

## 9.0 GEOLOGY AND HYDROGEOLOGY

### 9.1 Introduction

9.1.1 Soils and geology play an important role in determining the environmental character of an area. Major development schemes can have both direct and indirect effects on geology and groundwater. Existing soil conditions, particularly land contamination, can impose constraints on development and conversely new contaminants can be introduced into the soils and groundwater, both in the short-term, during construction, and in the long-term from the proposed use. This section of the ES assesses the effects of the proposed development upon the geology and hydrogeology (i.e. groundwater) in the area local to the site.

### 9.2 Methodology

9.2.1 The initial assessment was undertaken as a desk-based study, the information for which has been derived from the sources summarised in Table 9.1.

**Table 9.1 Sources of Geological and Hydrogeological Information**

<b>Data source</b>	<b>Information obtained</b>
British Geological Survey, Geology Map Extracts 1:50 000 series.	Superficial and solid geology.
Environment Agency Mapping Systems – Groundwater Source Protection Zones	Groundwater and aquifer information.
Site-specific Initial pre-demolition Intrusive Investigation Report (2008)	Soil & groundwater profile present below the site.
Site-specific Topographical Survey	Topography.

9.2.2 The potential effects of the presence of contamination at the site have been identified and evaluated using the source-pathway-receptor ('conceptual model') risk assessment approach and from this, potential pollutant linkages have been identified. In terms of the layout of this section, potential contamination sources and sensitive receptors are considered in Section 9.3 Baseline Conditions. The potential for the creation of pathways between them,

as well as consideration of the significance of the predicted effect, is considered in Section 9.4 Assessment of Effects.

- 9.2.3 The sensitive receptors identified as part of this assessment are considered in terms of their importance and their sensitivity to change within the context of the site. The criteria used to define this are presented in Table 9.2.

**Table 9.2 Evaluation of Sensitive Receptors**

<b>Importance</b>	
National	Nationally designated sites (e.g. Geological SSSI) A nationally important feature that is rare in the region
Regional	A feature that falls short of national designation guidelines but provides a resource that is rare or relied upon at a regional level
Local	A regularly occurring feature that provides a resource that is relied upon at a local level
<b>Sensitivity to Change</b>	
High	Long-term integrity of the receptor may be compromised at a national or regional level
Medium	Integrity of the receptor may be compromised at a local level
Low	Integrity of the receptor is not at risk

- 9.2.4 Where potential pathways between sources of contamination and sensitive receptors have been identified, predicted effects have been documented. The prediction of these effects has considered the importance and sensitivity of the receptor and has also sought to determine whether the predicted effect is beneficial or adverse, direct or indirect and permanent or temporary.

- 9.2.5 The predicted effects have been evaluated in terms of their likely significance, which has informed the mitigation measures that are proposed in Section 9.5. The criteria used to determine the significance of predicted effects are provided in Table 9.3. Where the significance of a predicted effect would be influenced by further intrusive data and quantitative risk assessment, a worst-case scenario has been assumed in order to provide a robust assessment.

**Table 9.3 Impact Significance**

<b>Significance</b>	<b>Criteria</b>
Major Adverse	The effect would adversely affect the integrity of the receptor, and would be difficult to reverse and/or alleviate
Moderate Adverse	The effect would not permanently affect the integrity of the receptor but may result in noticeable damage that would require mitigation
Slight Adverse	No permanent or noticeable damage but requiring mitigation as a preventative measure
No Significant Effect	No significant adverse or beneficial effects would result
Beneficial	The effect would benefit the quality of the receptor but not such that its importance would be improved
Major Beneficial	The effect would improve the integrity of the receptor such that its overall importance would improve

### **9.3 Baseline Conditions**

#### ***Sensitive Receptors***

9.3.1 This Section considers the geological and groundwater receptors within the study area that may be sensitive to change and, in particular, exposure to contamination.

#### ***Geology/Proven Ground Conditions***

9.3.2 The geological survey sheet covering this part of Lincolnshire (Sheet 89), 1:50,000 scale) indicates that the study area is underlain by solid geology of Middle Jurassic age comprising the Hibaldstow Limestone formation (shelly limestone and calcareous sands). Drift deposits of marine/estuarine alluvium are shown to the east of the site. The site is also indicated to lie within a wide area of Made Ground.

9.3.3 The intrusive investigations undertaken at the site encountered Made Ground, typically between 1.0m and 1.5m thick; although locally reaching a maximum of 3.45m at one location. Beneath the surface hardstanding this generally comprised re-worked natural sands and clays with assorted extraneous materials including bricks, concrete, rootlets, organic matter, wood, glass, slag/clinker, limestone, flint and quartzite. Beneath the Made Ground, superficial deposits were generally encountered, represented initially by a clay layer, again typically 1.0m – 1.5m in thickness, further underlain by variable

thicknesses of sand and gravel. The underlying limestone was encountered at depths ranging between 3.2m and 6.7m.

### ***Hydrogeology***

- 9.3.4 The Hibaldstow Limestone is classified as a major aquifer. The superficial sand and gravel deposits are likely to be classified as a minor aquifer. The superficial clay layer which appears to overlie these aquifers across much of the site is significant as it provides an environmental benefit - reducing the potential for pathways which might allow shallow contaminants to penetrate downwards into the aquifers. The site falls within a groundwater source protection zone (zones 1 and 2) for an abstraction borehole located on the site and formerly used by the sugar beet factory.
- 9.3.5 The Environment Agency has confirmed that there are no other current abstraction licences within an approximate 1km radius of the site.
- 9.3.6 Although the licence for the borehole abstraction on site is current, it should be noted that there are no plans to abstract water for use at the proposed development. Should this situation change in the future, water would only be abstracted for process purposes and would not be used as a potable supply. Nevertheless, the groundwater resources below the site are considered to be of local importance with a medium sensitivity to change.
- 9.3.7 Site investigations undertaken in 2007 recorded groundwater strikes in most boreholes during drilling, at depths of between 2.70m and 4.20m below ground level. Subsequent borehole monitoring recorded groundwater levels between 0.70m and 2.60m below ground level. (Details of the intrusive site investigations carried out are presented at Appendix 2 of the Phases 1 & 2 Environmental Site Assessments Report, prepared by the Rolton Group, dated April 2008 – a full copy of this document can be made available upon request).
- 9.3.8 The groundwater monitoring undertaken at the site indicates a hydraulic gradient falling from west to east. There is some evidence of locally perched groundwater within the Made Ground. However, most groundwater strikes were apparent either immediately upon, or soon after, encountering the permeable sand and gravel deposits. The overlying clay layer confines the

groundwater, which is likely to be under a local sub-artesian pressure and in hydraulic continuity with the River Ancholme .

### ***Potential Contamination Sources***

- 9.3.9 The previous use of the site as a sugar factory introduces the potential for contamination sources to be present. Accordingly, a detailed assessment has been undertaken, based upon the on-site sampling and laboratory testing undertaken in the pre-demolition investigations, to examine the risks posed to sensitive receptors and the potential need for remediation. In the first instance, assessments were presented in the report referred to in 9.3.7 above. However, upon receipt of comments from the Environment Agency, revised risk assessments have recently been produced and issued. These are based on current UK guidance including Contaminated Land Exposure Assessment (CLEA) methodologies and Environment Agency Remedial Target Methodology (RTM).
- 9.3.10 The pre-demolition site investigations and laboratory analysis have identified a localised source of total petroleum hydrocarbons, near to an above-ground storage tank at the southern end of a former packaging plant. Concentrations of total petroleum hydrocarbons were found in samples of both soil and groundwater taken from this location. However, the data suggests that this spillage/leakage is of limited scale/extent and the quantitative risk assessment undertaken concludes that, following removal of the primary and secondary sources (i.e. the tank and impacted soil), it is extremely unlikely that there would be any unacceptable residual risks to either controlled waters or human health.
- 9.3.11 The industrial processes involved in operating the proposed REP would not involve the use of any hazardous substances and, therefore, the risks associated with contamination of groundwater resources are restricted to minor oil/fuel spills at surface level, and subsequent conveyance via surface water runoff into soils with high permeability.

## 9.4 Assessment of Effects

9.4.1 This section considers the predicted effects that may occur should pathways between the identified receptors, together with site staff engaged in the construction of the plant and sources of contamination be created. The following Section 9.5 will go on to discuss mitigation strategies that would be implemented in order to avoid these effects.

- human receptors;
- solid geology;
- surface water system/shallow groundwater;
- deep groundwater/abstraction resource.

In addition to the above, site personnel engaged throughout the construction phase may become exposed to sources of contamination.

### *Construction Effects*

9.4.2 The potential effects on site staff, geology and groundwater during construction have been considered in terms of the creation of the following potential pathways:

- direct physical contact;
- mobilisation of any existing pollutants through ground disturbance;
- creation of pathways to groundwater; and,
- potential contamination from spillage of construction materials/from construction plant.

### *Direct Physical Contact*

9.4.3 Construction plant operatives and labourers could, potentially, come into direct physical contact with soils containing relatively high concentrations of total petroleum hydrocarbons, during the site remediation works. This could result in slight adverse effects in terms of human health.

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*Mobilisation of Existing Pollutants*

- 9.4.4 Excavation of the ground can give rise to the mobilisation of contaminants within the soils, superficial and hard rock geology depending on the final depth of the excavation, foundation construction etc, which could possibly result in moderate adverse effects. Excavations may also give rise to the mobilisation of soil particles to ground and surface waters that may be polluted with contamination previously encapsulated below the study area, resulting in moderate adverse effects.
- 9.4.5 Any suspected contaminated material encountered during the groundworks phase of the project would be assessed by a suitably qualified environmental scientist and, if necessary, removed from site. However, it is feasible that machinery tracks and wheels could also pick up soil residues which could be distributed across the development platform. These mechanisms may, in turn, give rise to cross-contamination and spread the pollution across a wider area resulting in slight adverse environmental effects.
- 9.4.6 Excavations and subsurface structures within a shallow groundwater area can sometimes have an effect upon the rainwater infiltration rate, flow direction and rate of groundwater flow beneath the study area. This may result in a slight adverse effect on the quality of shallow groundwater and any groundwater recharge of the surface watercourse system.

*Creation of Pathways to Groundwater*

- 9.4.7 During the excavation processes and any piling operations for new foundations, pathways for potentially polluted shallow groundwater to flow into deeper groundwater may be created. The deep groundwater beneath the study area is designated as a Major Aquifer and although not currently used for any abstraction purpose, must be protected from potential pollution resulting from the development process. The creation of preferential pathways for potential contamination into the deeper groundwater would constitute a moderate adverse environmental effect.

*Potential Contamination from Spillage of Construction Materials/from Construction Plant*

- 9.4.8 The use of plant, equipment and machinery would require maintenance and refuelling. Accidental spillage of consumables, during storage or use, may lead to contamination of soils and groundwater through open excavation, resulting in slight adverse effects.

***Operational Effects***

- 9.4.9 Given the extent of proposed hardstanding across the site, the sealed, below-ground foul sewer and surface water drainage systems and the stringent controls that would be in place to operate the proposed REP, it is considered highly unlikely that any contamination of geology or groundwater would occur during operations and, as a result, no significant effects are predicted.

**9.5 Mitigation and Residual Effects**

- 9.5.1 This section outlines the mitigation measures that are likely to be proposed to minimise the risks of the potential effects on site personnel, geology and groundwater both during and after construction, on the surrounding environment. With the adoption of these measures the magnitude of the potential adverse effects can be reduced, so that no significant or unacceptable residual risks would remain.

***Construction Mitigation***

- 9.5.2 The potential effects on site personnel, geology and groundwater have been predicted to occur predominantly during the construction phase and, specifically, in relation to the potential creation of pathways during the preparatory groundworks exercise, piling operations, excavations for new foundations or the provision of services.
- 9.5.3 It will be necessary to undertake further ground inspection and site investigations following the demolition of buildings and removal of hardstandings, but prior to construction, to provide adequate overall coverage of the site. Investigations should be phased, targeted and efficient and based

upon current UK guidance and best practises, such as BS10175, BS5930 and CLEA guidance etc.

- 9.5.4 The pre-demolition investigations identified a single area of concern which has been impacted by hydrocarbon contamination as discussed in 9.3.10. The data and risk assessments undertaken to-date (9.3.9 refers) suggest that this contamination is of limited scale and extent and is best dealt with by a tactic of early source (impacted soil) removal and/or treatment followed by a groundwater monitoring programme to confirm the success of the treatments. Full details of this evaluation are provided in the revised risk assessments issued in February 2009 by Rolton Group Limited. These documents include an outline remedial strategy and have been submitted to the Environment Agency. The remedial criteria and outline strategy would be refined and formatted as a detailed specification for the works following inspections and further monitoring immediately post-demolition. Adopting this approach would ensure that the environmental risks presented to ground and groundwater resources are brought within acceptable and sustainable levels, resulting in no significant residual adverse effects.
- 9.5.5 Construction workers would be provided with appropriate personal protective equipment following a site-specific risk assessment, resulting in no significant residual effects.

#### ***Mobilisation of Pollutants***

- 9.5.6 The principal objective of any risk mitigation would be to sever any potential pollutant linkages and prevent or reduce the mobilisation of potential contamination within the ground and groundwater underlying the site.
- 9.5.7 All excavations would be carried out in accordance with current UK best practice so as to prevent the spread or mobilisation of any contaminated excavated material and cause surface water pollution. These practices would extend to the reuse or disposal of excavation residues as appropriate. If construction processes encounter suspected contaminated material, the nature and extent of the contamination would be assessed by a suitably qualified environmental scientist and the material dealt with as part of the remedial strategy.

- 9.5.8 All piling or deep excavations would be designed and carried out in accordance with current UK best practice guidelines with regard to the presence of a major aquifer and Source Protection Zone underlying the site. The advice of the Environment Agency would be sought and a foundation risk assessment would be undertaken, in line with EA guidance, prior to the commencement of excavation works to ensure that no significant residual effects occur.

### ***Operational Mitigation***

- 9.5.9 The proposed REP would be operated and regulated under an Environmental Permit and would be subject to regular inspection and rigorous record keeping. As a result, no significant effects upon geology or groundwaters are predicted during the operation of the plant and no specific mitigation measures are proposed as part of this assessment.
- 9.5.10 Generic measures to ensure effective site management, including procedures for dealing with accidental oil and fuel spillages during the use of plant, equipment and machinery would be included as part of the Environmental Management System for the site. Accordingly, no significant residual effects are predicted during the operation of the proposed development.

## **9.6 Conclusions**

- 9.6.1 This chapter has assessed the potential effects of the proposed development upon the geology and groundwaters local to the site. This has identified that there is evidence of a localised contamination source, resulting from the site's former use as a sugar factory, which would stimulate the need for remediation as part of the redevelopment process. Site Specific Risk Assessments and an outline strategy for remedial works have already been formulated based on the initial pre-demolition site investigation. A detailed remedial works specification to deal with this local source will be required following further post demolition inspections and monitoring.
- 9.6.2 In the absence of any hazardous substances in the processes proposed at the REP, the risk of contamination of the local geology or groundwaters is considered to be negligible from this potential source.

- 9.6.3 It has been predicted that any potential adverse environmental effects would occur predominantly during the construction phase and, specifically, in relation to excavation activities. Aside from the measures planned to deal with the contaminant source already identified, the requirements for additional measures to mitigate these effects would be determined through further ground investigations that would be required post demolition in order to provide adequate overall coverage of the site. The measures would include general adherence to best site practices as discussed above. Following this procedure, no significant residual effects are predicted.
- 9.6.4 Although no significant effects are predicted during the operation of the proposed development, generic measures would be introduced to ensure effective site management including procedures for dealing with accidental oil and fuel spillage during the use of plant, equipment and machinery and these would be included as part of the Environmental Management System for the facility.