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HYDROGEOLOGICAL RISK ASSESSMENT

PARK GROUNDS LANDFILL,

WOOTTON BASSETT

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Report prepared for:

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GENERAL NOTES

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CONTENTS

TABLES

DRAWINGS

APPENDICES

1 INTRODUCTION

1.1 Report context

Park Grounds Landfill is located approximately 2 km northwest of Wootton Bassett, Wiltshire and is centred about National Grid Reference (NGR) SU 052 839. The site is a non-hazardous landfill with planning permission for a new extension to the north and west of the existing operational and completed areas with restoration to agriculture.

The landfill benefits from an Environmental Permit, number EPR/SP3336SN, which now requires varying in order to include the extension area and to allow increased rates of waste input to the landfill to reflect changes in market forces.

SOL Environment are the Agents submitting the permit variation on behalf of Crapper and Sons Ltd. Hafren Water has been commissioned to prepare the Conceptual Site Model, Environmental Setting and Site Design (ESSD) report and the Hydrogeological Risk Assessment (HRA) in support of the application.

This report sets out the HRA and has been prepared with due regard to the hydrogeological risk assessment guidance (Environment Agency, 2016) and template (Environment Agency, March 2010) provided by the Environment Agency.

The design of the landfill and background information regarding the site setting are provided within the ESSD report (Hafren Water, 2018), which should be read in conjunction with this report. Background and baseline conditions are described within the ESSD report and these have been used to derive a conceptual model for the site in terms of source, pathways and receptors. The landfill forms a part below ground landfill, part land raise structure.

A summary of the prior investigations undertaken at the site is provided in *Table 2437/HRA/T1* below.

2437/HRA/T1: Summary of prior investigations undertaken at site	
Investigation/analysis	**Date**
Leachate level monitoring (data provided in Appendix 2437/ESSD/A1)	Regularly between 2005 and 2018
Leachate quality monitoring (data provided in Appendix 2437/ESSD/A1)	Regularly between 2005 and 2018
Surface water quality monitoring (data provided in Appendix 2437/ESSD/A4)	Regularly between 2005 and 2018
Installation of separate leachate & gas monitoring wells GW1 to GW7 (in Cells 1-7)	August 2016
Construction of leachate circulation pods	2013

The above data is used in this hydrogeological risk assessment

1.2 Conceptual hydrogeological site model

The conceptual hydrogeological model for the proposed waste operation is described in Sections 3.3, 3.5 and 4.1 of the ESSD report and illustrated on *Drawing 2437/HRA/D1*.

Geological and hydrogeological setting

The sequence of the solid geology underlying the site comprises Jurassic Oxford Clay with Corallian strata overlying it to the east and Kellaways Beds underlying it at depth.

The Oxford Clay has an estimated thickness of 80 m. It incorporates minor and laterally discontinuous claystone horizons which have at times been identified at the site. No superficial deposits are present in the immediate vicinity of the site, however, they are present to the southwest, associated with Thunder Brook.

The Oxford Clay is designated 'unproductive' by the Environment Agency.

Extraction of up to 7 to 8 m of Oxford Clay occurs in advance of landfilling to generate clay mineral suitable for use in clay cap engineering, sidewall and basal liners.

The permeability of the Oxford Clay is indicated in literature to vary between, 1×10^{-9} and 1×10^{-12} m/s. The lower values are likely to be representative of vertical permeabilities.

Engineering/landfill construction

The base and sides of the proposed landfill cells will be lined with a minimum of 1 m (more usually 1.5 m is achieved) re-engineered Oxford Clay with proven permeabilities of between 2.7×10^{-11} and 8.7×10^{-11} m/s (Cell 10). This overlies a natural geological barrier of approximately 70 m Oxford Clay (taking into account clay extraction). The mineral liner is overlain by a leachate collection and drainage layer comprising herringbone drains and leachate collection sump with coarse granular surround, sited within a layer of baled tyres.

To limit rainfall infiltration into the landfill, a minimum 1 m thick engineered mineral cap (more usually 2 m) will be placed over the waste. The cap will be keyed into the engineered sidewall liner. This will reduce the potential for any leachate within the landfill to egress from the site.

Groundwater control

Groundwater control is not required due to the absence of a distinct groundwater table in the Oxford Clay. Where ingress of water is identified within claystones in the sidewalls, any water entering the excavation is pumped from the landfill cell, the claystone is excavated before the sidewalls are constructed against the cut face. On completion of the mineral liner construction the sidewalls are inspected for any signs of groundwater ingress. If any 'damp' areas are identified these are re-excavated and re-constructed and inspection repeated until no further signs of potential seepage are observed.

Source

The landfill receives non-hazardous waste, which comprises predominantly wood, carpet, textiles, geotextiles (soft and foam), hygiene products (29%), <10 mm fines (23%) and cardboard and paper (16%, based on data for winter 2017). All waste is pre-treated and the non-hazardous nature of the waste is ensured by the application of strict Waste Acceptance Criteria and Procedures (WAC, provided elsewhere in the application) by appropriately trained staff.

The Permit variation is also seeking permission for increased rates of annual waste input to 60,000 tonnes non-hazardous and 20,000 tonnes inert waste.

Pathways

1. Lateral migration into claystones of the Oxford Clay: The claystones are proven to be laterally discontinuous and thin. Whilst some are water-bearing, this is limited and a distinct watertable does not exist. This pathway is, therefore, not considered viable for potential pollutant migration from the site.

2. Vertical through the base: The Oxford Clay has an extremely low vertical permeability and is likely to be over 70 m thick even in the areas of greatest mineral extraction from the site. There is, therefore, no plausible aquifer beneath the site. This vertical pathway is also not viable for potential pollutant migration.

3. Leachate breakouts through the cap, or a junction of cap and sidewall liner, and overland to surface watercourses: Two tributaries of Thunder Brook exist near the site; Stream 2 which is north of the site and Stream 3 which is the tributary west of the site. This latter tributary originally emerged from the site close to Withy Bed Wood. However, the upper reach has been diverted to the new ecological/flow balancing pond in the north of the site. A new perimeter drainage ditch, partly constructed, will collect all run-off

from the main landfill area and will direct this to a new balancing pond to be constructed to the west of the site. This will discharge to Stream 3, which is, currently, generally dry.

Any leachate egressing from the cap will be collected within the site perimeter drainage. It will be possible to cease off-site discharge via the use of the proposed flow control structures. This would contain any leakage on-site until such time as the Management and Environment Agency were informed and mitigation measures could be put in place.

Hence, should any leachate migrate to the site drainage and then Stream 3 it is unlikely to reach Thunder Brook. This pathway is, therefore, not considered viable for potential pollutant migration from the site.

Receptors

Groundwater is absent from the vicinity of the site and is therefore not considered to be a receptor.

Thunder Brook could be considered a secondary receptor as it could, potentially, receive water discharged from the site via Stream 3. The primary receptor, and the compliance point for site discharge, is considered to be the point at which water leaves the site at the discharge from the proposed flow balancing pond west of the site.

Statutory and non-statutory sites of conservation interest identified in the ESSD report Sections 1.2.7 and 1.2.8 and in Table 2437/ESSD/T1 could be receptors for leachate migration if they are groundwater dependant and a groundwater pathway existed. No such pathway exists hence they shall not be considered further in this risk assessment.

Identified receptors and pathways are summarised in *Table 2437/HRA/T2* below.

2437/HRA/T2: Summary of identified receptors and pathways	
Hazard	The composition of waste at the site will continue as current, however rates of input will increase to 60,000 tonnes per annum (tpa) non-hazardous and 20,000 tpa inert. This waste will generate a leachate and hence poses a hazard to the water environment.
Source	All waste to be deposited will adhere to Waste Acceptance Criteria and Procedures which shall ensure the waste is correctly characterised. Leachate quality has strengthened in recent years but still remains weak with respect to municipal waste landfills.
Potential primary pathway	A plausible primary subsurface pathway has not been identified due to the nature of the surrounding geology.

2437/HRA/T2: Summary of identified receptors and pathways	
	The site is excavated into 80 m of Oxford Clay where claystone bands have been found to be thin and discontinuous Junction of the clay cap with the sidewalls at ground level, or leachate outbreaks through the cap, may represent a possible pathway
Potential secondary pathway	Stream 3
Potential primary receptor	Surface water at site boundary
Potential secondary receptor	Surface water in Thunder Brook
Compliance point	For Hazardous and Non-hazardous pollutants – Discharge point from flow balancing lagoons (one existing and one proposed).

The conceptual model for the site showing source, pathway and receptors is provided on *Drawing 2437/HRA/D1* and a schematic cross-section through the site is shown on *Drawing 2437/HRA/D2*.

2 HYDROGEOLOGICAL RISK ASSESSMENT

2.1 Nature of the Hydrogeological Risk Assessment

Environment Agency guidance proposes a tiered approach to risk assessment such that the degree of effort and complexity reflects the potential risk posed by a particular site, or situation, the sensitivity of the site setting and the degree of uncertainty and likelihood of the risk being realised. To meet the requirements, a robust conceptual model for the site has been set out and basic risk screening undertaken. The conceptual model is set out in the ESSD report and the risk screening is summarised below in Section 2.2 below. A risk screening exercise is used to determine whether a landfill development represents, or potentially represents, a risk to groundwater or surface water resources.

2.2 Risk screening

2.2.1 Introduction

A qualitative risk screening should assess whether the potential discharge from an activity is acceptable and so will not require further assessment.

This could be because:

- the discharge has acceptably low concentrations of hazardous substances, or in concentrations that are the same as the natural background levels in the groundwater (whichever is the higher concentration)
- the discharge has concentrations of non-hazardous pollutants that are within the relevant environmental standards, or in concentrations that are the same as the natural background levels in the groundwater
- there is a very low risk to groundwater-fed receptors due to the presence of unproductive drift, or unproductive bedrock strata (and there are no aquifers present or near your activity) and remoteness from surface waters
- the volume, or hydraulic loading rate, of the discharge is so small such that only minimal dilution in underlying groundwater will be needed to avoid pollution by non-hazardous pollutants

2.2.2 Leachate

As the waste to be accepted at the site will continue to be non-hazardous, leachate potentially containing non-hazardous pollutants (hazardous substances have not been identified in the leachate) may result in concentrations above background conditions. Therefore, in accordance with Environment Agency guidance and the Landfill Directive, it will be necessary to collect and treat leachate.

2.2.3 Groundwater setting

The site is located within extensive Oxford Clay deposits and in an area devoid of superficial deposits. The site is located within strata designated by the Environment Agency as "Unproductive" and is outside any Source Protection Zones and over 1.5 km from any licensed groundwater abstractions.

A distinct watertable does not exist in the Oxford Clay which forms a very low permeability natural geological barrier surrounding the site.

Groundwater dependant sites of ecological importance do not exist within 1.5 km of the site.

The watercourses in the vicinity of the site are fed by surface water run-off and not groundwater.

It is considered therefore that "there is very low risk to groundwater-fed receptors" due to the presence of unproductive bedrock strata.

However, a small potential may exist for surface outbreaks of leachate through the landfill cap hence a limited generic quantitative risk assessment has been undertaken below.

2.3 Proposed assessment scenarios

2.3.1 Lifecycle phases

Environment Agency guidance states that a Hydrogeological Risk Assessment must be carried out for the whole lifecycle of the landfill, ie from the start of the operational phase until the point at which the landfill is no longer capable of posing an unacceptable environmental risk.

The phases to be assessed include:

- During the operational phase of the extension area leachate levels will be well below ground level. Breakouts through the cap are therefore not possible, this scenario has not therefore been quantified.
- Completion of the extension area; when all phases are capped but leachate management continues; again with this scenario leachate levels will be below the cap and outbreaks not possible.
- Completion of the extension area; when all phases are capped and leachate management ceases. Leachate levels will be allowed to rise and outbreaks through the cap or at the interface of the cap and sidewall are plausible and hence risks associated with this scenario have been estimated.

2.3.2 Failure scenarios and accidents

An assessment of the potential failure scenarios and accidents, together with the likelihood of their occurrence and magnitude of the consequences (in relation to compliance with the Environmental Permitting (England and Wales) Regulations (2016)) is presented in Section 2.9.

Failure scenarios

Failure scenarios include degradation of the landfill liner and leachate drainage system and spillage of leachate prior to re-circulation, or treatment in reed bed.

Accidents

Accidents are considered to be unintentional incidents that could reasonably occur, which are unforeseeable at their time of occurrence.

Accidents at the site could include fire, structural failure, vehicular accident, waste slippage, stability failure etc.

2.4 Priority contaminants to be assessed

The reasons for the exclusion of certain contaminants usually assessed in an HRA given in the March 2005 Hydrogeological Risk Assessment for site undertaken by JBJ Environment still stand and are repeated here for clarity.

"Potential contaminant or group of contaminants	***Reasons for exclusion from the model***
Complex and relatively complex organic chemicals	*1 Determinations are, and have been, made for a suite of more than fifty such compounds, none of which has been detected in any leachate sample.*
	2 Such compounds have relatively low mobility in formations, or materials, such as the Oxford Clay and seem often to be degraded in transit.
Heavy metals	*1 The site is contained by a combination of engineered and natural barriers, comprised almost entirely of clays. Bulk clays adsorb heavy metals and inhibit migration.*
	2 Heavy metals concentrations in the leachate are very low to unmeasurable. This enhances the adsorption potential and enhances attenuation greatly.
Ammonia	*NH_3-N binds readily to clay minerals with which it comes into contact in much the same way as heavy metals. However, it has been included in the assessment for information/comparison.*

BOD_5 and COD	*There is no practical but simple means of modelling BOD_5/COD in environments like the Oxford Clay. It is highly unlikely, in any case, that they will migrate very far in clay-rich environments because of the relative dimensions of the molecules and interstitial pore necks."*

In the absence of other suitable parameters, it is proposed that calculations are undertaken assuming a conservative (non-degradable or retarded) parameter, chloride, which will travel at the same rate as groundwater.

2.5 Review of technical precautions

Technical precautions are required to protect the water environment from activities and processed at the landfill. The measures put in place to protect groundwater and surface water quality are discussed below.

2.5.1 Waste inputs

All waste in coming to the site undergoes assessment to ensure that it complies with the Waste Acceptance Criteria for the site and conforms to the waste codes detailed in the Permit.

2.5.2 Engineering

The landfill liner system for the proposed extension area will be same as that employed in Cells 7 to 10. The landfill liner system separates the waste and leachate from the surrounding strata. It comprises a minimum 1 m thick mineral liner with proven permeability lower than 9×10^{-11} m/s overlying a natural geological barrier with a minimum thickness of approximately 70 m and permeability of less than 1×10^{-9} m/s with a leachate drainage layer consisting of baled tyres and horizontal and vertical leachate collection pipes; described in detail in the ESSD report. The liner system construction is subject to third party Construction Quality Assurance (CQA) and the mineral liner and cap is generally 1.5 to 2 m thick rather than the 1 m required by the Landfill Directive.

2.5.3 Monitoring

Monitoring of leachate heads and quality is regularly undertaken in each cell of the site as required by the permit. Leachate quality has been found to have evolved as the nature of the waste being received at the site has also evolved and with the introduction of leachate recycling

A distinct groundwater body does not exist in the vicinity of the site and hence groundwater monitoring is not undertaken.

Surface water monitoring is undertaken up and downstream of the site and the current discharge, and hence it is possible to identify any impact the site is having on surface water quality.

2.5.4 Review

It is considered that the proposed technical precautions, as reviewed above, are sufficient to ensure protection of the water environment in the vicinity of the site and are consistent with the assumptions made in this HRA.

2.6 Numerical modelling

2.6.1 Justification for modelling approach

A conservative parameter, chloride is modelled as this is not retarded and so acts as a conservative, worst case scenario. As this parameter is not retarded, or attenuated, in the mineral liner, or geological barrier, it will travel at the same rate as water passing through the landfill liner system. It is therefore proposed to undertake the risk assessment using simple Darcy's law analytical calculations, using the 'simple calcs' tab of the Environment Agency Groundwater Risk Assessment Toolkit, Version 2.

2.6.2 Model parameterisation

- Leachate head acting on the base = 2 m (highest currently recorded leachate head)
- Leachate head acting on cap = 0.5 m (assumed as currently leachate levels are below the cap)
- Hydraulic conductivity of engineered liner = 9 x 10^{-11} m/s (upper end of range achieved in Cell 10)
- Thickness of engineered liner = 1 m (minimum thickness)
- Hydraulic conductivity of natural Oxford Clay = 1 x 10^{-9} m/s (upper end of published range)
- Vertical thickness of Oxford Clay = 70 m assumed conservative minimum thickness based on depth of excavation to create cell and nearby borehole details)
- Horizontal thickness to nearest receptor; Stream 3 = 10 m (assumed standoff from site boundary

2.7 Sensitivity analyses

Not applicable with risk assessment calculation proposed.

2.8 Model validation

The Environment Agency Groundwater Risk Assessment Tool Version 2 was used in the estimation of travel times, using the 'simple calcs' tab. The output is provided in *Appendix 2437/HRA/A1*.

2.9 Accidents and their consequences

Drilling through the liner system during the construction of leachate monitoring wells may result in the flow of leachate directly into the surrounding natural strata. This natural strata comprises a minimum of 70 m of Oxford Clay. In addition as concrete target pads are constructed on the base of each cell above the liner the location of the base of the site will be readily identified and breach of the liner would not occur. The concrete target pads are surveyed to allow accurate location of drilling positions and depths for leachate monitoring wells. It is unlikely that drilling replacement wells will penetrate the liner.

Failure of a leachate pump may result in the temporary increase in head of leachate. As surface pumps are used for withdrawal of leachate, these are readily replaced within days during which time the rise in leachate level will be small. It is considered that there is no need for additional quantitative analysis in respect of the impact of temporarily elevated leachate levels following pump failure.

Spills may occur during the removal of leachate from leachate sumps and during transfer to the recirculation pods, which could result in the discharge of the leachate to the cap. Run-off from the cap could therefore become contaminated with pollutants from the leachate which could then enter the site surface water drainage system. From the perimeter ditches run-off will be directed to either the existing, northern, flow balancing pond or the proposed balancing pond to the west of the site. Discharge from these ponds to the natural surface water system will be controlled and it will be possible to contain any polluted run-off until such time as a disposal option is agreed. It is considered that the risk from spills of leachate to surface water is low. Additional quantitative analysis in respect of spills is not necessary

2.10 Emissions to groundwater

One of the main purposes of the HRA is to establish whether the predicted discharge from the landfill complies with the requirements of the Environmental Permitting (England and Wales) Regulations (2016) Schedule 22 Groundwater activities.

2.10.1 Hazardous substances

The HRA must demonstrate that the proposed technical precautions will prevent Hazardous substances from entering groundwater. Consequently it must consider whether there is likely to be a discernible discharge of Hazardous substances to groundwater.

Hazardous substances have not been detected in the leachate. If hazardous substances are present, they are in concentrations below the limits of detection. Vertical movement through 70+ m of Oxford Clay will reduce concentrations even further, by mechanisms such as adsorption, etc, and they will be even further below the detection threshold if they reach any underlying aquifer.

Without attenuation and retardation, it is estimated, using Darcy's Law calculations provided in *Appendix 2437/HRA/A1*. The worst case scenario results are presented below:

- 10 m distance to receptor –

Assuming a 2 m leachate head acting on the natural Oxford Clay beneath the landfill (ie, ignoring the mineral liner), a flow rate of 0.019 m/year is predicted through the natural Oxford Clay. The time for groundwater, and any conservative pollutants, such as chloride, to reach the assumed receptor (10 m away) is 527 years.

2.10.2 Non-hazardous pollutants

The HRA must demonstrate that technical precautions will limit the introduction of Non-hazardous pollutants into groundwater so as to avoid pollution. Consequently it must consider whether predicted concentrations of Non-hazardous pollutants are likely to exceed relevant standards and other environmental quality criteria, or cause an unacceptable deterioration in groundwater quality following dilution.

Non-hazardous pollutants are present in the leachate, in particular ammoniacal nitrogen concentrations within the range between 203 mg/l and just over 1000 mg/l in recent years. However it is also subject to adsorption and ion exchange in clay minerals and is unlikely to be found in measurable quantities in discharges from the Oxford Clay to an aquifer.

Estimates of travel times calculated using the Environment Agency's spreadsheet tool are provided in *Appendix 2437/HRA/A1* and a summary of the worst case scenario results are presented below;

- 10 m distance to receptor –

Assuming a 2 m leachate head acting on the natural Oxford Clay (ie, ignoring the mineral liner), a flow rate of 0.019 m/year is predicted through the natural Oxford Clay. The time for groundwater, and any conservative pollutants, such as chloride, to reach the assumed receptor is 527 years. For ammonia, a representative inorganic cation susceptible to attenuation, the time to reach the receptor 10 m away from the landfill is estimated as 2,810,000 years.

- 0.5 m leachate head acting on cap

The cap is generally 2 m thick and in reality there will not be a driving leachate head acting against it. However, for this hypothetical scenario, for a unit 1 m width of cap, a flow rate of 0.0038 m/year is predicted through the engineered clay. The time for groundwater, and any conservative pollutants, such as chloride, to travel through a 2 m cap is 2,850 years. For ammonia, a representative inorganic cation susceptible to attenuation, the time to travel through the engineered cap is estimated as 2,240,000 years.

Due to the absence of a defined watertable in the vicinity of the site, compliance points for both Hazardous Substances and Non-hazardous Pollutants will comprise the natural surface watercourses beyond the site drainage.

2.10.3 Surface water management

Surface water from the existing landfill and proposed extension will collect in perimeter drains as shown on *Drawing 2437/HRA/D2*. Where possible, this will be constructed off the landfill. If this cannot be avoided, the cap will be thickened locally to allow the formation of the drain without compromising the cap functionality. Flow in the perimeter drains will be directed to a new flow balancing pond to the west of the landfill. This pond has to date not been constructed.

The potential for the site to cause flooding has been considered in detail using Microdrainage software by Abington Consulting Engineers in their March 2017 report, which accompanied the planning application for the landfill extension. This confirmed that all surface water generated at the site during the operation of the landfill and on completion and restoration would be managed adequately on-site with the provision of the flow balancing lagoon fitted with a flow control device.

2.11 Emissions to surface water

Based on the risk assessment for groundwater pollution above, and the ability to control discharges from the site, the presence of engineered landfill base, sidewalls and cap and the other technical precautions in place, it is concluded that during normal operation and through to long-term post-closure, concentrations of Hazardous substances will not be discernible and Non-hazardous pollutants will be sufficiently low as to avoid pollution of surface water.

2.12 Hydrogeological completion criteria

Hydrogeological completion criteria refer to the conditions that must be met before an Environmental Permit can be surrendered, ie Permit Completion attained. Completion relating to hydrogeological risk will have been achieved when there is no longer any unacceptable risk of pollution from the landfill, ie the site complies with the Environmental Permitting (England and Wales) Regulations (2016) Section 22 Groundwater Activities without any active leachate management.

As the site is set within extensive Oxford Clay deposits, unacceptable discharge is considered unlikely. It is considered that hydrogeological completion criteria will not be the controlling factor in the ultimate surrender of the Environmental Permit.

3 REQUISITE SURVEILLANCE

3.1 Risk-based monitoring scheme

Under the Environmental Permitting (England and Wales) Regulations (2016), there is a requirement for 'requisite surveillance' in the form of leachate, groundwater and surface water monitoring.

Environmental monitoring is a crucial element of the risk assessment process as it:

i) Allows for validation of the risk assessment
ii) Can confirm whether risk management options are meeting their aims
iii) Provides a warning mechanism if adverse impacts are found

Control levels and compliance limits form the basis for assessing groundwater monitoring data at landfill sites.

Control levels are specific assessment criteria relating to groundwater, or other relevant parameters, that are used to determine whether a landfill is performing as designed. They act primarily as an early warning system to enable appropriate investigative or control measures to be implemented.

Compliance limits are specific compliance concentrations (or regulatory standards) and are specified in an Environmental Permit. If the defined compliance limits are exceeded, significant adverse environmental effects and/or breaches of regulatory standards will have occurred. Such effects are deemed consistent with groundwater having been polluted.

3.1.1 Leachate monitoring

Necessary leachate level and quality monitoring is set out in the current Permit. We do not propose to vary these requirements but suggest they are extended to cover the proposed cells 11 to 15.

3.1.2 Surface water monitoring

Surface water is currently monitored at three locations at the site as shown on *Drawing 2437/HRA/D2*. These locations are upstream and downstream of Cells A to C on Stream 1 and also downstream of the balancing and ecological pond which discharges to Stream 2.

It is proposed to construct an additional flow balancing pond to the west of the landfill and this will discharge at a controlled rate to Stream 3. It is recommended that an additional monitoring point (SW4) is located at the discharge from the new balancing pond once it has been constructed.

2437/HRA/T3: Proposed analytical suites for surface water samples

Frequency	Analytical suite
Quarterly	pH, conductivity, ammoniacal nitrogen, chloride, Chemical Oxygen Demand, Total Organic Carbon, Nitrate, Sulphate, fluoride, extractable petroleum hydrocarbons
Annually	As quarterly suite plus total alkalinity, sodium, magnesium, potassium, lead, copper, zinc, chromium, iron, manganese, arsenic, cadmium, nickel, polyaromatic hydrocarbons, BTEX

3.1.3 Groundwater monitoring

Groundwater monitoring is not required or appropriate at the site.

3.1.4 Compliance limits and control levels

i) Surface water

Compliance limits have not been set for surface water as this represents run-off from restored areas only.

ii) Leachate

Leachate quality compliance limits are not set.

Leachate levels are recorded in the leachate sump constructed at the lowest point in the cell. Compliance limits are currently set at 1 m above the base of each cell despite there being a previous informal agreement allowing for a 2 m head of leachate. As monitoring is currently at the lowest point in the cell, and the base of the cell is graded to this point, this data can be viewed as worst case and is not representative of the cell in general.

It is believed that the reason the 2 m head was not carried forward to the current Permit was due to concerns of leachate outbreaks through the cap. However, due to the site practice of excavating clay to depths in excess of 7 m below pre-existing ground levels (Cells 7-15) in order to generate clay for use in engineering at the site and for off-site uses, a head of 2 m would only come part way up the cell walls and would remain below ground level.

The base elevation of the site varies cell to cell and hence to apply a single leachate level to the site is meaningless. Instead of applying a universally applied 1 m head derived from central guidance and loosely tied to the Groundwater Directive, it is proposed that a more risk based approach to compliance limits would be more appropriate.

Leachate levels within the site are largely stable now and, in the case of Cell 6 falling. It is therefore considered that the current management scheme is effective in controlling leachate levels. In light of this, and the configuration of the site, it is proposed that the compliance limit for leachate levels in Cells 7 to 15 are set on a similar basis to that used for "hydraulically contained" sites whereby a free board is set below the lowest ground level adjacent to each cell. This freeboard is commonly set as 0.5 m. Where this would lead to a head greater than 2 m we suggest that until 12 months after cell closure the maximum head reverts to 2 m.

It is therefore suggested that the following leachate elevations and heads are incorporated as compliance limits for leachate level;

2437/HRA/T4: Leachate elevations and heads (compliance limits)

Cell	Elevation of nearest natural ground level (mAOD)[1]	Elevation with 0.5 m freeboard (mAOD)	Base of cell (m AOD)	Leachate head to freeboard (m)	Suggested compliance level (m)[3]
A	86.0	85.5	-	-	1
B	86.5	86.0	-	-	1
C	88.5	88.0	-	-	1
1	N/A		84.4		1.5
1A	85.0	84.5	82.5	2	2
1B	N/A		82.6		1.5
2	N/A		84.6		1.5
3	N/A		85.6		1.5
4	N/A		83.7		1.2
5	N/A		84.7		1.5
6	N/A		84.5		1.5
7	86.0	85.5	81.9	3.6	2
8	86.5	86.0	80.63	5.37	2
9	N/A		79.94		2
10	N/A		77.8		2
11	85.6	85.1	78.6[2]	6.5	2
12	80.5	80.0	73[2]	6.5	2
13	82.5	82.0	75.5[2]	6.5	2

2437/HRA/T4: Leachate elevations and heads (compliance limits)					
Cell	**Elevation of nearest natural ground level (mAOD)[1]**	**Elevation with 0.5 m freeboard (mAOD)**	**Base of cell (m AOD)**	**Leachate head to freeboard (m)**	**Suggested compliance level (m)[3]**
14	83.0	82.5	76[2]	6.5	2
15	83.0	82.5	76[2]	6.5	2

1 Based on LIDAR data and survey data
2 Assumes 7 m clay extraction
3 Suggested for first 12 months after completion and capping of active cells

It is suggested that the above conservative leachate heads balance the existing leachate management, keeping leachate levels below peripheral ground levels, and low risk proven to be posed by leachate migration from the site. It is proposed that action or control levels for leachate are set at 0.25 m below the compliance level based on a three point rolling average.

4 CONCLUSIONS

4.1 Compliance with the Landfill Regulations, 2002

It is likely that the leachate generated in Park Grounds Landfill will contain non-hazardous pollutants, hence the leachate is collected at the base of each cell and controlled. Details of the leachate collection system are presented in the ESSD report.

The construction of the mineral liner system in the future cells will be subject to CQA with the clay mineral liner expected to achieve maximum permeabilities of $9x10^{-11}$ m/s. The landfill design for the future cells complies with Annex I of the Landfill Directive. It is proposed that the engineered liner will comprise the in-situ Oxford Clay geological barrier and the engineered 1–2 m of reworked Oxford Clay removed from the base of the cell. This approach is consistent with Environment Agency guidance.

It is therefore considered that the landfill will be compliant with the requirements of the Landfill Regulations 2002.

4.2 Compliance with the Environmental Permitting (England and Wales) Regulations (2016)

As it is likely that the leachate will contain non-hazardous pollutants and a risk of release of these pollutants to groundwater exists. Hence the Environmental Permitting (England and Wales) Regulations (2016) apply.

Technical precautions, including the site engineering, leachate drainage and control and capping are proposed for future cells at Park Grounds Landfill. Requisite surveillance is also proposed and compliance limits have been set for leachate levels.

With these measures in place, the HRA has shown that with the low sensitivity of the site setting from a groundwater perspective, under normal circumstances landfilling at Park Grounds Landfill poses no risk to groundwater. Hazardous substances will not be present in groundwater beneath the site in concentrations discernible above background and Non-hazardous pollutants will not be present in concentrations such that pollution of nearby groundwater is caused.

It is therefore concluded that the site will be compliant with respect to the Environmental Permitting (England and Wales) Regulations (2016).

5 REFERENCES

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DRAWINGS

APPENDIX 2437/HRA/A1

Model output