Development of Waste Treatment Facility, comprising Reception and Recycling Hall; Mechanical Biological Treatment (MBT) Facility; Advanced Conversion Technology (ACT) Facility; Power Generation and Export Facility; Education and Office Accommodation; Landscaping and, Access.

Sinfin Lane, Derby

Resource Recovery Solutions (Derbyshire) Ltd.

Environmental Statement

Chapter 11

Hydrogeology and Ground Conditions

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11 Hydrogeology and Ground Conditions

11.1 Introduction

Overview

11.1.1 This chapter provides a description of ground conditions in terms of geology, hydrogeology and potential land contamination for the proposed development site at Sinfin Lane, Derby. An assessment has then been undertaken to ascertain whether, and to what extent, the proposed development, human health (i.e. construction workers and future site users), controlled waters and the general environment will be impacted by ground conditions, most notably contamination resulting from historical, current or the proposed land-use.

11.1.2 The significance of contamination identified on site is assessed by identifying pollutant linkages using a Source-Pathway-Receptor approach, an approach underpinned by current UK Guidance, notably Part IIA of the Environmental Protection Act 1990.

11.1.3 The nature and significance of potential impacts are assessed against pre-determined baseline conditions for the site. This assessment has largely relied on the available published results of previous investigations and assessments that pertain to the site. A key summary report (*RPS, 2009*) that presents a review of all historical documents produced since 1999 is provided in Appendix 11.1, this report underpins the hydrogeology and ground conditions chapter.

Proposed Deveopment

11.1.4 The proposed development is described in detail in *Chapter 4* and its layout shown in Drawing 4.1. It proposed to construct a new Waste Transfer Facility on the site that comprises reception facilities, Mechanical Biological Treatment plant and Advanced Conversion Technology plant. The three main elements to the design include new buildings, hardstanding areas and landscaping.

11.1.5 The principal structure associated with the development is situated in the centre of the site, with a total footprint covering approximately 1 hectare of the 3.4 hectare site.

11.2 Legislation and Planning Context

11.2.1 Re-development of Brownfield land must:

- Take into account the regulatory context of the proposal site and development;
- Provide information that is fit for purpose; and
- Be in accordance with UK good practice.

11.2.2 An environmental assessment of the condition of a site must not only consider the potential receptors of human health and controlled waters but also include a review of the relevant legislation and planning policy that applies to the site and its immediate environs.

11.2.3 A detailed review of the development plan documents and planning context in relation to the development proposals is provided in *Chapter 3*. This section summarises those polices that are directly relevant to hydrogeology, ground conditions and the assessments used herein.

Legislation & Guidance

11.2.4 Contaminated land is addressed by the following Acts of Parliament: -

- Environmental Protection Act 1990 Part IIA. A regime for the identification and remediation of contaminated land, implemented by the Local Authorities and the Environment Agency and is subject to statutory guidance.
- Water Resources Act 1991. Section 85. Control of pollution of groundwater by land contamination through direct or indirect discharges. The Environment Agency will encourage the effective remedial measures to prevent pollution.
- The Environment Act (1995) provides clarification of the roles for assessment, enforcement and remediation of contaminated land using the regulations summarised above.
- Town and Country Planning Act 1991 Section 106. The Environment Agency will seek to ensure that Planning Permission contains conditions designed to protect water resources through planning obligations with developers and Local Authorities for the identification and remediation of contaminated land.

CLR 11 - The Model Procedures for the Management of Land Contamination, CLR 11, have been developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination. The process involves identifying, making decisions on, and taking appropriate action to deal with land contamination in a way that is consistent with government policies and legislation within the UK.

National Planning Policy

Planning Policy Statement (PPS) 23: Planning and Pollution Control

11.2.5 Land contamination and its risk to health is a material consideration under planning and development control, and apply to the intended use of the site. Existing guidance on assessing risks to health under the Town and Country Planning Acts is limited to the amended Planning Policy Statement (PPS23): 'Planning and Pollution Control' which more clearly aligns the requirements under planning with those under Part IIA. This is consistent with the practical requirements that a site under planning for its intended or proposed use should not fail the

requirements for classifying a site as contaminated land under 'Part IIA' when the site is occupied and in use.

Planning Policy Guidance (PPG) 14: Development on Unstable Land

11.2.6 National Planning Policy Guidance on the geotechnical condition of soils is defined in Planning Policy Guidance Note (PPG) 14: 'Development on Unstable Land'. PPG14 identifies the situations that can result in and arise from the development of unstable ground. The guidance aims to:

- Minimise the risks and effects of land instability on property, infrastructure and the public;
- Help to ensure that various types of development are not placed in unstable locations without appropriate precautions;
- Bring unstable land, wherever possible, back into productive use; and
- Assist in safeguarding public and private investment through a full appreciation of site conditions and necessary precautionary measures.

Regional and Local Planning Policies

11.2.7 The regional and local planning policies pertaining to the proposed site are described in *Chapter 3*.

11.3 Assessment Methodology

Desk Study

11.3.1 The site ground conditions were determined by a review of historical information dating from 1999 that was made available at the time of writing. This information related to the current condition of the soils and groundwater beneath the proposed development site and included the following third party reports and associated documentation:

- Contamination Report (Construction Waste Materials Testing Ltd, 1999);
- Ground Investigation Report (Environmental Impact Analysis Group, 2000);
- Stage I / II Desk Study and Further Site Investigation Report, for Brightstar Environmental Partnership (WS Atkins, 2001);
- Quantitative Human Health and Environmental Risk Assessment of Proposed Development at Sinfin Lane, Derby, for Brightstar Environmental Partnership and Derby City Council (Atkins, 2002);
- Factual and Interpretative Geoenvironmental Summary Report (WS Atkins, March 2007);
- Geoenvironmental Summary Report and Outline Remediation Costings, for Derby City Council (Atkins, 2007);

- Factual Report (Allied Exploration and Geotechnics Ltd, 2008); and
- Potential Contamination Summary (Scott Wilson, 2008).

11.3.2 All information collected and reviewed as part of the desk-study is summarised in 'Summary and review of Historical Reports' (RPS, 2009) provided in Appendix 11.1. All documents relate to four phase of intrusive works undertaken between 1999 and 2008, the details of which are summarised in Table 11.1 and shown on Figure 11.1.

Table 11.1. Summary of Intrusive Investigations on the Sinfin Lane Site

Date of intrusive Works	Undertaken By	Client	Type of Works	Ref. IDs	No. Drilled / Excavated
November & December 2007	Allied Exploration and Geotechnical	United Utilities	Trial Pits	TP-01 to TP-12	12
			Boreholes	BH-01 to BH-10	10 BHs (15 Installations)*
May & June 2001	WS Atkins	Brightstar Environmental Partnership and Derby City Council	Trial Pits	TP201 to TP230	30
			Boreholes	BH101 to BH107	7
June & July 2000	Environmental Impact Analysis Group (EIAG)	Derby City Council	Trial Pits	TP1 to TP6	6
			Trenches	T1 to T6	6
			Borehole	BH1 to BH8	8
March 1999	Construction Waste Materials Testing Ltd	The Sherwin Club	Trial Pits	TP 1 to TP 17	17

* Some boreholes drilled on site were completed with installations at more than one depth.

11.3.3 Ground conditions have been determined from samples taken from a network comprising 25 boreholes, 67 trial pits and 6 investigation trenches, as shown on Figure 11.1 Clearly a comprehensive site wide coverage across has been achieved by these four intrusive investigations.

11.3.4 In addition to third party reports, the following information sources have been used in this assessment:

- Envirocheck Site Report *(*Landmark, 2008*);*
- Geological Maps and Memoirs (BGS, 1976);
- Environment Agency Website (http://maps.environment-agency.gov.uk/wiyby); and
- MAGIC website (http://www.magic.gov.uk/).

11.3.5 The existing information has been used to determine baseline conditions for the site. The information has been reviewed in the context of the proposed development to create a conceptual site model and evaluate the short, medium and long term, direct and indirect, permanent and temporary, adverse and beneficial impacts associated with the proposed development.

Baseline Assessment Methodology

11.3.6 Contaminated land occurs where historical land-management practices have led to the deliberate or accidental release or disposal of substances onto the land. These substances can pose a risk to humans, controlled waters, ecological systems, produce, livestock and buildings. "Contaminated land" is defined by section 78A(2) of Part IIA of the Environmental Protection Act 1990 as: "any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:

- Significant Harm is being caused or there is a significant possibility of such harm being caused;
- Pollution of Controlled Waters is being, or is likely to be caused.

11.3.7 Mitigation measures, or further works to be completed before construction, are identified which will ensure that there are no unacceptable risks to either human health or controlled waters. The basic principles underlying the quantitative risk assessments approaches undertaken for the Sinfin Lane site are described in the summary report contained in Appendix 11.1 and outlined briefly below.

Quantitative Human Health Risk Assessment

11.3.8 The most recent quantitative human health risk assessment referred to in this assessment have been undertaken in accordance with UK guidance namely CLR 7 -11 (WS Atkins, 2007). This involved the screening of historical analytical and chemical data against appropriate generic assessment criteria (GACs), that include published soil guideline values (SGVs) and in the absence of published SGVs, WS Atkins own derived SSVs.

11.3.9 It should be noted that in August 2008, the Environment Agency and DEFRA withdrew the existing CLEA guidance and supporting documentation, CLR7 to CLR10. Consequently there has been a recent removal of previous published Soil Guideline Values (SGVs) that would previously be used for comparison against soil chemical data and due to the revision of exposure scenarios and toxicity data, any derived generic assessment criteria (GACs) or Site Specific Assessment Criteria (SSACs) must take account of this. However it is considered reasonable that in the absence of the provision of new SGVs from regulators, chemical data can still be assessed against former SGVs and formally derived GACs and SSACs.

Controlled Water Quantitative Risk Assessment

11.3.10 In terms of assessing the potential risk to Controlled Waters the guidelines used to compare the contamination at the site with national standard guidelines are explained below :

- The risk assessment was undertaken following the Environment Agency guidance provided in R&D Publication 20 "Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources" and using the associated spreadsheet (version 2.2). The methodology follows a source-pathway-receptor analysis and ultimately calculates the concentrations to which contaminants must be reduced to within the soil and groundwater at the site in order to protect controlled waters on or off the site;
- The methodology applies a tiered approach. The first tier compares theoretical or actual contaminated soil pore water concentrations to a target concentration, and later tiers consider dilution factors, retardation and degradation. At the completion of each tier the assessor can either determine that no further action is necessary (i.e. there are no unacceptable risks to controlled waters), or take remedial action to reduce contaminant concentrations within the site, or progress to the next tier, which will require more data but may result in a less stringent remedial target; and
- A Tier 3 groundwater risk assessment was undertaken to determine acceptable source concentrations in groundwater beneath the site. These concentrations, termed remedial target concentrations, are used to screen recorded groundwater concentrations. Only those above the remedial target concentration are theoretically able to impact Controlled Waters at the designated compliance point located down gradient of the identified groundwater contamination source.

11.3.11 The controlled water QRAs reviewed by RPS (RPS, 2009) utilised the approach described above, through the Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources (Environment Agency R&D Publication 20).

Soil Gas and Built Structures Assessment

11.3.12 A soil gas assessment has been undertaken in line with UK guidance, CIRIA C665 *Assessing Risks Posed by Hazardous Ground Gases to Buildings*. CIRIA C665 advocates the replacement of concentration based screening criteria with flux based screening criteria for landfill gases to derive Gas Screening Values (GSVs). The above guidance defines the risk assessment framework for ground gases, both landfill and volatile organic compounds (VOCs) and has been used for the assessment of gas risks for the Application Site. The flux of gas (i.e. soil gas generation rate) is considered to more accurately represent the risk posed, and the flux of methane and carbon dioxide are used to derive the likely gas mitigation requirements. Screening criteria are presented in *Table 11.2* as per CIRIA C665.

Table 11.2. Soil Gas Assessment Screening Criteria (CIRIA C665, 2007)

Characteristic Situation	Gas Screening Value (CH_4 or CO_2) (l/hr)*	Additional Factors
1	<0.07	Typically methane ≤1% and/or carbon dioxide ≥5%. Otherwise consider increase to Situation 2
2	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to characteristic Situation 3
3	<3.5	-
4	<15	Quantitative risk assessment required to evaluate scope of protective measures.
5	<70	-
6	>70	-

11.3.13 All quantitative risk assessments relating to the site, that are referred to in this chapter, have been described in the historical reports summarised in *Appendix 11* .1(RPS, 2009). No new risk assessments have been undertaken for the purpose of this assessment.

Impact Assessment Methodology

11.3.14 A review of the baseline conditions was undertaken for the development site, to enable the nature of any potential impacts associated with the proposed development to be determined. The magnitude of potential impacts, above the pre-defined baseline conditions are assessed prior to the consideration of any mitigation measures. The significance of residual impacts are assessed in accordance with criteria in *Table 4*. Residual impacts reflect the incorporation of mitigation methods.

Impact Magnitude Assessment

11.3.15 The magnitude of potential impacts (using worst-case scenarios) during the operational and construction phases of the development have been qualitatively described and categorised based on the terminology in *Table 3*.

Table 11.3. Magnitude Criteria

Impact Magnitude	Criteria	Example / Description
High	Results in loss of attribute and likely to cause exceedance of statutory objectives and/or breaches of legislation	Contamination of a potable source of abstraction
Medium	Results in impact on integrity of attribute or loss of part of attribute possibly with / without exceedance of Statutory objectives or with/without breaches in legislation.	Reduction in the value of the feature
Low	Results in minor impact on attribute	Measurable changes in attribute, but of limited size and/or proportion
Negligible	Results in no discernible change or an impact on attribute of insufficient magnitude to affect the use / integrity	Discharges to watercourse but no significant loss in quality of the feature

11.3.16 The impact magnitude is determined, following the implementation of all mitigation measures identified in Section 11.5.

Significance Criteria

11.3.17 The prediction of impact significance is based on the magnitude of the impact and the importance or sensitivity of the receptors. The importance and / or sensitivity of receptors is described in the baseline characterisation of the site (Section 11.4). The assessment takes account of any mitigation measures to be applied in the implementation of the development proposals. The assessment of impact significance, for negative impacts, are assessed in the absence of any mitigation measures and secondly with the consideration of potential mitigation measures. The criteria for classifying impact significance are summarised in *Table 4.*

Table 11.4.Significance Criteria

Significance	Description
Major Adverse	Considerable detrimental impact (by extent, duration or magnitude) of more than local significance or in breach of recognised acceptability / legislation / policy standards.
Moderate Adverse	Limited detrimental impact (by extent, duration or magnitude) that may be considered significant.
Minor Adverse	Slight, very short or highly localised detrimental impact.
Negligible	No appreciable impact on the attribute, or the attribute of negligible importance
Minor Beneficial	Minor reduction in risk (Slight, very short or highly localised impact)
Moderate Beneficial	Moderate reduction in risk
Major Beneficial	Major reduction in risk

11.4 Baseline Conditions

Site Setting

11.4.1 The Sinfin Lane site is situated approximately 3 km south of Derby city centre (National Grid Reference 435230 333010) and covers an area of approximately 3.4 hectares. The site is currently derelict, comprising rough grass, brambles and other vegetation. The site is generally flat, with a surface elevation of approximately 50 m AOD.

11.4.2 The site is located in an area of mixed industrial and residential land-uses. The site is bounded to the west by Sinfin Lane and residential properties, to the north and east by railway lines and to the south by a sports ground and Rolls Royce factory.

Site History

11.4.3 The proposed development area has historically been the site of the following activities:

- Brick Works (Before 1883 to c. 1914); and
- Tannery (From c. 1915 to the 1980's)

11.4.4 Several clay pits associated with the former brick works were present in the vicinity of the site. A large pit located in the centre of the site was used as a fishing pond up to the 1980's.

11.4.5 Waste effluent waters from the tannery were historically pumped through four settlement lagoons, situated in the east of the site, prior to discharge to sewer. Dredgings from the settlement lagoons were dried in the north-east of the site, prior to final disposal in the east of the site.

11.4.6 The tannery closed in 1984 and all buildings were demolished. Rubble from the demolished buildings was used to backfill lagoons and pond (i.e. former clay pit) on the site. The site has since remained undeveloped.

11.4.7 The key areas associated with historic land-use are shown on Figure11.1 and include:

- Footprint of former tannery – Western parts of the site;
- Former fishing pond (originally a clay pit associated with brick works) - Central / northern area; and
- Former settlement lagoons – South-eastern area.

Environmental Setting

Geology

11.4.8 The site is underlain by a variable thickness of Made Ground. The greatest extent of Made Ground is found in the location of the former pond and settlement lagoons, where depths can exceed 5 m. This reflects the original depth of these features prior to backfilling with inert waste following demolition of the tannery. The pond and tannery areas demonstrate the most variable composition of Made Ground that comprises tarmac, ash, clinker, bottles, pottery, wood, slag, coal, fragments of asbestos roofing, metal, fabric foam, cables, ceramics, polythene sheet, ash and plastic.

11.4.9 The entire site is underlain by Triassic rocks of the Mercia Mudstone Group. The Mercia Mudstone Group comprises a sequence of red marls, interbedded with sandstone and bands of gypsum, which are shown to dip shallowly by 2º to the northwest (WS Atkins, 2007).

11.4.10 The upper surface of the Mercia Mudstone is characterised by a soft to firm, red to green/green sandy, silty clay that extends to a depth of approximately 8.5 mbgl (WS Atkins,

2007). The Made Ground generally overlies this Mercia Mudstone clay unit, which is likely to represent highly weathered Mercia Mudstone.

11.4.11 Beneath the clay, geological logs demonstrate that Mercia Mudstone on the site is characterised by a sequence of red-brown and grey-green mudstone and siltstone units with subordinate, but laterally extensive sandstone horizons

Hydrology

11.4.12 The closest watercourse to the site is referred to as Barracks Brook. This stream is only identified on historical maps, issuing approximately 80 m to the south-east of the site and flows in a southerly direction discharging to Cuttle Brook. Several discharge consents associated with licensed discharge to Barracks Brook (referenced as "tributary of Cuttle Brook") have been identified, suggesting that Barracks Brook may currently be culverted in this area.

11.4.13 Cuttle Brook is located approximately 300 m to the south-west of the site at its closest point. Cuttle Brook flows in a south-easterly direction before discharging into the Trent & Mersey Canal. Cuttle Brook has been allocated GQA grades of C (fairly good) for both biological and chemical indicators of river water quality.

Hydrogeology

11.4.14 The Mercia Mudstone Group is generally classified as non-aquifer unit (Environment Agency, 1998), although the groundwater vulnerability for the site indicates the site is underlain by a minor aquifer (Landmark, 2008). This designation of a minor aquifer relates to ancient lake and river terrace deposits on the site (WS Atkins, 2007). However, geological logs for the site clearly identify low permeability clay, siltstones and mudstones of the Mercia Mudstone Group across the site, suggesting limited importance as a water resource and supporting a non-aquifer designation for the geology underlying the site.

11.4.15 Perched groundwater has been identified within the Made Ground within the former clay pits and lagoon areas. Groundwater in the Made Ground is generally perched on the clay that forms the upper horizon of the Mercia Mudstone. Perched groundwater is not laterally persistent, being largely restricted to the infilled pond and lagoons, with the peripheral shallow Made Ground being dry. The Made Ground can be considered a non-aquifer.

11.4.16 Groundwater has been identified in all boreholes penetrating the Mercia Mudstone bedrock underlying the site. Groundwater levels are generally between 1.5 mbgl and 3.0 mbgl, with flow generally orientated to the south-east.

11.4.17 No groundwater abstraction licences are identified within 1.8km of the site and the site is not located within a groundwater Source Protection Zone (Landmark, 2008). These observations are consistent with limited importance as a water resource and non-aquifer designation of the Mercia Mudstone Group. Groundwater underlying the site is therefore considered to be of low sensitivity on the Sinfin lane site.

11.4.18 The only local receptor for groundwater within the Mercia Mudstone would appear to be the Barracks Brook and Cuttle Brook. However, the likely culverted nature of Barracks Brook and its position on clay deposits would suggest the degree of continuity is likely to be minimal. Perched water in Made Ground appears discontinuous and is unlikely to be in hydraulic continuity with either groundwater in the Mercia Mudstone or surface water courses. This potential groundwater receptor is therefore considered to be of low sensitivity.

Water Dependent Ecologically Sensitive Site

11.4.19 No ecologically sensitive, water dependant sites have been identified in the vicinity of the site.

Soil Contamination

11.4.20 The soil contamination of the site is described in the report contained in *Appendix 11.1* (RPS, 2008). Despite the nature and distribution of potentially contaminating activities historically undertaken on the site, there is no evidence of widespread or gross contamination of the site. Where contamination has been identified it is generally localised in nature and is usually associated with the former settlement lagoons, ponds and tannery.

11.4.21 The former settlement lagoons are dominated by the presence of metals and most notably chromium and to a lesser extent lead, with concentrations of the former exceeding 10,000 mg/kg in places (Trench 1, Trench 6 and TP226). There is also the localised presence of Polycyclic Aromatic Hydrocarbons (PAHs) and phenols. The lagoon area is also the location of highest sulphur (elemental and total) concentrations measured across the site.

11.4.22 The infilled pond is also characterised by elevated concentrations of various metals and specifically lead, although chromium is notably absent. Some PAHs were also identified in this area.

11.4.23 Contaminant distribution across the footprint of the former tannery is particularly dispersed. The tannery is the principal location of organic contamination identified on the site, most notably the localised occurrence of petroleum hydrocarbons as identified in TP208, TP203 and BH8. Elevated concentrations of total PAH are also observed in TP1 and TP201.

Groundwater Contamination

11.4.24 Groundwater samples have been obtained from the trial pits and boreholes excavated on the site. Only low concentrations of organic substances have been identified in groundwater and were not considered significant following tier 1 screening against relevant standards.

11.4.25 Low concentrations of inorganic contaminants were generally observed in groundwater with some notable exceptions: Slightly elevated concentrations of arsenic were detected in the south-east (BH106) and the infilled pond (BH107); and significantly elevated chromium (much of which was hexavalent chromium) within the former tannery area (BH102).

11.4.26 The majority of the samples that have concentrations that exceed the GACs are from perched groundwater contained in deep Made Ground within the former pond and lagoon areas.

Ground Gas

11.4.27 The most recent gas monitoring undertaken over three rounds in January 2008 did not identify any detectable concentrations of methane in any of the monitoring locations. Furthermore, carbon dioxide was only recorded at concentrations of up to concentrations of 1.4%. Ground gas was not identified as a risk in studies before 2008, although peak concentrations observed per-2001 were:

- Methane – up to 18.1% v/v in former pond area (MG) [BH5 & BH6]; and
- Carbon Dioxide – up to 7.4% v/v in former pond area (MG) [BH107].

Human Health Risk Assessment

11.4.28 Several detailed human heath risk assessments have been undertaken using soil data gathered on, most notably by WS Atkins (WS Atkins 2002 and 2007). The available data in respect of these quantitative risk assessments has been reviewed by RPS and summarised in *Appendix 11*.

11.4.29 The human health risk assessments have identified very few locations where near surface contaminant concentrations exceed the Generic Assessment Criteria (GAC) for an adopted commercial / industrial land end use. Concentrations in excess of GACs for a commercial / industrial end use include a few instances chromium within the lagoon area, lead concentrations in the infilled pond area and petroleum hydrocarbons in the vicinity of the former tannery (WS Atkins, 2007 and Scott Wilson, 2008).

11.4.30 As the majority of site will comprise hard-standing areas post development, it has been concluded that direct human exposure to contaminated soils following redevelopment, will be low. Thus the inadvertent contact, ingestion and inhalation of soils represents a low risk to human health and the formal remediation of near surface contaminated soils is therefore

considered to be negligible in the long term.

Controlled Waters Risk Assessment

11.4.31 The available data in respect of the controlled water risk assessment has been reviewed by RPS and summarised in Appendix 11.1 The controlled water risk assessment identified the following contaminants of concern in leachate/perched waters and are also present in groundwater sampled down gradient of the site:

- Ammoniacal Nitrogen;
- Arsenic;
- Copper;
- Nickel;
- Manganese; and
- Nitrogen.

11.4.32 The perched groundwater contained in the infilled lagoon and pits has higher concentrations than in samples from down-gradient wells, suggesting the weathered clay horizon and upward hydraulic gradient inhibits the vertical and lateral migration of contaminants in perched water.

11.4.33 Thus it can be concluded that owing to site specific hydrogeological and geological setting groundwater contamination, principally within, the Made Ground represents a low risk to either surface water courses (i.e. Barracks Brook) or groundwater in the Mercia Mudstone bedrock.

Ground Gas Risk Assessment

11.4.34 Peak gas concentrations measured in early gas monitoring round would classify the site, in the vicinity of the former pond, as a Characteristic Situation 2 requiring gas mitigation measures to be incorporated the building design. Conversely, the most recent gas monitoring would classify the site as a Characteristic Situation 1, although it is recognised that this monitoring did not include the former pond area, and is based on monitoring from wells screened within natural deposits rather than the Made Ground.

11.4.35 Therefore, as a precautionary approach, the site should either be over-engineered to provide gas protection suitable for a Characteristic Situation 2 (CS2) or further monitoring may be prudent if a more accurate gas assessment and hence site classification is to be completed .

11.4.36 Gas protection measures suitable for CS2, include:

- Reinforced Concrete floor slab with at least 1200 g DPM2; or
- Beam & Block or concrete floor slab (with at least 2000g DPM / reinforced gas membrane);
- Possibly under floor venting or pressurisation (in combination with the above);

- All joints and penetrations sealed.

11.5 Incorporated Enhancement and Mitigation

11.5.1 Although the risk to controlled water is low, agreement for a groundwater management plan shall be sought with the regulator and planning authority to minimise potential contact between site construction workers and perched waters in Made Ground during the construction phase. This shall include safe handling, storage and disposal of shallow groundwater where encountered, following UK best practice.

11.5.2 It is recommended that either the development be over-engineered to provide gas protection suitable for a Characteristic Situation 2 (CS2) or an additional ground gas survey is undertaken in line with UK guidance. A new gas survey would enable the risk from ground gas to be assessed principally in the vicinity of the infilled ponds and gas protection measures to be identified.

11.5.3 Chemicals, oil and fuel used on the operational site will be stored in bunded structures. The bunds will be designed and constructed in accordance with the latest regulatory guidance in order to contain 110% of the tanks maximum capacity with impermeable bases, which will mitigate impacts to soil and groundwater resulting from leakage.

11.5.4 Materials transported to site for processing will be contained within appropriately constructed structures with impermeable bases, which will mitigate impacts to soil and groundwater resulting from leakage.

11.5.5 Foundations and services will be designed and constructed to minimise the creation of pathways for the migration of contaminants, principally from the Made Ground to the underlying bedrock. The method of design and construction will be determined following an assessment of the results of further geotechnical site investigation to be undertaken. The controlled waters risk assessment shall be reviewed at this stage should this be deemed necessary. This will help to reduce the potential contamination of groundwater.

11.5.6 All vehicles will be covered and waste handling processes undertaken inside a purpose built unit thereby limiting the contamination potential.

11.5.7 During the construction phase all waste soils shall be tested and classified prior to disposal offsite to an appropriately licensed facility.

11.6 Identification and Evaluation of Likely Significant Effects

11.6.1 This section details the impacts of the development during the construction phase, post construction and during the operation of the proposed Waste Transfer Facility. From the potential impacts identified, the potential magnitude and then significance is addressed. In the following sections mitigation measures are suggested and evaluated, where required, and the residual impacts are then given.

Constuction Phase

11.6.2 Limited soil and groundwater contamination has been identified on the site (*Appendix 11*).

11.6.3 Disturbance of soil during construction may result in the mobilisation of contamination by increased exposure to rain, alteration to ambient physical / chemical conditions etc. This may result in a deterioration of water quality in the Made Ground and / or the generation more potentially contaminated shallow perched waters on the site. The magnitude of the impact is considered low, considering the comparatively low quality of water within the Made Ground and its low resource value. Thus the significance of a deterioration of water quality in the Made Ground is considered **Minor Adverse**.

11.6.4 Dust and silt resulting from disturbance during construction activities may arise as a result of the movement of potentially contaminated soil by construction machinery. In the absence of any non-culverted surface water courses on the site, if left uncontrolled this could result in the silting up of local drainage systems. Such an impact is considered to **Minor Adverse** significance.

11.6.5 The use of heavy machinery on site are likely to compact soils, although this is considered to be of **Negligible** significance.

11.6.6 The human health risk assessment undertaken to date indicates that short-term exposure to contamination within soils excavated during the construction represent a low risk to construction works. This impact is therefore considered to be of **Minor Adverse** significance. All soils excavated will however have to be fully classified to determine their suitability for re-use on site or the appropriate off-site disposal methods.

11.6.7 The groundwater risk assessment indicates that perched groundwater in the Made Ground poses little risk to water quality in the either the Mercia Mudstone bedrock underlying the site and/or proximal surface water courses, principally because of: the presence of clays beneath the Made Ground and the discontinuous nature of this water body. Thus the disturbance of the unsaturated zone soils is likely to have a **Negligible** impact on groundwater in the Mercia Mudstone and therefore a **Negligible** impact on surface water bodies.

11.6.8 Although groundwater contamination poses little risk to controlled waters, site workers may be subject to short-term exposure to shallow groundwater during construction. Such exposure is considered to represent a impact of medium magnitude. By the adoption of an agreed groundwater management plan (including such things as PPE requirements, dewatering methods, water storage and treatment\disposal procedures etc.) the significance of this exposure pathway can be limited to **Moderate Adverse.**

11.6.9 The construction of piled foundations may open new preferential pathway for contamination transport beneath the Made Ground and the bedrock. Although the Mercia Mudstone cannot be considered as a viable aquifer unit, methods of piling to mitigate adverse impacts are discussed below. This impact could be considered of medium magnitude, potentially resulting in a **Minor Adverse** impact on groundwater but **Negligible** impact on surface water bodies.

11.6.10 In the absence of gross and / or site wide contamination, the risk to human health through ingestion, inhalation and/or dermal contact with soil contamination is considered low (Appendix 11.1). Furthermore, the risk of this exposure pathway can be minimised by the production of a site construction management plan and adherence to UK best practice and guidance, most notably for works undertaken in the former pond and lagoon area. Although the magnitude of such exposure is considered to be Medium, the significance of this exposure pathway is considered **Minor Adverse**.

11.6.11 During construction there is potential for accidental spillage of contaminants from vehicles, plant and construction materials. The magnitude of the impact on the land due to accidental spillage of fuels from construction vehicles is dependent on the frequency and size of the spillage. Depending on the size of such an event, it is considered that the impact of a fuel or chemical spillage would be of **Negligible** to **Minor Adverse** significance considering the absence of pathways with any sensitive receptors (most notably controlled water).

11.6.12 The proposed structures are likely to use foundations that extend below the water table, which could affect groundwater flow in the Made Ground. The magnitude of the impacts of the foundations on groundwater flow is therefore low and is of **Negligible** significance.

Operational Phase

11.6.13 The use of hard-standing over most of the areas where soil contamination has been observed, suggests the potential impact from current soil contamination on human health is low and its significance **Negligible**. No in-situ or ex-situ remedial measures are proposed considering the distribution and nature of contamination and results of the human health risk assessment, in light of the wide spread hard-standing covering much of the site.

11.6.14 Historical data indicates that ground gas may pose a risk to future site users in the absence of gas control measures within design. This suggests a **Moderate Adverse** impact. Outside of the areas of the settlement lagoons and infilled pond, ground gas is considered to be of **Negligible** risk to future users.

11.6.15 The structures required for the development may have a permanent impact on the flow of groundwater if piling is required, primarily due to piling (if required). The magnitude and significance of this impact is **Negligible**.

11.6.16 Proper management of contaminated water, liquids leaching from the waste chemicals, oil or fuel stored on site during operation will ensure that they do not leak and enter the sub-surface or enter controlled waters, if poorly managed. Contaminated surface water runoff has the potential to have a medium magnitude of impact on the quality of perched groundwater. However the significance of such an impact is **Minor Averse** considering the discontinuous nature of this water body and the absence of continuity with sensitive surface water receptors.

11.6.17 Groundwater levels beneath the site may potentially change as a result of site development. Increased and improved hardstanding is likely to reduce infiltration and recharge of shallow groundwater. However this will only affect the discontinuous water in Made Ground and can considered of **Negligible** significance.

11.7 Mitigation

Construction Phase

11.7.1 All construction works shall be undertaken under the control of an Environmental Management Plan (EMP) produced by, or on behalf of, the client and to include all mitigations stated below. The EMP shall ensure that all the all relevant national guidance and current UK best practice is adhered to. This shall include, but not be restricted to the following:

- Pollution Prevention Guideline 6: Working at demolition and construction sites;
- Pollution Prevention Guideline 8: Safe Storage and Disposal of Fuel Oils;
- Groundwater Protection: policy and practice (GP3) (Environment Agency);
- CIRIA 132: A guide for safe working on contaminated sites; and
- CIRIA 73: Role and responsibility in site investigation.

11.7.2 During construction dust generation will be minimised by covering or damping down of dusty surfaces during dry weather, and wheel washing of vehicles exiting the site. It is also prudent to note that any temporary storage of materials will incorporate appropriate risk control measures (e.g. stockpiles will be appropriately fenced off in designated areas and covered or

damped down if likely to generate dust or leachate).

11.7.3 To alleviate the potential impact from accidental fuel and chemical spills, mitigation measures will be employed, including storage within bunded areas to contain chemical spillages during construction. Appropriate site-specific method statements for the works would cover storage and use of chemicals and fuels during construction. Emergency procedures would include the use of spill kits and booms to deal with fuel and chemical spillages in accordance with regulatory guidance (e.g. Environment Agency pollution prevention guidelines). These all hazardous materials to be stored on bunds or drip trays and away from surface water receptors.

11.7.4 A review of the controlled waters risk assessment shall be undertaken should the finalised foundation design result in significant change in the hydrogeological regime be identified.

11.7.5 The quantitative human health risk assessments (HHRA) shall be revisited in line with the final design for the proposed development, to confirm, or otherwise, the current low risk posed to human health through exposure to near surface contamination.

11.7.6 Precautionary measures will be put in place to protect construction workers involved in earthworks, by way of an earthworks methodology / construction management plan. This plan shall be designed to mitigate risks relating to the disturbance of residual soil or groundwater contamination, identification removal and validation of contamination hotspots and all statutory requirements associated with the earthworks such as discharge consents spoil generation handling and where appropriate off site disposal where required. This plan shall also include the groundwater management plan referred to earlier. Appropriate PPE shall be worn at all times during excavation and/or handling excavated soils.

11.7.7 Should residual risks be identified from the updated HHRA, appropriate remediation measures shall be agreed and included within the earthworks methodology / construction management plan.

11.7.8 Measures to prevent the uncontrolled discharge of silt laden surface water run-off from the site shall be included in the EMP developed for the site.

Operational Phase

11.7.9 Should a decision be made not to over-engineer the development design at this stage, a more robust ground gas investigation will be required. This new gas survey will enable the risk from ground gas to be assessed, most notably in the vicinity of the infilled ponds, and gas protection measures to be identified.

11.7.10 Regular inspection of tanks, bunds, hardstanding and subsurface structures (e.g. pipe-work, drains etc) shall be undertaken in order to assess ongoing integrity of all pollution prevention features included in the facility design. Inspections shall be undertaken by qualified personnel on a regular basis and compiled into a monitoring report and submitted to the Environment Agency on an agreed basis as part of the Environmental Permitting (EP) regime. The storage and use of potentially polluting substances stored on site should be audited. Any refuelling activities should be undertaken on areas of hard-standing with spill kits available to enable a quick and effective response to any spillages.

11.8 Residual Impact

11.8.1 The residual impacts remaining after the adoption of further mitigation measures identified above are summarised in *Table 11.5*.

Table 11. 5. Summary of Residual Impacts

Impact	Impact Type	Magnitude	Significance	Geographical Level of Importance of Issue*				
				I	N	R	D	L
Construction Phase Impacts								
Disturbance of residual soil / groundwater contamination, resulting in reduced water quality in perched waters in Made Ground	Adverse	Low	Negligible					X
Impact on construction works by short term exposure to contaminated soils.	Adverse	Low	Minor					X
Siltation of local drainage system by uncontrolled run-off.	Adverse	Low	Negligible-Minor					X
Soil compaction by heavy machinery	Adverse	Low	Negligible					X
Impact on controlled waters by reduced water quality in perched waters in Made Ground as a result of disturbance of residual soil / groundwater contamination.	Adverse	Low	Minor					X
Reduced water quality in controlled water by preferential pathways produced from foundation solution (i.e. piling)	Adverse	Low	Negligible – Minor					X
Impact on human health by short term exposure to contaminated waters in Made Ground.	Adverse	Medium	Minor					X
Impact from accidental spillage of contaminants.	Adverse	Low	Negligible - Minor					X
Impact on groundwater levels and flow resulting from building foundations, pavements and hard standing.	Adverse	Low	Negligible					X
Operational Phase Impacts								
Impacts of potential vehicle spillage	Adverse	Low	Negligible					X
Impacts of chemical storage	Adverse	Low	Minor					X
Impacts from buildings foundations, pavements and hard standing	Adverse	Low	Negligible					X
Impacts of ground gas on site users	Adverse	Negligible	Negligible					X

Impacts on groundwater flow	Adverse	Low	Negligible					X

* I denotes International, N denotes National, R denotes Regional, D denotes District and L denotes Local Scale impact.

11.9 Conclusions

11.9.1 An assessment of the baseline ground conditions has been undertaken for the proposed Waste Treatment facility at Sinfin Lane. This assessment has been based on a review of historical documents made available at the time of writing, that relate to the site's history, geology and hydrogeology. These documents relate to four phases of investigation work undertaken between 1999 and 2007, and included the qualitative and quantitative risk assessments produced subsequently on the basis of site-specific soil, groundwater and gas data.

11.9.2 The Sinfin Lane site is characterised by the presence of localised soil contamination, principally by metals, PAHs and petroleum hydrocarbons, in areas associated with historical activities on the site. These include backfilled lagoons and ponds, in addition to the footprint of a tannery formerly present on the site.

11.9.3 Perched groundwater has been identified in areas of deep Made Ground, associated with backfilled ponds and lagoons. Groundwater is also present in the Mercia Mudstone bedrock, situated beneath the Made Ground and overlying clay.

11.9.4 The majority of the samples that have concentrations that exceed the GACs are for perched groundwater. The geological and hydrogeological setting of the site suggests that groundwater in the Mercia Mudstone and proximal surface water course are considered at little risk of contamination in the Made Ground, regardless of activities during the construction and development phases.

11.9.5 As the majority of site will comprise hard-standing areas post development, it has been concluded that direct human exposure to contaminated soils following redevelopment, will be low. Thus the inadvertent contact, ingestion and inhalation of soils represents a low risk to human health and the need for formal remediation of near surface contaminated soils is not considered to necessary. However, the HHRA shall be revisited in-line with the final design for the development site.

11.9.6 All risks to construction works resulting from short-term exposure to soil and / or groundwater contamination shall be minimised by the development of an earthworks methodology / construction management plan for the construction phase, which shall include a groundwater management plan.

11.9.7 Historical data indicates that ground gas may pose a risk to future site users in the absence of gas control measures within design. Either the proposed development shall be over-engineered to incorporate gas protection measures suitable for CS2, or a more robust ground

gas investigation will be required. This new gas survey will enable the risk from ground gas to be assessed, most notably in the vicinity of the infilled ponds, and gas protection measures to be identified.

11.9.8 Foundation design shall be finalised following a geotechnical intrusive investigation. The controlled water risk assessment shall be revisited, should the final design introduce significant new pathways to principal receptors.

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