Carbrooke Quarry Eastern Extension

Environmental Permit Application

Hydrogeological Risk Assessment

Mick George Limited

December 2022

Prepared on Behalf of Tetra Tech Environment Planning Transport Limited.

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1.0 INTRODUCTION

1.1 REPORT CONTEXT

1.1.1 This document has been prepared by Tetra Tech on behalf of the Operator, Mick George Limited (Mick George) to support an environmental permit application for Carbrooke Quarry Eastern Extension (the site), Land off Mill Lane, Carbrooke, Norfolk, IP25 6TD.

1.1.2 This report presents the Hydrogeological Risk Assessment (HRA) for the proposed waste operation. The objectives of this document are to assess whether the proposed operations and end-use as an inert landfill, its engineered containment design and construction, monitoring network and management controls fulfil the requirements of the Groundwater Regulations 2009 and Landfill Directive 1999 and ensure that the site is in compliance with the requirements of the Environmental Permitting Regulations, 2010.

1.1.3 Details regarding other aspects of the proposed waste operation are provided in other supporting documents that have been prepared to support the Environmental Permit Application. This includes the Environmental Setting & Site Design (ESSD) report, Operating Techniques and Environmental Risk Assessment (ERA).

1.1.4 Due acknowledgement is made for specific background information used in this document which was obtained from Byrne Looby Partners Limited (Byrne Looby) report: Landfill Assessment, January 2022, parts of which are repeated here for completeness.

1.2 SITE LOCATION

1.2.1 The site is located approximately 580m south of the village of Carbrooke, 1km north of the village of Griston and 1.2km east of the town of Watton. The site is centred at the approximate National grid Reference (NGR) TF 95215 01069 and the environmental permit boundary is shown on Drawing Number MGL/B032575/PER/01.

1.2.2 Access to the site can be gained via the existing site entrance located off Mill Lane. The site sits within an area of agricultural land with quarrying operations in the immediate vicinity. The site is bounded by arable farmland to the north which extends to the east of the site beyond Cuckoo Lane located along the eastern boundary of the site.

1.2.3 The B1108 (Norwich Road) bounds the site to the south along with an area of deciduous woodland and

farming infrastructure. Approximately 1km southwest of the site is the former RAF Watton site. To the west of the site is Mill Lane beyond which is land occupied by quarrying and aggregate operations.

1.3 BRIEF SITE HISTORY

1.3.1 Planning Permission was granted by Norfolk County Council (NCC) for the 'Extraction of sand and gravel working with continued processing, stockpiling, weighing and sale of mineral' on 9th August 2007 (Ref C/3/2007/3006). An application was later submitted in 2018 to vary condition 2 of the original application to extend the operations for a further 8 years until 9th August 2027.

1.3.2 Planning permission for the site was originally granted by Norfolk County Council (NCC) in 2007 which authorised the 'extraction of sand and gravel with continued processing, stockpiling, weighing and sale of mineral'. In August 2018, planning permission (ref. C/3/2018/3004) was granted by NCC to vary Condition 2 of planning permission C/3/2007/3006 to extend operations from 2019 to 2027.

1.3.3 In April 2022, a planning application (ref. FUL/2022/0011) was submitted to NCC for the 'restoration of quarry to agriculture with enhanced landscaping using inert materials and use of existing Sunner Lane access for mineral relates HGV movements'.

1.4 PROPOSED DEVELOPMENT

1.4.1 The proposed development involved the extraction with progressive restoration of the site through the importation of inert material. The proposed development would be restored in accordance with the restoration proposals details in Drawing Number C27A/1/21/02.

1.5 LANDFILL DESIGN PHILOSOPHY

Basal Layer

1.5.1 Prior to the commencement of landfilling activities, a geological basal barrier will be constructed in compliance with the 'Landfill Operators: Environmental Permits' guidance (updated 17th February 2022), which specifies a minimum geological barrier of 1m thickness and shall have a hydraulic conductivity with permeability less than or equal to $1x10^{-7}$m/s (see Drawing Number MGL/B032575/HYD/02 showing engineering details).

Side Sloping Lining

1.5.2 An engineered side wall liner is to be constructed along the sidewall of the quarry and is to have a thickness of 1m and a permeability of no greater than $1x10^{-7}$ m/s.

1.5.3 The proposed construction of the basal and side liner would be to the specification detailed in the Construction Quality Assurance (CQA) Plan that will be produced for the site. The method and testing of the material will be pre-agreed with the Environment Agency (EA) and subsequently demonstrated to ensure that the quality of installation is to the required standards (i.e. no greater than $1x10^{-7}$ m/s).

Capping

1.5.4 In accordance with the current requirements of the Landfill Directive, an engineered cap (clay or plastic) is not required. On completion of filling to final levels, the site will be covered with 1m layer of restoration soils.

Restoration

1.5.5 The final restoration scheme for the site is shown on Drawing Number C27A/1/21/02. It is the intention of Mick George to restore the site to agricultural land with areas of proposed landscaping around the perimeter.

Aftercare

1.5.6 Aftercare will be undertaken for a period of 5 years in accordance with an aftercare scheme that will be submitted to NCC for approval.

1.5.7 An annual site meeting between Mick George and NCC will be undertaken to review the performance of the aftercare scheme for that year to ensure that the programme of aftercare arrangements is employed. The meeting shall also provide an opportunity for the NCC to agree alterations to the aftercare works for the following 12 months and these shall thereafter be implemented.

1.5.8 Any amendments to the aftercare steps will be agreed in writing between Mick George and NCC.

1.5.9 Details regarding the site's aftercare are provided in the Closure and Aftercare Plan (Appendix K of the Environmental Permit Application).

1.6 REGULATORY CONTEXT, GROUNDWATER AND SURFACE WATER PROTECTION

Aquifer designation

1.6.1 According to the Multi Agency Geographic Information for the Countryside (MAGIC) website and British Geological Survey (BGS) viewer, the drift geology in the Carbrooke area consists partially of Lowestoft Formation comprising sand and gravel. The drift geology of the remainder of the site remains within the Lowestoft Formation comprising of a Diamicton unit.

1.6.2 According to the BGS viewer the solid geology under and around the site comprises an undifferentiated sequence of Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Culver Chalk Formation. This geological unit, in terms of hydrogeological potential, is defined as a Principal Bedrock aquifer. Principal strata are defined by layers of strategically important rock units that potentially can have high permeability and water storage capacity.

1.6.3 In terms of aquifer designation, the site is both a Secondary A superficial drift aquifer and a Secondary (undifferentiated). A Secondary A is defined by the EA 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".* Meanwhile, a Secondary (undifferentiated) is defined as "*assigned where it has not been possible to attribute either category A or B to a rock type*".

1.6.4 The proposed facility is not located in a Groundwater drinking safeguarded zone however the site is located within a Source protection Zone 2 (MAGIC website).

Licensed and Unlicensed Abstractions

1.6.5 According to Byrne Looby (2022), a Freedom for Information (FOI) request was submitted to the Environment Agency requesting details of licensed groundwater and surface water abstractions within 2km of the site. In response, the Environment Agency confirmed that there are no licensed surface water abstractions within 2km of the site. However, there are five licensed groundwater abstractions within 2km of the site and are summarised in Table 1 below.

Table 1: Licensed Abstractions within 1km of the Site

Licence Holder	National Grid Reference	Abstraction Name	Distance from Site	Use Description
Mick George Limited	TF 95015 00975	Carbrooke Quarry	Adjacent (west of site within existing quarry site)	General washing/process washing
Mick George Limited	TF 95015 00975	Carbrooke Quarry		Mineral washing
Mick George Limited	TF 95015 00975	Carbrooke Quarry		Dust suppression
Anglian Water Services Ltd	TF 94 00	-	1.75km south west	Potable water supply – Direct
NOBES	TF 9414 0181	Borehole at Caudlesprings	1.2km north west	Transfer Between Sources (Post Water Act 2003)

Water Table

1.6.6 The proposal is for the void to be excavated down to the base of the RTDs. In view of this situation, the mineral unit will be worked above the average groundwater levels of the site. Hence, the installation is not described as being sub-water table.

Hydrology

1.6.7 According to the Flood Map for Planning Service (FMPS), the site is not located in a Flood Risk Zone, and therefore has a low probability of flooding.

1.6.8 The application site is positioned between the Blackwater River 3.8km to the north-east and the River Wissey 12km to the west of the site. The nearest statutory “Main River” is a drain located 985m to the east of the site. This watercourse is sourced from the Scoulton Mere SSSI positioned ~2.7km to the east of the site. Surface water within the vicinity of the site is managed via a network of drains which flow from east to west towards Watton and the River Wissey.

1.6.9 The closest surface water features include a pond to the south of the site and within the western part of the Carbrooke Quarry created by former mineral workings. A drain is identified on OS mapping approximately 100m to the south-west of the site which runs parallel to Norwich Road.

Ecology

1.6.10 The MAGIC website shows there are no statutory designated sites for ecology within 1km from the boundary of the site. A Nature and Heritage Conservation Screen (reference EPR/KB3901SB/A001) was requested from the EA and a report was produced on the 16th September 2022. The report shows there is one Local

Wildlife Site (the Watton Airfield (Army Training Area) located approximately 500m southwest.

1.6.11 The report also indicates that there is an area of deciduous woodland located east of the site. A copy of the Nature and Heritage Conservation Screen report is provided as part of the ERA (Appendix D of the Environmental Permit Application).

2.0 CONCEPTUAL HYDROGEOLOGICAL MODEL

2.0.1 The conceptual hydrogeological model for the site is based on the source-pathway-receptor linkages and relies on the geological and hydrogeological information gathered during site investigations.

2.0.2 A preliminary schematic conceptual hydrogeological model for the site (See cross sections in Drawing number MGL/B032575/HYD/02). This model will be updated as the site develops and more information becomes available.

2.0.3 It is proposed to only excavate and remove the overlying RTDs and terminate the landfill's void base to the top of the Chalk Formation with 1 in 2.5 slopes.

Source: potentially contaminating leachate that could be generated by rainfall infiltration through the emplaced inert material and any moisture inherent to the inert material itself.

Pathways: to include the landfill liner system (base and sides), an unsaturated zone within the *in situ* geology, and a saturated zone below the groundwater table in which dilution and degradation processes may occur.

Receptors: the groundwater system beneath the site is considered to be the primary receptor. To our knowledge there are no secondary receptors in the form of licensed surface water abstractions.

2.0.4 A detailed discussion of the three components of the conceptual model is given in the sections below.

3.0 CONCEPTUAL MODEL: SOURCE TERM

3.0.1 The requirements of the Landfill Directive for the disposal of inert waste material do not necessitate the installation of a leachate management or monitoring system. However, a leachate source term component will be incorporated into this risk assessment process.

3.0.2 Permitted wastes accepted at the site will be strictly inert as classified under the Landfill Directive (1999/31/EC) and Council Decision (2003/33/EC) of 19 December 2002 'Establishing criteria and procedures for the acceptance of waste landfills'.

3.0.3 Details regarding the proposed waste types including restrictions are provided in the Operating Techniques (Appendix B of the Environmental Permit Application).

3.0.4 A volume of 200,000 m^3 of imported material (or 300,000 tonnes using a conversion factor of 1.5m^3/tonne) is required in order to restore the site following mineral extraction.

3.0.5 The proposed types of waste to be deposited into the landfill void are detailed in the Operating Techniques report (Appendix B of the environmental permit application).

3.0.6 However, a consideration is made for the potential of accepting waste that is not inert (e.g. potentially contaminated soil) or non-inert waste concealed within a load of waste that appears to be inert. Due to the inert nature of the material to be used to restore the quarry, it is considered highly unlikely that water coming into contact with the material at the site will generate high concentrations of pollutants. It is proposed to screen incoming waste under Council Decision (2003/33/EC) Inert waste acceptance criteria.

3.0.7 It is recognised that hazardous substances and non-hazardous pollutants are present in these criteria and could occur from rogue loads of non-inert waste. However, to mitigate this, the operator would restrict the source of waste materials allowed on to the site and all waste would be subject to stringent Waste Acceptance Procedures (as detailed in the Operating Techniques, Appendix B of the Environmental Permit Application). It is therefore considered that hazardous substances are not expected to be present and non-hazardous substances are expected to be low with respect to the background groundwater quality.

3.0.8 The likelihood of any (or both) of these types of actions is predicted to be very low as strict source characterisation procedures will be applied to the loads being imported and visual inspection of each load will be undertaken prior to and during disposal.

3.0.9 Any fuel tanks and oil drums used on the site and by sub-contractors will be stored in a containment bund capable of containing 110% of the total quantity of fuel present at any one time.

3.0.10 All fuel spillages from moving plant or machinery will be remediated immediately in a safe and controlled manner by ensuring spills kits are kept on site and checked daily.

4.0 CONCEPTUAL MODEL: PATHWAYS

4.1 GEOLOGY

4.1.1 According to Byrne Looby (2022), the superficial sediments within the local vicinity of the site comprise of the Lowestoft Formation. The Lowestoft Formation forms an extensive sheet of silt and clay rich chalky till (*i.e*. Boulder Clay), together with outwash sands and gravels, silts and clays defined in this report as comprising part of the wider River Terrace Deposits (RTDs) unit. The site and surrounding quarries have been developed to exploit an isolated sand and gravel deposit of the Lowestoft Formation. The majority of this sand and gravel deposit is therefore expected to have been removed and in some areas replaced with waste materials.

4.1.2 River Terrace Deposits (RTDs) are also reported to be present 900m to the north of the site beyond Broadmoor Road.

4.1.3 The sedimentary units of the Lowestoft Formation overlie a bedrock geology formed of Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Culver Chalk Formation, undifferentiated (Upper Chalk Formation).

4.1.4 A total of 4 no. boreholes were installed around the site's perimeter. In addition to providing basic geological and hydrogeological information these boreholes indicated the depths of exploitable minerals.

4.1.5 According to the British Geological Survey's (BGS) 'Geology of Britain Viewer' and drilling information gathered, the geological sequence beneath the site is composed by approximately up to 3.5m of sandy topsoil and subsequently sand, gravel and clay drift deposits overlying the Lowestoft Formation.

4.1.6 The thickness of the sand and gravels mineral unit varies between a maximum of 17.6m, with a minimum of 9.9m, with an average of around 13.0m (Logs of available drilling data is included in Appendix A).

4.1.7 According to the results from the BGS' "Geology of Britain Viewer" there is no evidence of any mine activities (subsurface pathways) beneath the site.

4.2 HYDROGEOLOGY: AQUIFER DESIGNATION AND GROUNDWATER VULNERABILITY

4.2.1 The MAGIC website shows that the groundwater vulnerability for the site is Medium.

4.2.2 As noted in Section 1.6, the aquifer designation for the drift deposits is Secondary A and Secondary undifferentiated.

4.3 GROUNDWATER MONITORING BOREHOLES

Groundwater levels

4.3.1 The available groundwater data submitted by Mick George were plotted on the hydrograph of Appendix B (raw level data also in this appendix). The following comments apply to the plotted data:-

- The highest average water table levels are recorded in BH2 which is located to the south east of the site, whereas the lowest average levels were measured in borehole BH3 located to the north west of the site.
- From this data, the groundwater flow direction can be inferred to be broadly south east to north west.
- A groundwater contour map has been prepared and is presented as Drawing Number MGL/B032575/HYD/01.

4.3.2 The inferred groundwater flow direction has allowed for the identification of the up- and down-gradient boreholes, namely:-

- Up-gradient: BH2 and BH4;
- Down-gradient: BH1 and BH3.

Baseline Groundwater Quality

4.3.3 Groundwater quality data were obtained from the boreholes forming the current monitoring network (Drawing Number MGL/B032575/HYD/01) between January 2022 and August 2022.

4.3.4 The groundwater quality results for the indicator substances ammoniacal nitrogen (Amm. N) and chloride are chosen to identify potential contamination arising from the landfill due to their high mobility. Sulphate is also included as an additional substance since it is known as being a primary potential leachable component of inert waste along with chloride.

4.3.5 Various metals have also been included in the interpretation of the chemical characteristic of the groundwater and these have been discussed in the sections that follow.

4.3.6 The raw and plotted data to derive the time series chemographs are shown in Appendix C. Plotting of “less than” reported values has been possible by the application of the substitution rule of 0.5 x L, where L is the “less than” value, as per guidance “Final Technical Report P1-471_Techniques for the interpretation of monitoring data”.

4.3.7 It should be noted that potential outliers have not been removed at this stage due to the currently limited amount of monitoring information, but statistical analysis has been performed on the data set for the calculation of the Compliance Limits (CLs) in Section 6.2.

Up-gradient boreholes (BH2 and BH4)

- The Amm. N chemograph displays a peak in values on two occasions within BH2 during March and April 2022 visits. The remaining data points return to a harmonised linear pattern, with no discernible trends thereafter, as reflected by the trend in BH4. Average concentrations are recorded between a maximum of 0.87mg/l and a minimum of 0.37mg/l, the former value clearly impacted by the two peaks in concentration recorded earlier in the year.

- Chloride average concentrations are below 50mg/l for both these two up-gradient boreholes. The trend of both BH2 and BH4 display a very stable and linear trend during the monitoring period. Average concentrations are recorded to be between a very narrow range with minimum of 42mg/l and a maximum of 44mg/l.

- Average sulphate values are within a range of between a maximum of 174mg/l and a minimum of 60mg/l. The noted higher average values are attributed to BH4 which displays a totally different plotting position above the remainder of the monitoring boreholes. The plot of BH2 displays a relatively stable and linear trend with the noticeable lowering of concentrations during the course of the year.

- Common metal values up-gradient display similar patterns within the monitoring boreholes, most importantly with cadmium, lead and mercury having concentrations below the detection limits of the laboratory in all the visits and iron being found in the dissolved state on two occasions. The remaining metals have varying concentrations between being below the limits of detection or a narrow range of values.

Down gradient boreholes (BH1 and BH3)

- The Amm. N plot shows a very stable and linear behaviour for both these monitoring points, with average concentrations within a very narrow range of values varying between a minimum of 0.27mg/l and a maximum of 0.47mg/l, very similar to those obtained for the up-gradient borehole BH2 – in BH4 slightly higher due to the anomalous reading, as discussed previously.

- Average chloride concentrations are also all below 50mg/l and fall within a very narrow range of a minimum of 24mg/l and a maximum of 36mg/l. The linear trends displayed in the chemograph by these two monitoring points reflect contrasting behaviours with BH1 showing a sharp decrease in values after May 2022, and for BH3 a reverse trend of increasing concentrations but stabilizes with the other boreholes after May 2022.

- Average sulphate values are within a relatively narrow range of between 45mg/l and 48mg/l. The plot of these concentrations displays a relatively stable and linear trend for both these monitoring locations due to the narrow range in concentrations. Metal values down-gradient display similar patterns in concentrations to those of the up-gradient boreholes. A gain, cadmium, lead and mercury have not been detected above the limit of detection of the laboratory in all visits and iron is found in the dissolved state only in two visits. The remaining metals have varying concentrations between being below the limits of detection or a narrow range of values.

4.3.8 As an overall comment, the groundwater quality between the up-gradient and down-gradient monitoring points is nearly identical, as expected to be found within a hydrogeological environment that is anthropogenically undeveloped. However, due to the limited amount of statistical data currently available, the development of groundwater quality patterns will become clearer as more information is gathered.

Long Term Hydrogeological Changes

4.3.9 Hydrogeological changes are expected to occur within the RTDs as a result of the proposed extraction activities. These impacts are predicted as localised changes to recharge characteristics and flow directions; but would not affect resources within the underlaying Chalk Formations. The impact of the proposed activity on recharge and flow direction are assessed as being minor, but long term, due to the localised nature of the development.

4.3.10 Any impacts in terms of both magnitude and duration that future climatic changes could bring about on the groundwater regime are too difficult to predict given the localised nature of the development.

5.0 CONCEPTUAL MODEL: RECEPTORS

5.1 CURRENT LICENSED/EXEMPT GROUNDWATER OR SURFACE WATER ABSTRACTIONS

5.1.1 As noted in Section 1.6.4, there are five licensed groundwater abstractions within 2km of the site and are summarised in Table 1.

5.1.2 As noted in Section 1.6.3, the site does not lie within drinking water safeguard zone however, the site is situated within a groundwater source protection Zone 2.

5.1.3 Therefore, the remaining geological unit(s) outside of the development are considered to be the principal receptor for this assessment, following extraction of the superficial deposits within the void.

5.2 EXISTING NATURAL/INDUCED DISCHARGES (E.G. SPRINGS/WETLANDS)

5.2.1 Groundwater flow direction appears to be south east to north west, downgradient of the topographic dip of the strata towards the stream located about 1.2km from the site.

Surface Water

5.2.2 The site is located in the upper extents of the catchment of the River Great Ouse which flows to the North Sea at King's Lynn.

5.2.3 As noted in Section 1.6.9, the nearest surface water features include a pond to the west of the site and within the western part of the Carbrooke Quarry created by former mineral workings. As such, it is not considered to be a potential receptor. With the exception of the drain, there are no other surface water features within 1km of the site.

5.3 SITES OF ECOLOGICAL OR NATURE CONSERVATION SIGNIFICANCE

5.3.1 As noted in Section 1.6, there is one Local Wildlife Site (the Watton Airfield (Army Training Area) within 500m of the site and an area of deciduous woodland located east of the site.

6.0 QUANTITATIVE HYDROGEOLOGICAL RISK ASSESSMENT

6.1 THE NATURE OF THE ASSESSMENT

6.1.1 The proposed environmental permit application will be submitted for the site to receive inert materials. Given the definition of the inert wastes to be imported, the total leachability, pollutant content and ecotoxicity of any leachate generated are considered to be potentially insignificant and unlikely to endanger the quality of any receiving environment.

6.1.2 In line with current legislation, inert landfills could be subject to a quantitative risk assessment process if a reduction in the specification of the Landfill Directive, Annex 1 “geological barrier”, would be considered and the receiving environment has been identified as being particularly sensitive.

6.1.3 In the case of the proposed geological barrier its specification, as set out in the Operating Techniques, will not be reduced therefore the receiving environment i.e. the remaining RTDs outside of the development’s footprint and the Chalk Formation remaining *in situ* are not affected. However, a quantitative risk assessment will be undertaken in order to consider the risk due to an accidental acceptance of a rouge load of materials on the sensitive nature of the remaining geological units.

6.1.4 The inert nature of the materials imported into the site will ensure that any leachate generated (both in terms of quality and quantity) is expected to pose a negligible risk to the receiving environment therefore has considerably lowered the sensitivity of the first component of the Source-Pathway-Receptor linkage.

6.1.5 The likelihood of accidents that could result in a potential impact would be during the operational phase of the excavation and infilling activities, when plant and machinery are used in those tasks. Any fuel tanks and oil drums used on the site and by sub-contractors will be stored in a containment bund capable of containing 110% of the total quantity of fuel present at any one time.

6.1.6 All fuel spillages from moving plant or machinery will be remediated immediately in a safe and controlled manner by ensuring spills kits are kept on site and checked daily. However, the risk is considered low and closely related to efficient site management and conscientious equipment and plant operators who will ensure lowering/minimising risk through a robust implementation of site procedures which are detailed in the Operating Techniques document accompanying this application.

6.1.7 A risk screening exercise has also been carried out in order to identify key contaminants potentially generated within the leachate and associated with the Waste Acceptance Criteria (WAC) to be adopted, in accordance with EU Council Decision 2003/33/EC.

6.1.8 However, a quantitative assessment is undertaken based on the secondary nature of the aquifer around and the sensitive definition of the Chalk Formation beneath the site and the possibility of a rogue load(s) being accepted on site, on the assumption that some materials would not be subjected to testing, even though it has been stated that specific waste codes will be tested.

6.1.9 The current conditions around the site are such that groundwater levels will be above the base of the development and as such would require the application of a hydraulic containment model to quantify the potential for the site to contaminate the receiving environment.

6.1.10 The application of the Agency's "Contaminant Fluxes from Hydraulic Containment Landfill Spreadsheet V1.0" as the modelling tool for contaminant transport evaluation, supported by the characterisation of the source term using data available either from literature or site obtained.

6.1.11 The developed models are presented in Appendix D, for the three chosen indicator substances (non-hazardous) i.e. Amm N, chloride and sulphate, as well as one hazardous substance – chromium. The values for the leachate concentration input to the models are derived from the averages of each chosen substance (Appendix C).

6.1.12 The emissions to groundwater, in accordance with the results from the hydraulic containment spreadsheet tool, show that all the chosen substances do not to pose a contamination risk from the proposed development – no contaminant flux has been detected at the compliance point to cause pollution.

6.1.13 In order to simulate the highly unlikely importation of a series of rogue loads that could have an impact on the groundwater quality, a sensitivity analysis has been carried for the five chosen substances by increasing the concentration of the source term x 100 the current average concentrations found in the up-gradient groundwater.

6.1.14 Even at these excessive concentrations the models show that no breakthrough of contaminants is detected at the down-gradient compliance point, therefore the proposed engineered design of the basal and side slope system meets with the requirements of Paragraph 6 of Schedule 22 to EPR 2016).

6.1.15 The proposed material to be imported will fully comply with the waste types listed in Table 2 and 3 of the Operating Techniques (OT) report submitted as part of this application. In particular, Table 3 (page 4 of the OT) details those materials whose waste codes will be subjected to WAC testing.

7.0 REVIEW OF TECHNICAL PRECAUTIONS

7.1 REVIEW OF TECHNICAL PRECAUTIONS

7.1.1 A series of necessary technical precautions have been identified as part of this risk assessment, which will be reviewed during the life of the permit.

Capping

7.1.2 On completion of infilling to final waste levels, the installation will not require a capping system but the final landform will be restored with soil materials recovered during the preparation phase of the site.

Lining Design

7.1.3 The base and side slopes will have an engineered containment system, which has been risk assessed on the basis of the proposed design and according to the waste stream to be imported. Additional confidence in the robustness of these designs will be provided by the CQA supervision programme that will be implemented during the construction phases of each individual cell.

Leachate Head Control, Drainage and Extraction Systems

7.1.4 These operational controls will not be required as the installation is an inert landfill.

Groundwater Management

7.1.5 Given the difference in proposed basal level of the development and current average groundwater elevations it is not expected to encounter groundwater inflows into the working. Therefore a dewatering system will not be implemented in order to work the void safely.

7.1.6 The operator will also ensure that any rainfall collected within the open void is managed as necessary. Site CQA supervision will also ensure that any potential heave encountered during construction works will be managed and that safe working conditions will be maintained.

Surface Water Management

7.1.7 Surface water in the vicinity of the site is currently managed via a network of drains which flow from east to west towards Watton and the River Wissey. There is no formal surface water drainage system on the site at present and rainwater typically percolates into the ground. No dedicated surface water drainage system is proposed for the site as part of the restoration plan.

8.0 REQUISITE SURVEILLANCE

8.1 THE RISK BASED MONITORING SCHEME

Groundwater Monitoring

8.1.1 Groundwater level and chemical data are to be collected from the groundwater monitoring points shown in Drawing MGL/B032575/MON/01.

8.1.2 The parameters to be sampled and monitoring frequency to be included in the Environmental Permit are presented in Table 2 below. These requirements are considered adequate in providing an ongoing characterisation of the groundwater conditions.

Table 2: Groundwater Determinants and Sampling Frequency

Quarterly	Annually
Levels, pH, Chloride, Alkalinity, Amm N, Sulphate, Sodium, Potassium, Iron, Manganese, Cadmium, Chromium, Copper, Calcium, Nickel, Lead, Zinc, Electrical conductivity, Magnesium, Selenium, Mercury	To include quarterly suites plus: Hazard Substances

Surface Water

8.1.3 As mentioned in Section 7.1.6, it's envisaged that a dewatering system will not be implemented. As such, there will not be a discharge point to surface water.

8.1.4 In terms of surface water features, the nearest surface water feature to the site is a pond that is located to the west of the site within western part of the Carbrooke Quarry and was created by former mineral workings.

8.1.5 According to the EA's Landfill Technical Guidance Note 'Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water' (LFTGN02), at least one monitoring point is required for each area of ponded water located within the site or within the downgradient catchment area of the site where these are potentially at risk.

8.1.6 As noted in Section 4.3.1, the groundwater flow direction can be inferred to be broadly south east to north west. As such, it's considered that the pond is not within the down-gradient catchment area.

8.1.7 In light of the above, it's considered that no monitoring is required with regards to surface water.

8.2 COMPLIANCE LIMITS

8.2.1 Although the site will accept inert materials, a set of Compliance Limits (CLs) will still be required to form part of the Environmental Permit, since this is defined as a value set at the down gradient compliance points BH1 and BH3, calculated to be a maximum concentration allowable at that point in order to protect the identified potential principal receptor i.e. groundwater.

8.2.2 These limits can be applied equally to all the proposed down gradient boreholes BH1 and BH3, as prescribed in the regulatory requirement in Agency's H1 guidance, Annex J3 since these down-gradient boreholes intersect the same geology.

8.2.3 The compliance limits in Table 4 are derived using the protocol of the mean plus 2 times standard deviations using the average data from the up-gradient boreholes for non-hazardous substances Amm N, chloride, and sulphate, whereas for the hazardous substance chromium, the CLs are set at the corresponding minimum reporting value (MRV) as defined in UK Technical Advisory Group (UKTAG) – "Technical report on groundwater hazardous substances" or where background water quality exceeds the specified standard.

Table 4: Compliance Limits

Substance	MRV (mg/l)	BH3 (mg/l)	BH1 (mg/l)
Chromium	0.050	0.050	0.050
Chloride		52	65
Sulphate		90	73
Amm N		1.24	0.66

8.2.4 It is noted that for chloride and sulphate the selected CLs are both significantly lower than their corresponding Environmental Assessment Limits of 250mg/l. In the case of Amm N, the data set is currently too limited to be able to statistically determine a more realistic value.

8.2.5 It is recommended these CLs be reviewed during the annual monitoring reporting procedure but also informally following each monitoring visit due to the specific environmental circumstances associated with the site once operational.

8.3 CONTINGENCY ACTION PLAN

8.3.1 An annual review of the proposed compliance limits should be carried out and any alterations in the compliance levels discussed and agreed with the EA.

8.3.2 Where the site monitoring programme identifies an increase in groundwater determinants that could lead

to a breach, then a series of contingency actions will be required. Suggested contingency actions, which will need to be agreed with the EA, are presented in Table 5.

Table 5: Suggested Contingency Actions

Appropriate Contingency Action	Timescale
Advise Site Management	Immediately
Advise Operator's Environmental Manager	Within 1 Week
Advise EA	Within 1 Week
Confirm by repeat sampling and analysis	Within 1 Month
Review existing monitoring information	1 Month
Review site management/operations, implement actions to prevent future failure of a compliance level	3 Months
Review assumptions in conceptual site model	3 Months
Review existing HRA Compliance Levels	6 Months
Consult EA about need for corrective action	6 Months

9.0 CONCLUSIONS

9.0.1 The proposed engineered containment for the inert landfill at the site (Carbrooke Quarry) complies with the requirements of the Landfill Directive.

9.0.2 The proposed installation will comply with current engineering design, materials, specifications and CQA protocols applicable to current landfill containment best practices.

9.0.3 An independent CQA procedure will be carried out for all aspects of the basal and sidewall lining construction. This ensures that the liner meets the required engineering standards and thus complies with the Landfill Directive and will not have an impact on the groundwater system.

9.0.4 The hydraulic containment quantitative modelling has demonstrated that the proposed geological barrier will provide adequate containment of landfill 'leachate' to meet the requirements of Landfill Directive (1999/31/EC) and will provide sufficient attenuation to prevent a risk to the underlying strata and groundwater environment.

9.0.5 Compliance limits for groundwater have been derived and a robust monitoring network has been installed to ensure that the future performance of the site will be correctly managed.

9.0.6 The requirements of the Groundwater Regulations, 2016, have been satisfied by the inclusion of requisite surveillance of the groundwater quality to be carried out regularly as discussed in Section 8.

DRAWINGS

MGL/B032575/PER/01 – Site Location and Environmental Permit Boundary

C27A/1/21/02 - Restoration Phasing Plan

MGL/B029957/HYD/01 - Groundwater contours

MGL/B029957/HYD/02 - Site hydrogeological conceptual model with engineering details

APPENDICES

APPENDIX A – BOREHOLE LOGS

APPENDIX B – GROUNDWATER LEVEL DATA AND PLOT

APPENDIX C – GROUNDWATER QUALITY DATA AND PLOTS

APPENDIX D –HYDRAULIC CONTAINMENT LANDFILL MODELS