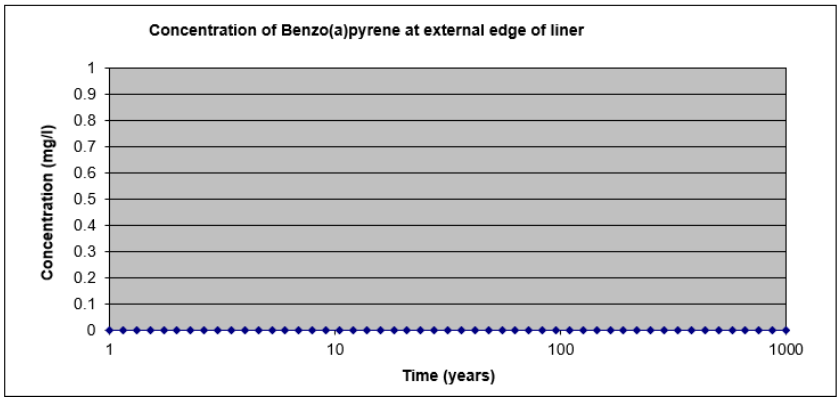
Benzene

CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	2.7E-112	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years



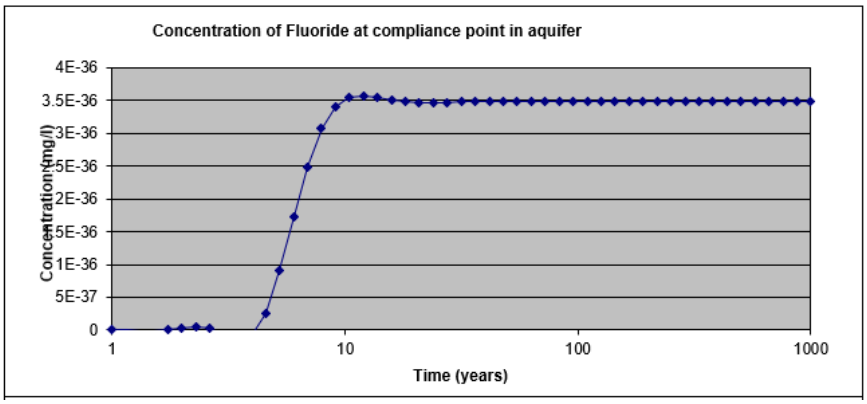
Benzo(a)pyrene

CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	0	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years



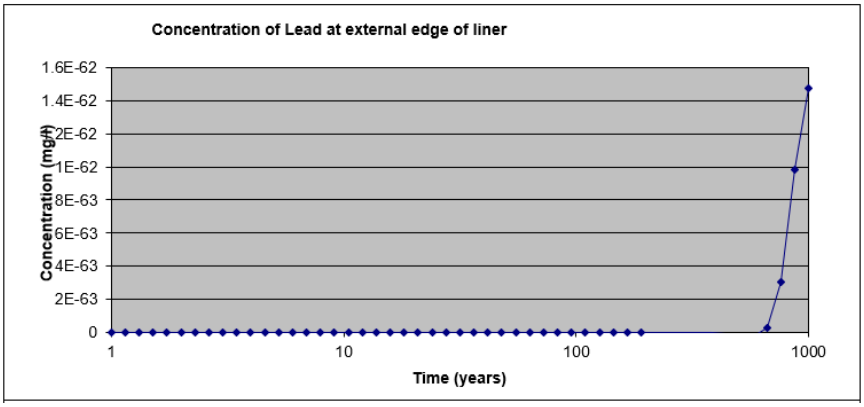
Fluoride

STEADY STATE DILUTION			
Hydraulic gradient in the aquifer	aq_I	0.004	-
Hydraulic conductivity of the aquifer	k_aq	1.00E-05	m/s
Downgradient distance of compliance point from landfill	dist_cp	70	m
Mixing width	Mix_W	110	m
Mixing depth	Mix_D	12	m
Dilution flow in aquifer directly under the landfill	aq_Q	0.0000528	m3/s
CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	3.57457E-36	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years



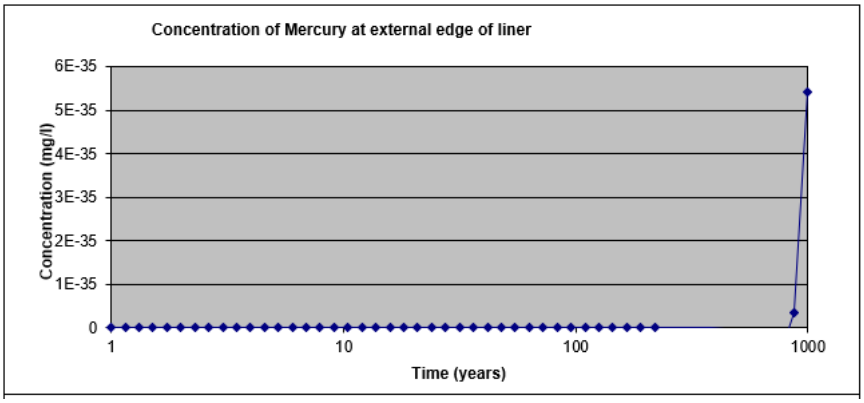
Lead

CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	1.47708E-62	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years



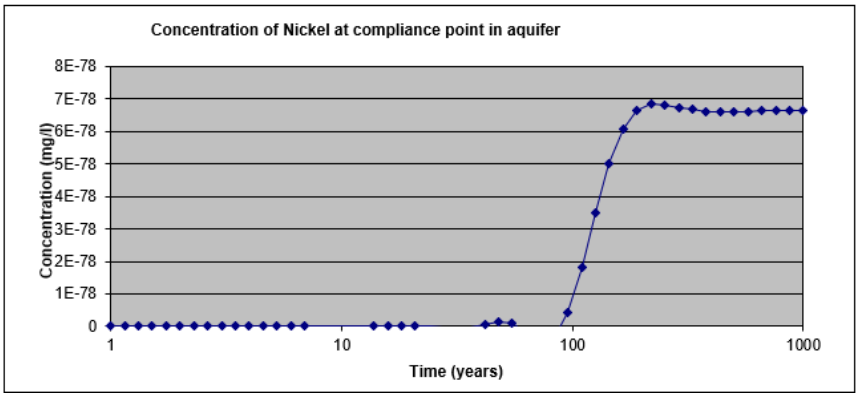
Mercury

CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	5.40943E-35	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years



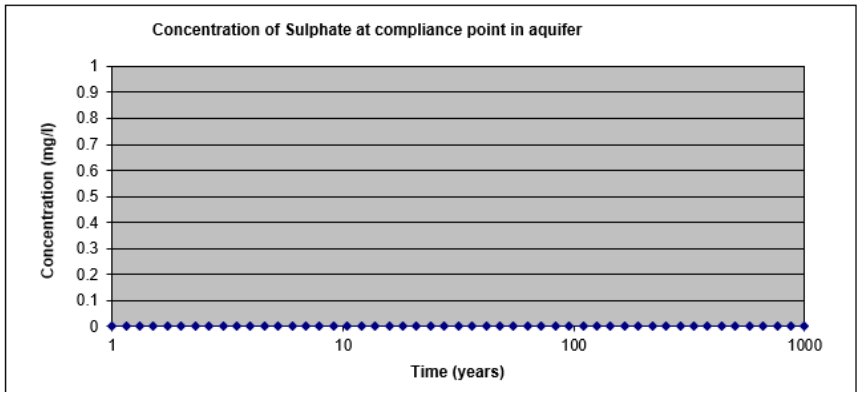
Nickel

STEADY STATE DILUTION			
Hydraulic gradient in the aquifer	aq_I	0.004	-
Hydraulic conductivity of the aquifer	k_aq	1.00E-05	m/s
Downgradient distance of compliance point from landfill	dist_cp	70	m
Mixing width	Mix_W	110	m
Mixing depth	Mix_D	12	m
Dilution flow in aquifer directly under the landfill	aq_Q	0.0000528	m3/s
CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	6.84428E-78	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years



Sulphate

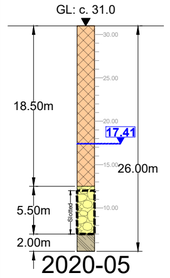
STEADY STATE DILUTION			
Hydraulic gradient in the aquifer	aq_I	0.004	-
Hydraulic conductivity of the aquifer	k_aq	1.00E-05	m/s
Downgradient distance of compliance point from landfill	dist_cp	70	m
Mixing width	Mix_W	110	m
Mixing depth	Mix_D	12	m
Dilution flow in aquifer directly under the landfill	aq_Q	0.0000528	m3/s
CONTAMINANT AND WATER FLUXES			
Groundwater flux into landfill		0.00058756	m3/s
Maximum contaminant concentration at compliance point at tmax	C_comp	0	mg/l
CHART PARAMETERS			
Minimum axis display	tmin	1	years
Maximum axis display	tmax	1.00E+03	years

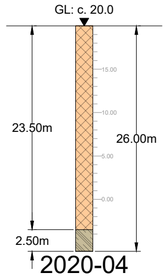


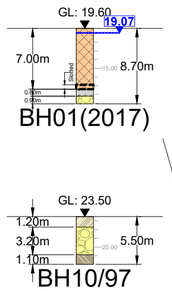
APPENDIX 08

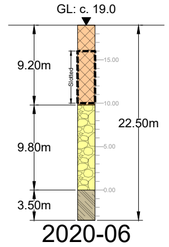
Electronic Copies of Models

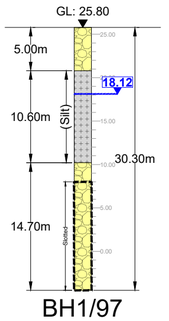
DRAWINGS

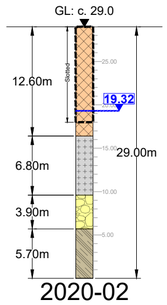


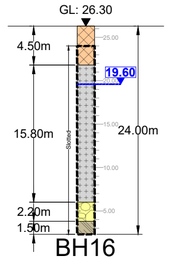


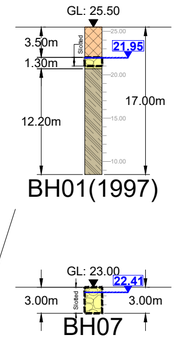


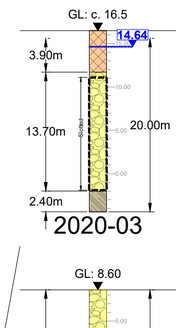


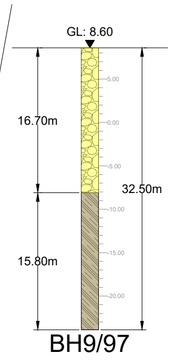


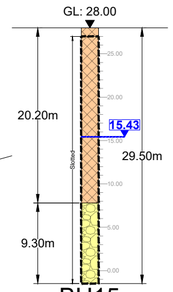


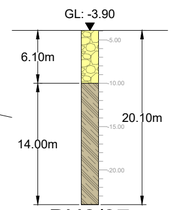


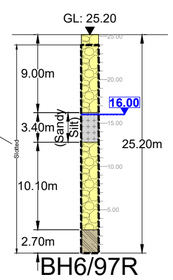


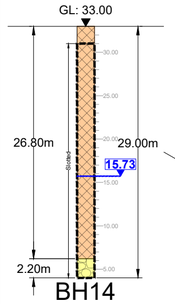


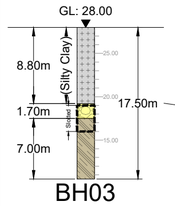


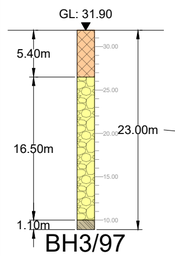


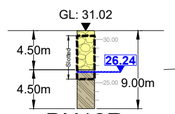


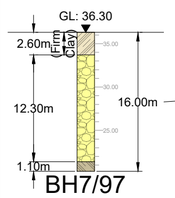


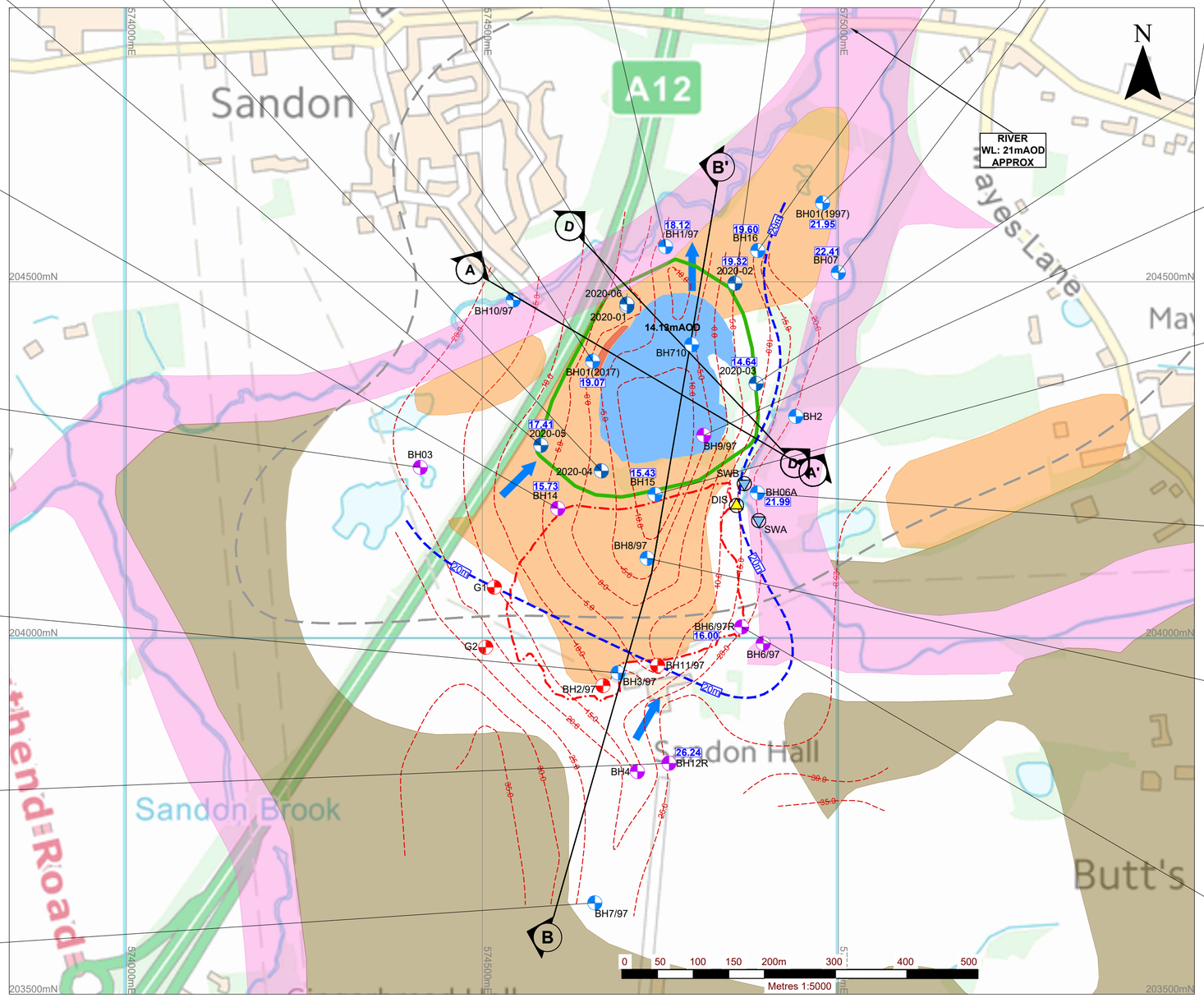












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BOREHOLE GEOLOGY

- FILL
- CLAY
- SAND & GRAVEL
- SILT / CLAY
- LONDON CLAY
- GROUNDWATER LEVEL (mAOD) OCTOBER 2020 (16.03)
- SLOTTED PIPE SECTION

NOTES

1. DRAWING INFORMATION SUPPLIED BY BRETT GROUP LTD, DRAWING REF: I/348 TOPOGRAPHICAL SURVEY OF RESTORED SITE 2018, DATED: 21.11.2018 & DRAWING REF: I/262 HAM FARM MONITORING LOCATIONS, DATED: 14.02.2017.

LEGEND

- PROPOSED ENVIRONMENTAL PERMIT BOUNDARY
- SOUTHERN VOID ENVIRONMENTAL PERMIT BOUNDARY
- SWA — SURFACE WATER SAMPLING LOCATION & REFERENCE
- DIS — PUMPED DISCHARGE FROM QUARRY LOCATION & REFERENCE
- GS1 — IN-WASTE GAS MONITORING LOCATION & REFERENCE
- BH14 — PERIMETER GAS MONITORING LOCATION & REFERENCE
- BH15 — GROUNDWATER MONITORING LOCATION & REFERENCE
- 2020-01 — 2020 GROUNDWATER MONITORING LOCATION & REFERENCE
- 26.7 — GROUNDWATER ELEVATION (mAOD) 13th MAY 2021
- 20m — INFERRED GROUNDWATER CONTOURS (mAOD)
- INFERRED GROUNDWATER FLOW DIRECTION
- 20.0 — TOP OF LONDON CLAY CONTOURS
- APPROXIMATE EXTENT PALEO CHANNEL
- APPROXIMATE OUTCROP OF LONDON CLAY
- APPROXIMATE EXTENT OF ALLUVIUM
- APPROXIMATE EXTENT OF MADE GROUND
- APPROXIMATE EXTENT OF SHINGLE BANK

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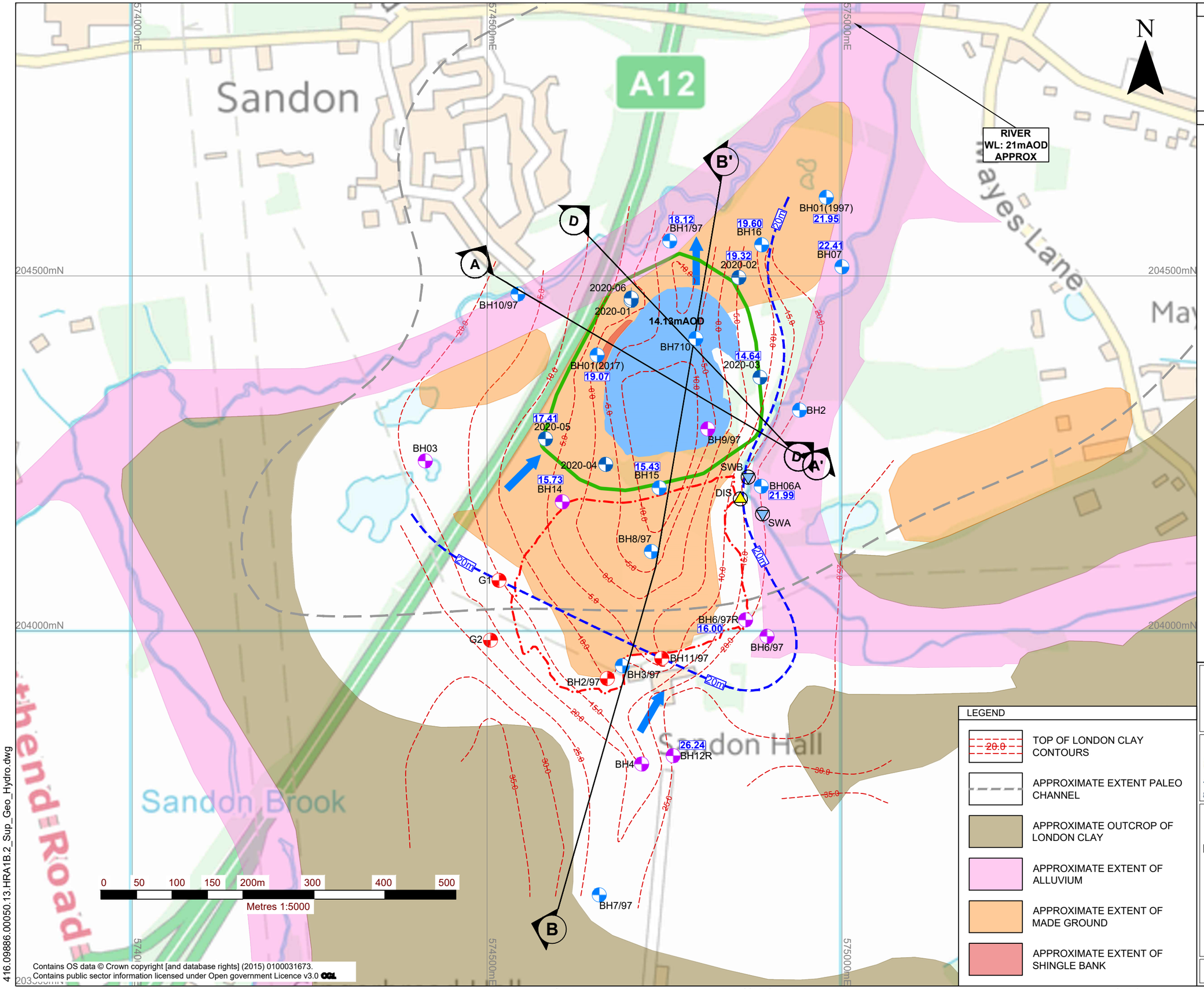
NORTHERN VOID RESTORATION

ENVIRONMENTAL PERMIT APPLICATION
HYDROGEOLOGICAL RISK ASSESSMENT

SUPERFICIAL GEOLOGY & HYDROGEOLOGY WITH BH LOGS

HRA1A

Scale: 1:5000 @ A2
Date: JANUARY 2022



NOTES

1. DRAWING INFORMATION SUPPLIED BY BRETT GROUP LTD, DRAWING REF: I/348 TOPOGRAPHICAL SURVEY OF RESTORED SITE 2018, DATED: 21.11.2018 & DRAWING REF: I/262 HAM FARM MONITORING LOCATIONS, DATED: 14.02.2017.

LEGEND

- PROPOSED ENVIRONMENTAL PERMIT BOUNDARY
- SOUTHERN VOID ENVIRONMENTAL PERMIT BOUNDARY
- SWA — SURFACE WATER SAMPLING LOCATION & REFERENCE
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- 20m — INFERRED GROUNDWATER CONTOURS (mAOD)
- INFERRED GROUNDWATER FLOW DIRECTION

LEGEND

- 20.0 — TOP OF LONDON CLAY CONTOURS
- APPROXIMATE EXTENT PALEO CHANNEL
- APPROXIMATE OUTCROP OF LONDON CLAY
- APPROXIMATE EXTENT OF ALLUVIUM
- APPROXIMATE EXTENT OF MADE GROUND
- APPROXIMATE EXTENT OF SHINGLE BANK

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HRA1B

Scale: 1:5000 @ A3
Date: JANUARY 2022

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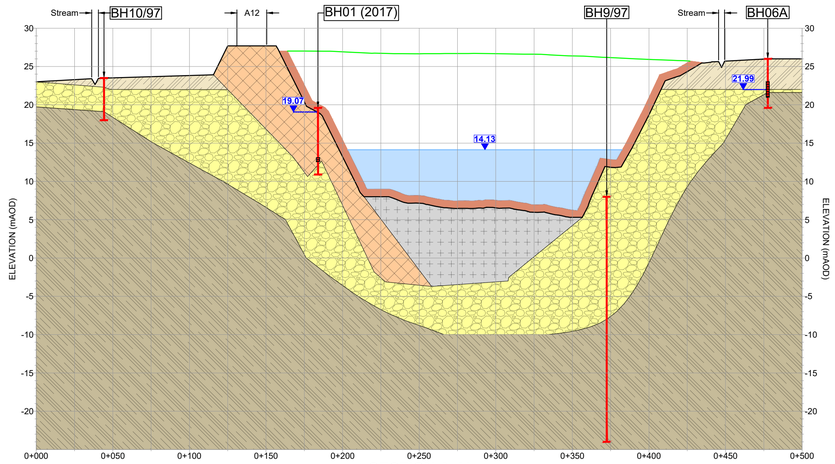
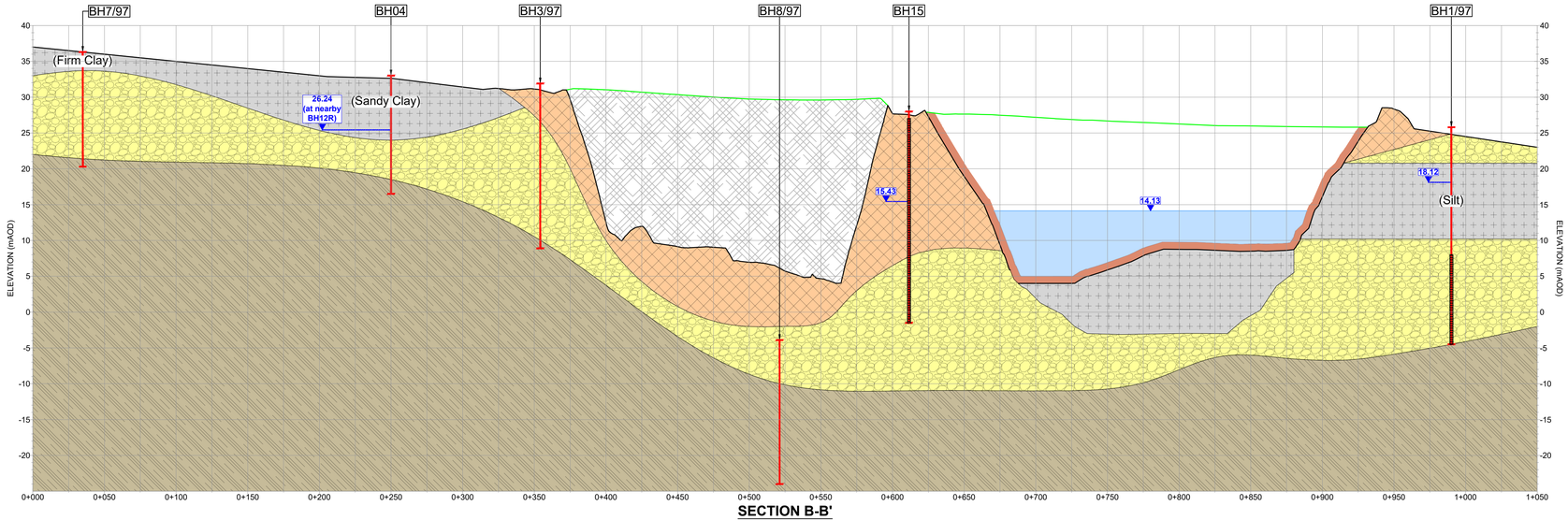
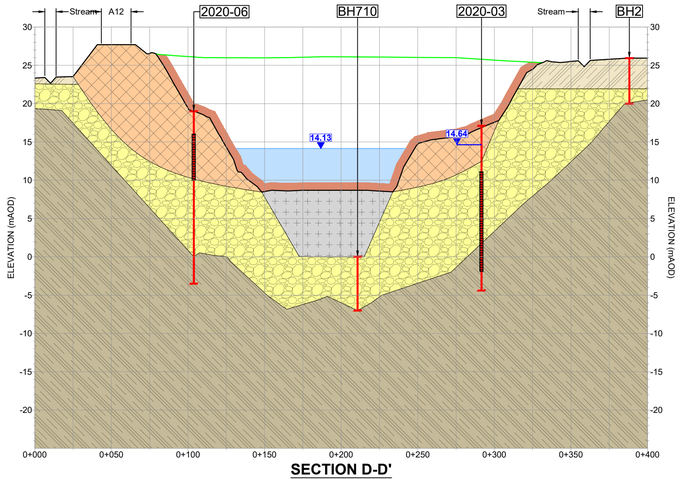


SECTION A-A'



SECTION B-B'



SECTION D-D'

0 5 10 15 20m
0 20 40 60 80m 120 160 200
Metres 1:400
Metres 1:2000

NOTES

1. DRAWING INFORMATION SUPPLIED BY BRETT GROUP LTD, DRAWING REF: I/348 TOPOGRAPHICAL SURVEY OF RESTORED SITE 2018, DATED: 21.11.2018 & DRAWING REF: I/262 HAM FARM MONITORING LOCATIONS, DATED: 14.02.2017.

LEGEND

- TOPOGRAPHIC SURVEY LEVEL PROFILE
- RESTORATION LEVEL PROFILE
- ARTIFICIAL ATTENUATION LAYER (1m THICK @ k ≤ 1 x 10^{-7} m/s)
- SURFACE WATER POND
- WASTE FILL
- ENGINEERED FILL
- ALLUVIAL CLAY
- SAND & GRAVEL
- SILT / CLAY
- LONDON CLAY
- BOREHOLE
- SLOTTED SECTION OF BOREHOLE
- 17.29 WATER LEVEL (MAY 2021)

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HYDROGEOLOGICAL RISK ASSESSMENT

HYDROGEOLOGICAL CROSS SECTIONS

HRA2

Scale	Date
1:2000 @ A1	JANUARY 2022

416.09886.00050.13.HRA2.2_Hydro_X_Sections.dwg

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