



PT-CE Ltd

PODE HOLE QUARRY

Deposit for Recovery Permit Application -
Hydrogeological Risk Assessment



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WSP

Attenborough House, Browns Lane Business Park

Stanton-on-the-Wolds

Nottingham

NG12 5BL

Phone: +44 115 9371111

WSP.com



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Signature				
Checked by	Nicola White			
Signature				
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ELECTRONIC COPY OF GOLDSIM MODEL

1 INTRODUCTION

1.1 TERMS OF REFERENCE

This Hydrogeological Risk Assessment (HRA) has been prepared by WSP UK Limited (WSP) on behalf of PT-CE Ltd (PT-CE) in support of its Environmental Permit (EP) for waste Deposit for Recovery (DfR) (hereafter referred to as the 'permit application') for Pode Hole Quarry, The Causeway, Thorney, Peterborough, PE6 0QH (hereafter referred to as the 'Site').

1.2 CURRENT DEVELOPMENT

The Site is located 1.85 km west of the village of Thorney and 5 km west of Peterborough. The A47 ('The Causeway') runs 460 m to the north of the Site and Willow Hall Lane runs along the western boundary of the Site. The Site extends to approximately 68.5 hectares (Ha). The Grid Reference for the centre of the Site is TF 25663 302876. Access to the Site is from the A47 to the north of the Site. **Drawing ESID1 – Site Location Plan** shows the location of the Site.

The current Site layout including the location of the Site entrance, reception, weighbridge and wheel wash are shown on **Drawing ESID4 – Site Layout and Waste Deposition**. Bar Pastures Quarry is located outside the EP application boundary, but activities at that location will share the Site entrance and associated facilities.

The Site is a shallow quarry for the extraction of sand and gravel operated by Aggregate Industries UK Ltd (Aggregate Industries). Quarry operations started at the Site in 1998 and ceased in November 2019. The material was extracted dry (i.e. the sands and gravels were temporarily dewatered by groundwater abstraction that took place from a point towards the north of the Site (at grid reference TF 26040,03040)). There is currently no dewatering occurring at the Site (dewatering activities ceased with the completion of quarrying activities). Surface water and groundwater from the shallow aquifer accumulate to form shallow pools. Dewatering continues at the neighbouring Bar Pastures Quarry and the Land Logical sites. Most of the aggregate has already been extracted from the Site and there are no longer any quarrying operations taking place at the Site.

Surface water is currently discharged to one of the Sites silt lagoons for infiltration to groundwater. Clean outflow from the lagoon falls to Internal Drainage Board (IDB) drains.

Within the quarry void are semi-restored areas backfilled with overburden materials, areas where the underlying Oxford Clay has been excavated and replaced in engineered layers, and stockpiles of sub-soil and topsoil.

Land immediately to the north of the Site has been progressively restored where quarrying operations have previously been completed under separate planning permissions, as shown on **Drawing ESID6 – Restoration Plan**. This restoration has taken place using site-derived overburden from quarrying operations only, and no waste has been imported to date.

A clay batter was installed in 2016/2017 along an approximately 300 m section of the quarry sides in order to provide protection from deterioration of a nearby scheduled ancient monument (Iron Age and Roman Settlement at Bar Pastures) from the operations at the Site.

1.3 PROPOSED DEVELOPMENT AND PROJECT OBJECTIVES

Aggregate Industries has engaged Quarry Restoration Partnerships Ltd to deliver restoration of the Site. The restoration proposal for the Site is described in Planning Permission Ref.

18/02044/MMFUL dated 12 April 2019 for the “Importation of up to 1,807,000 cubic metres of inert waste to restore Pode Hole Quarry”.

The Directive on Waste (2008/98/EC), amended in 2018 (2018/851) includes a definition of ‘backfilling’ as a recovery operation where suitable non-hazardous waste is used for reclamation in excavated areas or for engineering in landscaping (i.e. waste material is used instead of non-waste material to perform a function). To take advantage of this definition, Planning Permission Ref. 19/01373/NONMAT dated 16 October 2019 was subsequently issued to amend the wording of Condition 20 and 22 of Planning Permission Ref. 18/02044/MMFUL to remove reference to the ‘waste hierarchy’ and refer to the use of ‘inert materials’ to restore the quarry as opposed to ‘waste materials’. This is to enable restoration to be performed as a waste for recovery operation rather than as landfilling of waste.

Restoration of the Site will be undertaken using either site-won topsoil or by selected imported waste soils. The waste soils imported will be placed as subsoils. The topsoil will be stripped from relevant areas of the Site, stored and then placed on top of the imported waste. This will ensure that the imported waste is not used as a growing surface medium.

On completion of filling to final levels, the majority of the Site will be restored back to farmland and has been designed to create a congruous landform that contains similar profiles and features to the surrounding landscape. The restored landform will maintain the existing direction of surface drainage towards the southeast of the Site. The southeast corner of the Site will be restored as grassland and wetland with a wildlife pond.

This document forms the HRA to support the DfR permit application for restoration of the site and aims to assess the potential impacts of restoring the quarry with inert materials. This report should be read in conjunction with the updated Environmental Setting and Installation Design (ESID) Report (report ref. UK0038843_2142-WSP-RP-GW-0002).

Enhanced pre-application advice was sought from the Environment Agency ahead of this EP application (EA, ref. EPR/JP3220LG/P001 dated 11 March 2025). Guidance received in relation to the Hydrogeological Risk Assessment has been referenced where appropriate throughout this document.

1.4 REPORT STRUCTURE

This report presents the HRA for the Pode Hole Quarry DfR as follows:

- Section 2 summarises the conceptual hydrogeological model;
- Section 3 summarises the modelling developed;
- Section 4 summarises the review of technical precautions in place; and
- Section 5 summarises the requisite surveillance in place.

2 CONCEPTUAL HYDROGEOLOGICAL MODEL

2.1 DEFINITIONS

In the definition that has become accepted by the environmental and waste industries, there are three components to any risk assessment:

- The source is the potentially contaminating components of the leachate that will be generated by the collection of infiltrating precipitation in the waste;
- The pathways are any routes linking the source with the receptors, including the unsaturated zone in which degradation processes may occur; and
- The receptors are groundwater and surface water bodies that are connected to the source by the pathways, such as surface watercourse, local supply boreholes, or springs.

These three components are linked within a hydrogeological conceptual model for a site. Should either one of the source, pathway or receptor be absent from the site setting, negligible risk will be posed to the groundwater and surface water environment.

In relation to Deposit for Recovery Permits, EA guidance states that you must carry out a qualitative risk assessment, which may lead to a quantitative risk assessment if your waste recovery activity is in a sensitive location or could result in an unacceptable discharge.

A summary of each component of the risk assessment is provided in the following sections.

2.2 SOURCE

2.2.1 PROPOSED DESIGN AND CONSTRUCTION

The landfilling operations will consist of progressive restoration of the void remaining after the sand and gravel extraction. The estimated volume of the void is 1.8 million m³ across an area of 617,500 m². The Waste Recovery Plan has estimated that 2,700,000 tonnes will be imported to Site, based on an estimated waste density of 1.5 tonnes/m³. It is proposed to fill the quarry void in 10 phases as shown on **Drawing ESID4 – Site Layout and Waste Deposition** over a period of approximately 10 years at a rate of approximately 270,000 tonnes per year.

The basal geological barrier will be created by the *in-situ* Oxford Clay. The Oxford Clay is more than 10 m thick in the vicinity of the Site. In accordance with the Landfill Directive for inert landfill, a geological barrier with a minimum specification of 1 m thickness and 1×10^{-7} m/s, permeability (or equivalent) is required. The attenuation layer will be created using excavated Oxford Clay.

The attenuation layer will conform to a specification contained within a Construction Quality Assurance (CQA) Plan submitted to the EA prior to construction in accordance with the Environmental Permit. Cell design and CQA procedures for engineering the attenuation layer system are defined within the CQA Plan. A CQA Validation Report, which presents the final as built construction and engineered details of each cell, is submitted to the EA after construction.

A clay batter was installed in 2016/2017 along an approximately 300 m section of the quarry sides in the southwest corner of the Site (see **Drawing ESID4 – Site Layout and Waste Deposition**). It is understood that the clay batter was constructed in approximately 300 mm layers and compacted with a sheepfoot roller, but no further details have been made available.



This section will be conformance tested in accordance with the requirements of the CQA Plan and be accepted for inclusion following receipt of conforming test results. Should any of the conformance test results not attain the required values, suitable remediation work, as approved by the CQA Engineer, shall take place initially and retesting undertaken to confirm acceptance.

Dry inert waste will be placed into each phase as the works progress. The inert waste will be deposited in discreet layers, no greater than 300 mm in thickness. Compaction of the inert waste will reduce the amount of settlement and allow restoration to be completed to the approved levels, as shown in **Drawing ESID6 – Restoration Plan**.

2.2.2 LEACHATE MANAGEMENT

Leachate collection and management will not be required as the Site will only accept inert waste.

2.2.3 WASTE CHARACTERISATION

The Site will be designed and operated to accept only inert wastes as defined in Article 2(e) of the Landfill Directive 1999/31/EC. Types of waste accepted at Site will be limited to the waste codes, with further restrictions, as listed in Table ESID2-1 of the ESID report. Waste must be tested to ensure it meets the appropriate Leaching Limit Values (LLV / LLVs) for inert waste. Current guidance for deposit for recovery guidance (EA, 2023a) states that, for eleven specified waste codes (ten of which are included in the proposed waste list for the Site)), waste producers do not need to test their waste if the waste comes from a single source, is well characterised and described, and carries no risk of contamination (i.e. these waste codes will exclude material from contaminated sites). Otherwise, the waste producer must test their waste and provide the results of any analysis to the deposit for recovery site.

The Site must also test each waste stream using the same methods and techniques as the waste producer (where known) one to three times per year, depending on the operator’s knowledge of the waste and its variability. Any waste which fails to meet the LLVs must be removed from Site. The Site is also required to retain all analysis testing results to be submitted as part of the Site’s permit surrender application.

The results of the testing must be within the LLVs provided in **Table 2-1**, detailed in “Criteria and Procedures for the Acceptance of Waste at Landfills”, Annex 2003/33/EC to Landfill Directive 1999/31/EC. **Table 2-1** also presents screening of the LLVs against the relevant Water Quality Standards (WQS) for hazardous and non-hazardous substances.

Table 2-1 – Inert Waste Acceptance Criteria – Leaching Limit Values

Parameter	Hazardous/ Non-hazardous	Inert Waste Limit Values L/S=10 l/kg mg/kg	Inert Waste Limit C ₀ [^] µg/l	DWS/EQS# µg/l	MRV/ LoQ µg/l	Inert Waste Limit C ₀ multiple of WQS
Arsenic	Hazardous	0.5	60	10	5	12
Barium	Non-hazardous	20	4,000	1,000	-	4
Cadmium	Non-hazardous	0.04	20	0.08	-	250
Chromium	Non-hazardous	0.5	100	4.7 ³	-	21.3
Copper	Non-hazardous	2	600	1	-	600

Parameter	Hazardous/ Non-hazardous	Inert Waste Limit Values L/S=10 l/kg mg/kg	Inert Waste Limit C ₀ [^] µg/l	DWS/EQS [#] µg/l	MRV/ LoQ µg/l	Inert Waste Limit C ₀ multiple of WQS
Mercury	Hazardous	0.01	2	0.07	0.01	200
Molybdenum	Non-hazardous	0.5	200	70	-	2.86
Nickel	Non-hazardous	0.4	120	4	-	30
Lead	Hazardous	0.5	150	1.2	0.2	750
Antimony	Non-hazardous	0.06	100	5	-	20
Selenium	Non-hazardous	0.1	40	10	-	4
Zinc	Non-hazardous	4	1,200	10.9	-	110
Chloride	Non-hazardous	800	460,000	250,000	-	1.84
Fluoride	Non-hazardous	10	2,500	1,500	-	1.67
Sulphate	Non-hazardous	1,000	1,500,000	250,000	-	6
Total Dissolved Solids	Non-hazardous	4,000	-	-	-	-
Phenol Index	Non-hazardous	1	300	-	-	-
Dissolved Organic Carbon	Non-hazardous	500	160,000	-	-	-
Total Organic Carbon	Non-hazardous	30,000*	-	No abnormal change	-	-
BTEX	Hazardous	6	-	1 (benzene)	1 ²	-
Polychlorinated Biphenyls (7 congeners)	Hazardous	1	-	-	0.001	-
Mineral oil (C10-C40)	Non-hazardous	500	-	0.1	-	-
Polycyclic Aromatic Hydrocarbons	Hazardous	Limit value will be set by the UK	-	Note ¹ :		
				0.00017	0.04	-
				benzo(a)pyrene:		
				0.00001	0.05	-

In the case of soils, a higher limit value may be admitted by the Environment Agency, provided the Dissolved Organic Carbon (DOC) value of 500mg/kg is achieved at LS10 at its own pH or at pH 7.

- Standard not available, no multiples of standard. [^] C₀ Concentration is the initial leachate concentration of the waste. Concentrations in leachate are expected to decrease over time.

Value is the lowest of UK DWS and EQS, where available.

¹ The UK DWS for Polyaromatic Hydrocarbons is for the sum of the detected and quantified concentrations of specified compounds benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene. LoQ for these four compounds is 0.00005 µg/l except for indeno(1,2,3-cd)pyrene which is 0.00004 µg/l.

² MRV for benzene is 1 µg/l, for toluene is 4 µg/l, for xylenes is 3 µg/l, no MRV/LoQ for ethyl-benzene.

³ EQS for total chromium is not available, EQS value is for Chromium III.

Table 2-1 indicates that even though concentrations will be limited to the Inert Waste LLVs, the waste could still contain both hazardous substances and non-hazardous pollutants above Water Quality Standards in some cases, in particular hazardous metals. Though the requirements for waste acceptance procedures are robust, it is also possible that rogue loads containing contaminated material may inadvertently be accepted at the Site introducing concentrations of substances listed in Table 2-1 above the WQS.

2.2.4 ASSESSMENT OF PRIORITY CONTAMINANTS

Of the contaminants listed in Table 2-1, ammoniacal nitrogen, chloride and sulphate are ubiquitous in both waste and naturally occurring material. Chloride and sulphate are also highly mobile in groundwater. Arsenic and lead are both classified as hazardous metals. Nickel is highly mobile in groundwater and is classified as a non-hazardous metal. Of the hydrocarbons which have the potential to be present in rogue loads, benzene is present in fuels and many other materials and may enter the waste via leaks from plant processing and transporting the waste and is therefore considered a good representative hydrocarbon.

For the purposes of assessment, it is proposed that the priority contaminants to be assessed for the Deposit for Recovery activity should be:

- Lead – hazardous less mobile metallic ion.
- Arsenic – hazardous less mobile metallic ion.
- Ammoniacal nitrogen – non-hazardous inorganic chemical.
- Chloride – non-hazardous more mobile inorganic cation.
- Sulphate – non-hazardous inorganic cation.
- Nickel – non-hazardous more mobile metallic ion.
- Benzene – hazardous hydrophobic organic chemical.

2.3 PATHWAYS

2.3.1 GEOLOGY

2.3.1.1 Regional Geology

The British Geological Survey Sheet 158 for Peterborough (1:50,000 scale) and BGS Geoindex indicates that the Site is underlain by Quaternary River Terrace deposits which overlie the Jurassic Oxford Clay Formation and Kellaways Sand. The geological succession is summarised in **Table 2-2**.

Table 2-2 – Summary of Regional Geology

Age	Formation	Description	Approximate Thickness (m)
Quaternary	River Terrace Deposits	Sand and gravel, locally with lenses of silt, clay or peat	Variable
Jurassic	Oxford Clay (Lower Part – Peterborough Member)	Olive grey fossiliferous, bituminous shale and blocky mudstone	63 – 76 m
	Kellaways Sand	Grey clayey silt and mud	1.9 – 6.4 m
	Kellaways Clay	Grey fissile mudstone	1.4 – 5.8 m
	Cornbrash	Fine grained shell-detrital limestone	1.2 – 4.3 m
	Blisworth Clay	Grey/Green mudstone with thin limestone	3.0 – 6.0 m
	Blisworth Limestone	Shell-detrital to micritic limestone with marl and mudstone	1.9 – 5.1 m

There is a small area of Tidal Flat deposits mapped in the southern part of the Site and no superficial deposits are mapped along the eastern part of the Site. The River Terrace Deposits are also mapped to the west and south of the Site but are not laterally extensive; other superficial deposits such as Tidal Flat Deposits, which normally comprise a soft silty clay, and Peat dominate the mapped superficial geology east of the Site and further to the south. No faults are mapped at the Site.

2.3.1.2 Local Geology

Current ground levels in the surrounding area are fairly flat and at about 3 m above Ordnance Datum (AOD). The Site currently has a shallow undulating landform that is mostly below surrounding ground level.

Within the quarry void are semi-restored areas backfilled with overburden materials, areas where the underlying Oxford Clay has been excavated and replaced in engineered layers, and stockpiles of sub-soil and topsoil.

There are four BGS borehole records located within the Site (BGS, 2023 – BGS borehole references TF20SE4, TF20SE5, TF20SE50 and TF20SE51). These describe the local geology as comprising topsoil over silty sands, and sand and gravel to between about 4 m and 6 m below ground level, underlain by a grey, blue-grey or bluish-green clay. This geology correlates well with additional logs from boreholes and trial pits completed in 1989, 1991 and 2017 on nearby parcels of land also targeted for sand and gravel reserves (Aggregate Industries, 2017 and 2018). These show topsoil underlain by around 3 m to 8 m (but typically to about 6 m) of alternating layers of sand and gravel, and silty clay (River Terrace Deposits), that are underlain by a grey clay (Oxford Clay).

A deeper BGS borehole (TF20SW53) located approximately 850 m to the south-west of the site reports 0.61 m of topsoil with underlying River Terrace Deposits to a depth of 8.23 m BGL (thickness of 7.62 m), and then Oxford Clay to a depth of 18.59 m BGL (thickness of 10.36 m), beneath which lies the “Kellaways Beds” comprising 0.31 m of “stone” to 18.9 mBGL (likely to be the Kellaways Sands) over 5.18 m “blue clay” to 24.08 mBGL (likely to be the Kellaways Clay). Another BGS

borehole in the vicinity of the Site (TF20SW55) recorded a thickness of Oxford Clay of 15.24 m and Kellaways Sand of 1.53 m.

Six monitoring wells were installed at the Site during April 2024 (Key GeoSolutions, 2024). The works involved drilling six boreholes to depths ranging between 4.0 and 7.4 metres below ground level (mBGL) and installing monitoring wells (BH01 to BH06) to depths ranging between 3.0 mBGL and 6.1 mBGL. The geology encountered is summarised in **Table 2-3** and broadly correlates with that found in BGS boreholes and during earlier ground investigations.

Table 2-3 – Summary of Geology Encountered by 2024 Ground Investigation

Depth (mBGL)	Thickness (m)	Geology
0.5 – 0.7	0.5 – 0.7	Soft dark brown sandy clay topsoil
0.5 – 1.1	0.2 – 0.4	Soft brown mottled orange brown slightly sandy gravelly clay – River Terrace Deposits
0.7 – 0.8	0.1	BH05 only: Mottled brown slightly clayey gravelly sand – River Terrace Deposits
0.7 – 6.4	2.2 – 5.5	Orange brown slightly clayey very sandy gravel (flint and sst) – River Terrace Deposits A layer of soft grey slightly gravelly silt was encountered in BH02 from 5.0-5.1 mBGL (0.1 m thick), in BH05 from 2.8-4.1 mBGL (1.3 m thick) and in BH06 from 2.9-4.0 mBGL (1.1 m thick).
3.0 – 7.4 (Base not proven)	1-1.1 (Thickness not proven)	Stiff to very stiff bluish grey clay - Oxford Clay

2.4 GROUNDWATER

2.4.1 HYDROGEOLOGY

Groundwater dewatering activities at Site took place while the quarry was active but have now ceased. Dewatering continues at the neighbouring Bar Pastures Quarry and the Land Logical sites to the west of the Site.

Groundwater flow in the near-surface superficial deposits is likely to be heavily influenced by the surface network of drainage dikes and the River Nene. It will also be influenced groundwater abstractions that are dewatering the sands and gravels for mineral extraction. Therefore, natural groundwater flow in the area is likely to be towards major drainage ditches and the River Nene to the south but may be locally and temporarily influenced by dewatering to the west.

2.4.2 GROUNDWATER LEVELS AND FLOW

Water strikes recorded on the BGS borehole records located within the Site boundary (BGS, 2023 – BGS borehole references TF20SE4, TF20SE5, TF20SE50 and TF20SE51) indicate groundwater was encountered near, or within about 2 m of, the surface.



Additional information supplied for five monitoring boreholes on site (referred to as Locations A-E) provides groundwater level data between 2017 and 2023. Groundwater level in these boreholes ranged between 1.1 and 3.8 m from the surface.

The response zones of all six boreholes installed during April 2024 are located within the River Terrace Deposits. Fourteen groundwater monitoring rounds were carried out between April 2024 and April 2025, inclusive. Groundwater level data is included in **Appendix HRA1** and summarised in **Table 2-4**.

The groundwater levels encountered during 2024 and 2025 appear to be lower than those encountered between 2017 and 2023 in Locations A-E however it is difficult to compare without elevation information.

Table 2-4 – Summary of Groundwater Statistics (April 2024 to April 2025)

Loc.	Depth Range (mBGL)	Elevation Range (mAOD)	Range (m)	Minimum (mAOD)	Median (mAOD)	95th %ile (mAOD)	Maximum (mAOD)	St Dev (mAOD)
BH01	3.44 – 3.84	-1.22 – -0.82	0.40	-1.22	-0.98	-0.86	-0.82	0.10
BH02	3.65 – 6.65	-3.85 – -0.85	3.00	-3.85	-1.02	-0.86	-0.85	1.16
BH03	3.34 – 4.24	-1.62 – -0.72	0.90	-1.62	-1.45	-0.87	-0.72	0.28
BH04	6.25 – 6.86	-4.66 – -4.05	0.61	-4.66	-4.58	-4.24	-4.05	0.16
BH05	3.79 – 4.22	-2.37 – -1.94	0.43	-2.37	-2.08	-1.97	-1.94	0.12
BH06	3.62 – 4.6	-3.4 – -2.42	0.98	-3.40	-2.92	-2.49	-2.42	0.26

All measured groundwater levels in BH01 and BH04 are below the base of the installed well and the last three measurements recorded for BH02 are also below the base of the installed well. These boreholes are therefore assumed to be dry.

Groundwater flow in the near-surface superficial deposits is likely to be heavily influenced by dewatering activities at nearby quarries, the surface network of drainage dikes, and the River Nene. It will also be influenced by groundwater abstractions that are dewatering the sands and gravels for mineral extraction. Therefore, natural groundwater flow in the area is likely to be towards major drainage ditches and the River Nene to the south but may be locally and temporarily influenced by dewatering to the west.

2.5 RECEPTORS

The specific receptors that are considered in this HRA are:

- The groundwater beneath and adjacent to the Site (including groundwater abstractions); and
- Surface water drains (including surface water abstractions).

2.5.1 GROUNDWATER BENEATH AND ADJACENT TO SITE

2.5.1.1 Aquifer Status

Although not apparent at the scale available online¹, in their pre-application response the EA state that the superficial deposits (River Terrace Deposits) at the Site are classified as a Secondary A Aquifer. Secondary A aquifers are 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. The hydrogeological map of England and Wales (DEFRA, 2023) indicates that such superficial deposits, which mainly comprise silty clays, could provide limited supplies of uncertain quality from the sand and gravel components.

The bedrock aquifer (Oxford Clay) designation is 'unproductive'. The Oxford Clay Formation comprises largely clays that confine underlying aquifers and is described as rocks with essentially no groundwater (BGS, 2023).

Groundwater vulnerability is classified as medium-low over most of the Site. The eastern-most part of the Site is located on an area classified as being unproductive, so has no groundwater vulnerability classification.

2.5.1.2 Water Supplies and Groundwater Abstractions

The Site is not located in a Source Protection Zone (SPZ) or near any water supplies for human consumption. Groundwater abstraction in the area is mainly to support the mineral industry (i.e. for dewatering or mineral processing). Surface water abstraction is largely used for irrigation. The nearest SPZ is located over 10 km west of the Site and is associated with an abstraction located between Peterborough and Markey Deeping (DEFRA, 2023).

The EA and Peterborough City Council have been contacted for information about licensed and private water supplies near the Site. The EA licensed abstractions from groundwater positioned within 2 km of the Site are presented in **Table 2-5**. These are all for agricultural or industrial purposes, and not for human consumption.

Table 2-5 – Environment Agency Licensed Groundwater Abstractions within 2 km

Licence Number	Name	Use	Distance (direction) from Application Boundary
AN/032/0011/035	NENE SANDS AND GRAVELS AT THORNEY	Agriculture / General Agriculture / Spray Irrigation - Storage	~0.75 km NNW
AN/032/0011/037/L*	PASTURE HOUSE FARM	Industrial, Commercial and Public Services / Mineral Products / Dewatering	Licence is for an area that is adjacent to the Site (W)
AN/032/0011/037/R01*	PASTURE HOUSE FARM	Industrial, Commercial and Public Services / Mineral Products / Dewatering	Licence is for an area that is adjacent to the Site (W)

¹ <https://magic.defra.gov.uk/MagicMap.html>

Licence Number	Name	Use	Distance (direction) from Application Boundary
AN/032/0011/053	LAGOON AT EYE LANDFILL	Industrial, Commercial and Public Services / Refuse and Recycling / Dewatering	Licence is for an area. Nearest point on boundary ~1.5 km (SW)
AN/032/0011/048	LAGOON AT WILLOW HALL QUARRY	Industrial, Commercial and Public Services / Extractive / Dewatering	Licence is for an area that is adjacent to the Site (SW)

* Licences are for the same polygon for the same purposes, but registered to different holders. It is assumed these are variations of the same licence.

There are no private water supplies recorded by Peterborough City Council located within 2 km of the Site. The nearest private water supply is positioned approximately 6 km northwest of Site at Chase Farm.

2.5.2 SURFACE WATER

2.5.2.1 Surface Watercourses

Surface water and groundwater from the shallow aquifer accumulate to form shallow pools. There are surface waterbodies located on Site that are associated with the quarrying operations. Surface water drainage ditches (dikes) run around much of the perimeter of the Site and across the wider area that provide land drainage. The dikes around the Site drain towards Thorney Dike and Thorney River before discharging into the River Nene at North Side (approximately 3.5 km south of the Site).

Cat's Water Drain is located 600 m to the west of the Site, which flows in a southerly direction, also towards the River Nene. However, groundwater levels measured at the Site (the maximum groundwater elevation measured between April 2024 and April 2025 was -0.72 mAOD) are below the average elevation of the drain (1.63 m AOD), preventing any potential pathway between surface and groundwater from forming. In addition, flow in Cat's Water Drain is considered to be ephemeral and controlled by discharges from sites, including active quarries. Hence, it is concluded that the drain would be providing recharge to groundwater further decreasing the potential for contaminants to migrate into the surface water. Therefore, Cat's Water Drain is considered unlikely to be affected by the restoration activities while groundwater in the area is being actively managed by nearby quarries.

There is currently no dewatering occurring at the Site (dewatering activities ceased with the completion of quarrying activities). Surface water is currently discharged to one of the Site's silt lagoons for infiltration to groundwater. Clean outflow from the lagoons falls to Internal Drainage Board (IDB) drains.

2.5.2.2 Surface Water Abstractions

There are numerous EA licenses for the abstraction of surface water, largely for agricultural spray irrigation, positioned on watercourses both on Site and in the immediate surrounding area. No surface water abstractions are listed as being for human consumption.

2.5.2.3 Flood Risk

Part of the eastern half of the Site is mapped by the EA as being located in Flood Zone 3 (EA, 2023b). This means it is located on land that has a high probability of flooding from rivers and/or the sea. Flood defences have been built to protect against flooding. Flood risk from rivers or the seas is given as medium (i.e. there is a between 1% and 3.3% chance of flooding each year taking account of the effect of flood defences) (EA, 2023c).

There are also localised areas mapped as being at up to high risk from surface water flooding (i.e. there is a more than a 3.3% chance of flooding each year) (EA, 2023c). Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding. The Site is not at risk from flooding from reservoirs.

The closest Special Protection Area (SPA) and Special Area of Conservation (SAC) is the Nene Washes, approximately 3.3 km to the south of the Site and none of the Site activities are considered to have an effect on this area.

2.6 COMPLIANCE POINTS

Current EA guidance² states that *‘for predictive modelling of hazardous substances, your compliance point will normally be set immediately downgradient of the discharge, at a point just below the water table adjacent to the edge of the discharge area and within the expected vertical mixing depth. Practically, compliance with control levels and compliance limits for hazardous substances are assessed at monitoring points which are normally one or more boreholes directly adjacent to the landfill. This reflects the practical problems in collecting samples from beneath a landfill.*

For non-hazardous pollutants the compliance point will also normally be the monitoring boreholes adjacent to the landfill. Where groundwater has no current or potential future resource value, boreholes for monitoring non-hazardous pollutants further from the site may be appropriate.’

The groundwater and surface water abstractions have not been considered further specifically as by assessment of the risk to groundwater immediately beneath and adjacent to the Site; this is also naturally protective of off-Site sources.

In light of this guidance, compliance points for assessing the risk posed by contamination originating at the Pode Hole Quarry are as follows:

- For Hazardous Substances, the receptor point will be the edge of the attenuation layer just within groundwater in the River Terrace Deposits above the Oxford Clay, and the point within groundwater just at the base of the Oxford Clay above the Kellaways Sands; and
- For Non-Hazardous Substances, the primary receptor point will be the downstream boundary of the Site within the River Terrace Deposits and Kellaways Sands. Surface water courses will form secondary receptors.

² <https://www.gov.uk/guidance/landfill-developments-groundwater-risk-assessment-for-leachate#compliance-points>.

2.7 ENVIRONMENTAL ASSESSMENT LIMITS

Receptor sensitivity can be gauged by the specification of Environmental Assessment Levels (EALs). EALs may be used to benchmark the predicted or observed site performance against. EALs differ from compliance limits, which are borehole/location specific and, therefore reflect potential spatial variation in groundwater concentrations from off-Site sources.

An input of a hazardous substance is considered to have been prevented if the substance concerned is not discernible in the groundwater above natural background conditions or a relevant minimum reporting value (MRV) after the immediate dilution as the leachate enters the groundwater. Groundwater quality information from locations directly upgradient of the Site was not available. Therefore, to be protective of groundwater as a potential resource, EALs for hazardous substances have been set at the EA's MRV (DEFRA, 2017). If no MRV has been developed a Limit of Quantification (LoQ) has been used, which is either defined by the UK Technical Advisory Group (UK TAG) on the Water Framework Directive (WFD TAG, 2016), or in a commercial laboratory is defined as being three times a commercially available limit of reporting.

For non-hazardous pollutants, the EALs have been set at the most stringent UK DWS or FW EQS. The EALs for the priority contaminants are provided in **Table 2-6**.

Table 2-6 – Environmental Assessment Levels (EALs)

Parameter	Units	Inert Waste Limit C ₀ Concentration	UK DWS	FW EQS	MRV / LoQ	Proposed EAL	Justification
Ammoniacal Nitrogen as N	mg/l	-	0.39*	-	-	0.39	Non-hazardous, UK DWS
Arsenic	µg/l	60	10	50	5	5	Hazardous, LoQ
Chloride	mg/l	460	250	250	-	250	Non-hazardous, UK DWS
Lead	µg/l	150	10	1.2 [^]	0.2	0.2	Hazardous, LoQ
Nickel	µg/l	120	50	4 [^]	-	4	Non-hazardous, FW EQS
Sulphate	mg/l	1,500	250	400	-	250	Non-hazardous, UK DWS
Benzene	µg/l	-	1	10 [^]	1	1	Hazardous, MRV

* There is no UK DWS for ammoniacal nitrogen, the value used is the UK DWS for ammonia (0.5 mg/l) converted to the equivalent concentration of ammoniacal nitrogen as N using molecular weight.

[^] FW EQS values are for the annual average concentration; these parameters also have higher maximum allowable concentrations.

- Standard not available.

2.8 SUMMARY OF CONCEPTUAL MODEL

The base of the Site sits on over 10 m of low permeability Oxford Clay and the sands and gravels of the River Terrace Deposits form the sidewalls. The River Terrace Deposits are not mapped as being laterally extensive; clayey Tidal Flat Deposits or outcropping Oxford Clays are largely mapped to the east and south of the Site.

Groundwater is likely to be encountered near to ground surface in the superficial deposits, with flow likely to be heavily influenced by the surface network of drainage dikes and the River Nene. It will also be influenced by local groundwater abstractions that are dewatering the sands and gravels for mineral extraction. Therefore, natural groundwater flow in the area is likely to be towards major drainage ditches and the River Nene to the south but may be locally and temporarily influenced by dewatering in the surrounding area.

The River Terrace Deposits surrounding the site, and the Kellaways Sand beneath the Site at depth are classed as a Secondary A aquifer.

The Site is not located in an SPZ or near any water supplies for human consumption. Groundwater abstraction in the area is mainly to support the mineral industry (i.e. for dewatering or mineral processing). Surface water abstraction is largely used for irrigation.

The closest Special Protection Area (SPA) and Special Area of Conservation (SAC) is the Nene Washes, approximately 3.3 km to the south of the Site and none of the Site activities are considered to have an effect on this area.

The Environment Agency considers a sensitive area for groundwater to mean:

- On or in a Principal aquifer or Secondary A aquifer.
- Below the water table – in any strata where the groundwater provides an important contribution to river flow or other sensitive surface water.
- Source protection zones 2 and 3.
- In an area where groundwater provides a direct pathway to other sensitive receptors such as surface water, habitat sites or wetlands.

As the River Terrace Deposits at the Site are classified as a Secondary A aquifer, the quarry void is present below the natural water table (in the absence of dewatering in the surrounding area) and the groundwater at Site may contribute base flow to nearby surface water bodies the Site is considered to be in a sensitive area.

As stated in EA DfR guidance where the site is in a sensitive location it is expected that an attenuation layer is likely to be required to give protection against the risk of acceptance of rogue loads. It is therefore proposed that an attenuation layer 1m in thickness with a minimum permeability of 1×10^{-7} m/s (or equivalent) will be present on both the base and sidewalls.

3 HYDROGEOLOGICAL RISK ASSESSMENT

3.1 THE NATURE OF THE HYDROGEOLOGICAL RISK ASSESSMENT

The adopted risk assessment methodology has been chosen taking into account the complexity and sensitivity of the hydrogeological site setting. A detailed quantitative risk assessment has been undertaken using GoldSim which can model contaminant mobilisation and transport in groundwater using Monte Carlo probabilistic calculation methodology.

3.2 MODELLING APPROACH AND ASSESSMENT SCENARIOS

As described in section 2.2.3 even though under 'normal operating conditions' source concentrations will be limited to the Inert Waste LLVs, the waste could still contain both hazardous substances and non-hazardous pollutants above Water Quality Standards in some cases, in particular hazardous metals. Though the requirements for waste acceptance procedures are robust, it is also possible that rogue loads containing contaminated material may inadvertently be accepted at the Site introducing higher concentrations of substances above the LLVs ('failure conditions'). It is assumed that the whole mass of restoration materials comprised a potential source of contaminants. An assessment will be undertaken using a suitable range of priority contaminant concentrations representative of the heterogeneity of the inert waste, substances which may meet the LLV but have concentrations above WQS under normal operating conditions, and also of occasional accidental rogue loads under failure conditions.

The Landfill Directive does not require leachate levels to be managed within an inert waste mass, and therefore levels will generally be expected to reflect groundwater levels external to the Site. The restored landform will comprise agricultural land with a series of ditches and drains to direct rainfall towards the southeast of the Site. It is assumed that substances within the inert waste will migrate to the down hydraulic gradient edge of the attenuation layer and enter groundwater in the River Terrace Deposits. Some groundwater is likely to preferentially flow around the low permeability sidewall rather than through the Site. It is possible that due to the heterogeneity of the waste a greater than natural head gradient could temporarily form from leachate to groundwater, resulting in the advective flow of contaminants through the attenuation layer and into the River Terrace Deposits. The travel time for priority contaminants through the attenuation layer and dilution within groundwater outside the sidewall will be assessed. Although the compliance point for non-hazardous substances is at the site boundary, for conservatism only concentrations at the edge of the attenuation layer prior to transport within the aquifer to the site boundary have been calculated,

The thickness of the Oxford Clay beneath the base of the waste void is greater than 10 m, forming a significant barrier to the downwards migration of leachate. Therefore, the risk to the groundwater in the Kellaway Sands beneath the Oxford Clay will not be modelled specifically, although it is noted that the risk to the River Terrace Deposits which will be assessed is also considered bounding of the risk to the Kellaways Sand which lies at much greater distance from the waste mass.

3.3 MODEL PARAMETERISATION

3.3.1 SOURCE TERM

The pre-application response provided by the EA included a range of concentrations for arsenic, ammoniacal nitrogen, lead, nickel, sulphate and chloride which have observed to be typically found in leachate affected by “accidental rogue load acceptance”, presented in **Table 3-1**. As the Site is not yet operational, no leachate data is available to characterise the potential leachate generated at Site. Therefore, the suggested ranges provided by the EA in their pre-application advice have been used to determine the risk to groundwater and surface water from the proposed development.

The provided range of concentrations do not include hydrocarbon compounds. Therefore, a source term for benzene has been calculated using the typical limit of detection as the minimum and calculation of the maximum leachate concentration using a Level 1 assessment in ConSim from the Inert Waste Limit Value (L/S=10 l/kg) of 6 mg/kg (conservatively assuming that all the BTEX is benzene). The resulting leachate concentration of benzene is 3.61 mg/l, included in **Table 3-1**.

Table 3-1 – Leachate Concentration Input Ranges for Inert Waste, including accidental rogue load acceptance (mg/l)

Parameter	Distribution	Minimum	Most Likely	Maximum
Arsenic	Log Triangular	0.001	0.007	0.06
Lead	Log Triangular	0.002	0.007	0.15
Ammoniacal Nitrogen	Log Triangular	0.3	8	25
Chloride	Triangular	100	300	800
Sulphate	Triangular	200	1200	1800
Nickel	Log Triangular	0.002	0.02	0.12
Benzene	Log Uniform	0.001	-	3.61

3.3.2 PROPERTIES OF ATTENUATION LAYER AND LANDFILL GEOMETRY

The attenuation layer to be placed will comprise Oxford Clay excavated from the base of the Site with the properties presented in **Table 3-2**.

Table 3-2 – Attenuation Layer Properties Model Inputs

Parameter	Units	Distribution	Value	Justification
Thickness	m	Single	1	Minimum design thickness
Permeability	m/s	Single	1 x 10 ⁻⁷	Maximum design value
Effective porosity	fraction	Uniform	0.2, 0.3	WSP estimate
Dry Bulk density	g/cm ³	Uniform	1.65, 2.10	WSP estimate
Hydraulic Gradient	-	Uniform	0.001,0.01	Conservatively assumed to be one order of magnitude higher than the range for River Terrace Deposits to conservatively account for low permeability attenuation layer and waste heterogeneity causing potential above natural gradient across attenuation layer.
Landfill Width	m	Single	1200	Maximum width of landfill perpendicular to assumed flow direction towards the River Nene.

3.3.3 AQUIFER GEOMETRY AND PROPERTIES

Representative properties for the River Terrace Deposits are presented in **Table 3-3**.

Table 3-3 – Aquifer Properties Model Inputs

Parameter	Units	Distribution	Value	Justification	
River Terrace Deposits	Hydraulic Conductivity	m/s	Single	0.000122	Hydraulic conductivity of River Terrace Deposits at nearby Flag Fen. (Wagstaff et al, 2016)
	Hydraulic Gradient	-	Uniform	0.0001,0.001	Based on available groundwater data for the area with uncertainty range
	Aquifer thickness	m	Single	4.4	Average distance from assumed groundwater elevation to depth to top of Oxford Clay in BH01-BH06 borehole logs.

3.3.4 CONTAMINANT PROPERTIES

Contaminant partition coefficients in clay are required by the retarded travel time calculations.

Table 3-4 summarises the values used for the priority contaminants.

Table 3-4 – Priority Contaminant Properties Model Inputs

Parameter	Units	Distribution	Value	Justification
Kd in clay: Ammoniacal Nitrogen	l/kg	Triangular	0.15, 1.5, 5	Value for glacial till from ConSim help files (most similar lithology available)
Kd in clay: Arsenic	l/kg	Uniform	29, 249.6	Value for glacial till from ConSim help files (most similar lithology available)
Kd in clay: Lead	l/kg	Uniform	434.6, 900	Expected value ConSim help files for Glacial till (most similar lithology available)
Kd in clay: Chloride	l/kg	Single	0	Chloride assumed to be unretarded
Kd in clay: Sulphate	l/kg	Single	0	Sulphate assumed to be unretarded
Kd in clay: Nickel	l/kg	Uniform	65, 86	Conservative value from ConSim
Koc in clay: Benzene	l/kg	Uniform	38, 146	EA, 2003 "Review of the Fate and Transport of Selected Contaminants in the Soil Environment", Draft Technical Report P5- 079/TR1
Fraction of Organic Carbon (FOC)	Fraction by mass	Uniform	0.01, 0.1	Range of values from ConSim helpfiles
Half life: Benzene	years	Uniform	0.27, 1.37	Conservatively assumed anaerobic half life from ConSim help files

3.4 EMISSIONS TO GROUNDWATER

The GoldSim model 'PodeHole_GoldSim' used in the contaminant transport calculations is presented electronically in **Appendix HRA2**.

Table 3-5 presents the estimated travel times through the attenuation layer and the resulting post-dilution concentrations at its outer boundary for priority contaminants.

Table 3-5 – Modelled Concentrations and Travel Times for the River Terrace Deposits

Priority Contaminant	Retarded Travel Time (years)		Post Dilution Concentration (mg/l)		EAL (mg/l)
	5%ile	50%ile	50%ile	95%ile	
Ammoniacal nitrogen	81.3	252	0.082	0.38	0.39
Arsenic	3,624	15,054	0.000059	0.00041	0.005
Lead	34,506	73,670	0.00010	0.00082	0.0002
Chloride	7.8	14.5	3.21	13.98	250
Sulphate	7.8	14.5	8.38	38.40	250
Nickel	4,498	8,240	0.00013	0.00094	0.004
Benzene	3,708	10,026	0	0	0.001

The calculated 50%ile and 95%ile concentrations are significantly below the EALs for the priority contaminants modelled with the exception of the 95%ile for lead which is 0.0008 mg/l compared to a WQS value of 0.0002 mg/l. However, the 5%ile travel time is reported to be around 34,500 years, and therefore beyond the timescales considered to pose a risk. It is therefore considered that the risk of contamination from the DfR waste to the River Terrace Deposits (and thereby also the Kellaway Sands and surface water) during normal operating conditions and in the unlikely accidental acceptance of rogue loads is acceptable.

4 REVIEW OF TECHNICAL PRECAUTIONS

4.1 CAPPING

After deposit for recovery operations have ceased the waste will be covered with soils won from Site or clean imported soils. An engineered cap is not required.

4.2 ATTENUATION LAYER DESIGN

The attenuation layer will be constructed of excavated Oxford Clay with a minimum thickness of 1 m and hydraulic conductivity of 1×10^{-7} m/s (or equivalent). The geological base of the landfill will be in-situ Oxford Clay.

4.3 LEACHATE MANAGEMENT

Leachate collection and management will not be required as the Site will only accept inert waste.

4.4 GROUNDWATER MANAGEMENT

During quarrying the sands and gravels were temporarily dewatered by a groundwater abstraction that took place from a point towards the north of the Site (at grid reference TF 26040,03040)). Dewatering at that location has ceased but continues at the neighbouring Bar Pastures Quarry and the Land Logical sites, which keeps surrounding groundwater levels low.

There are some limited shallow pools currently present on-site as a result of surface water and groundwater seepage accumulating in the base. This water is currently managed by pumping to a silt lagoon for soak away into the ground. This is expected to continue for as long as required during operation.

If further active groundwater management is required during construction of the attenuation layer, and restoration activities, a groundwater management plan will be developed and implemented.

4.5 SURFACE WATER MANAGEMENT

There are surface waterbodies located on Site that are associated with the quarrying operations. Surface water drainage ditches (dikes) run around much of the perimeter of the Site and across the wider area that provide land drainage. The dikes around the Site drain towards Thorney Dike and Thorney River before discharging into the River Nene at North Side (approximately 3.5 km south of the Site).

Surface water currently accumulates in the quarry void and is pumped and discharged to a silt lagoon for infiltration to groundwater. Clean outflow from the lagoon falls to Internal Drainage Board (IDB) drains. This will continue during restoration activities.

The restored landform will maintain the existing direction of surface drainage towards the southeast of the Site. Rainfall will therefore be directed towards the nature conservation and pond area via a series of ditches and drains. The banks around the pond have been designed to facilitate a wide draw-down area for water.

5 REQUISITE SURVEILLANCE

5.1 LEACHATE MONITORING

The Site is not located within a Source Protection Zone or in or above a Principal Aquifer. The waste streams will be inert and regulated on entry to the Site. The EA DfR guidance (EA, 2023a) states that leachate monitoring is not required.

5.2 GROUNDWATER MONITORING

Due to the sensitive environment the Site is located in, groundwater monitoring is considered to be required to control and monitor emissions from the Site.

Current groundwater elevations, and therefore flow direction, in the River Terrace Deposits is variable, likely caused by dewatering activities at nearby quarries. During the operational phase it is proposed to monitor groundwater within the River Terrace Deposits on a quarterly basis in six boreholes (BH01 to BH06) spread around the perimeter of the Site for groundwater levels and quality. Monitoring locations are shown on **Drawing ESID10 – Monitoring and Extraction Point Plan**. The monitoring of groundwater is also considered to be protective of the local surface water courses which could receive discharge from groundwater within the superficial deposits.

DfR guidance states that you may need to carry out aftercare monitoring to confirm the waste is physically and chemically stable. Aftercare is the period after you stop depositing waste until the Environment Agency accept the surrender of your permit. If you carried out monitoring when you were depositing the waste (the operational phase), you must continue that monitoring for a short period after you stop depositing waste. The length of time you do this for will depend on what you found during your operational phase monitoring.

Table 5-1 describes the proposed monitoring regime throughout the lifecycle of the Site:

Table 5-1 – Proposed Groundwater Monitoring Requirements

Location	Parameter	Frequency	Monitoring Standard or Method
DfR Restoration Phase			
BH01, BH02, BH03, BH04, BH05, BH06	Level, pH, electrical conductivity, ammoniacal nitrogen, chloride, sulphate, alkalinity, sodium, potassium, calcium, magnesium, iron, manganese, cadmium, chromium, copper, nickel, lead, zinc, arsenic, TOC, TON, TPH-CWG incl BTEX, PAH	Monthly during the restoration phase and six-monthly post restoration.	As specified in Environment Agency Guidance TGN02 'Monitoring of Landfill Leachate, Groundwater and Surface Water' (February 2003), Horizontal Guidance Note H1 - Environmental Risk Assessment for permits, Annex J3, version 2.1, Dec 2011, or such other subsequent guidance as may be agreed in writing with the Environment Agency.

5.2.1 GROUNDWATER COMPLIANCE LIMITS

Schedule 10 of the Environmental Permitting Regulations requires that groundwater compliance limits are set for potentially polluting substances at locations down gradient of the Site. Compliance limits are typically based on baseline groundwater quality, which may be location/borehole specific to reflect potential spatial variation in groundwater concentrations from off-site sources. However, as no baseline groundwater quality data is currently available, the groundwater compliance limits will in the interim be set for the priority contaminants at the EALs established in Section 2.7, as shown in **Table 5-2**. Once a sufficient amount of groundwater monitoring data has become available (a minimum of 12 data sets, representing a 12-month period), this HRA may be reviewed and the Compliance Limits updated using the available baseline groundwater quality data.

Until such time as dewatering activities cease and the groundwater rebounds to its natural level, compliance limits will be applied to all perimeter boreholes. Once rebound has occurred and the natural flow direction within the superficial deposits is confirmed, compliance limits for boreholes located upgradient of the local flow can be removed.

Table 5-1 describes the proposed interim groundwater compliance limits.

Table 5-2 – Interim Groundwater Compliance Limits

Parameter	Proposed Compliance limit (mg/l)
Ammoniacal Nitrogen	0.39
Chloride	250
Sulphate	250
Nickel	0.004
Lead	0.0002
Arsenic	0.005
Benzene	0.001

Exceedance of a defined compliance limit concentration on two successive monitoring rounds would initiate the following action plan:

- The sample will be re-tested for the determinand by the analytical laboratory within 10 days;
- If the result of the second analysis also exceeds the compliance limit, 1 year of data from the borehole will be plotted on a time history graph to establish the presence of trends or patterns;
- An inspection will be carried out to determine whether there has been any unusual activity or occurrence on the Site that could account for the increase in concentration of the parameter exceeding the compliance limit; and
- If the laboratory results from the monthly monitoring do not indicate a decline in the concentration of the parameter over the following 6 months, and the evidence indicates that the Site is the most likely cause of the increase in levels, then a meeting will be called with the EA to discuss the possible cause of the compliance limit exceedance.

5.3 SURFACE WATER MONITORING

During restoration activities it is proposed to monitor the quality within the silt lagoon (SW1), as shown on **Drawing HRA10 – Monitoring and Extraction Point Plan**.

Should discharge from the Site be required at other locations during the lifetime of the Site (for example if further dewatering is required) it is proposed that monitoring be undertaken upstream and downstream of the discharge point into the surface water body to monitor and control the emissions from Site. It is recommended that a regime of surface water monitoring in the receiving surface water body be undertaken prior to installing any surface water discharges to adequately characterise the background surface water quality.

The surface water quality within the silt lagoon is proposed to be monitored on a monthly basis following the EA guidance (LFTGN02) during the restoration activities. Where flow permits, the surface water is proposed to be monitored for the list of determinands given in **Table 5-3**.

Table 5-3 - Proposed Surface Water Monitoring Requirements

Location	Parameter	Frequency	Monitoring Standard or Method
SW1 (Silt Lagoon)	pH, Electrical Conductivity, Ammoniacal Nitrogen, Chloride, Sulphate, BOD, suspended solids, visual oil and grease.	Monthly	As specified in Environment Agency Guidance TGN02 'Monitoring of Landfill Leachate, Groundwater and Surface Water' (February 2003), Horizontal Guidance Note H1 - Environmental Risk Assessment for permits, Annex J3, version 2.1, Dec 2011, or such other subsequent guidance as may be agreed in writing with the Environment Agency.

Table 5-4 shows the compliance limits and control levels that are proposed for the Silt Lagoon monitoring point. The Compliance Limits are set to the UK DWS/FW EQS. The Control Level has been set at 90% of the Compliance Limit.

Table 5-4 - Proposed Compliance Limits and Control Levels for Surface Water

Determinand	Units	Compliance Limit	Control Level
pH	pH units	<9 > 6	<8.5>6.5
Chloride	mg/l	250	225
Ammoniacal Nitrogen	mg/l	0.39	0.35
Sulphate	mg/l	250	225
BOD	µg/l	10	8
Suspended Solids	mg/l	100	90
Oil and Grease	-	None visible	-



If surface water compliance limits are exceeded, the following action plan shall be undertaken:

- Advise site management, environmental manager of landfill operating company and EA.
- If the result is above the compliance level and outside of the level of uncertainty, the sample will be retested by the laboratory within two weeks to confirm the measurement.
- If the result is confirmed by the laboratory the surface water sampling point should be resampled within one month.
- If repeat analysis confirms breach, then a specific action plan will be implemented, including where appropriate review of existing monitoring data using statistics and graphical presentation to establish the presence of any trends or patterns, increased monitoring frequency and/or review of site management and operations.
- In the event that the compliance limit is exceeded for more than six months then a further specific action plan will be submitted to the Environment Agency and implemented, including review of the assumptions incorporated into the conceptual site model, along with the existing risk assessment, and compliance limits.

6 CONCLUSIONS

In accordance with Schedule 22 of the Environmental Permitting Regulations, necessary measures will be taken to prevent the input of hazardous substances to groundwater. Discharges of hazardous substances will not be discernible in groundwater immediately downgradient of the landfill. Both hazardous substances and non-hazardous pollutants could be present within the leachate produced at the Site. There is potential for contaminants to migrate through the attenuation layer; however, the travel times and diluted concentrations have been calculated to remain below the relevant quality standards under both normal operating conditions and failure conditions (accidental rogue loads) and therefore are considered to pose negligible risk to groundwater and surface water quality.

The proposed technical precautions including the attenuation layer and management of groundwater and surface water, will prevent unacceptable discernible discharge of hazardous substances and non-hazardous pollutants to groundwater throughout the Site's lifecycle and are therefore considered compliant with Schedule 22 of the Environmental Permitting Regulations.

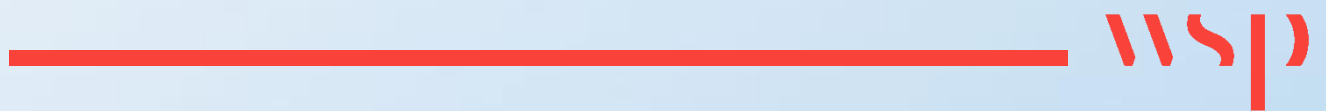
The provision of suitable requisite surveillance of groundwater is a requirement of Schedule 22 of the Environmental Permitting Regulations. The requisite surveillance for the DfR restoration is considered to be in accordance with EA guidance.

7 REFERENCES

- Aggregate Industries (2017) Pode Hole Quarry – Bar Pasture East Trail Pit & Reserve Reconciliation Report: Review of remaining mineral deposits in Bar Pasture East. August 2017
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Appendix HRA1

GROUNDWATER LEVEL DATA



Appendix HRA1 - Groundwater Level Data

Depth below top of case (m)	BH01	BH02	BH03	BH04	BH05	BH06
25/04/2024	3.6	3.83	3.73	6.64	4.43	4.48
23/05/2024	3.66	3.84	3.96	6.93	4.25	4.02
10/06/2024	3.7	3.89	4.08	7.08	4.37	4.3
05/07/2024	3.73	3.93	4.21	7.12	4.29	4.38
01/08/2024	3.76	3.98	4.35	7.17	4.5	4.69
29/08/2024	3.82	4.03	4.49	7.2	4.68	4.81
24/09/2024	3.8	4	4.6	7.24	4.54	4.53
17/10/2024	3.7	3.9	4.57	7.23	4.3	4.13
21/10/2024	3.72	4.1	4.58	7.25	4.38	4.5
15/11/2024	3.76	4	4.61	7.2	4.41	4.55
02/02/2025	3.8	4.92	4.35	7.14	4.4	4.5
24/02/2025	3.86	6.59	4.42	7.14	4.3	4.63
16/03/2025	3.91	6.63	4.51	7.24	4.4	4.68
07/04/2025	4	6.83	4.63	7.17	4.29	5

Borehole installation details (from CQA Report)						
Casing height	0.65	0.6	0.7	0.73	0.72	0.77
Ground Elevation (m AOD)	2.78	2.98	3.01	2.59	2.31	1.6
Casing Elevation (m AOD)	3.43	3.58	3.71	3.32	3.03	2.37
Install Depth (m bgl)	3	5.5	5.6	6.1	5.6	5.6
Install Depth Elevation (m AOD)	-0.22	-2.52	-2.59	-3.51	-3.29	-4
Top of Clay Elevation (mAOD)	-0.22	-2.52	-3.39	-3.81	-3.29	-4

Calculated GW elevation (m AOD)	BH01	BH02	BH03	BH04	BH05	BH06
25/04/2024	-0.17	-0.25	-0.02	-3.32	-1.4	-2.11
23/05/2024	-0.23	-0.26	-0.25	-3.61	-1.22	-1.65
10/06/2024	-0.27	-0.31	-0.37	-3.76	-1.34	-1.93
05/07/2024	-0.3	-0.35	-0.5	-3.8	-1.26	-2.01
01/08/2024	-0.33	-0.4	-0.64	-3.85	-1.47	-2.32
29/08/2024	-0.39	-0.45	-0.78	-3.88	-1.65	-2.44
24/09/2024	-0.37	-0.42	-0.89	-3.92	-1.51	-2.16
17/10/2024	-0.27	-0.32	-0.86	-3.91	-1.27	-1.76
21/10/2024	-0.29	-0.52	-0.87	-3.93	-1.35	-2.13
15/11/2024	-0.33	-0.42	-0.9	-3.88	-1.38	-2.18
02/02/2025	-0.37	-1.34	-0.64	-3.82	-1.37	-2.13
24/02/2025	-0.43	-3.01	-0.71	-3.82	-1.27	-2.26
16/03/2025	-0.48	-3.05	-0.8	-3.92	-1.37	-2.31
07/04/2025	-0.57	-3.25	-0.92	-3.85	-1.26	-2.63

values in italics fall below the base of the installation/top of clay and are assumed to indicate that the borehole is dry

Appendix HRA2

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Attenborough House, Browns Lane Business Park
Stanton-on-the-Wolds
Nottingham
NG12 5BL

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