Hydrological and Hydrogeological Investigation of the area surrounding a proposed extension to Long Drowpits Landfill, Kettering

VERSION 1
January 2008

Report prepared for:

Barton Plant Ltd
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KETTERING
Northamptonshire
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Hydrological and Hydrogeological Investigation of the area surrounding a proposed extension to Long Drowpits Landfill, Kettering

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- Appendix 1: Geological logs of monitoring boreholes
- Appendix 2: Water levels recorded on site visit (25th October 2007)
- Appendix 3: Laboratory test results showing hydraulic conductivity of backfill
1 INTRODUCTION

1.1 Background

Long Drowpits inert landfill is operated by Barton Plant Ltd. The site comprises former ironstone workings, which are being restored via the importation of inert fill.

The former mineral workings comprise long narrow features, known locally as ‘gullets’, these voids have been used for the recycling and landfill of inert construction and demolition waste.

It is estimated that the current working area will be filled by the end of 2009 and Barton Plant Ltd is looking to expand their workings by continued infilling of the gullet to the east of the current site.

1.2 Scope of assessment

Hafren Water has been commissioned to undertake the necessary hydrological and hydrogeological investigation of the area around the proposed extension referred to within this report as the Application Area.

The objectives of the assessment can be summarised as below:

- Define current conditions in the vicinity of the existing works and baseline conditions for the proposed extension area, relating to all aspects of water and its management.
- Identify and evaluate current and potential impacts of the proposed development upon the water environment.
- Propose appropriate mitigation measures, if required.
- Identify residual effects that may remain after the completion of the proposed restoration.

1.3 Data sources

The following data sources were used in the investigation:

The Environment Agency
- Rainfall data
- Licensed abstractions
- River Ise flow data
- Statutorily protected sites of ecological interest
- Surface water quality (GQA) data

British Geological Survey
- Geological map, 1:50,000 Sheet 71, Kettering
- Well records
- British Regional Geology

Ordnance Survey
- 1:25,000 scale, Explorer 224, Corby, Kettering & Wellingborough

Kettering District Council
- Environmental Health Services, unlicensed private water supplies

Natural England
- Sites of Special Scientific Interest
2 SITE LOCATION AND DESCRIPTION

2.1 Location

Long Drowpits Landfill lies on the south side of Weekley Hill (Figure 1) approximately 1 km north of the town of Kettering, Northamptonshire at National Grid Reference (NGR)SP 878 815. The proposed extension is situated on the eastern perimeter of the current workings.

2.2 Landform

The site is situated on a hill within an area of woodland and arable farmland. The Application Area comprises open fields within a steep sloping gullet striking east to west. The area is bounded to the south and east by the A43 and to the west by the A6003.

2.3 Sites of ecological interest

Details of designated sites of ecological interest, both statutory and non-statutory, within a 2 km radius of the centre of the Application Area were obtained from Natural England.

One Site of Special Scientific Interest (SSSI) is situated within a 2 km radius of the centre of the proposed extension area. The site is known as the River Ise SSSI and extends from Barford railway viaduct to Geddington Bridge approximately 1.5 km northwest of the Application Area (Figure 2).

Parts of Weekley Hall Wood, 750 m northwest of the Application Area, have been identified as wet woodland by the Biodiversity Action Plan (BAP) priority habitats.

2.4 Historical site development

The site was previously operated as a quarry for the extraction of ironstone for the Corby Steel Works. Historically workings have been undertaken across large sections of the surrounding area. The method employed was to extract across a wide face, depositing overburden material behind as the face advanced. This has given rise to long narrow features, known locally as ‘gullets’, comprising the final face and working area upon cessation of extraction. Void spaces created by the mineral extraction have been used for the recycling and landfill of inert construction and demolition waste.

Previous areas of inert landfill to the west and north of the current site were completed under Waste Management Licences WML44, WML47 and WML73069 in 1996, 2001 and 2003 respectively.
3 HYDROLOGY

3.1 Watercourses

The site is located within the catchment of the River Ise (Figure 2), which is situated to the north and east of the site, and flows southwards. It lies approximately 1 km from the site at its closest point. The flow in the River Ise at Geddington, ~1 km northeast of the site, was estimated to be approximately 1 m³/s at the time of the site visit (25th October 2007). The river channel is some 4 m in width, the banks approximately 1 m high and the water depth some 0.5 m, over a gravel/sand bed. The Slade Brook, a tributary of the River Ise, lies approximately 1.8 km to the southwest of the site and flows in a southerly direction.

3.2 Waterbodies

The nearest waterbodies to the site comprise two small ponds 100 m northwest of the Application Area. They lie at a higher elevation than the site and are likely to be perched on underlying Boulder Clay and fed by surface run-off. A series of man-made ornamental lakes are located along the course of the River Ise (Boughton House Lakes) which lie ~750 m to the east of the proposed extension.

Several springs are located at a distance of over 1 km to the southeast of the site near Weekley (Figure 2). These are considered likely to be associated with the outcropping boundary between the Northampton Sandstone and the underlying mudstone. Swallow holes are understood to occur within the limestone in the vicinity of the site.

3.3 Surface water quality

Data from the Environment Agency website was obtained for the closest reach of the River Ise, sampled at the A43 road bridge in Geddington. The River Quality Objective is RE1, water of good quality and suitable for all fish species. Proposed river usage targets are F1 salmonid fishery, LW livestock watering, HA high amenity (recreation). Chemical quality is good (B) and biological quality is graded as B ‘good’. Nitrate and Phosphate are graded as 4 ‘moderate’ and 3 ‘moderate’ respectively.

3.4 Surface water levels and flooding

The site does not lie within a floodplain as defined by the Environment Agency.

3.5 Rainfall

Data from the closest Environment Agency gauging station to the site has been obtained. A summary of long-term average monthly rainfall is shown below. The mean annual rainfall between the years 2000-2006 is 657 mm.

<table>
<thead>
<tr>
<th>Station name: Kettering</th>
<th>Station Number: 161372</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station location: NGR 87100,80000</td>
<td>Period data collected: 01/2000 - 01/2007</td>
</tr>
<tr>
<td>Month</td>
<td>Jan</td>
</tr>
<tr>
<td>Average rainfall</td>
<td>44.9</td>
</tr>
</tbody>
</table>

Table 3.5: LTA monthly rainfall data (mm)
3.6 Abstractions

Information from the Environment Agency indicates there are no current licensed surface water abstractions within a 1.5 km radius of the site.
4 GEOLOGY

4.1 Regional

An extract from the BGS 1:50,000 Sheet 71, Kettering, is provided on Figure 3, which indicates the regional geology.

The regional geology is dominated by Jurassic strata, which is obscured over much of the county by superficial deposits comprising sands, gravels and till (Boulder Clay) deposited during Quaternary glaciations.

The sequence of solid geology in the vicinity of the site, taken from BGS 1:50,000 map 171, is detailed below with the youngest strata at the top of the table.

<table>
<thead>
<tr>
<th>Formation</th>
<th>Thickness (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blisworth Limestone</td>
<td>4 – 8</td>
<td>Limestone with shell fragments and mudstone</td>
</tr>
<tr>
<td>Rutland Formation</td>
<td>5 – 14</td>
<td>Mudstone with limestone and sandstone beds</td>
</tr>
<tr>
<td>Wellingborough Limestone (within the Rutland Formation)</td>
<td>0 – 3</td>
<td>Limestone and mudstone (shelly)</td>
</tr>
<tr>
<td>Unconformity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Lincolnshire Limestones</td>
<td>0 – 12</td>
<td>Limestone, shell-detritus, ooidal and peloidal</td>
</tr>
<tr>
<td>Grantham Formation</td>
<td>0 – 8</td>
<td>Sandstone, siltstone and mudstone</td>
</tr>
<tr>
<td>Northampton Sand</td>
<td>0 – 8</td>
<td>Ironstone, ooidal, sandy</td>
</tr>
<tr>
<td>Whitby Mudstone</td>
<td>49 – 58</td>
<td>Mudstone with nodular limestone bed at base</td>
</tr>
</tbody>
</table>

Table 4.1: Solid geology sequence

The regional structure is fairly uniform. The strata are generally horizontally bedded or have a gentle dip to the east, such that successively older strata crop out to the west. Due to the dip, formations tend to thin westwards. There are no geological faults indicated on the map in close proximity to the site. Glacial deposits of Boulder Clay cover much of the high ground in the region and occasional deposits of glaciofluvial sand and gravel occur. Post-glacial alluvium deposits occur within the larger river valleys and floodplains.

It is worth highlighting that much of the insitu material within the region has been removed by the extensive mineral workings mentioned in section 2.4 of this report. Backfilled overburden therefore dominates the region surrounding the site.

4.2 Local

A geological cross-section through the site is provided on Figure 4. At the top of Weekley Hill an isolated occurrence of in-situ material is still present, surrounded by backfilled areas of historic ironstone working. According to the BGS cross-section the base of the Northampton Sand dips eastwards from ~90 metres Above Ordnance Datum (mAOD) at the western site boundary to approximately 71 mAOD on the eastern margin of the gullet.
According to the BGS cross-section (Map Sheet 71) the underlying geology is as follows:

<table>
<thead>
<tr>
<th>Lithological description</th>
<th>Thickness (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder Clay</td>
<td>5</td>
</tr>
<tr>
<td>Wellingborough Limestone</td>
<td>4</td>
</tr>
<tr>
<td>Rutland Formation (mudstone)</td>
<td>6</td>
</tr>
<tr>
<td>Lower Lincolnshire Limestone</td>
<td>5</td>
</tr>
<tr>
<td>Grantham Formation (sandstone, siltstone, mudstone)</td>
<td>5</td>
</tr>
<tr>
<td>Northampton Ironstone</td>
<td>5</td>
</tr>
<tr>
<td>Whitby Mudstone</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 4.2: Local geological sequence

Further information of the local geology was obtained from geological logs (Appendix 1) of 13 monitoring boreholes drilled across the site. This information was used to construct a geological cross-section of the underlying lithology at the site of the existing landfill (Figure 5). Similar lithology and hydrogeology can be expected for the proposed extension.

Within the proposed Application Area location, 2 boreholes were installed north of the proposed infill area and 2 to the south (Figure 6). The northern boreholes (6 and 7) were installed within the in-situ geology. The geology encountered was described as ~11 m of clay underlain by ~3 m of Ironstone, in turn underlain by Limestone. Within Borehole 7, 2.5 m of superficial loess was encountered overlying the clay.

Within the southern boreholes (8 and 9) the geology (backfill) encountered was described as ~14 m of reworked clay, underlain by ~3.5 m of Ironstone, with Borehole 8 terminating in Limestone.
5 HYDROGEOLOGY

5.1 Setting

Two principal aquifers exist in the vicinity of the Application Area: the Permo-Triassic Sherwood Sandstone aquifer at depth and the shallow Lincolnshire Limestone and Northampton Sands aquifer. The depth of the Sherwood Sandstone and the low hydraulic conductivity of the overlying formations are such that this deep aquifer is not considered further within this assessment.

The shallow Lincolnshire Limestone and Northampton Sands aquifer is itself very restricted by the large areas surrounding the aquifer comprising of mining backfilled material. This material is thought unlikely to comprise an aquifer.

The site is not located within any Source Protection Zones (SPZs).

5.2 Local

The Application Area is bounded to the north by the Northampton Sands and Lower Lincolnshire Limestone and to the south by fill material from the historic workings.

The Lower Lincolnshire Limestone is classified as a Minor Aquifer by the Environment Agency. The Northampton Sand Formation is also classified as a Minor Aquifer and historically provided public water supplies to Kettering. The fill material is unlikely to comprise an aquifer.

The Application Area is underlain by further fill, which in turn is underlain by the Whitby Mudstone Formation. The latter is a Non-aquifer and will act as a natural barrier to downward flow of groundwater.

5.2.1 Groundwater levels

Groundwater levels have been monitored in the vicinity of the current active landfill on a quarterly basis since January 2003. Additional boreholes were installed in 2007, four of which are located adjacent to the Application Area. The locations of the monitoring boreholes are shown on Figure 6 and details are included with the borehole logs in Appendix 1. Groundwater level data was obtained from all 13 monitoring boreholes during a site visit undertaken on 25th October 2007. Water level readings are included within Appendix 2.

5.2.2 Spatial distribution

It is considered that the in-situ Northampton Sand comprises an aquifer to the north of the site. Groundwater flows in a southerly direction from this unit into the less permeable (clay-rich) backfill emplaced beneath and to the south of the site. The Whitby Mudstone forms a low permeability base beneath both formations. Intergranular flow will be the predominant mechanism for groundwater flow through the backfill.

A cross-section was created of the existing landfill using existing monitoring data (Figure 5); very similar conditions can be expected within the proposed Application Area site. As indicated on the cross-section the base of the existing quarry void and inert waste is some 4 to 5m above the maximum winter watertable. The culverted drainage ditch along the base of the filled gullet is also above the watertable.

5.2.3 Groundwater flow direction and saturated thickness

Groundwater level contours plotted using levels recorded on 25th October 2007 (Figure 6) indicate groundwater flows in a general southerly direction, reflecting the topography of the area.
At the proposed Application Area site, groundwater flow direction is to the southeast, towards the River Ise. There appears to be a steep hydraulic gradient between boreholes BH2 and BH9, which is probably a result of the reduction in permeability due to the backfilled mining waste. The hydraulic gradient is approximately $6 \times 10^{-2}$.

Groundwater discharge is likely to occur along the contact between the Northampton Sand/mining backfill and the underlying Whitby Mudstone. Evidence of this is shown by the presence of a spring to the south of Weekley (Figure 2).

The watertable lies between 10-20 m below ground level (mbgl) (between ~95 and 77 mAOD) within the Northampton Sand Formation and the mining backfill.

Using water level readings taken on 25th October 2007 the indicated saturated thickness above the Whitby Mudstone is thought to be approximately 1.1 m in BH11, 2.7 m in BH12, 2.2 m in BH3 and 8.4 m in BH1.

5.2.4 Aquifer properties

In-situ material

Within the limestone to the north and northeast of the site the predominant groundwater flow mechanism is considered likely to be via fractures and joints.

The flow mechanism within the sandstone is likely to be intergranular although the presence of iron cementation may have reduced this significantly. Fractures and joints are present and will provide secondary porosity through which groundwater flow will also occur. Typical values of hydraulic conductivity in sandstones fall in the range 0.1 to 10 m/d.

Backfill material

The backfill material comprises clay and limestone fragments, the hydraulic properties of which are likely to differ significantly from the in-situ strata to the north. Clay will have low permeability but broken hard rock may leave significant void spaces and thus create permeable horizons, although these are unlikely to be continuous in nature.

Tests previously undertaken on compacted overburden backfill indicate a hydraulic conductivity of less than $1 \times 10^{-7}$ m/s (8.64 x $10^{-3}$ m/d). This has been deemed suitable for the construction of an artificial geological barrier for the landfill operations. The results of the laboratory tests are provided in Appendix 3.

5.2.5 Groundwater abstractions

Information from the Environment Agency indicates there are no current licensed groundwater abstractions within a 1.5 km radius of the site.

Kettering Borough Council reported that they do not hold records of any private water supplies within 2 km radius of the site.

5.2.6 Groundwater quality

The groundwater quality has been monitored on a quarterly basis at the site since March 2003 using monitoring boreholes (1 to 5). A summary of representative determinands are presented in Table 5.2.6.

Cadmium is below the detection limit of 0.5 µg/l in all boreholes. Nickel was below detection limit <10 µg/l in BH1, just above detection limit once in BH2, eleven times in BH3 and BH4 and five times from six in BH5.
<table>
<thead>
<tr>
<th></th>
<th>BH1</th>
<th></th>
<th>BH2</th>
<th></th>
<th>BH3</th>
<th></th>
<th>BH4</th>
<th></th>
<th>BH5</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21 samples</td>
<td>17 samples</td>
<td>21 samples</td>
<td>21 samples</td>
<td>6 samples</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>Max</td>
<td>Min</td>
<td>Mean*</td>
<td>Max</td>
<td>Min</td>
<td>Mean*</td>
<td>Max</td>
<td>Min</td>
<td>Mean*</td>
<td>Max</td>
</tr>
<tr>
<td></td>
<td>8.5</td>
<td>7.1</td>
<td>7.7</td>
<td>8.5</td>
<td>6.9</td>
<td>7.5</td>
<td>8.4</td>
<td>6.7</td>
<td>7.3</td>
<td>8.5</td>
</tr>
<tr>
<td>Conductivity (µS/cm)</td>
<td>780</td>
<td>466</td>
<td>674</td>
<td>2390</td>
<td>1132</td>
<td>1697</td>
<td>3610</td>
<td>1627</td>
<td>2405</td>
<td>2518</td>
</tr>
<tr>
<td>Ammoniacal Nitrogen as N</td>
<td>1.7</td>
<td>&lt;0.1</td>
<td>0.3</td>
<td>9</td>
<td>&lt;0.1</td>
<td>0.9</td>
<td>1.4</td>
<td>&lt;0.1</td>
<td>10.3</td>
<td>3</td>
</tr>
<tr>
<td>Chloride</td>
<td>29</td>
<td>12</td>
<td>17</td>
<td>34</td>
<td>13</td>
<td>20</td>
<td>34</td>
<td>8</td>
<td>12</td>
<td>45</td>
</tr>
<tr>
<td>Sulphate</td>
<td>234</td>
<td>83</td>
<td>104</td>
<td>1243</td>
<td>536</td>
<td>903</td>
<td>1679</td>
<td>909</td>
<td>1411</td>
<td>1380</td>
</tr>
<tr>
<td>Calcium</td>
<td>166</td>
<td>124</td>
<td>148</td>
<td>567</td>
<td>280</td>
<td>398</td>
<td>773</td>
<td>672</td>
<td>611</td>
<td>582</td>
</tr>
</tbody>
</table>

Notes:
*1 Mean calculated using detection limits if bdl
*2 Anomalous
Units mg/l unless stated otherwise

Table 5.2.6: Summary of representative groundwater quality determinands
The land to the north and west of the site is cultivated and it is considered likely that pesticides and fertilisers are regularly applied. This application of agrochemicals may have impacted upon local groundwater quality.

One section of historical landfill (not within the PPC permit boundary), completed before 15\textsuperscript{th} October 1997, may contain excavated road material including small amounts of tarmac. After 1997 the classification of inert waste was revised and tarmac is no longer accepted for landfill at the site.

The historical backfill material may contain materials which would no longer be accepted within an inert landfill according to current legislation.
6 EXISTING DEVELOPMENT

6.1 Site layout

The current Phase 2 landfill is 9.5 hectares in area. The site accepts inert waste without testing, as described in Landfill Regulatory Guidance Note 2 (RGN2). Emplacement of waste is progressing eastwards with an estimated completion in 2009. Recent landfill volumes are shown below for the period 2003 to 2007.

<table>
<thead>
<tr>
<th>2003-2004 (m$^3$)</th>
<th>2004-2005 (m$^3$)</th>
<th>2005-2006 (m$^3$)</th>
<th>2006-2007 (m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>55,000</td>
<td>74,000</td>
<td>93,700</td>
<td>160,000</td>
</tr>
</tbody>
</table>

Table 6.1: Volumes of inert waste

6.2 Existing water management

Water collected within the landfill drains to the east, along the top of the geological barrier. The drainage water is then regulated by the use of a holding pond from where controlled discharge is made northeastwards, to the remainder of Long Drowpits Gullet, via a ditch in its base. The natural fall on the gullet floor ensures that surface water does not accumulate at the base of the tipping face. At the eastern end of the gullet the ditch discharges into the deeper Porters Lodge Gullet (which runs east-west) over a cliff that is some 15–18 m high. The surface water dissipates into the floor of Porters Lodge Gullet and a permanent surface water drainage feature is not present.

In advance of landfilling, the ditch at the base of Long Drowpits gullet is progressively piped within a permeable fill surround, beneath the compacted geological barrier. It is understood water has never been seen to issue from this conduit.

Perimeter ditches prevent the ingress of surface water run-off from adjoining land outside the site. Surface water derived from this and the previously filled parts of the permit Application Area drain via ditches and culverts into the ditch that flows south under the Kettering Northern Relief Road. This ditch eventually discharges into the River Ise at Kettering. The ditches were dry during the site visit on 25th October 2007.
7 THE PROPOSED DEVELOPMENT

7.1 Site layout

The proposed extension would be developed in a similar manner to the current workings. In accordance with the landfill regulations a geological barrier will be installed across the base and sides of the site to provide sufficient attenuation to prevent risk to underlying groundwater. The artificial geological barrier will comprise a minimum 1 m thick layer of compacted, in-situ, low permeability (<10⁻⁷ m/s) overburden material.

Due to the inert nature of the waste leachate management and monitoring infrastructure is not anticipated.

7.2 Water management

The Application Area essentially represents an extension of the current Phase 2 operation and water will be managed in a similar manner to that which currently pertains.

Water which collects within the landfill will be drained eastwards, along the top of the geological barrier and through a pipe installed at its base. Water will be temporarily held in a pond from where controlled discharge will be made into the deeper Porters Lodge Gullet. Water will then be allowed to dissipate into the floor of Porters Lodge Gullet.

Perimeter ditches will be constructed to prevent the ingress of surface water run-off from adjoining land outside the site. Surface water derived from these ditches and the previously filled parts of the site will be conveyed into the ditch that flows south under the Kettering Northern Relief Road. This ditch eventually discharges into the River Ise at Kettering.

7.3 Water ingress

Water inflow to the Application Area will be derived from direct rainfall-sourced surface run-off. Due to the landfill being situated above the watertable groundwater ingress is not anticipated. The volumes of inflow have been calculated as detailed below.

The volume of rainfall-derived water has been calculated by multiplying the rainfall catchment area by the average rainfall. The current landfill area of Phase 2 is incorporated within the rainfall catchment area of the Application Area (Phase 3) as the water from Phase 2 will flow eastwards through the Application Area. The total rainfall catchment area of the Application Area is some 28 Ha and the calculated rainfall volumes are shown below. These are conservative (high) estimates and likely to be lower during the summer months due to the effect of evapotranspiration.

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave rainfall (mm)</td>
<td>44.9</td>
<td>42.2</td>
<td>40.4</td>
<td>52.9</td>
<td>63.5</td>
<td>41.4</td>
<td>72.3</td>
<td>55.9</td>
<td>51.1</td>
<td>86.7</td>
<td>65.6</td>
<td>55.7</td>
</tr>
<tr>
<td>Area (km²)</td>
<td>0.28</td>
<td>0.28</td>
<td>0.28</td>
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</tr>
<tr>
<td>Rainfall (l/s)</td>
<td>1.3</td>
<td>1.4</td>
<td>1.2</td>
<td>1.6</td>
<td>1.9</td>
<td>1.3</td>
<td>2.1</td>
<td>1.6</td>
<td>1.5</td>
<td>2.5</td>
<td>2.0</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Table 7.3: Rainfall ingress volumes at Application Area

The total discharge requirement is equivalent to the calculated average rainfall volume taken from the above table of 1.7 l/s.
7.4 Restoration proposals

The site will be restored to woodland with a 10-year programme of aftercare. Restoration work will generally take place in autumn each year, with the emplacement of soils and the planting of trees. Following completion of the importation of fill, a further 6-12 months will be needed to complete the restoration work.

Restoration soils placed above the waste will comprise indigenous material stripped and stockpiled for this purpose, plus imported soils from the local area, to make a total depth of over 1 m. Soil placement will proceed in accordance with the requirements of the Planning Permission.
8 POTENTIAL IMPACTS and MITIGATION MEASURES

8.1 Groundwater

8.1.1 Groundwater levels

The base of the void within the proposed extension area is above groundwater levels and therefore there is no requirement for groundwater management prior to landfill engineering or infilling. Groundwater levels will therefore not be significantly affected by the infilling of the void space.

8.1.2 Groundwater flow pattern

Significant changes in groundwater flow patterns are not predicted.

8.1.3 Groundwater flow pattern after restoration: residual effects

Rainfall intercepted by the current void space would partly infiltrate into the underlying backfill material. Upon creation of the landfill, a zone of impermeable material will be emplaced at the bottom of the void space, thereby limiting the amount of water infiltrating into the underlying material. This water will instead be conveyed to the Porters Lodge Gullet, where it will infiltrate to the underlying strata. The predicted effect of this will be to reduce very slightly groundwater levels beneath the Application Area and increase groundwater levels under the Porters Lodge Gullet. However, given the very limited quantities of water (1.7 l/s) the magnitude of any effect is considered to be insignificant.

8.1.4 Groundwater abstractions

There are no current licensed or unlicensed abstractions within a 1.5 km radius of the site. It is therefore not anticipated that the proposed extension will impact upon any groundwater abstractions.

8.1.5 Groundwater quality

The watertable is below the base of the site, therefore interaction with the infilled material is considered to be extremely unlikely. Water coming into contact with the waste will be limited to rainfall and this is likely to run-off rather than infiltrate due to the highly compacted and impermeable nature of the waste (largely clays and subsoils).

Groundwater within the historic back fill material may be already chemically altered by the historic waste. Groundwater quality is not likely to be impacted further by water percolating through the inert landfill as its content is now regulated far more stringently than previously.

8.2 Surface water

The proposed extension lies within the catchment of the River Ise. Water derived from the Application Area currently emerges as springs and seepages some 1 km to the southeast of the site, from where they flow into the River Ise.

The proposed extension is unlikely to have any significant impact upon groundwater flows (which support the springs/seepages) either during or after completion of the proposed works and therefore is unlikely to impact upon the spring and seepage flows into the River Ise.

The restoration of the site is likely to reduce future rates of runoff into the Porters Lodge Gullet as a consequence of the reduced slopes of the final landform, the low gradient of the proposed ditches and the planting of most of the surface with trees. The lakes situated at Boughton House are supported by the River Ise. The river is highly unlikely to be affected by the proposed works; consequently impact upon the lakes is not considered to be possible.
The two small ponds located 100 m north of the Application Area are thought to be perched on underlying Boulder Clay and fed by surface run-off. The ponds are at a higher elevation than the site and groundwater contours indicate that they are up-gradient of the site. It is therefore highly unlikely that they will be impacted upon by the proposed landfill extension.

8.3 Water quality

The potential of the site to generate leachate is low, therefore the risk of creating an adverse impact on either groundwater or surface water is considered to be commensurately low. There are likely to be no List I or List II substances within the waste and input is strictly controlled to prevent polluting substances entering the waste stream. Hence it is considered that the Groundwater Regulations 1998 do not apply to this site and active leachate management is not proposed.

There is the possibility that pollution of surface water may arise due to the accidental loss of fluid from fixed or mobile plant. In the unlikely event of spillage, surface water will be retained within the control pond and from there will be collected by the use of oil sorbent materials. The contaminated material will then be disposed of in accordance with current best practice.

Surface water from the site is left to soakaway within the Porters Lodge Gullet, there is therefore no risk of silt contamination to nearby surface waterbodies.

8.4 Ecology

The River Ise SSSI lies some 1 km to the north of the site and will not receive groundwater or surface water discharge from the proposed extension.

Likewise Weekley Hall Wood is situated up-gradient from the proposed extension and will not receive groundwater or surface water discharge from the proposed extension.

8.5 Abstractions

There are no current licensed or unlicensed abstractions within a 1.5 km radius of the site. It is not anticipated that the proposed extension will impact upon any surface water abstractions.
9 SUMMARY AND CONCLUSIONS

9.1 Barton Plant Ltd proposes to expand the workings to the east of the current site known as Long Drowpits inert landfill.

9.2 The proposed extension is situated on former ironstone workings comprising a long narrow feature, known locally as a ‘gullet’. It is proposed to restore this void via the importation of inert fill.

9.3 The proposed extension will be developed in a similar manner to the current workings. In accordance with the landfill regulations a geological barrier will be installed across the base and sides of the site to provide sufficient attenuation capacity to prevent a potential risk to underlying groundwater.

9.4 The base of the void within the proposed extension area is above the watertable and therefore there is no requirement for groundwater management prior to landfill engineering or infilling. Groundwater levels will therefore not be significantly affected by the infilling of the void space.

9.5 Water collected within the proposed extension will be conveyed to the east into the deeper Porters Lodge Gullet, where it will infiltrate into the ground. The drainage water will be regulated using a holding pond from where controlled discharge will be made. Perimeter ditches will prevent the ingress of surface water run-off from adjoining land outside the site. Collected water will either dissipate or eventually discharge into the River Ise at Kettering, via a series of ditches.

9.6 It is not anticipated that the proposed extension will augment or decrease flows significantly within the River Ise.

9.7 The lakes at Boughton House are supplied by the River Ise. As the river is highly unlikely to be affected by the proposed works, so likewise it is also unlikely that the lakes will be affected.

9.8 Two small ponds located 100 m north of the Application Area are thought to be perched on underlying Boulder Clay and fed by surface run-off. They are at a higher elevation than the site and groundwater contours prove the ponds are up-gradient of the site. It is therefore unlikely that these ponds will be impacted upon by the proposed extension.

9.9 Due to the inert nature of the waste the risk of creating an adverse impact on groundwater and surface water quality is considered to be low. There are likely to be no List I or List II substances within the waste. It is considered that the Groundwater Regulations 1998 do not apply to this site and active leachate management is not required.

9.10 There are no current licensed or unlicensed abstractions within a 1.5 km radius of the site. It is not anticipated therefore that the proposed extension will impact upon any surface or groundwater abstractions.

9.11 The site will be restored to woodland with a 10-year programme of aftercare. Following the completion of the importation of fill, a further 6-12 months will be needed to complete the restoration work.
FIGURES
APPENDIX 1

Geological logs of monitoring boreholes
APPENDIX 2

Water levels recorded on site visit (25th October 2007)
APPENDIX 3

Laboratory test results showing hydraulic conductivity of backfill
### Table 5.2.6: Summary of representative groundwater quality determinands

<table>
<thead>
<tr>
<th></th>
<th>BH1</th>
<th>BH2</th>
<th>BH3</th>
<th>BH4</th>
<th>BH5</th>
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<tbody>
<tr>
<td></td>
<td>21 samples</td>
<td>17 samples</td>
<td>21 samples</td>
<td>21 samples</td>
<td>6 samples</td>
</tr>
<tr>
<td>pH</td>
<td>Max 8.5</td>
<td>Min 7.1</td>
<td>Mean* 7.7</td>
<td>Max 8.4</td>
<td>Min 6.7</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Max 780</td>
<td>Min 466</td>
<td>Mean* 674</td>
<td>Max 2390</td>
<td>Min 1132</td>
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<tr>
<td>Ammoniacal</td>
<td>Max 1.7</td>
<td>Min &lt;0.1</td>
<td>Mean* 0.3</td>
<td>Max 9</td>
<td>Min &lt;0.1</td>
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<tr>
<td>Nitrogen as N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>Max 29</td>
<td>Min 12</td>
<td>Mean* 17</td>
<td>Max 34</td>
<td>Min 13</td>
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<tr>
<td>Sulphate</td>
<td>Max 234</td>
<td>Min 83</td>
<td>Mean* 104</td>
<td>Max 1243</td>
<td>Min 536</td>
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<tr>
<td>Calcium</td>
<td>Max 166</td>
<td>Min 124</td>
<td>Mean* 148</td>
<td>Max 567</td>
<td>Min 280</td>
</tr>
</tbody>
</table>

Notes:
*1 Mean calculated using detection limits if bdl
*2 Anomalous
Units mg/l unless stated otherwise
Figure: 1
Title: Site Location
Date: 20/01/08
Scale: As shown
Client: Barton Plant Ltd
Cranford Road, Burton Latimer, Kettering, NN15 5TB.
Reproduced from British Geological Survey Map 171

Drift deposits listed above are not necessarily in order of superposition.

- Geological boundary, Drift and Artificial deposits
- Geological boundary, Solid
- Fault at rockhead, crossmark on downhill side
- Generalized dip of gently inclined strata, dip in degrees where indicated
- Water well or borehole
- Mine shaft, abandoned
- Art, abandoned, with orientation showing direction of entry
- Symbol indicates Quaternary deposit at surface and Solid formation at rockhead; other Quaternary deposits may intervene

Scale 1:1000 (1 cm to 10 m)

North

Site

Start of line of section

Proposed Extension Area

Client: Barton Plant Ltd
Cranford Road, Burton Latimer, Kettering, NN15 5TB.

Date: 20/01/08

Figure: 3

Scale: As shown

Geology
Approximate line of section, north-east to south-west. Location shown on Figure 2.

WL = water level on 9/3/07