Quantifying Dynamic Baseline Water Environment Conditions in Sand and Gravel Extraction Areas in order to Assess the Potential Impact of Water Drawdown upon Historic Environment Assets

Volume 2: Case Studies of Newington and Over Quarries

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Contents

1. INTRODUCTION

Background

The Importance of Historic Environment Assets

1.1 A large proportion of the land area of England has been designated for its historic and / or environmental value. This resource makes a major contribution to the national and regional character of the country. The historic environment has been shown to be of considerable importance to our understanding of the cultural, environmental and social aspects of past human societies; whilst the environmental resource represents the best examples of geology, soils and landscapes within England.

1.2 The historic environment is a fragile, vulnerable, non-renewable and finite resource. It includes all aspects of the landscape that have been built, formed or influenced by human activities. The historic environment not only includes features such as historic buildings and townscapes, parks and gardens, designated landscapes, ancient monuments, and archaeological sites and landscapes; but also those undesignated assets which are both nationally and regionally important[1].

Aggregate Extraction and the Historic Environment

1.3 Mineral resources (especially sands and gravels) represent key parts of the economy. They are important components in both housing and infrastructure development and provide the raw materials which are required by society in order to generate economic growth.

1.4 Maintaining the balance between aggregate quarrying, the requirements of society and the environmental impact associated with mineral extraction is often a contentious issue; not only between regulators and industry, but also society as a whole. This is especially pertinent when aggregate extraction is undertaken in areas of significant historical and / or environmental value.

1.5 Moreover it is difficult to quantify the scale and extent of the historic environment resource as many finds / features (i.e. those of archaeological origin) lie beneath the modern ground surface. As such, it is only possible to estimate (from previous documentary evidence) the potential of unearthing further features during aggregate extraction operations. As a consequence, and given the unknown historic environment potential of mineral producing areas, it is therefore essential to assess any significant impacts associated with aggregate extraction upon this resource, and particularly upon potential buried archaeological features whose preservation depends upon the maintenance of a water environment equilibrium (whether in respect of saturation or water quality changes)[2].

Aggregate Extraction and the Water Environment

1.6 Soil hydrology and hydrogeology (together with water quality) are the main environmental parameters affecting the preservation and conservation of many historic environment assets which are dependent upon surface (i.e. soil) and ground water.

1.7 Quarrying may have a wide range of impacts upon the water environment (both above and below ground) if unmitigated. In particular, the effects of dewatering and the associated radius

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[1] English Heritage and the Association of Local Government Archaeological Officers, 2002; Olivier, 2004; Lillie and Ellis, 2007; Department for Cultural Media and Sport, 2008

[2] Mankelow et al., 2008; Thompson and Howarth, 2008

of influence have been found to be potentially detrimental to the preservation of buried artefacts as a result of changes in saturation, aeration and / or water quality.

1.8 Although there are also beneficial effects to water draw-down, both at a local and catchment-wide level (e.g. enhanced slope stability and reduced flood risk [in certain areas of the country]), the majority of the effects (if unmitigated) can potentially have a serious impact upon water resources, surface water features, and many historic environment assets and environmental designations that are dependent upon surface and / or groundwater[3].

Case Study Sites

1.9 The case studies of Newington and Over quarries which are presented in this document support Volume 1 of the main report. The quarry sites have been considered for assessment based upon two key criteria, both of which are essential in order to fulfil the aims and objectives (see below) of the current study. These are as follows:

- The quarries contain a proven historic environment resource (including undesignated archaeological and palaeoenvironmental remains, and designated environmental and cultural heritage features), both within their planning application boundaries, and in the surrounding environment; and
- The local and wider catchment area of the quarry sites have been the subject of (some) water environment monitoring in recent years (the results of which have been utilised within this report).

Scope of Report

Project Aim and Objectives

1.10 the over-arching aim of this research project was to develop a draft Dynamic Baseline Methodology (DBM) that assists in the basic interpretation of water environment monitoring data in order to differentiate background changes (both natural and anthropogenic) in the water environment within sand and gravel deposit areas.

1.11 Such a methodology would aim to be simple but reliable, 'user-friendly', and without the immediate requirement for complex analysis or numerical modelling. It was hoped that such a methodology would aid the assessment of the extent to which such changes in the water environment may impact upon the historic environment resource located within these areas.

1.12 In order to achieve this aim, the project has several more specific objectives. The revised[4] objectives are:

- **1. Defining the requirement of a draft generic DBM:** review the existing water balance/level spreadsheet models to identify their ability to be tailored for use in determining water environment baseline conditions; work towards a draft methodology for defining the dynamic baseline of the water environment within an area that is currently being actively quarried, or an area of preferred mineral working.
- **2. Developing the requirements of a DBM**: this would be done by utilizing the data collected during the previous stages (including input from stakeholder consultees at a research workshop held on 28th January 2011), to produce a report which sets out the

[3] French and Taylor, 1985; Welch and Thomas, 1998; Brunning et al., 2000; Chapman and Cheetham, 2002; Van Heeringen and Theunissen, 2002; English Heritage, 2003; Lillie and Smith, 2007,2008

[4] the original objectives naturally evolved to accommodate the findings from the various stages of the work, see Volume 1 for further details.

major findings of the work and makes recommendations for how a methodology might be further developed and employed.

- **3. Undertake high-resolution, baseline hydrological and water chemistry monitoring programmes at two case study sites**: perform a background study and carry out the monitoring at sites where proven historical environment assets are located in close proximity to areas of current / future mineral working and would contribute to understanding how a draft DBM might be developed by collecting data.

1.13 This document is designed to meet the relevant objectives outlined in Stages 1 and 2 of the main report.

Report Layout

1.14 This report is sub-divided into a number of sections (1-7). Section 2 provides a brief overview of the location and planning background of the quarry sites.

1.15 Section 3 presents the geological, hydrological and hydrogeological settings of the sites and their surrounding environs.

1.16 Section 4 provides an overview of the historic environment assets of interest (both at the study sites and in their surrounding environs) and identifies those features that may be considered as potential receptors to changes in the water environment.

1.17 Section 5 outlines the methods used for the water environment monitoring of the quarry sites, the results obtained by employing these techniques and the interpretation of the data generated; both in terms of assessing the water environment system and the effect that these physico-chemical properties may have upon the preservation of historic environment assets that are located both within and surrounding the extraction areas.

1.18 The penultimate section (6) presents the results obtained by employing the techniques outlined in Section 5; and the subsequent interpretation of the data generated.

1.19 Finally, Section 7 concludes the report by discussing the main findings.

2. BACKGROUND TO THE CASE STUDY SITES

2.1 This section introduces the location of the study sites and their planning backgrounds.

Newington Quarry

Location

2.2 The Newington Quarry site is located approximately 2 km to the east of the town of Bawtry (National Grid Reference: SK675943). The 40.75 ha site is bounded by Bawtry Road to the north and the River Idle to the south and is dissected by Slaynes Lane.

2.3 The active extraction area (shown in yellow) sits within the northern half of the site and can be seen, along with the study area, in Figure 2.1 below.

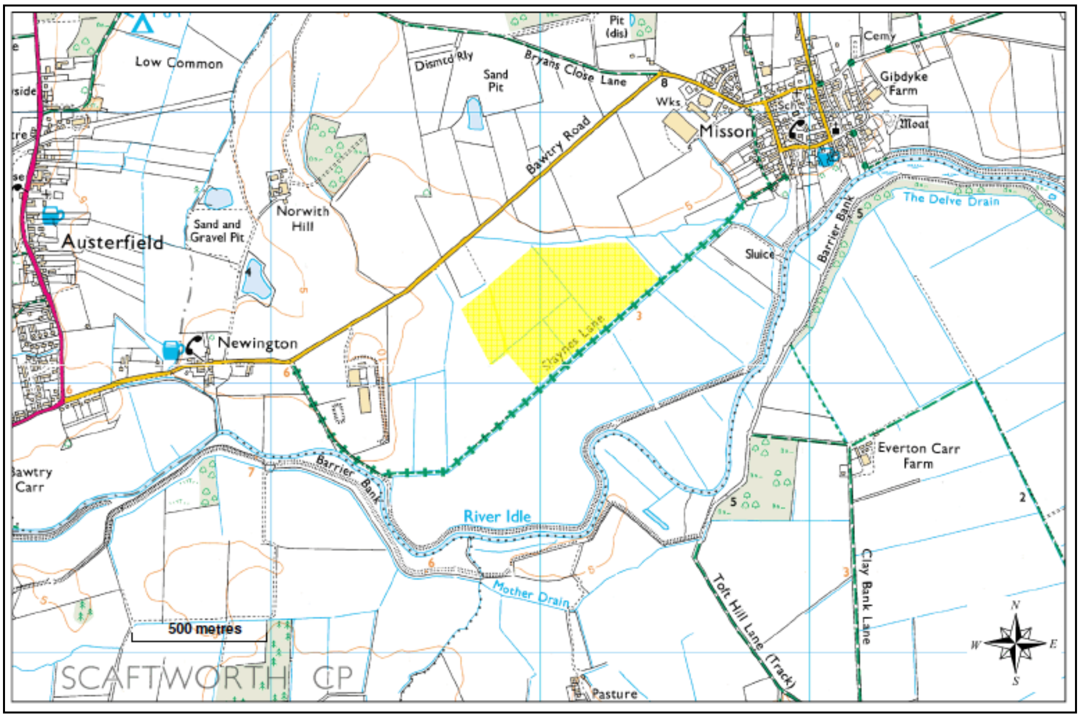

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Figure 2.1Location map showing the current extraction area at Newington Quarry.

Planning Background

2.4 Originally granted planning permission in 2000, the site is being worked in six phases (with completion in 2014). At the time of monitoring for this study (February 2010-January 2011), the final phase (6) (located to the eastern corner of the current extraction area) was being actively dewatered.

Over Quarry

Location

2.5 The Over Quarry site is located in the Fens, Cambridgeshire and covers an area of approximately 350 ha. It is situated at approximately 0.5 km south of Earith. The active extraction area (shown in yellow) sits within the north-western part of the site and can be seen, along with the study area, in Figure 2.2 below. Willingham Mere is located within the north-east of the quarry site.

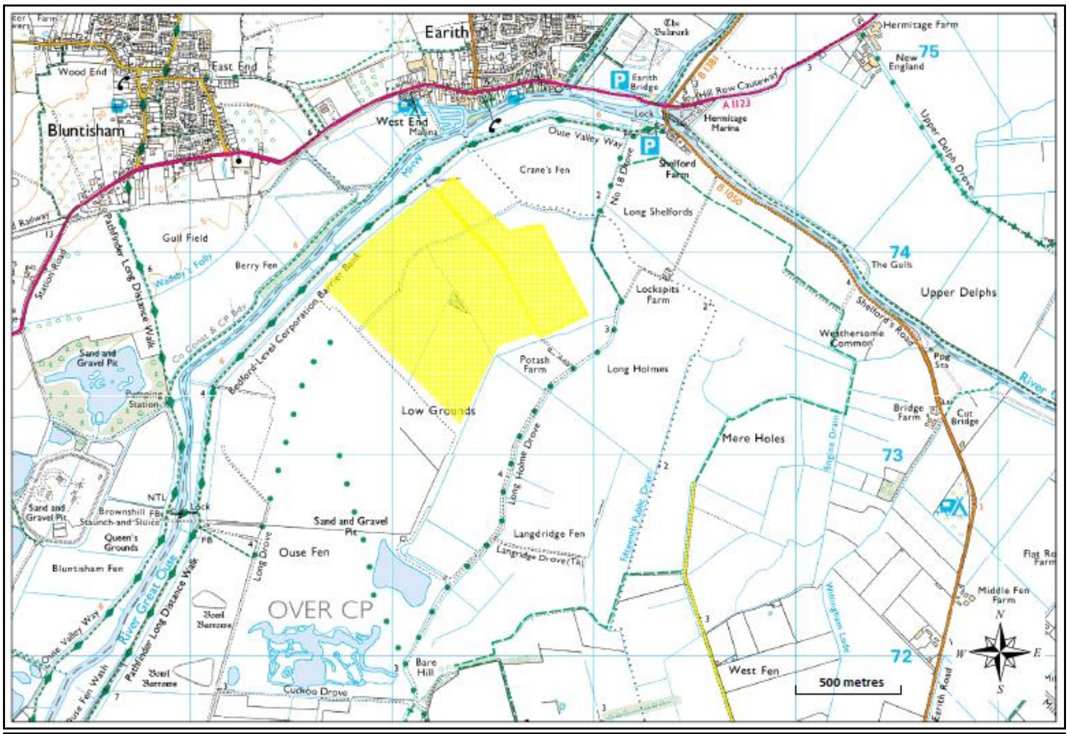

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Figure 2.2 Location map showing the current extraction area at Over Quarry.

Planning Background

2.6 In June 1994, planning permission was granted for the establishment of a major sand and gravel quarry covering an area of approximately 945 ha near Needingworth village and to the north of Over village. An additional extension to the quarry is proposed at Bare Fen / West Fen (which is located immediately to the east of the current site).

3. CONCEPTUAL MODEL

3.1 The conceptual model of each quarry site presented in Section 3 is generated from their geological, hydrological and hydrogeological settings and surrounding environs, and is based upon the findings of a number of previous investigations[5].

Newington Quarry

Geology and Soils

3.2 The 1:50,000 British Geological Survey map for this area shows that the bedrock geology is of the Nottingham Castle Sandstone Formation of the Sherwood Sandstone Group (formerly known as the Bunter Sandstone). Above the bedrock are superficial deposits of Ipswichian age Older River Gravels and Devensian age First Terrace deposits. The latter directly underlie the modern floodplain which comprises deposits of sands (of aeolian and / or fluvial derivation), floodplain and marginal peats, and alluvial deposits.

3.3 Figure 3.1 (below) shows the distribution of superficial geology across the site.

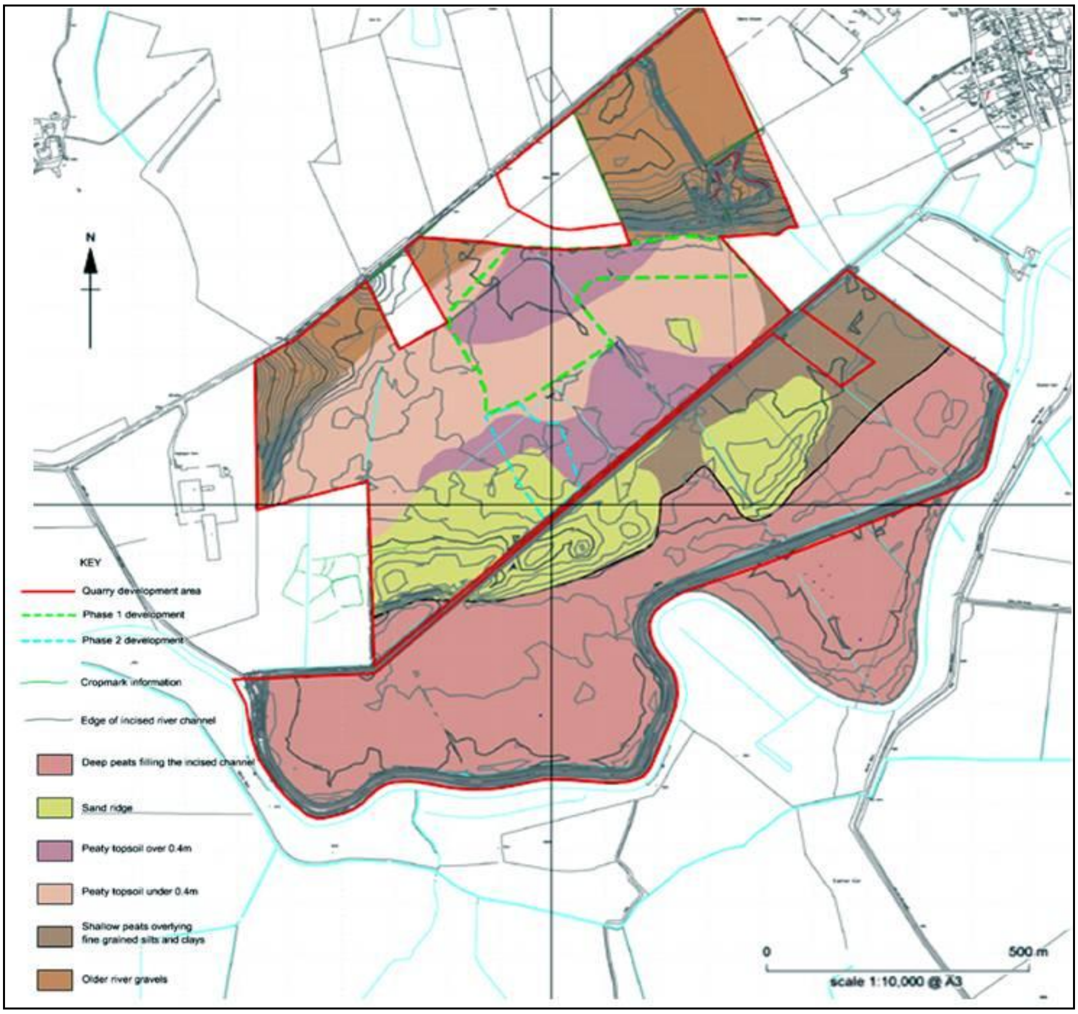

Figure 3.1 Superficial Devensian and Holocene units at the Newington site (from Lakin and Howard, 2000 [in Lillie and Smith, 2007]).

[5]Institute of Geology, 1979; Perrin et al., 1979; Evans, 1987; Lewis and Bridgland, 1991; Entec, 1999; French et al., 1999; Howard et al., 1999; Royle, 1999; Lakin and Howard, 2000; Leake, 2000; Evans and Webley, 2003; French, 2004; Golder Associates, 2006; Lillie and Smith, 2007,2008; Vander Linden and Evans, 2007; Bennett, 2009; Evans and Vander Linden, 2009

3.4 The superficial sand and gravel deposits form a ridge, upon which shallow peats (in the north and eastern side of the site), and fine-grained silts and clays (to the west) occur. The superficial peat and silts / clays recorded in the area range between approximately 0.6 m thickness away from the floodplain to a maximum of approximately 4 m of peat and alluvial deposits within the floodplain itself.

3.5 Four broad categories of soil are found in the area, including: stony organic topsoil over sandy subsoils; deep, light-textured soils over the sandy ridge and terrace deposits; slightly stony peaty loams which occur at the boundary between the terrace and floodplain deposits; and peaty soils over the south-west corner of the site (within the vicinity of the peat filled channel sequences).

Hydrology

3.6 In general, the topography of the extraction area is low-lying, ranging from between 2-3 m AOD and rising to between 6-8 m AOD on its northern margins. The site is located on the northern side of the River Idle at a point where the floodplain widens, and the river changes its course from east to north, flowing past Misson towards Idle Stop at SK72109650. The river is characteristic of lowland British rivers, and is currently flowing in a single channel, reflecting the low-energy environment of the river. The water management system at Newington is shown in Figure 2.3 below.

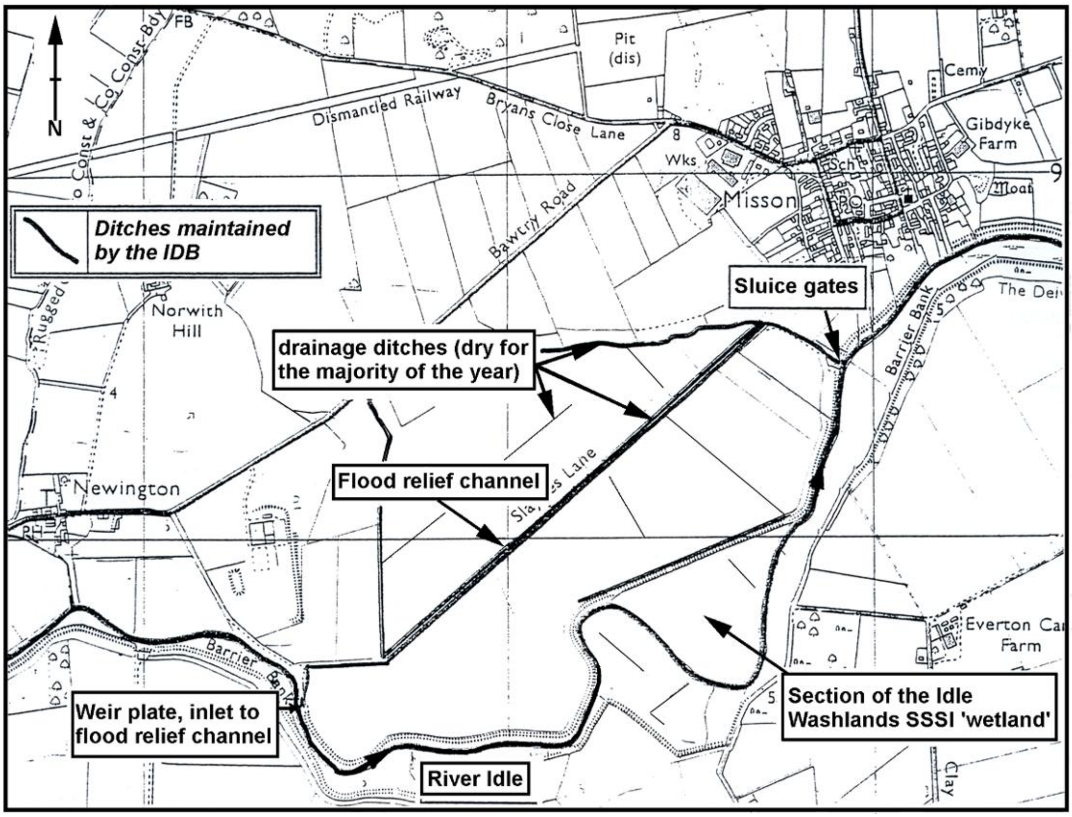

Figure 3.2 Water features in the vicinity of Newington (from Leake 2000: Figure 3 [in Lillie and Smith, 2007]).

3.7 The land drainage of the area is regulated by the Idle and Ryton Internal Drainage Board and the Environment Agency. Historically, flooding within the Idle catchment was exacerbated by high water regimes in the River Trent, into which the Idle discharges at West Stockwith. Significant remedial works in the 1980's, including re-grading of the current Idle channel and the construction of a flood relief channel south of Slaynes Lane, have reduced the impact of flooding in the reach of the Idle's course near Newington Quarry.

Hydrogeology

3.8 Site water movement and dewatering occurs via a pump located in the central part of the current extraction area (Figure 2.1). This discharges water into a lagoon created from the excavation of part of Phase 6. Water is then discharged from the lagoon into the Slaynes Lane ditch (which is isolated from the adjacent river by sluice gates at both ends, and that are only opened when additional flow capacity is required), and subsequently pumped into the River Idle. During this time, both the groundwater abstraction and the discharge for the purpose of quarry dewatering did not require a licence. As such, the pumping rates and the operation times were not monitored on site. The water level in the lagoon in was also not monitored.

3.9 The largest abstraction to the south of the study site is a Public Water Supply (PWS) which is operated by Severn Trent Water Limited. There are also a number of significant abstractions operated by Tarmac Ltd for the purposes of mineral washing. The majority of abstractions are small scale supplies to farms for the purposes of spray irrigation and are licensed for six months of the year during the crop growing period.

3.10 Newington Quarry contains ten company boreholes (Hanson Aggregates Limited) installed for hydrogeological monitoring and four deep Environment Agency boreholes within the immediate vicinity. Two of the deep boreholes are located in the sands and gravels adjacent to the River Idle; with the remainder situated in the Sherwood Sandstone, away from the site (as shown in Figure 3.3 below).

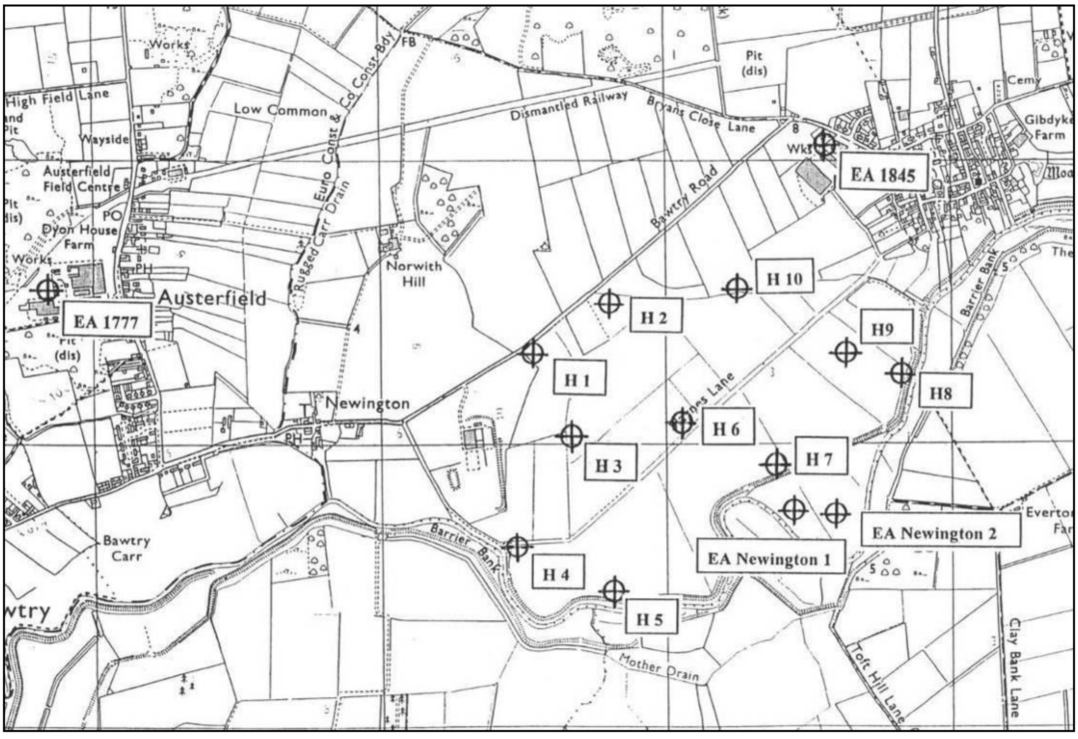

Figure 3.3 Hanson Aggregates Limited (H1-10) and Environment Agency boreholes (EA Newington 1 and 2) located in the sands and gravels adjacent to the River Idle; and two deeper boreholes (EA1777 and EA1845) situated within the Sherwood Sandstones, away from the extraction site (from Leake 2000: Figure 7 [in Lillie and Smith, 2007]).

3.11 Previous research identified that, at that time, the groundwater flow direction within the sands and gravels across the site was to the north-west, rather than to the River Idle as might be expected in a natural system. The work also demonstrated that in the extraction area to the north of Slaynes Lane, water levels ranged from approximately 0.5 m Ordnance Datum (OD) at Slaynes Lane, lowering to between -0.5 to -0.75 m OD at Bawtry Road on the northernmost side of the extraction site (as shown in Figure 3.4 below). In addition, the Environment Agency has previously identified depressed regional water levels and over-abstraction as significant issues in the region.

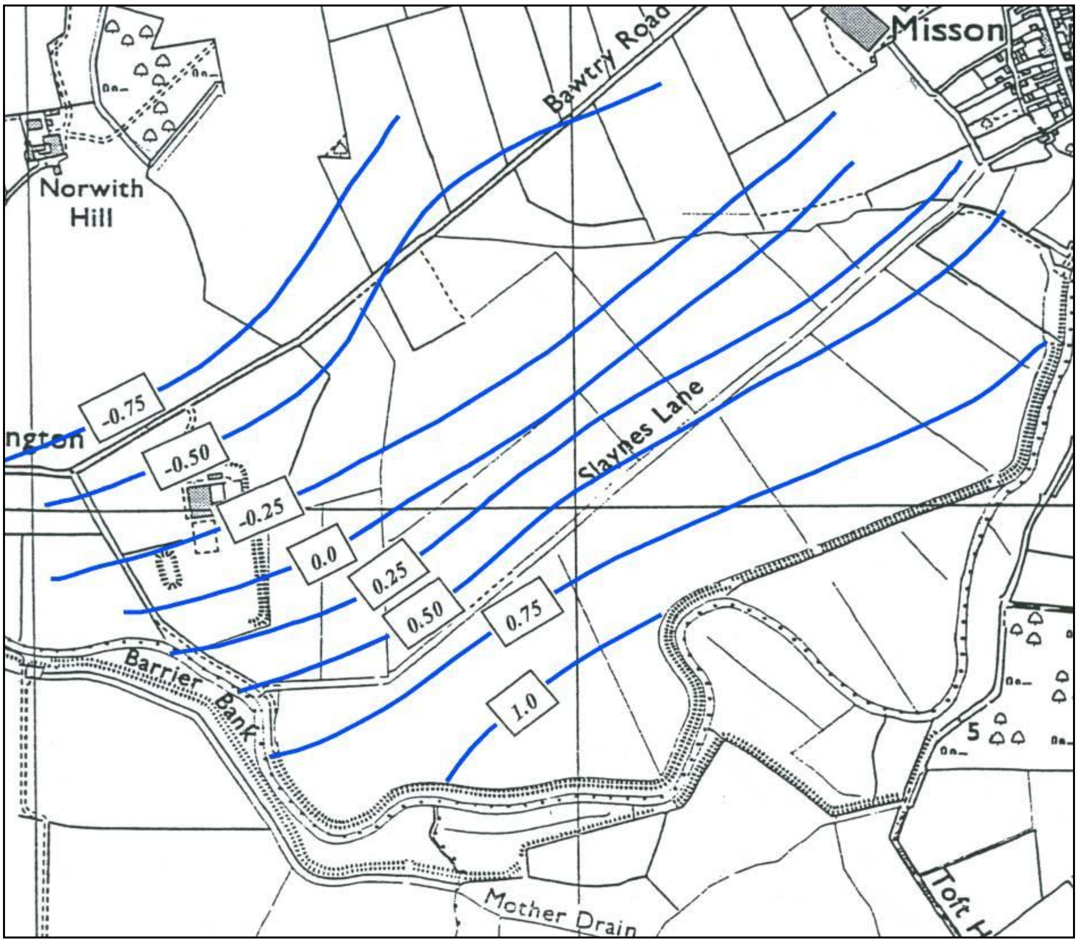

Figure 3.4 Sand and gravel groundwater head contours (in metres Above Ordnance Datum [mAOD]) (from Leake, 2000: Figure 12 [in Lillie and Smith, 2007]).

3.12 Cross-sectional profiles obtained from the Environment Agency for three locations on the River Idle, south of Newington Quarry, indicate that the river has a width of approximately 18 m, with a bed elevation of between –0.1 and –0.9 m AOD. However, the bed elevation does not fall uniformly downstream, and is deeper in the intermediate point (–0.9 m AOD) than at the upstream (–0.1 m AOD) and downstream (–0.5 m AOD) points. The nature and thickness of bed sediment in the stream section remains poorly constrained.

3.13 In addition, the nature of the near surface geology is such that the Nottingham Castle Sandstone and all of the superficial deposits are in complete hydraulic continuity. Consequently, it could be anticipated that regional influences will also impact directly upon these superficial deposits within the immediate vicinity of the extraction site.

3.14 The Newington site is situated upon the Sherwood Sandstone, which is a Principal Aquifer (as defined by the Environment Agency), and which is an important regional water source for public consumption.

3.15 The wider regional hydrogeology as attested by the Environment Agency boreholes located at Misson (EA1845) and the G.R.Stein refractories (EA1777) (as displayed in Figure 3.3 above), indicate that although these locations fail to provide any meaningful short-term / seasonal trends, during the period 1982-1998, the Misson data does indicate an overall trend of decreasing groundwater levels from –0.75 m OD to c. –1.5 m OD. At the G.R.Stein refractories from 1991 onwards, major short duration fluctuations are in evidence, but these data reflect the close proximity of this location to licensed groundwater abstractions.

3.16 In addition to the information presented above, a more comprehensive groundwater modelling exercise of the study site and the surrounding catchment in order to develop a conceptual model of groundwater flow. The relationships between hydrostratigraphic units, surface water and quarrying activities are described and presented schematically in Figure 3.5 below.

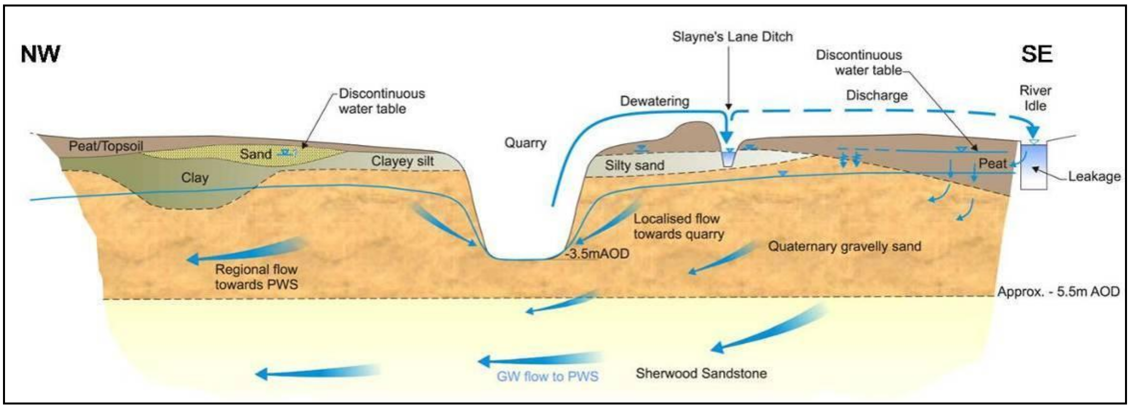

Figure 3.5 Schematic hydrogeological cross-section / conceptual model (modified from Golder Associates Ltd, 2006 [in Lillie and Smith, 2007]).

3.17 A regional groundwater head contour and several local groundwater head contour plots (prior to [September 2002] and after [November 2003] water abstraction operations commenced) from the model history are presented in Figures 3.6, and 3.7 to 3.8 respectively (below). It can be seen that the regional groundwater contours (Figure 2.7) indicate that flow within the model domain occurs from the west, suggesting that flow is largely captured by abstraction within this area, with little apparent flow occurring east into the confined zone. The local groundwater contour patterns on site (Figures 3.7 [pre-dewatering] and 3.8 [during dewatering operations]) highlight water flow into the de-watered area of the quarry site.

3.18 Figure 3.9 highlights particle pathlines modelled during the period of the simulation in order to arrive at the margin of the dewatered area. These paths are modelled in reverse, with the line showing the path along which it has travelled during the simulation.

3.19 The results indicate that dewatering has only captured the particles (representing the water) within a relatively small radius around various sump points. In close proximity of the dewatered area, particles drawn into the quarry at the end of the model sequence have flowed from an approximate 400 m radius over a modelled five year period.

3.20 The results also show that the particles to the south of Slaynes Lane begin to move north-west, being captured and pulled back into the quarry when dewatering commences. The effect of quarry dewatering is demonstrated in the particle paths which are seen at approximately 150 m away from the quarry.

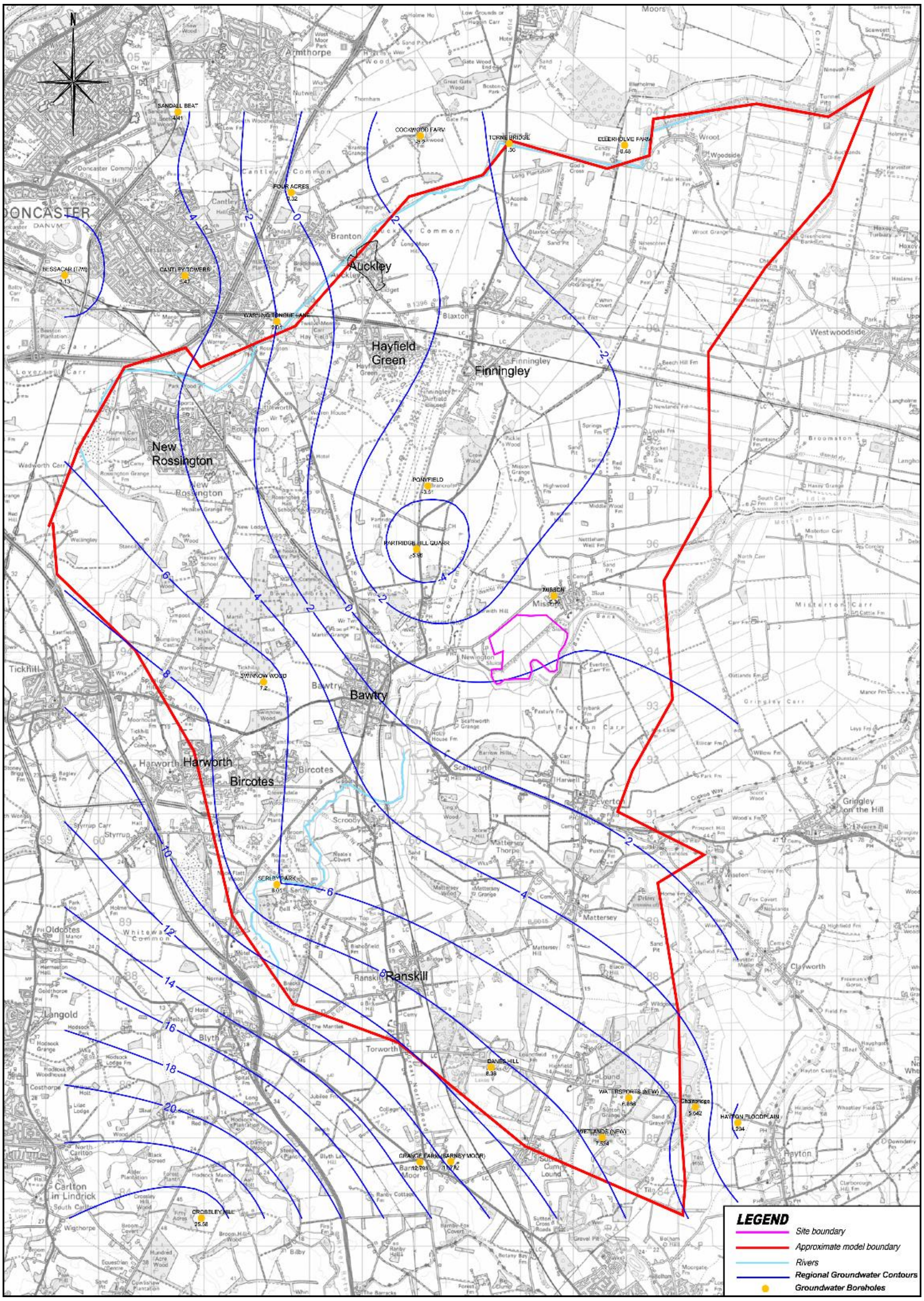

Figure 3.6 Regional groundwater model contours of the Nottingham Castle Sandstone Formation (from Golder Associates Limited, 2006 [in Lillie and Smith, 2007]).

3.21 The results of the catchment-scale modeling have highlighted a number of significant factors relating to the groundwater table and the floodplain environments at Newington Quarry. In particular that licensed groundwater water abstraction is having the biggest influence on groundwater in the catchment. This is due to the fact that in the modelled area groundwater resources have been heavily exploited for use by industry and for public supply. Licensed abstractions for the purpose of general farming and domestic use range from 9,955,740 m^3/year at the Austerfield and Highfield Lane PWS, to 1,137 m^3/year at Lovershall Farm, and that the eight public water supplies within the model domain and abstraction of process water at Harworth Colliery constitute the largest abstractions in the model, with other abstractions licensed to remove >300,000 m^3/year being generally for the purpose of mineral washing associated with sand and gravel extraction.

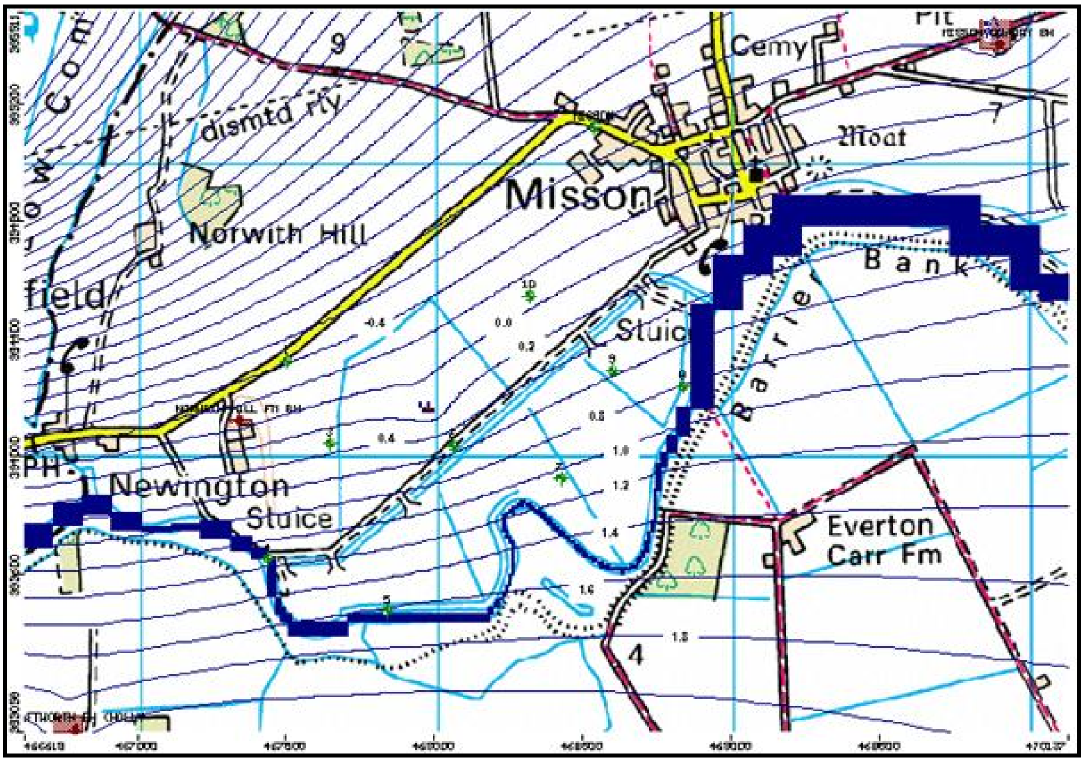

Figure 3.7 Groundwater head contours (in mAOD) from the transient model history, for September 2002 (from Golder Associates, 2006 [in Lillie and Smith, 2007]).

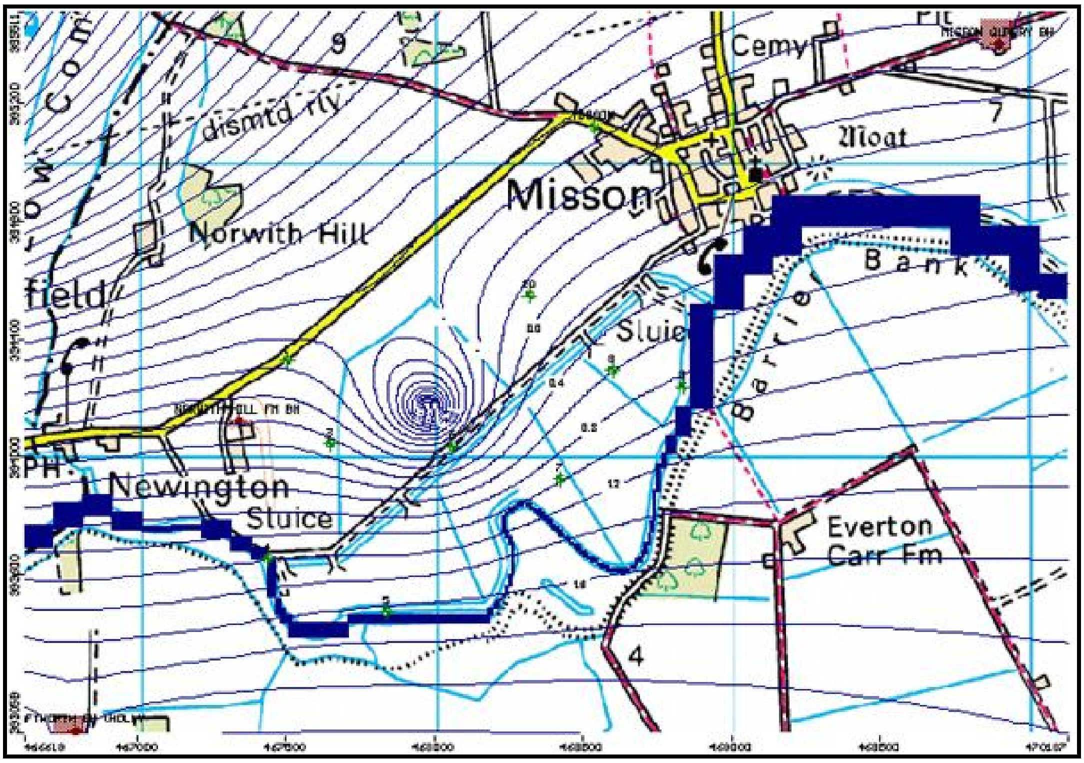

Figure 3.8 Groundwater head contours from the model history, for November 2003 (from Golder Associates, 2006 [in Lillie and Smith, 2007]).

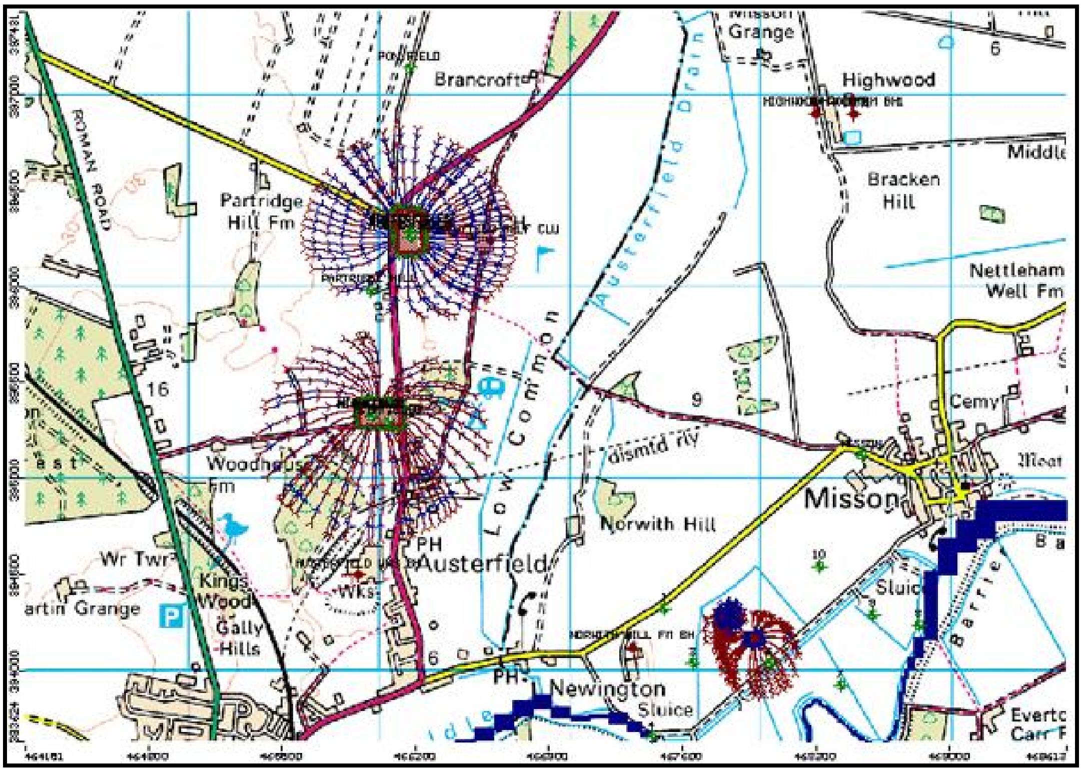

Figure 3.9 Predicted particle pathlines, backward simulation, quarry margins and abstractions (from Golder Associates, 2006 [in Lillie and Smith, 2007]).

3.22 The main observation drawn from the modeling is that limited drawdown occurs in and around the area of aggregates extraction. The results suggest that quarry dewatering at Newington is not having a significant effect on the groundwater levels in this area, and that no marked (and sustained) lowering of the water table has resulted from the extraction of aggregates in this catchment. In fact, the main cause of lowered groundwater tables in the vicinity of Newington occurs as a direct result of water abstraction in the catchment.

Over Quarry

Geology and Soils

3.23 The basic geology of the Fens was formed during the Jurassic period and primarily comprises consolidated clays (Corallian Clays). These are soft, easily eroded and give rise to flat tracts of land which are generally associated with low-lying areas. The Corallian Clays are extensively covered by river gravels and alluvium.

3.24 Much of the Fen Basin is infilled by Quaternary sediments (boulder clays, sands and clays, and peat) which mask the majority of the underlying bedrock, and indicate a varied and complex geomorphological history. Previous investigations have suggested that the present shape and topology of the Fen Basin was formed during the Anglican Glaciation.

3.25 More recently, this basin has been a large embayment of the sea which inundated parts of the river systems. At other times the area has been heavily affected by ice sheets which deposited vast thicknesses of Boulder Clay across the area. These deposits have been mostly eroded by subsequent glacial and interglacial events, and are largely only evident on the higher ground. However, the most significant imprint of the effects of glaciations is seen in the vast spreads of sand and gravel deposits laid down by melt-waters associated with the Quaternary ice sheets.

3.26 Of particular interest within the north-eastern part of the extraction site boundary lies a sand ridge (termed 'The Goodwin Ridge') which directly beds upon the basal gravels and forms a marked quasi-linear landscape feature in the Ouse floodplain. The Goodwin Ridge runs along a southwest-northeast axis and extends for approximately 1400 m to the north-eastern limits of the quarry, adjacent to Earith village and where the present-day river debouches into the Fens (as shown in Figure 3.10 below).

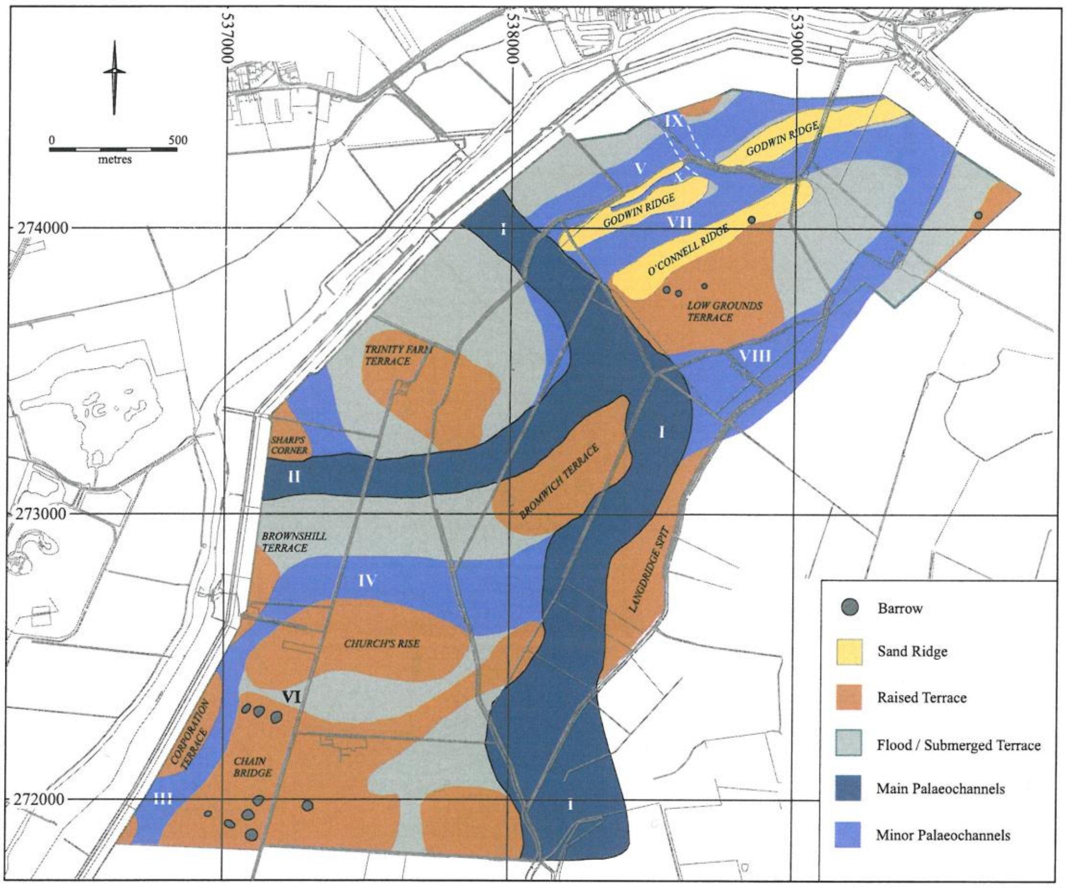

Figure 3.10 Sedimentary units associated with the north-eastern part of the Over site (from Evans and Vander Linden, 2009).

3.27 The Goodwin Ridge is well-preserved, raising approximately 1.4-3 m (OD) above the Ouse floodplain, and is between 60 and 150 m wide. However, it does not constitute a continuous land mass and a minor palaeochannel bisects it into two parts. The western length stretches for approximately 550 m, with its width varying between 60 and 70 m.

3.28 This Late Glacial sand ridge has a complex and composite internal stratigraphy, comprising basal silt (occasionally associated with gravely clay) which is overlain by sand and sandy clay. Its geological formation is complex, being initially interpreted as a roddon. However, it has recently been identified as an original upstanding feature of the glacial braidplain that had subsequently been carved-out by later palaeochannels into its 'linearity'.

3.29 The Goodwin Ridge is bordered on each side by palaeochannels related to the activity of the Ouse delta; to the west, a main palaeochannel of the Ouse River and, to the north and south, smaller channels; the latter separating the sand ridge from another 'matching' formation, the southern, O'Connell Ridge.

3.30 Based on available environmental evidence from the Over, Barleycroft Farm, Meadow Lane and St Ives quarries, the upper Ouse-side gravel terraces generally seem to have been dry prior to the Middle / later Iron Age.

3.31 There is a distinct or uniform wet / dry divide within the Over quarry site boundary, with the fen-edge only coming into being during the later Bronze Age. In fact, during archaeo-environmental investigations, the inversion of widely held presumptions concerning preservation was observed; with the lighter terraces acting as channels which, when breached at critical points, allowed water to flow out at high velocity. Instead, it is the heavier deposits of the off-terrace pools, palaeochannels and 'bottomlands' that lock in water and permit organic preservation.

3.32 The whole study area is under arable cultivation, and over 60 % of it comprises alluvial deposits that range in depth between 0.5 and 2.5 m below the ground surface. The remaining land area is covered by peat deposits and calcareous freshwater lake silts to depths of approximately 2 m in its north-eastern part.

<u>Hydrology</u>

3.33 As a result of the low-lying topography of the area, the landscape is very sensitive to change; and to sea level change in particular. This sensitivity has been tamed by the use of extensive water management systems emplaced with the Fen Basin over the past few centuries. These water management systems and structures (e.g. canals, windmills, etc.) are now an integral part of the Cambridgeshire fenland landscape. River courses have been altered and barrier banks have been raised in order to produce a vast open landscape within a regimented and highly organised drainage pattern.

3.34 This land management system has, however, created new problems; the most significant of these affecting the area is land degradation, resulting from peat shrinkage due to water drainage and enhanced wind erosion due to soil destabilisation and the flatness of the topography.

<u>Hydrogeology</u>

3.35 The hydrogeology of Over Quarry and the surrounding catchment area has been studied by a number of previous investigations. The main findings are detailed below.

3.36 Groundwater level data collected in advance of extraction activities between 1992 and 1999 show that seasonal fluctuations reached up to 1.5 m; with higher levels near the River Great Ouse, falling away to lower levels near to the Internal Drainage Board (IDB) pumped drains.

3.37 Dewatering to the base of the sand and gravel aquifer promotes groundwater to be released and drawn in from adjacent areas, primarily from the River Great Ouse. A proportion of the dewatering volume is also derived from direct rainfall onto the area of the quarry being dewatered.

3.38 Mathematical modelling using ModFlow, demonstrated that much of the quarry water is derived by leakage from the River Great Ouse and that the lateral spread of drawdown of groundwater levels is limited to a maximum of 0.5 m at a 200 m radius. In addition, dewatering on the west side of the river did not result in the drawdown of groundwater on the east side.

3.39 In light of the findings presented above, proposed extraction operations at Over Quarry highlighted a number of significant hydrogeological and hydrological issues, both on-site and within the surrounding catchment. The main issues are outlined below:

3.40 It was considered possible that extraction operations could affect the hydrogeology / hydrology of Berry Fen SSSI (shown in Figures 3.11 and 3.12). This was primarily due to the uncertainty regarding the degree of interaction that would occur between the river and the groundwater systems;

3.41 Dewatering operations in the river corridor extensions also have the potential to cause leakage from the River Great Ouse of the order of 2.5 to 5.0 megalitres per day. In times of low flow, this impact could be significant (-measures were introduced in order to ensure that these leakage rates did not become excessive by limiting the lengths of the free draining excavation face; including the rescheduling of sensitively located extraction operations and the alternative discharge of dewatering drainage directly into the river); and

3.42 Further quarry dewatering impacts also had the potential to cause major impacts on the Over and Willingham IDB system. Therefore, a comprehensive conceptual plan was formulated in order to mitigate the effects which included drainage channel diversions and control of discharges (both quality and quantity) from the excavation area.

3.43 Additional comprehensive geotechnical-based designs were formulated in order to address key issues regarding water drawdown; these included the construction of an impermeable bund using reworked basal clay being constructed parallel to the Great River Ouse and in conjunction with the expansion of extraction operations towards the north of the site (as shown in Figure 3.11 above); and the use of reworked overburden in the construction of the perimeter canal, branch feeders, reed-beds and low level drainage channels (as presented in Figure 3.12 below).

3.44 Concern regarding the construction of the abstraction intake on the River Great Ouse and the possible effects on the flood embankment is covered by comprehensive design proposals. These included the instigation of a well controlled contract programme which was aimed at minimising flood risks whilst construction works were being undertaken and embankment reinstatement to an appropriate geotechnical specification.

3.45 Other investigations studying the water environment system both in the quarry site and within its immediate surroundings has provided additional information associated with dewatering. In total, three phases of water environment monitoring were undertaken between November 1994 and September 2001 in the study area. This comprised three years of pre-extraction monitoring, eighteen months of scaled-down pre-extraction data collection and two-and-a-half years of monitoring during extraction operations.

3.46 With the commencement of extraction operations, the effects of water abstraction on the hydrological system were both marked and abrupt. The groundwater levels within the extraction area and beyond to the north were maintained at c. 5 m below the present day ground surface by the mineral operator’s managed pumping regime. This dramatically affected an area up to 500-600 m from the extraction face, but primarily downstream of the area being quarried. The clay bunding of the quarry accentuated this effect. In contrast, the groundwater table along the southern edge of the bund re-established itself to pre-extraction levels almost as quickly as it fell, i.e. within a couple of months.

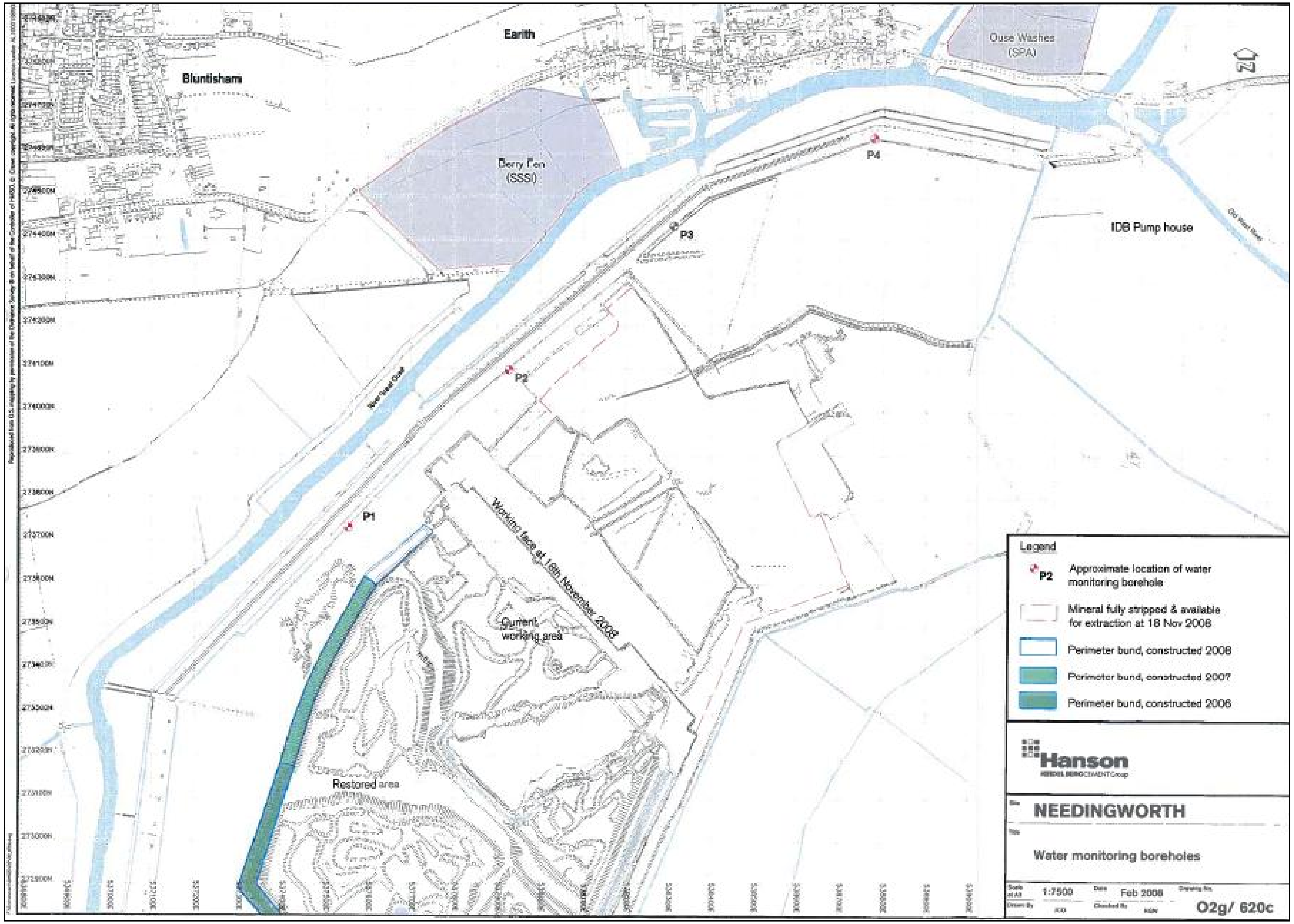

Figure 3.11 Location of groundwater monitoring boreholes and perimeter bund situated in the north of the extraction site (from Bennett, 2009).

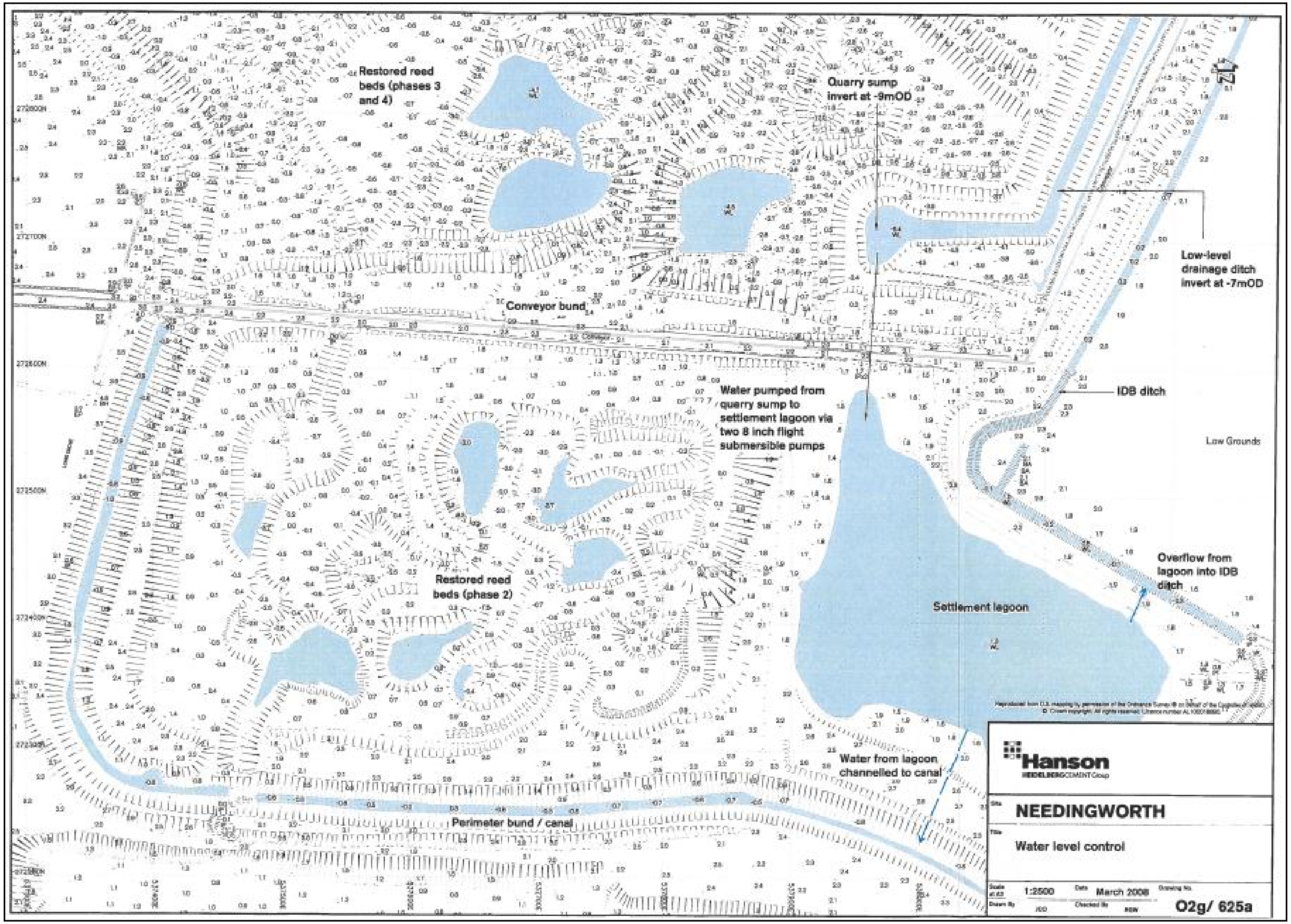

Figure 3.12 Water level controls in the north of the extraction site (from Bennett, 2009).

3.47 The significant observations from the above work included:

- Due to dewatering operations, the groundwater table within the extraction area was depressed to 5 m below the modern ground surface;
- pH and dissolved oxygen values increased in the sediment;
- Downstream from, and beyond the extraction area, the groundwater table gradually dropped to approximately 2 m to 5 m below the modern ground surface;
- A zone of dewatering influence effect was recorded for a distance of up to 600 m beyond the extraction area; and
- 'Bunding' with impermeable clays slightly negated these impacts to the south of the extraction area, but unconstrained conditions to the north allowed the impacts of draw-down to extend north.

3.48 Four groundwater monitoring boreholes were installed in 2005 along the eastern side of the River Great Ouse (as shown in Figure 3.11 above) in order to assess the extent of water drawdown in relation to the river and the effect that the construction of perimeter clay bund has in relation to it.

3.49 The groundwater level data are presented in Figure 3.13 below. The data shows a close correlation of levels for Boreholes P2-P4 throughout 2006, and the majority of 2007. However, Boreholes P2 and P3 then diverge from P4, and fall below OD.

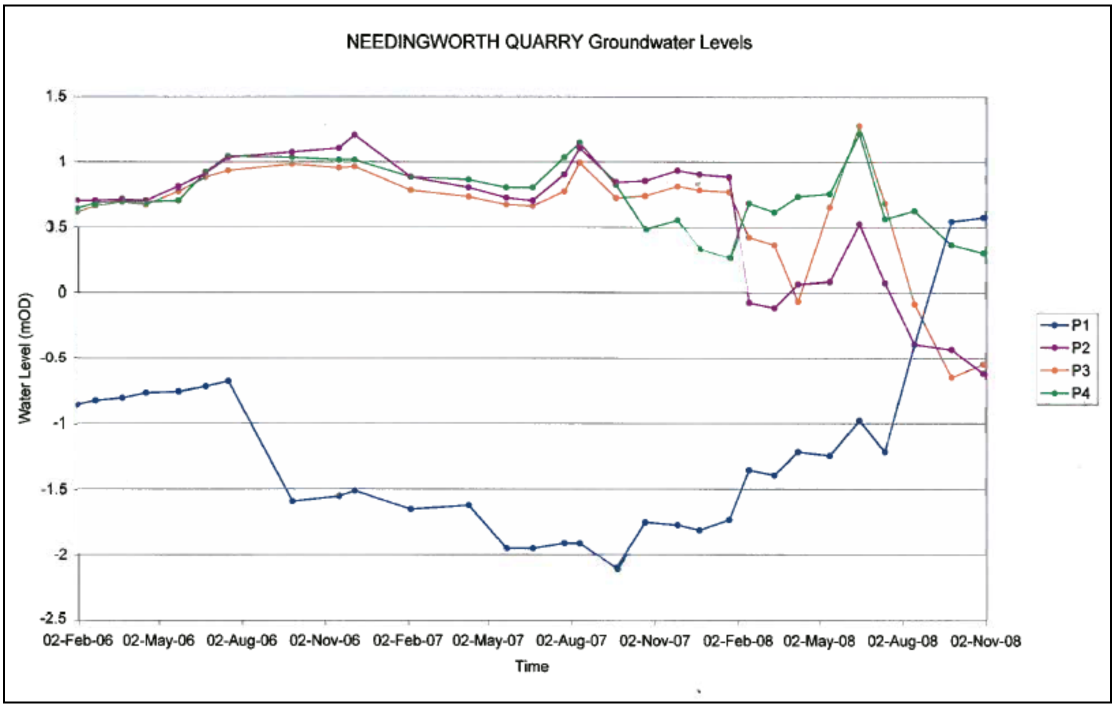

Figure 3.13 Groundwater borehole measurements immediately adjacent to the River Great Ouse (from Bennett, 2009).

3.50 In contrast, P1 shows groundwater levels depressed below OD throughout the duration of the monitoring programme, with the exception of the latter part of 2008, when a substantial recovery of over 1.5 m took place from July. The resulting groundwater level in November was higher than at Boreholes P2-P4.

3.51 By reference to Figure 3.13, it is apparent that quarry dewatering in the current working area caused a substantial drawdown of the groundwater level at P1. Recovery only took place when the perimeter bund was constructed beyond P1 in 2008.

3.52 In addition, at the same time that the limit of the extraction area has moved northwards towards P2, a drawdown of groundwater level in excess of 1 m has been identified. The level at P3 has also declined by approximately the same amount. It is likely that levels at P2 will not recover until the perimeter bund has been constructed northwards beyond the borehole position.

4. HISTORIC ENVIRONMENT

4.1 This section provides an overview of the historic environment assets of interest (both at each quarry site and its surrounding environs) and identifies those features that may be considered as potential receptors to changes in the water environment.

4.2 The following account of the historic environment setting of each site has been developed on the basis of studies by numerous authors[6] and historic environment information[7]. Full bibliographic references are presented in Section 8.

Newington Quarry

Landscape Development

4.3 Palynological studies show that floodplain sequences at the site span the period 13,000 to 2000 years uncalibrated radiocarbon date Before Present (uncal BP). Dendrochronological assessment of oaks contained within the floodplain peats suggest an age range of c. 1136 Before Common Era (BC) and 1120 BC for the trees, with an end date of c. 1100 BC. These dates are wholly consistent with the palynological data from the upper sequences at this site, and broadly conform to the results of radiocarbon dating of the upper sediment units, which have ranges between c. 1200-400 calibrated radiocarbon date (cal) BC.

4.4 In general, the sequences of deposits recovered from extensive borehole excavations of the floodplain areas indicate initial wetland development following paludification of the sands adjacent to the main channel. Subsequently, a unit of overlying silt-clay sediments with organic remains reflects the deposition of alluvium following the spread of the river beyond its earlier, discrete channel, and the inundation of the wetland areas on the floodplain alongside the development of fen-carr woodlands. Within the floodplain areas the occurrence of an upper woody peat unit reflects the establishment of fen-carr communities over the study area.

4.5 At present, no deposits that post-date the prehistoric period have been recovered from the study area.

Recorded Sites

4.6 A search has been performed for registered and designated sites within a radius of 3 km from the centre of the quarry. Figure 4.1 below, shows the location of two designated Scheduled Ancient Monuments (labelled as 1 and 2) in relation to the excavation area. These are as follows:

- Scheduled Ancient Monument (No: 23217; Grid Ref: SK69299497) comprising a Moated Site and Fishpond, located to the east of Misson Village approximately 1 km from the site.
- Scheduled Ancient Monument (No: 29923; Grid Ref: SK65939274), a Roman fort and corduroy road at Scaftworth, located at a distance of 2.7 km from the quarry site.

4.7 The preservation of the Roman Road at Scaftworth has direct implications for the Newington floodplain sequences in that a proven archaeological potential exists within c. 3 km of the

[6] Buckland and Dolby, 1973; French and Wait, 1988; Evans, 1991; Hall, 1992; French and Pryor, 1993; Garton et al., 1995; Dinnin, 1997; Evans and Knight, 1997; Van de Noort and Ellis, 1997; Van de Noort et al., 1997; Cambridgeshire County Council, 1998; Morris and Garton, 1998; French et al., 1999; Howard et al., 1999; French, 2000, 2003, 2004; Gearey et al., 2000; Kirby and Gearey, 2001; Lakin and Howard, 2000; Schofield, 2001; Gearey and Lillie, 2002; Northern Archaeological Associates, 2002; Evans and Webley, 2003; Lille and Smith, 2007, 2008; Vander linden and Evans, 2007; Evans and Vander Linden, 2009

[7] Nottinghamshire Historic Environment Record; Archaeology Data Service website; and the Government's Heritage Gateway and MAGIC websites

study area. In terms of its preservation, excavations at the Scaftworth site show it to be in an on-going state of compromise. In 1948, the road line was not visible in the floodplain, by 1991 a low ridge was noted running across the floodplain, and by 1995, the ridge had become pronounced due to continued desiccation of the surrounding organic matrix.

4.8 Figure 4.1 also identifies the area covered by three management units of the River Idle Washlands Site of Special Scientific Interest (labelled as 3a to c and denoted by the green areas in Figure 4.1). These management units all represent areas of neutral grassland which are in an unfavourable / recovering (3a), favourable (3b) and unfavourable / declining (3c) condition.

4.9 In addition to the Scheduled Ancient Monuments and the River Idle Washlands Site of Special Scientific Interest, there are approximately sixty-five other recorded historic assets (for example, structures, artefacts and ecofacts) that are located within a 3 km radius of the quarry site boundary.

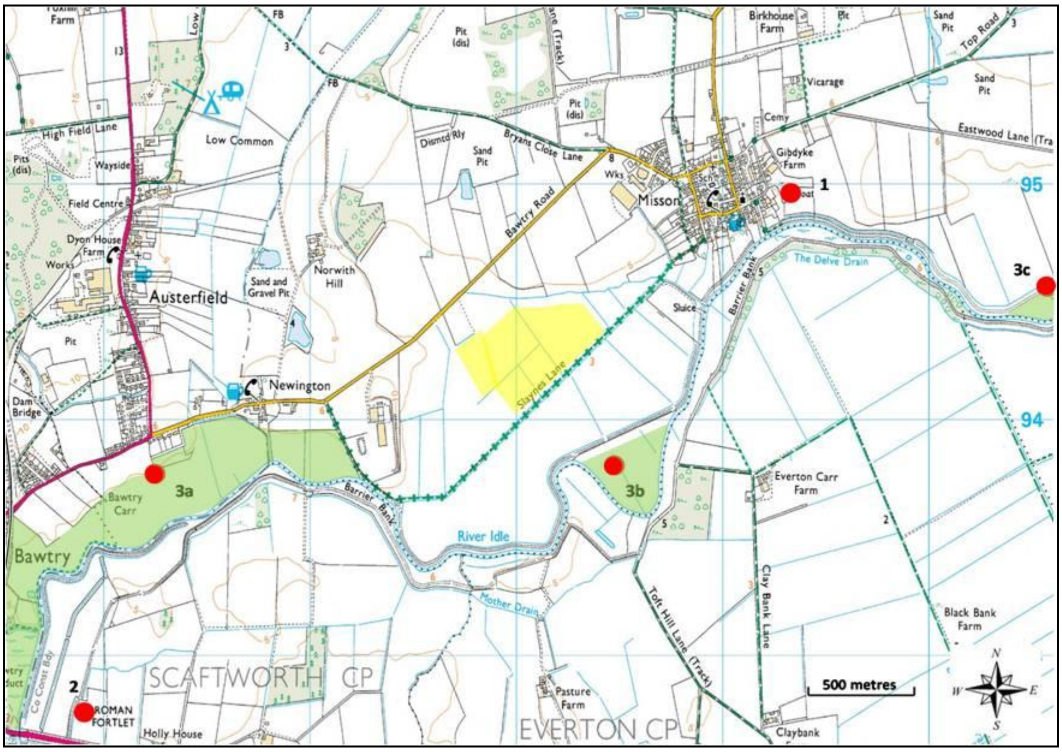

Figure 4.1 Location of the Scheduled Ancient Monuments and River Idle Washlands Sites of Special Scientific Interest units.

Archaeological Sites

4.10 The Newington Quarry site and its surrounding area has been subjected to detailed archaeological research, at the site specifically, mitigation strategies have prompted the undertaking of a number of evaluations as the extraction of the mineral has progressed. The following text summarises the findings from these investigations.

4.11 In the wider region of the Idle valley system, investigations have identified Romano-British field systems at Blaco Hill Quarry, near Mattersey and later Medieval field banks at Tiln. Mesolithic material has been recovered at Misterton Carr and there is evidence of human activity intimately associated with the watercourses of the region from the Mesolithic period onwards. The deeply stratified organic sequences associated with the rivers of the Humber

Lowlands have a significant, and proven potential in terms of the preservation of organic cultural remains and palaeoenvironmental material.

4.12 A broad age range of archaeological material has been highlighted in this area, from the earlier prehistoric period through to more recent historic periods. The archaeological remains in the immediate vicinity of the site include crop mark evidence of probable Romano-British date, and biogenic deposits which hold the potential for the recovery of organic remains associated with activity from the Mesolithic period onwards. Recent field-walking has produced scatters of worked lithics throughout the sandy areas, with an apparent 'gap' in distribution in those areas where deeper superficial peats are in evidence. This bias may well reflect the obscuring effects of the peats, which have been dated to the later Neolithic through to Iron Age periods.

4.13 A discrete concentration of Bronze Age flint has been recovered from a buried soil in the vicinity of the extraction area, indicating the presence of an activity site of this period. Overall, the general age of the flints recovered from this area appeared to span the Neolithic to Bronze Age periods. However, as the earliest date for peat inception to the north of Slaynes Lane is placed in the later Neolithic, it was suggested that earlier Mesolithic and Neolithic activity could be anticipated on the buried land surfaces in the extraction area, as these are exposed by topsoil stripping.

4.14 Confirmation of this earlier hypothesis was provided by the discovery of a late Mesolithic to earlier Neolithic concentration of worked flint, which was excavated in the vicinity of the extraction area immediately to the north of Slaynes Lane.

Palaeoenvironmental Sites

4.15 Newington Quarry site and its surrounding environs have also been subjected to detailed palaeoenvironmental assessment. The following text summarises the findings from these investigations.

4.16 Elsewhere in the Idle valley, at Tiln c. 10 km south of Newington, previous investigations have recorded Late Devensian and Early Holocene minerogenic sediments - braided river sands and gravels - overlain by a palaeosol of Late Devensian age (>13,500 BP). Other, organic, deposits were recorded within braided river deposits, which indicated an open, treeless, tundra landscape which was dominated by herbaceous taxa, typical of Late Devensian environments.

4.17 Palaeoenvironmental studies of the deposits at Scaftworth, Misterton Carr, Bull Hassocks, Star Carr, Thatch Carr and West Carr, whilst undated in absolute terms, have indicated potential age ranges for the onset of organic sedimentation occurring from the Late Glacial at c. 11,000-10,200 BP (the Younger Dryas PZIII) up to c. AD 43-410 or later.

4.18 Preliminary studies indicated the possibility for the preservation of biogenic sediments dated to c. 13-10,000 BP (the Late Glacial), located in the south-western corner of the study area. Elsewhere in the floodplain, ages of c. 7-5000 BP were indicated for the development of the floodplain peats, with expansion onto the upper areas of the floodplain margins occurring by c. 2-3000 years ago.

4.19 Targeted assessment through test-pitting and radiometric dating of the depositional sequences at Newington has yielded ages for wood, charcoal and peats which span the period c. 2860-290 cal BC.

4.20 A sample of charcoal recovered from basal silts yielded a date of 4050±50 BP (Beta-168361) which calibrates to 2860-2810 and 2690-2470 cal BC. This provided a terminus ante quem of the later Neolithic for the sealing of the land surface within the extraction area at Newington.

This basal date also provides a temporal marker for the subsequent development of wetland deposits in the floodplain areas to the north of the main channel and floodplain margins. The upper age of these deposits is placed at c. 2450±60 BP (Beta-168360 and 168364), which calibrate to 790-390 cal BC, and in palynological terms, the uppermost sample in the sequence (discussed below), on the basis of sediment depth and accumulation rates, was considered unlikely to date much after the mid-late Iron Age / Romano-British period.

4.21 Pollen analysis of the organic sediments in this area indicated that birch dominated fen was present during the earlier stages of organic sedimentation within the extraction area, with damp, acidic conditions indicated by the consistent presence of Sphagnum. High percentages of Alnus and Quercus indicate that alder and oak were also present nearby. The former species suggests areas of open water, since this tree tends to grow with its roots in water. In addition to the tree species discussed above, hazel and lime are attested in the immediate area. The wild grass pollen recorded in low quantities throughout the samples studied might reflect some local wetland grasses but these could also be derived from grassland habitats in the wider landscape. A low peak of Plantago lanceolata is also recorded. This peak may be significant since ribwort plantain will not grow in woodland or wetland habitats, and as such must reflect open, grassy and possibly anthropogenically disturbed habitats beyond the fen edge.

4.22 Towards the upper part of the depositional sequence an increase in Alnus and a concomitant decrease in Betula are in evidence from 0.64 m, indicating a change in the on-site vegetation from birch to alder dominance. Alder fen carr communities, as indicated by this sample, are commonly recorded from floodplain habitats in the Humber lowlands during the mid-Holocene. The shift from birch to alder probably reflects amelioration from mesotrophic to more eutrophic conditions, but there is insufficient data to support this observation at present.

4.23 There is little evidence to suggest anthropogenic activity in the catchment as total tree and shrub frequencies account for over 95 % of total land pollen. A 'successional reversal' of the kind outlined above is recorded in a pollen diagram from Shirley Pool in the Humberhead levels and is dated to around 4400 BP. It is hypothesised that this is either due to the increased influence of nutrient rich surface water occurring as a result of woodland clearance, or a rise in base levels concomitant with a rise in relative sea level.

4.24 The upper levels studied by palynology have indicated that the vegetation in the area is characterised by few trees, either on the sampling site or in the wider landscape. The marked reduction in the local and extra-local tree cover is presumably a result of anthropogenic activity, but actual palynological evidence for this is limited in this sample, with pollen from the local sedge wetland forming the major source of pollen.

4.25 A more recent palaeoenvironmental study undertaken at Newington has shown that preservation of microfossil material is generally poor, though with some variability in evidence. The lower part of the studied core produced an age of 8740±40 BP (Beta-191006) which calibrates to the earlier Holocene at 7950-7610 BC, while the uppermost part of the sequence is dated to 2650±40 BP (Beta-191005) and calibrated to 850-790 BC, the later Bronze Age.

4.26 The earliest age for organic sedimentation appears to suggest that in the south-western corner of the site an isolated hollow or depression at the edge of the blown sand deposits promoted early Holocene water-logging and organic accumulation. Subsequently, the onset of floodplain peat development appears to be temporally divorced from this early organic sedimentation by c. 1-2000 years. However, this latter phase of floodplain development remains undated in absolute terms.

Over Quarry

Landscape Development

4.27 The Over Quarry has been the subject of extensive archaeological investigations which have taken place over the last 24 years. These have shown the intricacy of the human settlement pattern and of the reconstructed palaeoenvironment within the quarry site boundary.

4.28 The landscape is dominated by the activity of the River Ouse and its numerous associated channels. Together they form a delta-like landscape and delimit several 'gravel islands'. These constitute relatively dry areas where traces of human activity have been identified.

Recorded Sites

4.29 A search has been performed for registered and designated sites within a radius of 3 km from the centre of the quarry. Figure 4.2 below, shows the location of 16 designated Scheduled Ancient Monuments in relation to the excavation area. These are as follows:

- A moated site which is located at c. 90 m north-west of Moat House (Monument No: 33271; Grid Ref: TL370760) (labelled as 1 on Figure 4.2).
- Three bowl barrows which are located at c. 380 m south of Brownshill Staunch House (being part of the Over Round Barrow Cemetery) (Monument Number: 33362; Grid Ref: TL371722) (labelled as 2 on Figure 4.2).
- Five bowl barrows that are situated at c. 790 m north-west of Chain House (being part of the Over Round Barrow Cemetery) (Monument Number: 33360; Grid Ref: TL371718) (labelled as 3 on Figure 4.2).
- A bowl barrow that is situated at c. 450 m west of Shelford Farm (Monument Number: 33376; Grid Ref: TL399744) (labelled as 4 on Figure 4.2).
- Two bowl barrows which are located at c. 370 m and 505 m south of New England respectively (being part of the Haddenham Round Barrow Cemetery) (Monument Number: 33366; Grid Ref: 404744) (labelled as 5 on Figure 4.2).
- Three bowl barrows which are situated at c. 370 m and 505 m south of New England respectively (being part of the Haddenham Round Barrow Cemetery) (Monument Number: 33363; Grid Ref: 409749) (labelled as 6 on Figure 4.2).

4.30 Two SSSIs are also present within the study area. They comprise Berry Fen (ID: 1002793; Grid Ref: TL379744) and Ouse Washes (Units 12, 13, 15, 18-23) (Grid Ref: TL395753) (labelled as 7 and 8 respectively and denoted by the green areas in Figure 4.2).

4.31 With the exception of the SAMs and SSSIs highlighted above, there are a plethora of additional recorded historic environment assets (including structures, artefacts, ecofacts, etc.) that are situated within a 3 km radius of the quarry site.

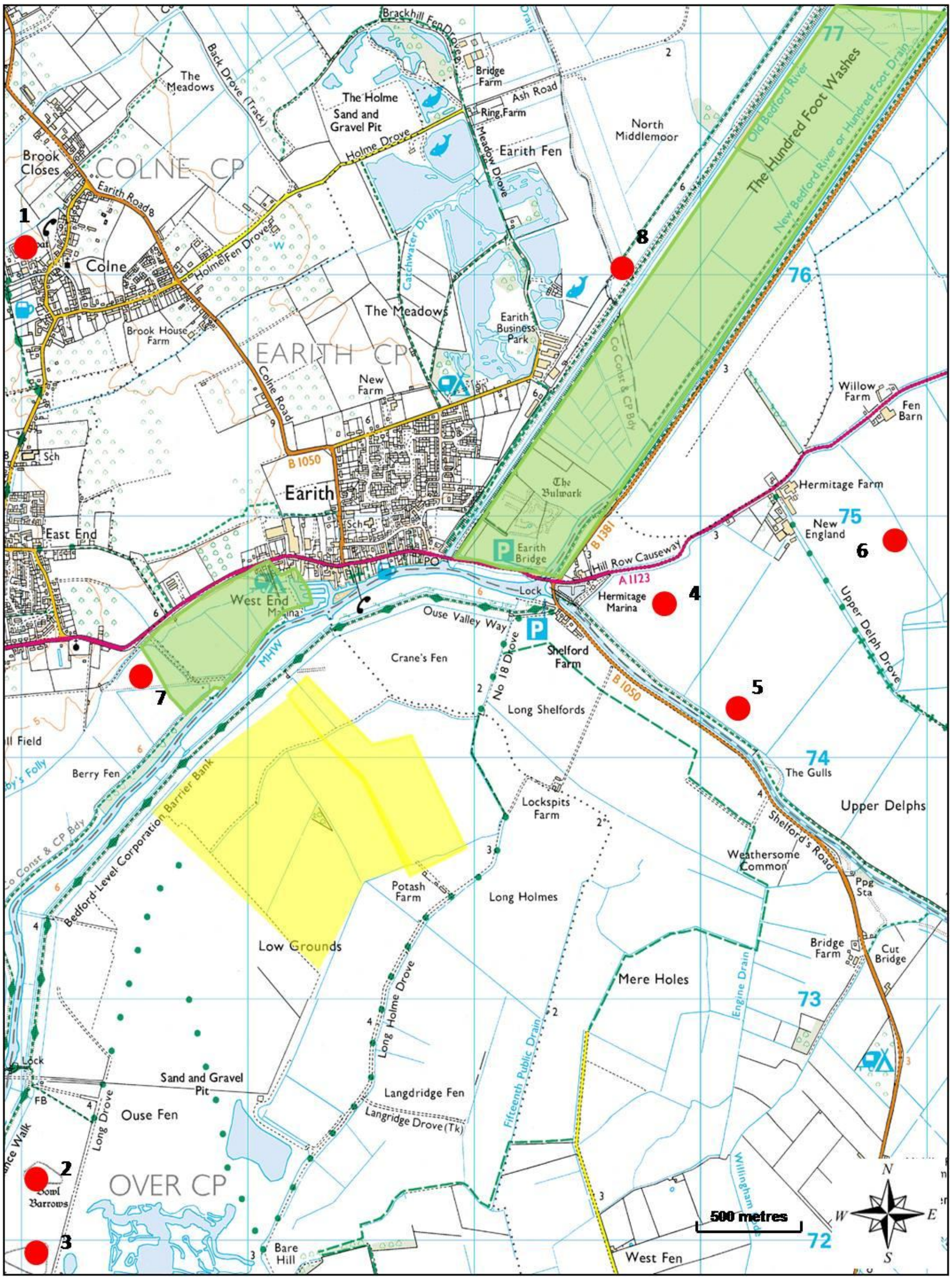

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Figure 4.2 Location of the SAMs and the SSSI units in relation to the study area.

Archaeological Sites

4.32 The recorded archaeology that lies within the extraction site includes artefactual material, sites and cropmark evidence which range in date from the Mesolithic to the Roman period. The most visual of these features are the two groups of Bronze Age barrow mounds that are located in the south-western and north-western parts of the study area; and an extensive zone of probable Iron Age / Romano-British cropmarks that are situated in the southern and south-eastern boundaries of the site.

4.33 Probably the most important archaeological site within the quarry boundary is located on the western end of the Goodwin Ridge and comprises a continuous archaeological sequence from the early Mesolithic to Roman times. Mesolithic (both early and late) and Iron Age remains are the most noticeably represented periods.

4.34 A major period of human activity was prevalent in the Bronze Age. This period is represented by a tight cluster of five barrows and a linear group of three barrows to the south of the study area. Further west, a large field system completes the Bronze Age landscape.

4.35 Freshwater peat growth subsequently subsumed this landscape in the later Bronze Age, followed by the aggradation of silty-clay alluvium in historic times.

Summary of Historic Environment Receptors

4.36 As has been previously discussed in Section 1, soil hydrology and hydrogeology (together with water quality) are the main environmental parameters affecting the preservation and conservation of many historic environment assets which are dependent upon surface (i.e. soil) and groundwater.

4.37 The effects of quarry dewatering and the associated radius of influence have been found to have a potentially detrimental impact upon water resources, surface water features, and many historic environment assets (including buried artefacts) and environmental designations that are dependent upon surface and / or groundwater, as a result of changes in saturation, aeration and / or water quality.

4.38 This chapter has detailed the historic environment assets that are located within the extraction boundaries of both quarry sites and their surrounding environs. Due to the proven archaeology (and in the case of Newington Quarry, additional palaeoenvironmental evidence) at both study sites, it is considered likely that further unrecorded archaeological / palaeoenvironmental remains lie ‘in situ’ within the sedimentary units which overlie the sand and gravel deposits.

4.39 In addition, many cultural heritage (Scheduled Ancient Monuments) and environmental (Sites of Special Scientific Interest) designations are located within the wider landscape settings of both quarry sites; the majority of which are dependent upon the water environment for their future survival.

4.40 Thus, in light of the above information, it is considered likely that the majority of these historic environment assets located within the surroundings of both case study sites may be impacted upon during the dewatering of the sand and gravel deposits. The degree to which these assets are implicated in the dewatering regime is largely dependent upon the spatial extent of the associated radius of influence at each site.

5. PROJECT MONITORING

5.1 This section of report outlines the methods used for the water environment monitoring of the study sites, the results obtained by employing these techniques and the interpretation of the data generated, both in terms of assessing the water environment system and the effect that these physico-chemical properties may have upon the preservation of historic environment assets that are located both within and surrounding each extraction site.

Methods

5.2 The methods undertaken during this project in order to assess the water environment at both case study sites comprised a combination of hydrological and hydrogeological monitoring, and water chemistry analysis. These techniques are outlined below.

Hydrological and Hydrogeological Monitoring

5.3 Hydrological monitoring was undertaken by the installation of 1 m, 2 m and 3 m long PVC tubes (depending upon the depth of the soil) into the superficial sediment deposits. Attached to the buried end of the tube was a piezometer tip of 300 mm length, consisting of a perforated PVC tube containing a filter membrane designed to prevent contamination from surrounding sediment (as shown in Figure 5.1 below).

5.4 The piezometers were located in a grid formation (as denoted by the red dots in Figures 5.2 and 5.3 below) and were cored into place using a hand auger with a 30 mm diameter screw tip.

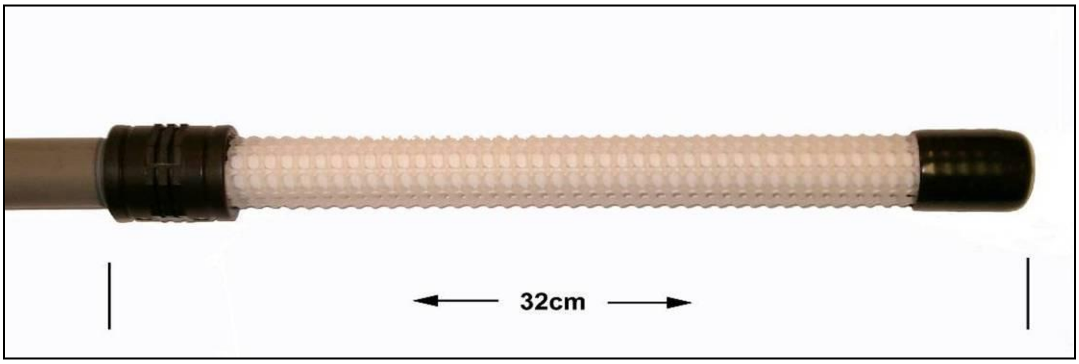

Figure 5.1Piezometer tip: white area is 32 cm in length and is a perforated PVC tube with plastic membrane lining, designed to allow water infiltration and restrict sedimentation.

5.5 The generation of groundwater monitoring data comprised data acquisition from a number of (previously installed) company boreholes which are located within the boundary of the study sites (as denoted by the black dots in Figure 5.2 and 5.3 below). The top of the boreholes were located at 0.50 m above the ground surface.

5.6 Hydrological data was recovered through the monitoring of c. sixty-five piezometer points established within a 1 km radius of the study site (if the location of each quarry site within the surrounding landscape permitted this), and sunk to the base of the sediment.

5.7 The top of the piezometers were located at 0.30 m above the ground surface and at depths of 1 m, 2 m and 3 m, depending upon the thickness of the sediment. These depths were used to pinpoint perched or connected waters and compare with the sand and gravel water levels in order to identify hydraulic connectivity between the shallow sediments and the deeper deposits. The grid was designed to enable a hydrological assessment of the each study site and target the identification of any potential zone of dewatering influence in the sediments away from the extraction areas.

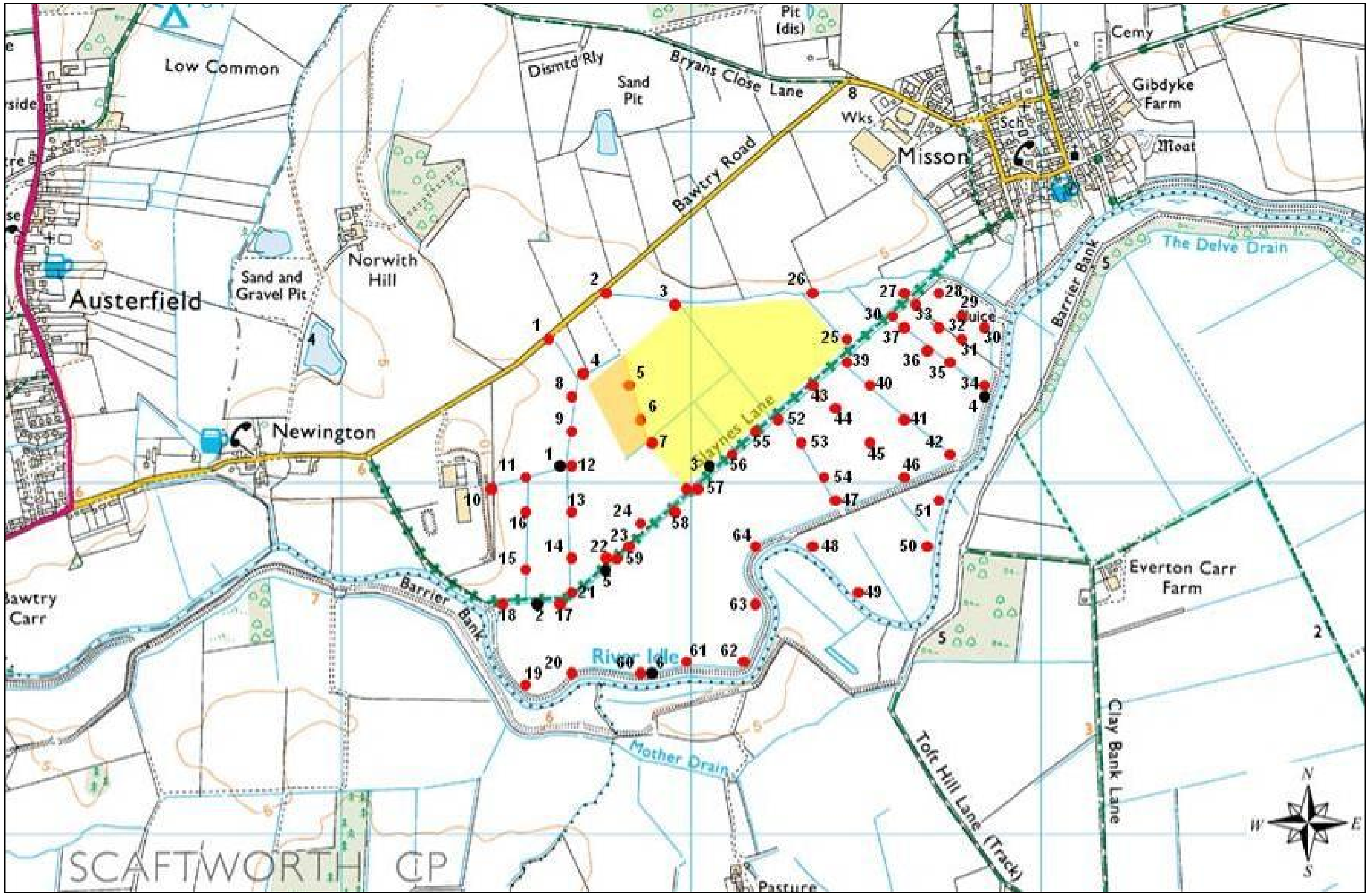

Figure 5.2 Newington monitoring network.

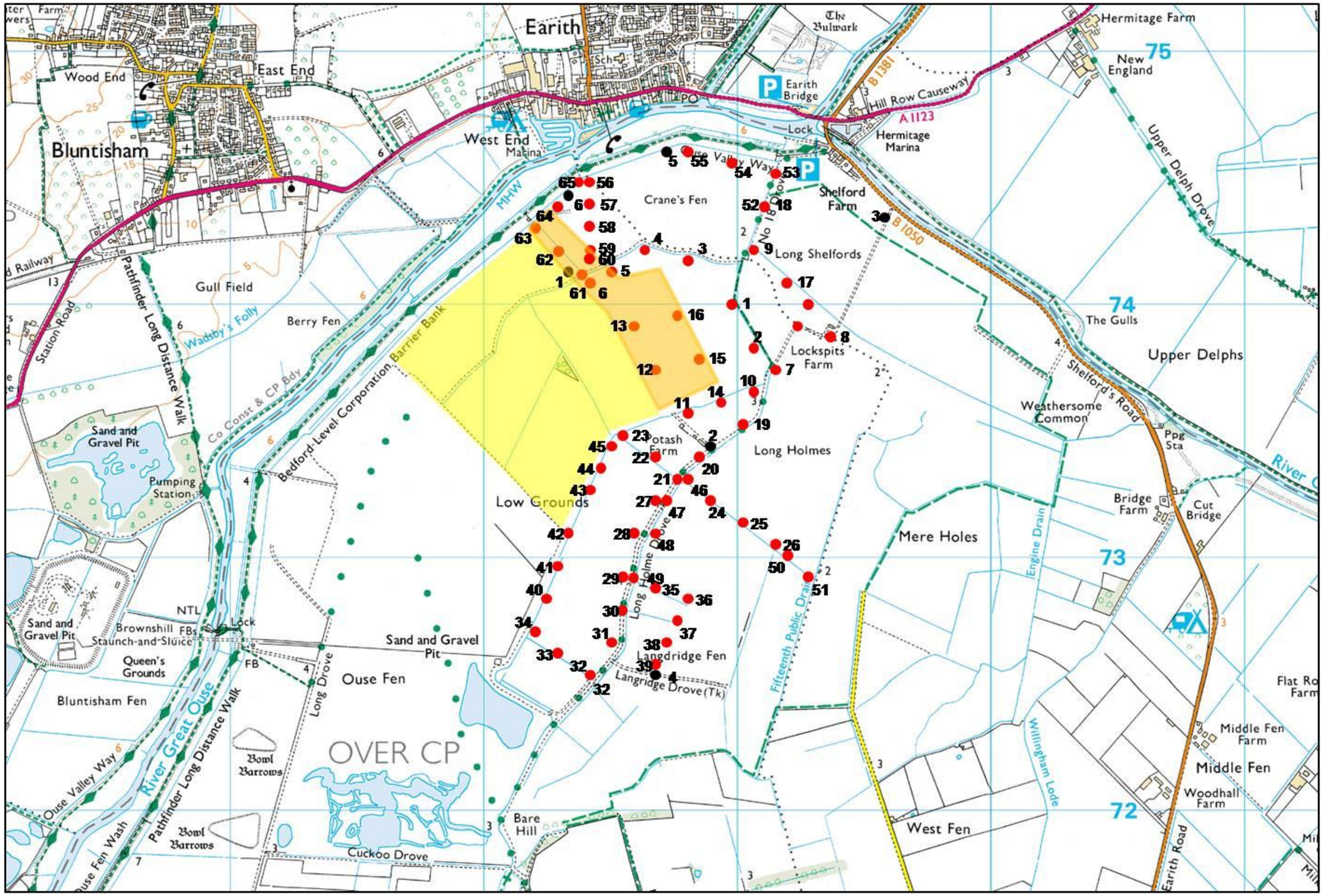

Figure 5.3 Over monitoring network.

5.8 A dip meter was used to measure water levels in both the boreholes and piezometers. This device consisted of an electrical sensor at the end of a plastic tape measure. The sensor was lowered into the borehole / piezometer in order to take the readings. An audible alert sounded and an LED illuminated when the sensor met the water surface. Readings were systematically obtained for all boreholes / piezometers in the network for each visit. The results were recorded on a standard recording sheet.

5.9 The locations of the piezometers and boreholes were recorded using a Leica differential Global Positioning System (GPS). Accuracy using this equipment is in the region of ±0.02 m. Piezometer and borehole monitoring was undertaken on a monthly basis.

5.10 During field monitoring, the raw data generated from the piezometers and boreholes were recorded in the form of measurement depth (in metres) below the top of the piezometer / borehole, and later converted into metres Above Ordnance Datum (mAOD).

5.11 The observed depths of the surface / groundwater table in the piezometers / boreholes were measured by subtracting the height of the top of the piezometer / borehole above the ground surface from the observed depth of the water level.

5.12 Due to the ongoing extraction operations at both quarries, a number of piezometer points that were located in close proximity to the quarry working were destroyed during the period of monitoring. The piezometers that were destroyed during these operations are shown within the orange areas in Figures 5.2 and 5.3 above.

Water Chemistry Analysis

5.13 Water chemistry monitoring was undertaken in conjunction with the hydrological / hydrogeological dip rounds. A multi-parameter instrument measuring pH, oxygen redox potential (ORP) and temperature was used to test the water present in the piezometer tubes / boreholes.

5.14 Water samples were obtained by the insertion of a plastic bailer into the water within the piezometer tube. The samples were subsequently poured into the base of the multi-parameter unit, and pH, oxygen redox potential (ORP) and temperature readings were obtained following the manufacturer’s instructions. After each set of readings had been collected, the instrument was thoroughly rinsed with distilled water in order to reduce cross-contamination.

5.15 After each monitoring visit, the instrument was rinsed with the manufacturer’s cleaning solution. It was calibrated using the manufacturer’s recommended calibration solutions prior to each site visit in order to ensure accuracy in the readings obtained. All readings were recorded on a standard recording sheet.

6. RESULTS

6.1 This section of the report presents the results obtained by employing the techniques outlined in Section 5; and the interpretation of the data generated, both in terms of assessing the water environment system and the effect that these physico-chemical properties may have upon the preservation of historic environment assets that are located both within and surrounding each extraction site.

Newington Quarry

Hydrogeological Monitoring

6.2 Figure 6.1 below shows the water levels obtained from the hydrogeological monitoring of the sand and gravel boreholes located within close proximity to the extraction site (-see Figure 5.2 which displays all piezometer and borehole locations). The water levels associated with Boreholes 2 and 5 are not highlighted in Figure 6.1 as vandalism of these boreholes occurred within the first two months of the monitoring programme, hence preventing the collection of water data. Vandalism of Borehole 1 also took place in August 2010 which also prevented any further measurements being undertaken.

6.3 The water level data in Figure 6.1 indicates that water levels in Boreholes 1 and 3 are between 2.5 and 3.0 m depths, whilst the water levels in Boreholes 4 and 6 are between 0.8 and 2.0 m depths, throughout the duration of monitoring. Boreholes 1 and 3 are located within c. 200 m and immediately adjacent to the extraction site boundary, respectively. Boreholes 4 and 6 are situated adjacent to the River Idle, c. 500 m from the extraction site boundary.

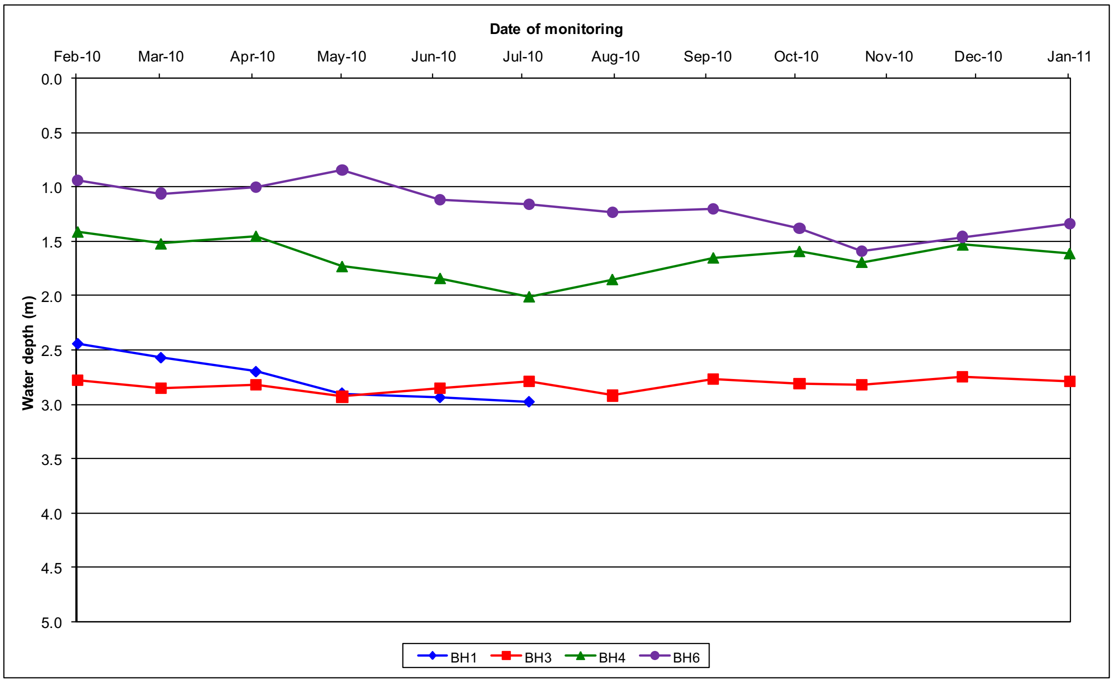

Figure 6.1 Groundwater depths obtained from sand and gravel monitoring wells over the duration of monitoring.

6.4 The results from the hydrogeological monitoring of the area surrounding the extraction site indicate that groundwater depths close to the quarry are generally 1 m lower than those measured further away (i.e. adjacent to the River Idle). This suggests that quarry dewatering may be impacting upon groundwater levels close to the extraction site and / or that seepage from the River Idle is recharging the sand and gravel aquifer in areas which are within close proximity to the river (-as highlighted in Figure 2.6).

Hydrological Monitoring

6.5 Figures 6.2 and 6.3 below present water level data obtained from a number of piezometers surrounding the extraction site over the duration of the monitoring programme. The water levels within these piezometers are representative of the water levels within the peat deposits across the entire site. Detailed hydrological data for each piezometer point is included in Appendix 1 for reference purposes.

6.6 Figure 6.2 shows water level data obtained from Piezometers 12, 34 and 60 over the duration of monitoring. Piezometer 12 is located at c. 200 m to the west of the extraction site boundary, and Piezometers 34 and 60 are situated at c. 300 and 500 m respectively to the east and south of the extraction site (adjacent to the River Idle) (-see Figure 5.2 which displays the locations of all the piezometers surrounding the quarry site).

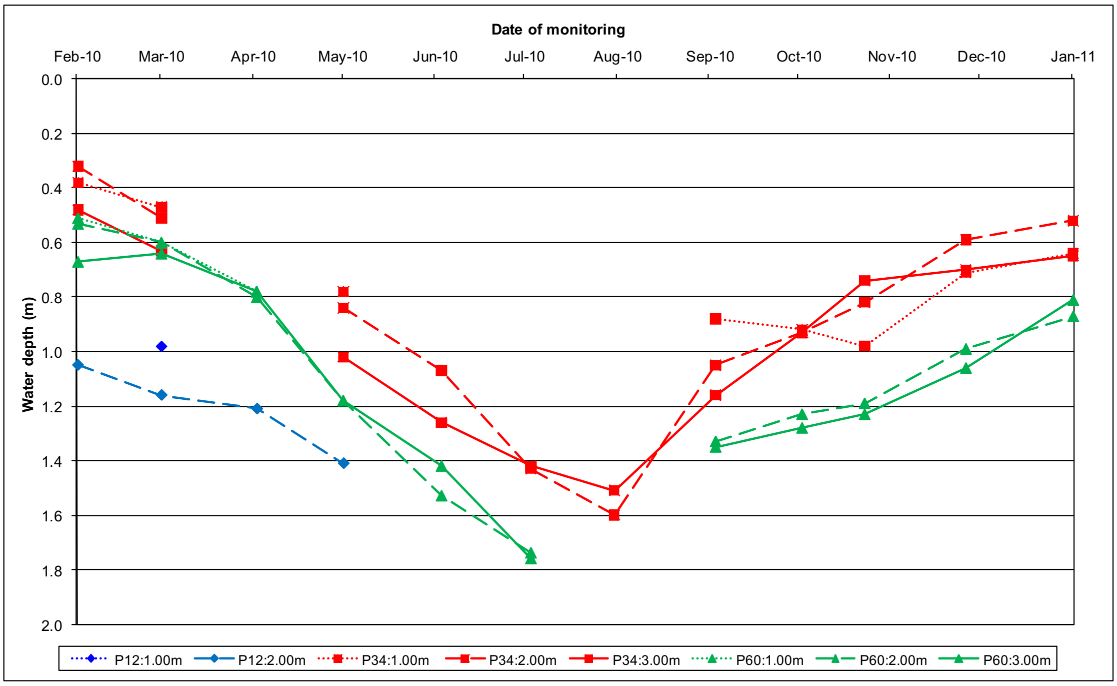

Figure 6.2 Water depths obtained from Piezometers 12, 34 and 60 over the duration of monitoring.

6.7 Throughout the duration of monitoring there is evidence for comparability between the different water level depths obtained from both Piezometers 34 and 60 (-the gap in data from Piezometer 12 prevents further assessment). This indicates that the water levels within the sediment at these locations are being mirrored at 1 m, 2 m and 3 m depths, and that synergy in response to hydraulic head is occurring (i.e. there is a significant relationship between water level pressure and the depth of the piezometer; with the water pressure greatest in the 1 m piezometer and lowest in the 3 m piezometer). These results indicate that the water levels at these locations are rainfall fed; as opposed to groundwater fed (i.e. the piezometer which is located at 3 m depth would produce a higher water level reading than the piezometer located at 1 m depth).

6.8 Water level data obtained from Piezometer 12 (1 m and 2 m depths) indicates that although water depths of between 1.1 and 1.5 m were recorded between February and May 2010, there was no water present in the surface sediment after May 2010, throughout the remainder of the monitoring programme.

6.9 Water level data collected from Piezometers 34 and 60 show a seasonal pattern in evidence over the duration of the monitoring programme. In the winter months water levels are between

0.3 and 0.7 m depth in Piezometer 34 and between 0.5 and 0.9 m depth in Piezometer 60; whilst in the spring and summer months there is a gradual increase in water level depth to between 1.1 and 1.6 m depth in Piezometer 34 and between 1.3 and 1.8 m depth in Piezometer 60. Due to the density of vegetation on site during July and August 2010 it was not possible to collect monitoring data from Piezometer 60. It is suggested that the water decline is purely rainfall related instead of associated with the dewatering of the sands and gravels, due to the fact that monthly anecdotal observations note the presence of an active pumping regime over the duration of the monitoring period.

6.10 Figure 6.3 shows surface water level data obtained from Piezometers 30, 47 and 59 over the duration of monitoring. Piezometer 30 is located c. 300 m to the east of the extraction site boundary, Piezometer 47 is situated c. 400 m to the south-east of the extraction site and Piezometer 59 is located c. 300 m to the south of the site (-see Figure 5.2). Throughout the duration of the monitoring programme water level data obtained from the three piezometers at 1 m, 2 m and 3 m depths generally indicate a similar pattern to that previously described above (i.e. that synergy in response to hydraulic head is occurring). This patterning suggests that the sediments at these locations are primarily rainwater fed.

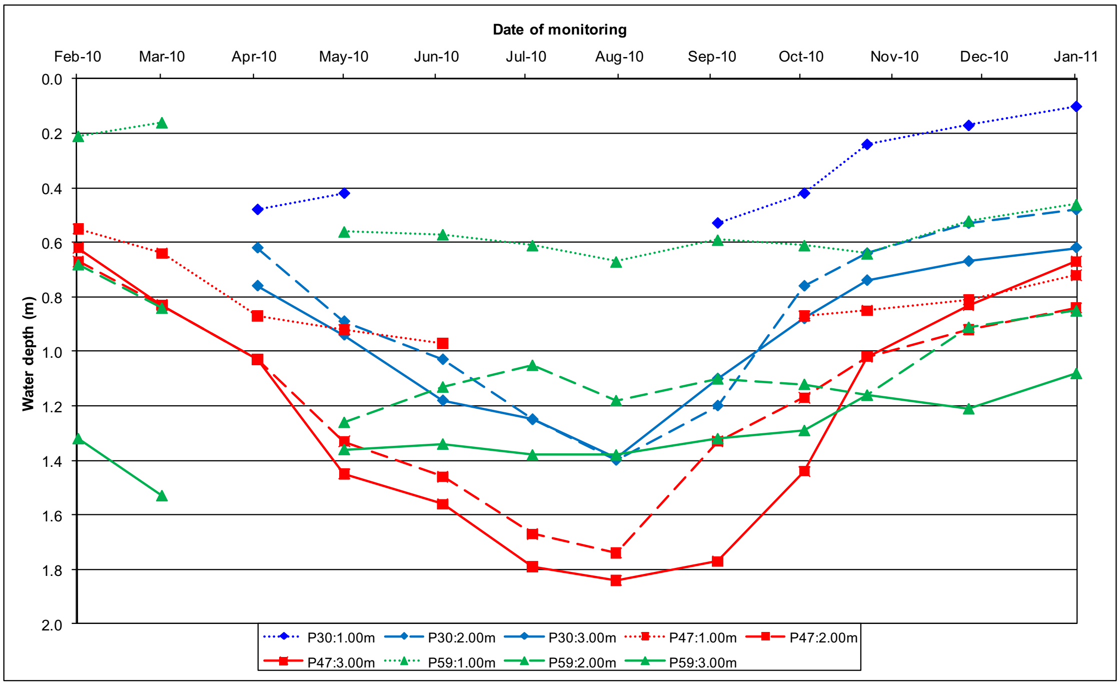

Figure 6.3 Water depths obtained from Piezometers 30, 47 and 59 over the duration of monitoring.

6.11 Water levels obtained from Piezometers 30 and 47 display a similar seasonal pattern to the water levels in Piezometers 34 and 60 (shown in Figure 6.2 above) over the duration of the monitoring programme. In the winter months water levels are between 0.1 and 0.7 m depth in Piezometer 30 and between 0.5 and 1.0 m depth in Piezometer 47; whilst in the spring and summer months there is a gradual increase in water level depth to between 0.4 and 1.2 m depth in Piezometer 30 and between 1.3 and 1.9 m depth in Piezometer 47.

6.12 Greater differences in hydraulic head are apparent between measurements obtained at 1 m and 2 m depths in Piezometer 30 than previous piezometers which may indicate changes in the nature / composition of the upper sediments.

6.13 Water levels obtained from Piezometer 59 do not display such a marked seasonal trend as shown in Piezometers 30 and 47. Water levels at 2 m and 3 m depths remain between 0.9

and 1.5 m below the ground surface throughout the duration of the monitoring programme. This patterning may be associated with the seepage of water from the adjacent Slaynes Lane drain that is located immediately to the north of the monitoring point. Anecdotal observations indicate that the water level within the drain remains consistent throughout the year, hence allowing the sediment at this location to be recharged.

Water Chemistry Analysis

6.14 Figures 6.4-6.6 below presents Oxygen Redox Potential (ORP), pH and temperature measurements obtained from a number of piezometers and Borehole 4, respectively. These piezometers / borehole are representative of the water chemistry values across the site. All water chemistry data for the piezometers / boreholes is included in the Appendix 1.

6.15 Previous investigations have defined ORP values of >+400 mV indicative of oxidised conditions, values between +100 to +400 mV are indicative of moderately reducing conditions, values between –100 to +100 mV highlight reduced conditions and values between –300 to –100 mV indicate reduced conditions.

6.16 The ORP values of Piezometers 34, 47, 59 and 60, and Borehole 4 (shown in Figure 6.4 below) displays a seasonal pattern throughout the duration of the monitoring programme (with the exception of the reading obtained from Piezometer 60 in April 2010). In general, during the winter months, ORP values obtained from Piezometers 34, 47, 59 and 60 indicate moderately reducing conditions, and during the summer months, ORP values are indicative of reduced conditions.

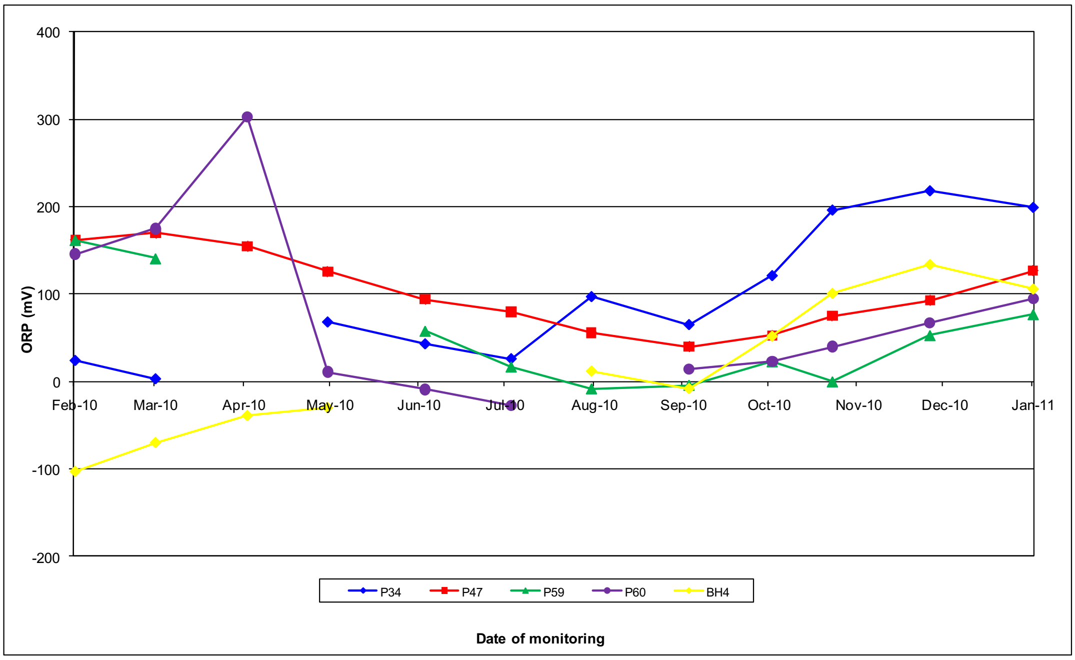

Figure 6.4 ORP values obtained from Piezometers 34, 47, 59 and 60, and Borehole 4 over the duration of monitoring.

6.17 The ORP values of Borehole 4 does not display the same seasonal pattern as the piezometers, with reduced conditions in evidence between February and November 2010 and moderately reducing conditions prevalent from December 2010 onwards.

6.18 The pH values of Piezometers 34, 47, 59 and 60, and Boreholes 4 and 6 (shown in Figure 6.5 below) all display a similar seasonal pattern (with the exception of Piezometer 59 in September 2010), with pH values obtained from the summer months higher than those collected during the spring months; these are, in turn, higher than the winter readings.

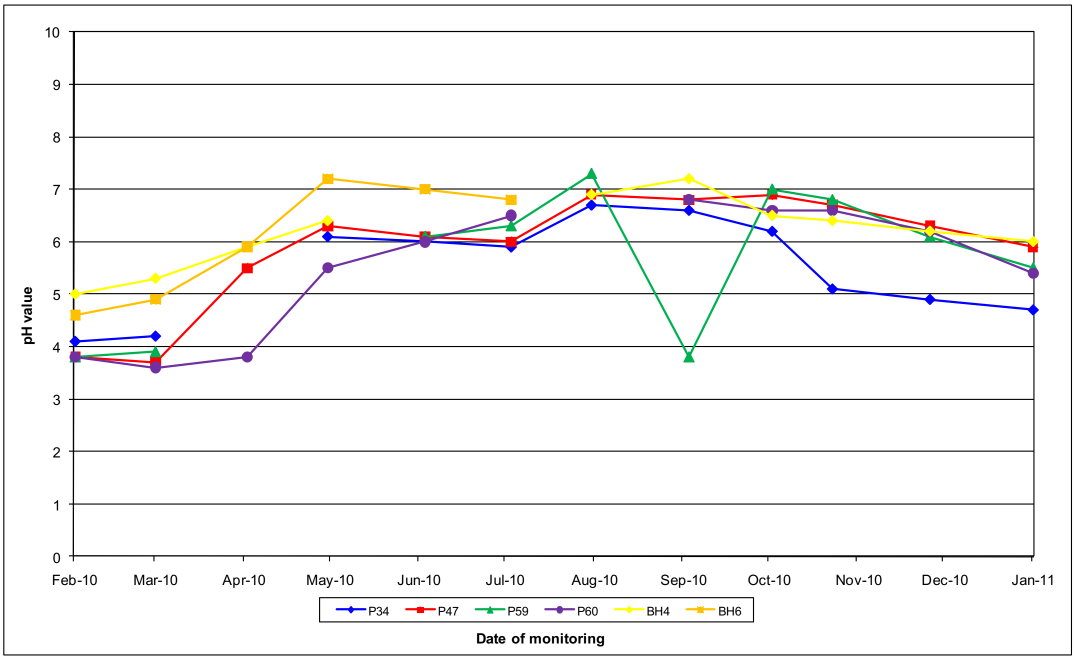

Figure 6.5 pH values obtained from Piezometers 34, 47, 59 and 60, and Borehole 4 over the duration of monitoring.

6.19 In general, pH values in the summer are between pH 6 and 7.2, values in the spring are between pH 3.5 and 6, and values in the winter are between pH 4.9 and 7. The pH values associated with each piezometer / borehole monitored throughout the duration of the study, on average, vary by c. 2 units between the spring (where pH readings are more acidic) and the summer (where pH values become more neutral).

6.20 The temperature values of Piezometers 34, 47, 59 and 60, and Boreholes 4 and 6 (shown in Figure 6.6 below) all display a seasonal pattern.

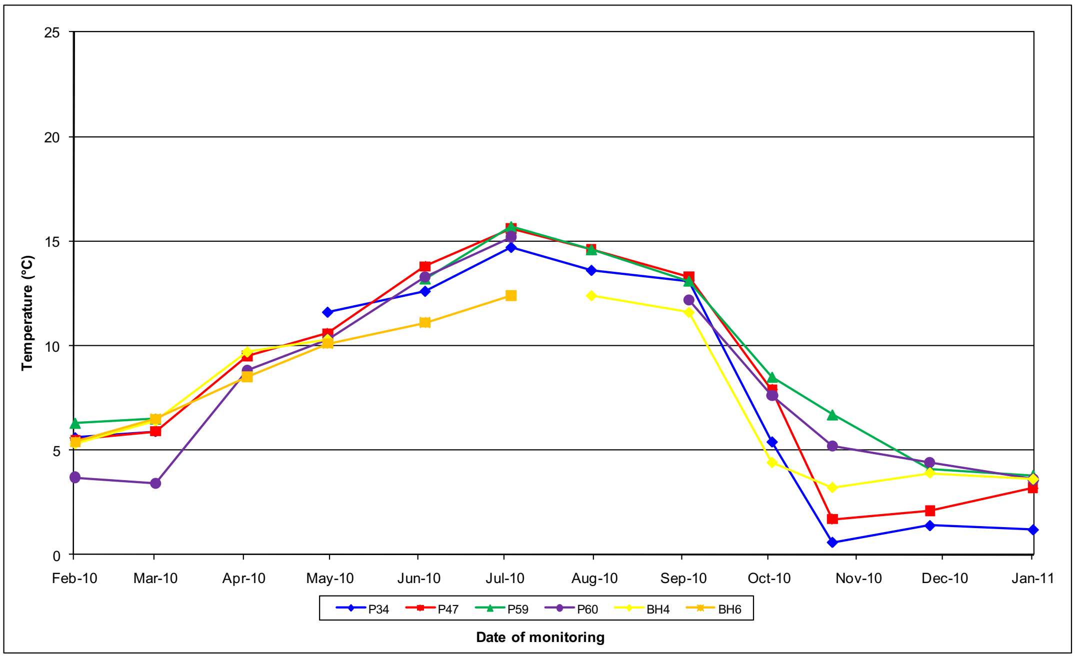

Figure 6.6 Temperature values obtained from Piezometers 34, 47, 59 and 60, and Borehole 4 over the duration of monitoring.

6.21 The results indicate that the temperature values obtained during the summer months are c. 10 °C higher (with values of between 12-16 °C) than in the winter months (displaying values of between (1-7 °C).

Discussion

6.22 The results from the hydrogeological / hydrological monitoring and water chemistry analysis of the area surrounding the quarry site have identified a number of important findings. These are discussed below, both in terms of assessing the water environment system and the effect that it may have upon the preservation of historic environment assets that are located both within and surrounding the extraction site.

6.23 The hydrogeological monitoring of the groundwater boreholes located within close proximity to the extraction site indicates that water depths close to the quarry are c. 1 m lower than those further away from the site (i.e. adjacent to the River Idle). This result suggests that either quarry dewatering is reducing groundwater levels in areas that are located within close proximity to the extraction site (e.g. within c. 200 m) and / or that water seepage from the River Idle is recharging the sand and gravels in areas that are within close proximity to the river.

6.24 The results of the hydrological monitoring of the piezometers suggest that water levels in the surface sediments are rainfall fed; as opposed to groundwater fed. As such, this water table is separated off from the underlying groundwater table for the majority of the year. In addition, water levels within the majority of the surface peat deposits are deep for most of the year (with the exception of water recharge from the Slaynes Lane drainage ditch [and its associated tributaries] and percolation through the profile by rainfall).

6.25 Water chemistry analysis (ORP, pH and temperature) of the piezometers / boreholes indicate that seasonal patterning is in evidence over the duration of the monitoring period. In general, across the study area, ORP values indicate moderately reducing conditions, pH values are between 4.9 -7 and temperature values are between 1-7 °C during the winter months; whilst ORP values are indicative of reduced conditions, pH values are between 6-7.2 and temperature values are between 12-16 °C during the summer months.

6.26 In light of the findings presented above, although the reducing potential of the water present within the surface peat deposits indicates good conditions for the preservation of archaeological and environmental organic material within the study area, fluctuations in the height of the water table (of nearly 1 m in peat deposits) between the summer and the winter months can severely decrease the environmental stasis of the burial environment by increasing the oxidising nature of the peat; thereby significantly reducing its in situ preservation potential.

Over Quarry

Hydrogeological Monitoring

6.27 Figure 6.7 below shows the water depths obtained from the hydrogeological monitoring of the groundwater boreholes located within close proximity of the extraction site (see Figure 5.3). Borehole 1 was destroyed during the extraction operations in May 2010, and as a consequence, no water level data is available after this date.

6.28 The water level data displayed in Figure 6.7 indicates that water levels in Borehole 1 between February 2010 (3.5 m depth) and May 2010 (4 m depth) increased in depth by 0.5 m, as the extraction operations moved in a north-easterly direction (i.e. towards the borehole). This suggests that increased water drawdown associated with the movement of extraction operations was in evidence at this location.

6.29 Water levels at Borehole 3 remain consistent throughout the duration of the monitoring programme (i.e. between 0.75 and 1.2 m depths). In respect of the 6 boreholes monitored, Borehole 3 was located the furthest distance away from the limit of both previous and current extraction operations.

6.30 The water level data obtained from Boreholes 5 and 6 show a gradual increase in depth over the duration of the monitoring programme; with Borehole 6 showing a more marked increase. Water levels at Borehole 5 increase in depth from 1.7 m in February 2010 to 3.0 m depth in January 2011; whilst water levels at Borehole 6 increase from 1.7 m depth in February 2010 to 3.7 m in January 2011. Both boreholes are located to the north-east of the extraction site boundary and along the south-side of the River Great Ouse (with Borehole 6 being situated the furthest away out of the two boreholes from extraction operations). This suggests that the movement of extraction operations in a north-easterly direction promotes a lowering of water levels up to 500 m beyond the quarry face.

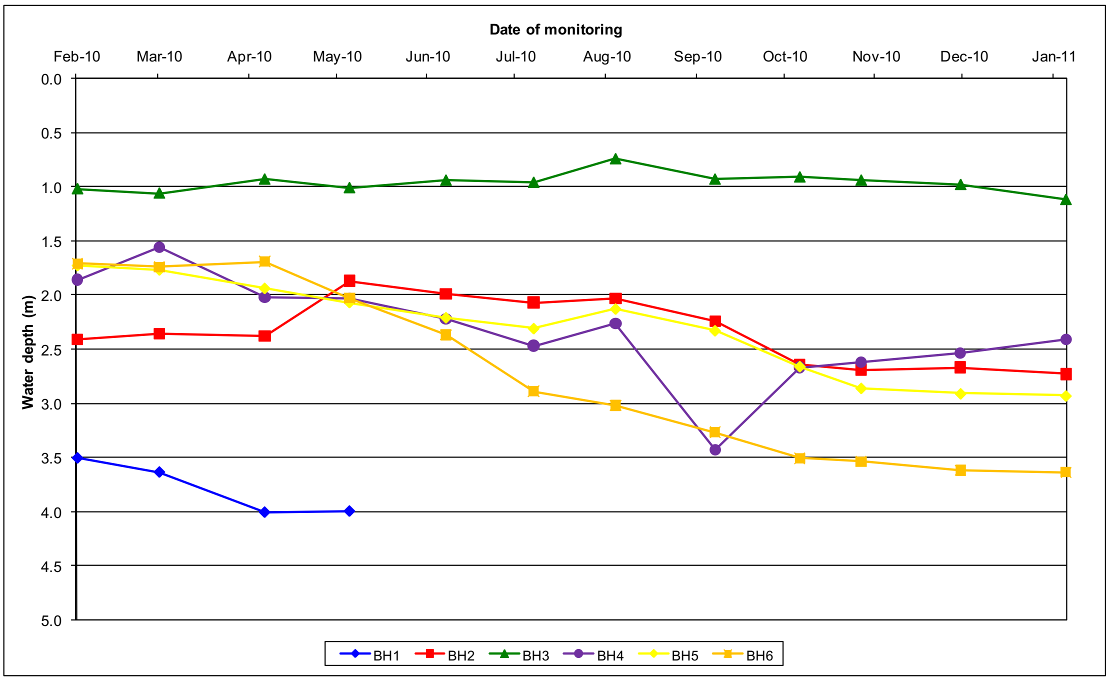

Figure 6.7 Groundwater depths obtained from Boreholes 1-6 over the duration of monitoring.

6.31 Water level depths collected from Borehole 2 also show a similar patterning to Boreholes 5 and 6, albeit with a less marked increase in depth over the duration of the monitoring programme (with the exception of those readings collected between February and April 2010).

6.32 Contrary to the water level data from Boreholes 1, 2, 3, 5 and 6 (above), water levels obtained from Borehole 4 do not show a clear pattern over the duration of the monitoring programme. Water levels range from 1.5 m depth in March 2010 to 3.5 m depth in September 2010. It is suggested that due to the location of the borehole being approximately the same distance from the Fifteenth Public Drain located to the east and the area of previous extraction operations to the west (where water levels are still managed), the hydrogeology of the area surrounding Borehole 4 may be influenced by each factor at different times during the year.

Hydrological Monitoring

6.33 Figure 6.8 below presents surface water level data obtained from a number of piezometers surrounding the extraction site boundary over the duration of the monitoring programme. These piezometers represent a small number of points where water levels can be measured; in the majority of cases however, no water is present within the surface sediments across the study area (see Appendix 2 for all piezometer and borehole monitoring data). The water level data displayed has been measured from piezometers that are located within close proximity to drainage ditches; thus indicating that recharge of the sediment from ditch water may be apparent.

6.34 In general, the piezometers shown in Figure 6.8 indicate seasonal patterning, with water depths increasing in the summer months and decreasing in the winter months. Water level measurements from the majority of the piezometers are below 1.0 m depth (with the exception of Piezometers 45 and 55 [1 m depths]). This pattern is common throughout the study area.

6.35 Only the limited water level data obtained at the start of the monitoring programme from Piezometer 55 suggests that synergy in response to hydraulic head is occurring (i.e. the sediment at this location is predominantly rainwater fed). The lack of water above 1 m depth across the site and the depth of sediments limiting the installation of deeper piezometers (i.e. 3 m) prevents a more detailed analysis of hydraulic head being undertaken across the site.

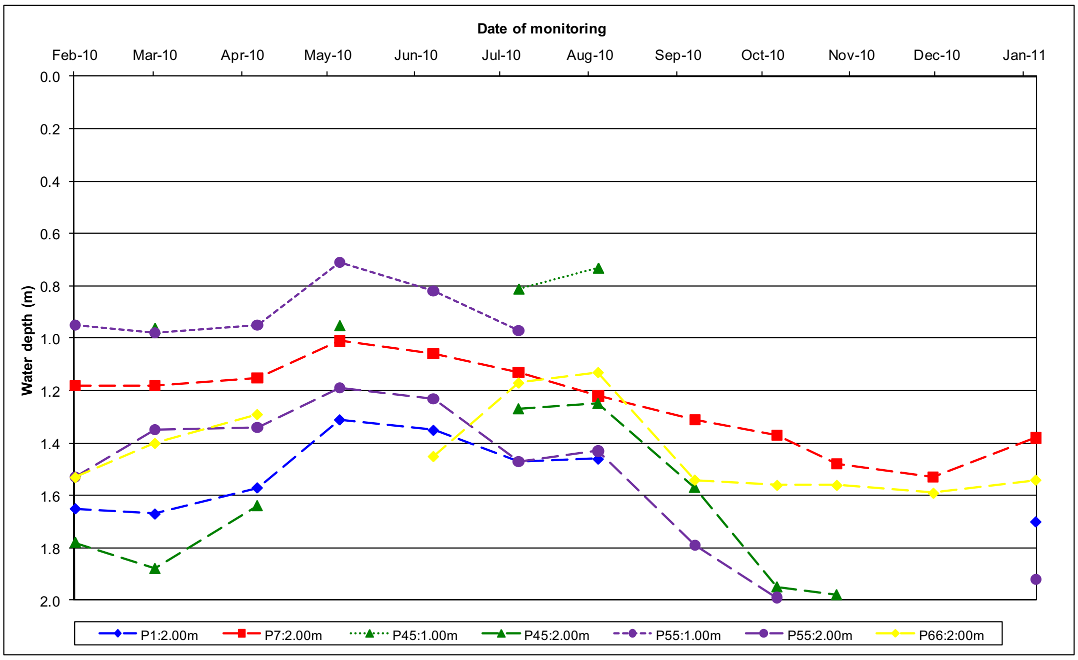

Figure 6.8 Surface water depths obtained from Piezometers 1, 7, 45, 55 and 66 over the duration of monitoring.

6.36 Although it has been highlighted above that water depths obtained from the 2 m piezometers shown in Figure 6.8 (above) display a seasonal pattern, individual piezometers display different water levels across the study area (i.e. the water level measurements collected from Piezometers 1, 45 and 55 are generally of greater depth than the water levels obtained from Piezometer 66, which are in turn, of greater depth than the levels obtained from Piezometer 7).

6.37 In addition, water measurements obtained from Piezometers 1, 45 and 55 indicate that levels had increased below 2 m depth during the autumn; with water levels measurements only being recorded again in Piezometers 1 and 45 at the end of the monitoring period. It is suggested that the differences in water depths are associated with water present in the adjacent drainage ditches; these are controlled by an extensive water management system within the Fens (as outlined in Section 3.33).

Water Chemistry Analysis

6.38 Figures 6.9-6.11 below present Oxygen Redox Potential (ORP), pH and temperature measurements obtained from a number of piezometer points and Borehole 3 that surround the extraction site boundary over the duration of the monitoring programme. These points are representative of the water chemistry values across the entire site. Detailed water chemistry data for each piezometer / borehole is included in the Appendix 2.

6.39 In general, the ORP values obtained from Piezometers 1, 7, 45, 55 and 66, and Borehole 3 (shown in Figure 6.9 below) indicate moderately reducing conditions during the spring (+100 to +400 mV); whilst during the summer months, ORP values are indicative of reduced conditions (–100 to +100 mV). The only exceptions to this pattern are the readings collected from Piezometer 45 and Borehole 3 where moderately reducing conditions prevailed throughout the spring and summer.

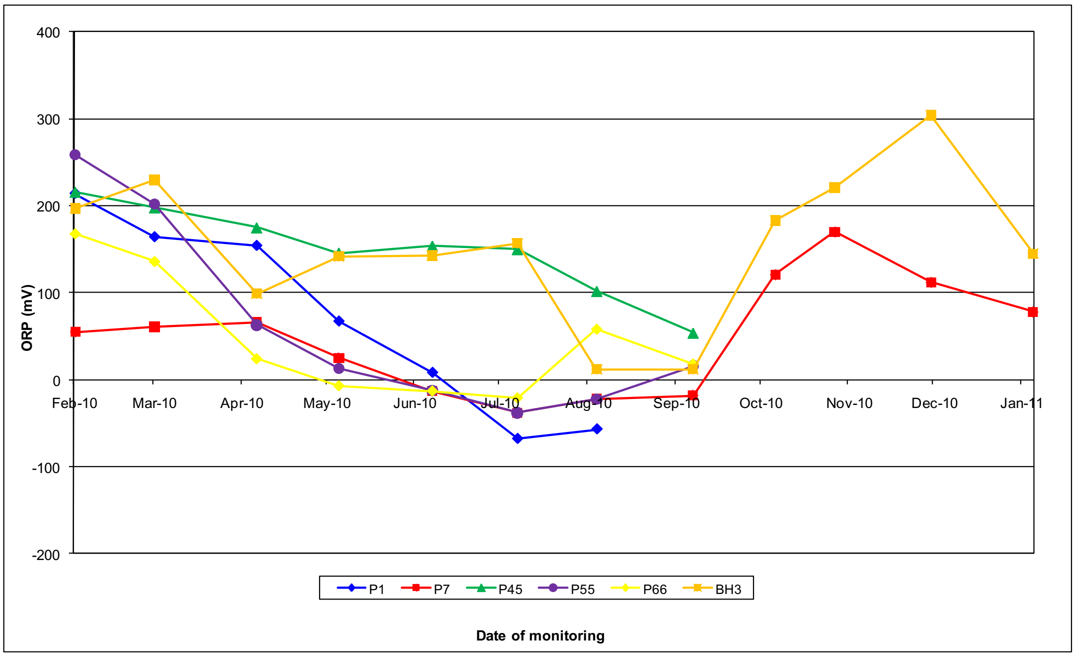

Figure 6.9 ORP values obtained from Piezometers 1, 7, 45, 55 and 66, and Borehole 3 over the duration of monitoring.

6.40 ORP measurements were not collected from Piezometers 1, 45, 55 and 66 after September 2010 due to the lack of water available for sampling and assessment purposes. Thus, it is not possible to infer whether the ORP values obtained during the first 8 months of the monitoring programme reflect a seasonal pattern.

6.41 The majority of the ORP values collected from Piezometer 7 over the duration of the monitoring programme are indicative of reducing conditions throughout the year; with the exception of the autumn months where moderately reducing conditions are in evidence.

6.42 The ORP values obtained from Borehole 3 over the duration of monitoring indicate that moderately reducing conditions are in evidence throughout the majority of the year; albeit with the exception of late-summer, where reduced conditions prevail.

6.43 In general, the pH values of Piezometers 1, 7, 45, 55 and 66, and Borehole 3 (shown in Figure 6.10 below) all display a similar pattern throughout the duration of the monitoring programme. During the first 2 months of monitoring, pH values varied by 4 pH units; with acidic water present in Piezometer 45 (pH 5.3-5.4), near neutral conditions present in the water collected from Piezometers 1, 7 and 55 (pH 6.6-7.2) and slightly alkaline water present in Piezometer 66 and Borehole 3 (pH 7.5-9.3).

6.44 Between April and June 2010, pH values obtained from Piezometers 1, 7, 45, 55 and 66, and Borehole 3 converged, with pH readings obtained in June 2010 remaining similar between pH 7 and 7.5. This pattern continues until December 2010 (-the lack of water on site after September 2010 prevented pH readings being collected from Piezometers 1, 7, 55 and 66 up until the end of the monitoring programme); with the exception of the last pH values obtained from Borehole 3 which show an increase in the alkalinity of the water to pH 8.2.

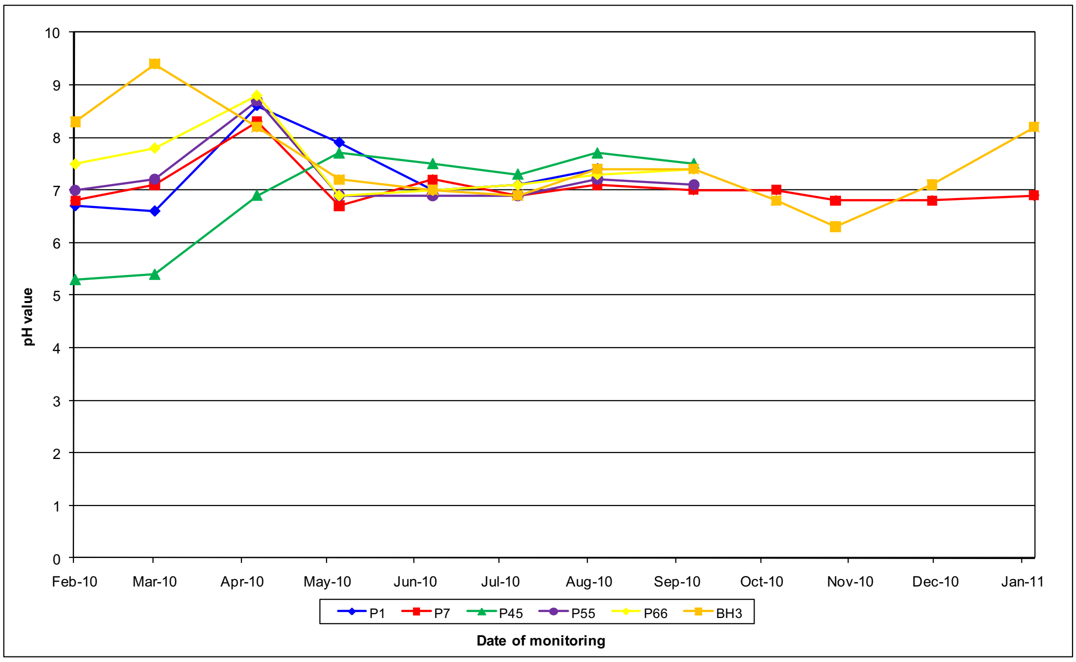

Figure 6.10 pH values obtained from Piezometers 1, 7, 45, 55 and 66, and Borehole 3 over the duration of monitoring.

6.45 The temperature values of Piezometers 1, 7, 45, 55 and 66, and Borehole 3 (shown in Figure 6.11 below) all display a seasonal pattern. Temperature values obtained during the summer months are c. 10-15 °C higher (with values of between 13-23 °C) than in the winter months (displaying values of between 5-7 °C). An exception to this trend is the temperature measurements collected during July and August 2010 at Piezometer 66, where readings were similar to those in the winter months.

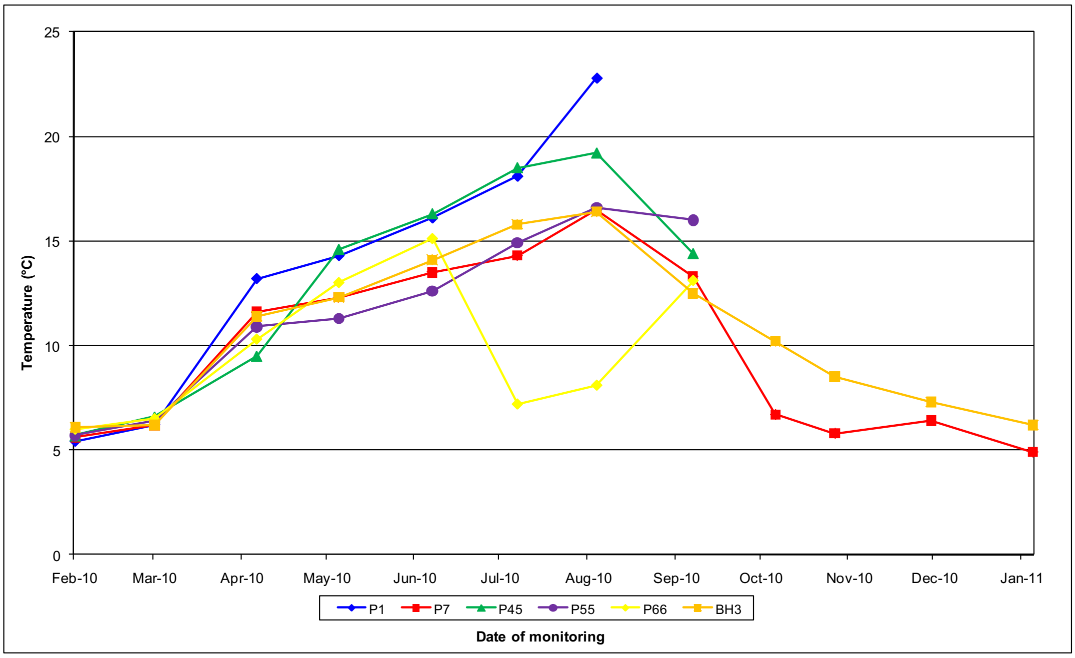

Figure 6.11 Temperature values obtained from Piezometers 1, 7, 45, 55 and 66, and Borehole 3 over the duration of monitoring.

Discussion

6.46 The results from the hydrogeological / hydrological monitoring and water chemistry analysis of the Over Quarry study area have identified a number of important findings which are discussed below.

6.47 The hydrogeological monitoring of the groundwater boreholes indicates that water levels increase in depth towards the extraction area. The water level data in Borehole 1 increases in depth by 0.5 m between February and May 2010, as the extraction operations moved in a north-easterly direction (i.e. towards the borehole). Water levels obtained in Boreholes 5 and 6 also show a gradual increase in depth over the duration of the monitoring programme; with Borehole 6 showing a more marked increase.

6.48 Contrary to the above, water level depths at Borehole 3 remain consistently less than those at Boreholes 1, 2, 5 and 6 throughout the duration of the monitoring programme. Borehole 3 was located the furthest distance away from the limit of both previous and current extraction operations.

6.49 In light of the information provided above, it is suggested that the movement of extraction operations in a north-easterly direction promotes a lowering of water levels up to c. 500 m beyond the quarry face within this part of the study area. However, the lowering of water levels seems to be less marked to the east (Borehole 2) than to the north-east of the current extraction operations (Boreholes 5 and 6).

6.50 The results of the hydrological monitoring of the surface water piezometers suggest that water levels in the surface sediments are low for most of the year; and that the only areas where water is present throughout the duration of the monitoring programme are those in close proximity to drainage ditches (anecdotal observations of which indicate that water levels remain relatively constant throughout the year). Water recharge of the sediments near to drainage ditches and (some) percolation through the sediment profile from rainfall are the primary potential sources of water inputs into the local system.

6.51 ORP and temperature analysis of the piezometers / borehole indicate that seasonal patterning is in evidence over the duration of the monitoring period. In general, across the study area, ORP values indicate moderately reducing conditions with temperature values between 5-7 °C during the winter months; whilst ORP values are indicative of reduced conditions and temperature values between 13-23 °C during the summer months.

6.52 In general, pH values collected from the piezometers / boreholes do not display a seasonal pattern. However, the lack of data after October 2010 limits further interpretation. Prior to October, the pH readings collected indicate a convergence of pH values to near neutral conditions which takes place over the first 5 months of monitoring.

6.53 Thus, although the findings shown above indicate that there is little water present within the study area throughout the duration of the monitoring programme (with the exception of sediments located in close proximity to drainage ditches), this lack of water may enable the stable burial conditions to be created, which can, in turn, promote the in situ preservation potential of these sediments (and therefore any archaeo-environmental material contained within).

7. CONCLUSIONS

7.1 This report has assessed the location and planning background (Section 2), and the geological, hydrological and hydrogeological settings (Section 3), of two contrasting sand and gravel quarry sites and their surrounding environs - Newington Quarry being located at 2 km to the east of the town of Bawtry, Nottinghamshire and Over Quarry situated in the Fens, 0.5 km south of Earith, Cambridgeshire.

7.2 Both quarry sites were assessed on the basis of two key criteria:

- The quarries contain a proven historic environment resource (including undesignated archaeological / palaeoenvironmental assets, and designated environmental and cultural heritage features), both within their planning application boundaries and in the surrounding environment; and
- The local and wider catchment area of the quarry sites have been the subject of (some) water environment monitoring in recent years (the results of which have been incorporated into this report).

7.3 An overview of historic environment assets, both at the study sites and in their surrounding environs, has been presented in Section 4, with particular features that may be considered as potential receptors to changes in the water environment discussed therein.

7.4 A water environment monitoring strategy was employed at both case study sites in order to assess the water environment system (from a hydrological, hydrogeological and water quality perspective) and the effect that these physico-chemical properties may have upon the preservation of those historic environment assets located both within and surrounding the extraction areas (Section 5). The results of which have been discussed in Section 6.

Summary of Key Findings

7.5 As has been previously discussed, soil hydrology, hydrogeology and water quality are the main environmental parameters affecting the preservation and conservation of many historic environment assets which are dependent upon surface (i.e. soil) and groundwater.

7.6 The effects of quarry dewatering and the associated rate and extent of water drawdown have been found to have a potentially detrimental impact upon many historic environment assets (including archaeological / palaeoenvironmental remains) and environmental designations that are dependent upon surface and / or groundwater, as a result of changes in saturation, aeration and / or water quality.

7.7 Both Newington and Over case study sites contain proven archaeology (and in the case of Newington Quarry, additional palaeoenvironmental evidence). As such, it is considered likely that additional unrecorded archaeological / palaeoenvironmental remains lie ‘in situ’ within the sedimentary units which overlie the sand and gravel deposits.

7.8 Furthermore, many cultural heritage (Scheduled Ancient Monuments) and environmental (Sites of Special Scientific Interest) designations are located within the wider landscape settings of both quarry sites; the majority of which are dependent upon the water environment for their future survival.

7.9 Therefore, in light of the above information, it is suggested that the majority of both undesignated and designated historic environment assets located within the surface sediments surrounding both case study sites may be impacted upon during the dewatering of the underlying sand and gravel deposits. However, the degree to which these assets are implicated in the dewatering regime is largely dependent upon the spatial extent of the associated radius of influence at each site.

Newington Quarry

7.10 The hydrogeological monitoring of the groundwater boreholes located within close proximity to Newington Quarry indicates that water depths close to the extraction site are approximately 1 m lower than those further away from the quarry (i.e. adjacent to the River Idle); indicating that either quarry dewatering is reducing groundwater levels in areas which are located within close proximity to the extraction site (e.g. within approximately 200 m) and / or that water seepage from the River Idle is recharging the sand and gravels in areas that are in close proximity to the river.

7.11 The results of the hydrological monitoring of the surface peats suggest that water levels are rainfall fed; as opposed to groundwater fed. As such, this surface water table is separated off from the underlying groundwater table for the majority of the year. In addition, water levels within the majority of the surface peat deposits are at depth for most of the year (with the exception of water recharge from the Slaynes Lane drainage ditch [and its associated tributaries] and percolation through the profile by rainfall).

7.12 Thus, in light of the above information, although the reducing potential of the water present within the surface peat deposits indicates good conditions for the preservation of archaeological and environmental organic material within the study area, fluctuations in the height of the water table within the peats (of approximately 1 m) between the summer and the winter months can severely decrease the environmental stasis of the burial environment, thus increasing the oxidising nature of the peat and thereby significantly reducing its in situ preservation potential.

Over Quarry

7.13 The hydrogeological monitoring of the groundwater boreholes located in close proximity to Over Quarry indicates that water levels increase with depth towards extraction site. As extraction operations move in a north-easterly direction, water levels obtained in this area show an increase in depth over the duration of the monitoring programme. This promotes a lowering of water levels up to approximately 500 m beyond the quarry face within this part of the study area.

7.14 The results of the hydrological monitoring of the surface sediments suggest that water levels are low for most of the year; and that the only areas where water is present throughout the duration of the monitoring programme are those in close proximity to drainage ditches. Water recharge of the sediments near to the drainage ditches and (some) percolation through the sediment profile from rainfall are the primary potential sources of water inputs.

7.15 Therefore, although the findings presented above indicate that there is little surface sediment water within the study area throughout the duration of the monitoring programme (with the exception of sediments located in close proximity to drainage ditches), this lack of water may enable stable burial conditions to be created, which can, in turn, promote the in situ preservation potential of these sediments (and therefore any archaeo-environmental material contained within).

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APPENDIX 1:
NEWINGTON QUARRY WATER ENVIRONMENT DATA

Groundwater level data from boreholes

Borehole number		1	3	4	6
National Grid Reference (SK)		67648	68060	66838	67844
		94054	94041	94257	93460
Ground level (mAOD)		8.50	5.50	5.29	3.50
Date of measurement					
23-Feb-10	mbgl	2.44	2.78	1.41	0.94
	mAOD	6.06	2.72	3.88	2.56
23-Mar-10	mbgl	2.57	2.85	1.52	1.06
	mAOD	5.93	2.65	3.77	2.44
26-Apr-10	mbgl	2.70	2.82	1.45	1.00
	mAOD	5.9	2.68	3.84	2.50
25-May-10	mbgl	2.90	2.93	1.73	0.84
	mAOD	5.7	2.57	3.56	2.66
27-Jun-10	mbgl	2.94	2.85	1.84	1.12
	maOD	5.56	2.65	3.45	2.38
27-Jul-10	mbgl	2.98	2.79	2.01	1.16
	mAOD	5.52	2.71	3.28	2.34
24-Aug-10	mbgl	DbEO	2.92	1.85	1.23
	mAOD		2.58	3.44	2.27
27-Sep-10	mbgl		2.77	1.65	1.20
	mAOD		2.78	3.64	2.30
26-Oct-10	mbgl		2.81	1.59	1.38
	mAOD		2.19	3.70	2.12
16-Nov-10	mbgl		2.82	1.69	1.59
	mAOD		2.70	3.60	1.91
20-Dec-10	mbgl		2.75	1.53	1.46
	mAOD		2.75	3.76	2.04
25-Jan-11	mbgl		2.79	1.61	1.34
	mAOD		2.21	3.68	2.16
DbEO - Destroyed by extraction operations					

Please note - Borehole 1 was destroyed by extraction operations, and Boreholes 2 and 5 were vandalised prior to the first monitoring visit*

Water level data from 1 m piezometers

Piezometer number		1	2	3	4	5	6	7	8	9	10	11
National Grid Reference (SK)		67648	67747	67909	67789	67713	67820	67814	67658	67666	67457	67538
		94445	94535	94524	94384	94323	94311	94170	94135	94203	93999	94022
Base of piezometer (mbgl)		0.40	0.40	1.00	0.40	0.90	1.00	1.00	0.40	1.00	0.75	0.90
Ground level (mAOD)		8.30	8.30	7.30	7.52	8.30	7.30	7.30	8.30	8.30	10.16	9.30
Date of measurement												
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.45	0.63	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	6.85	6.67	Dry	Dry	Dry	Dry
23-Mar-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.40	0.69	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	6.90	6.61	Dry	Dry	Dry	Dry
26-Apr-10	mbgl	Dry	Dry	Dry	Dry	DbEO	DbEO	DbEO	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
25-May-10	mbgl	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
27-Jun-10	mbgl	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
	maOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
27-Jul-10	mbgl	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
24-Aug-10	mbgl	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
27-Sep-10	mbgl	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
26-Oct-10	mbgl	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
16-Nov-10	mbgl	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
20-Dec-10	mbgl	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
25-Jan-11	mbgl	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry				Dry	Dry	Dry	Dry
DbEO - Destroyed by extraction operations												

Water level data from 1 m piezometers (continued)

Piezometer number		12	13	14	15	16	17	18	19	20	21	22
National Grid Reference (SK)		67656	67655	67668	67539	67541	67635	67472	67510	67668	67669	67802
		94056	93962	93862	93785	93880	93657	93652	93439	93473	93681	93814
Base of piezometer (mbgl)		1.00	1.00	0.40	0.80	0.65	1.00	1.00	1.00	1.00	0.80	1.00
Ground level (mAOD)		8.30	8.30	8.03	9.07	9.30	5.32	5.14	2.48	3.30	6.16	6.54
Date of measurement												
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.45	0.63	0.71	0.61	0.42	0.54
	mAOD	Dry	Dry	Dry	Dry	Dry	4.87	4.51	1.77	2.69	5.74	6.00
23-Mar-10	mbgl	0.98	Dry	Dry	Dry	Dry	0.40	0.69	0.74	0.65	0.40	0.57
	mAOD	7.32	Dry	Dry	Dry	Dry	4.92	4.45	1.74	2.65	5.70	5.97
26-Apr-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.64	0.92	RI	RI	0.73	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	4.68	4.22	RI	RI	5.43	Dry
25-May-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.64	0.89	0.78	0.96	0.75	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	4.68	4.25	1.7	2.04	5.41	Dry
27-Jun-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.64	0.92	Dry	Dry	0.79	Dry
	maOD	Dry	Dry	Dry	Dry	Dry	4.68	4.22	Dry	Dry	5.37	Dry
27-Jul-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.66	0.93	Dry	Dry	0.87	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	4.66	4.21	Dry	Dry	5.29	Dry
24-Aug-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.71	DAM	Dry	0.96	0.82	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	4.61		Dry	2.04	5.34	Dry
27-Sep-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.61		0.70	0.95	0.76	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	4.71		1.78	2.05	5.40	Dry
26-Oct-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.59		0.69	0.94	0.73	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	4.73		1.79	2.06	5.37	Dry
16-Nov-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.60		0.67	0.97	0.72	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	4.72		1.81	2.03	5.44	Dry
20-Dec-10	mbgl	Dry	Dry	Dry	Dry	Dry	0.57		0.66	0.89	0.63	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	4.75		1.82	2.11	5.53	Dry
25-Jan-11	mbgl	Dry	Dry	Dry	Dry	Dry	0.60		0.71	0.83	0.61	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	4.72		1.77	2.17	5.55	Dry

RI - Reinstated

DAM - Damaged

Water level data from 1 m piezometers (continued)

Piezometer number		23	24	25	26	27	28	29	30	31	32	33
National Grid Reference (SK)		67871	67978	68443	68326	68609	68711	68823	68831	68836	68750	68686
		93881	93976	94393	94520	94524	94483	94440	94401	94360	94423	94467
Base of piezometer (mbgl)		0.40	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ground level (mAOD)		6.14	5.53	5.30	6.30	4.69	4.30	3.30	3.30	3.30	3.76	4.30
Date of measurement												
23-Feb-10	mbgl	Dry	Dry	0.50	Dry	0.91	UW	UW	UW	UW	UW	Dry
	mAOD	Dry	Dry	4.8	Dry	3.78	UW	UW	UW	UW	UW	Dry
23-Mar-10	mbgl	Dry	Dry	0.52	Dry	0.94	UW	UW	UW	UW	0.15	Dry
	mAOD	Dry	Dry	4.78	Dry	3.75	UW	UW	UW	UW	3.61	Dry
26-Apr-10	mbgl	Dry	Dry	0.82	Dry	Dry	Dry	RI	0.48	RI	0.82	RI
	mAOD	Dry	Dry	4.48	Dry	Dry	Dry	RI	2.82	RI	2.94	RI
25-May-10	mbgl	Dry	Dry	0.78	Dry	Dry	Dry	0.69	0.42	Dry	Dry	Dry
	mAOD	Dry	Dry	4.52	Dry	Dry	Dry	2.61	2.9	Dry	Dry	Dry
27-Jun-10	mbgl	Dry	Dry	0.83	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	maOD	Dry	Dry	4.47	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27-Jul-10	mbgl	Dry	Dry	0.95	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	4.35	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
24-Aug-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27-Sep-10	mbgl	Dry	Dry	0.80	Dry	Dry	Dry	0.7	0.53	Dry	Dry	Dry
	mAOD	Dry	Dry	4.50	Dry	Dry	Dry	2.60	2.77	Dry	Dry	Dry
26-Oct-10	mbgl	Dry	Dry	0.77	Dry	Dry	Dry	0.68	0.42	Dry	Dry	Dry
	mAOD	Dry	Dry	4.53	Dry	Dry	Dry	2.62	2.88	Dry	Dry	Dry
16-Nov-10	mbgl	Dry	Dry	0.70	Dry	Dry	Dry	0.63	0.24	Dry	Dry	Dry
	mAOD	Dry	Dry	4.60	Dry	Dry	Dry	2.67	3.06	Dry	Dry	Dry
20-Dec-10	mbgl	Dry	Dry	0.68	Dry	Dry	Dry	0.61	0.17	Dry	Dry	Dry
	mAOD	Dry	Dry	4.62	Dry	Dry	Dry	2.69	3.13	Dry	Dry	Dry
25-Jan-11	mbgl	Dry	Dry	0.64	Dry	Dry	Dry	0.57	0.10	Dry	Dry	Dry
	mAOD	Dry	Dry	4.66	Dry	Dry	Dry	2.73	3.20	Dry	Dry	Dry

RI - Reinstated

UW - Underwater

Water level data from 1 m piezometers (continued)

Piezometer number		34	35	36	37	38	39	40	41	42	43	44
National Grid Reference (SK)		68846	68784	68710	68630	68568	68436	68548	68634	68738	68349	68420
		94263	94306	94360	94426	94442	94337	94240	94173	94084	94265	94182
Base of piezometer (mbgl)		1.00	1.00	1.00	0.80	0.75	0.90	0.90	1.00	1.00	0.90	0.50
Ground level (mAOD)		3.30	3.30	4.10	4.30	4.94	5.30	4.30	4.30	3.30	5.30	4.30
Date of measurement												
23-Feb-10	mbgl	0.38	0.25	0.24	0.32	0.43	0.46	Dry	0.51	0.39	0.45	Dry
	mAOD	2.92	3.05	3.86	3.98	4.51	4.90	Dry	3.79	2.91	4.85	Dry
23-Mar-10	mbgl	0.47	0.31	0.29	0.37	0.54	0.38	Dry	0.57	0.44	0.54	Dry
	mAOD	2.83	2.99	3.81	3.93	4.40	4.92	Dry	3.73	2.86	4.76	Dry
26-Apr-10	mbgl	RI	0.54	0.53	RI	RI	0.61	Dry	0.87	0.84	0.82	Dry
	mAOD	RI	2.76	3.60	RI	RI	4.69	Dry	3.43	2.46	4.48	Dry
25-May-10	mbgl	0.78	RI	0.52	0.85	RI	0.73	Dry	Dry	0.91	Dry	Dry
	mAOD	2.52	RI	3.58	3.45	RI	4.57	Dry	Dry	2.39	Dry	Dry
27-Jun-10	mbgl	Dry	0.62	0.61	0.93	0.44	Dry	Dry	Dry	Dry	Dry	Dry
	maOD	Dry	2.68	3.49	3.37	4.50	Dry	Dry	Dry	Dry	Dry	Dry
27-Jul-10	mbgl	Dry	0.76	0.65	0.98	0.48	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	2.6	3.45	3.32	4.46	Dry	Dry	Dry	Dry	Dry	Dry
24-Aug-10	mbgl	Dry	Dry	0.87	Dry	0.50	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	3.23	Dry	4.44	Dry	Dry	Dry	Dry	Dry	Dry
27-Sep-10	mbgl	0.88	0.59	0.57	Dry	0.41	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	2.42	2.71	3.53	Dry	4.53	Dry	Dry	Dry	Dry	Dry	Dry
26-Oct-10	mbgl	0.92	0.56	0.54	Dry	0.39	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	2.38	2.74	3.56	Dry	4.55	Dry	Dry	Dry	Dry	Dry	Dry
16-Nov-10	mbgl	0.98	0.55	0.51	0.81	0.37	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	2.32	2.75	3.59	3.49	4.57	Dry	Dry	Dry	Dry	Dry	Dry
20-Dec-10	mbgl	0.71	0.48	0.44	0.77	0.33	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	2.59	2.82	3.66	3.53	4.61	Dry	Dry	Dry	Dry	Dry	Dry
25-Jan-11	mbgl	0.64	0.43	0.38	0.75	0.31	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	2.66	2.90	3.72	3.55	4.63	Dry	Dry	Dry	Dry	Dry	Dry

RI - Reinstated

Water level data from 1 m piezometers

Piezometer number		45	46	47	48	49	50	51	52	53	54	55
National Grid Reference (SK)		68480	68574	68416	68275	68730	68705	68412	68276	68322	68370	68154
		94098	93986	93945	93836	93990	93851	93715	94176	94097	94020	94094
Base of piezometer (mbgl)		0.90	0.60	1.00	1.00	1.00	0.75	1.00	1.00	0.65	0.55	1.00
Ground level (mAOD)		4.30	4.17	4.20	2.80	3.30	3.30	3.30	5.05	4.30	4.30	5.11
Date of measurement												
23-Feb-10	mbgl	Dry	0.31	0.55	0.41	0.41	0.32	0.64	0.73	Dry	0.88	0.56
	mAOD	Dry	3.86	3.65	2.39	2.89	2.98	2.66	4.32	Dry	3.42	4.55
23-Mar-10	mbgl	Dry	0.29	0.64	0.48	0.48	0.37	0.85	0.85	Dry	0.99	0.65
	mAOD	Dry	3.88	3.56	2.32	2.82	2.93	2.45	4.2	Dry	3.31	4.46
26-Apr-10	mbgl	Dry	RI	0.87	0.58	0.58	RI	0.62	Dry	Dry	Dry	0.87
	mAOD	Dry	RI	3.33	2.22	2.72	RI	2.68	Dry	Dry	Dry	4.24
25-May-10	mbgl	Dry	0.64	0.92	0.89	Dry	Dry	0.68	Dry	Dry	Dry	0.93
	mAOD	Dry	3.53	3.28	1.91	Dry	Dry	2.62	Dry	Dry	Dry	4.18
27-Jun-10	mbgl	Dry	0.82	0.97	0.85	Dry	Dry	0.63	Dry	Dry	Dry	Dry
	maOD	Dry	3.35	3.23	1.95	Dry	Dry	2.67	Dry	Dry	Dry	Dry
27-Jul-10	mbgl	Dry	Dry	Dry	0.76	Dry	Dry	0.78	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	2.04	Dry	Dry	2.52	Dry	Dry	Dry	Dry
24-Aug-10	mbgl	Dry	Dry	Dry	0.64	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	2.16	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27-Sep-10	mbgl	Dry	0.87	Dry	0.46	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	3.3	Dry	2.34	Dry	Dry	Dry	Dry	Dry	Dry	Dry
26-Oct-10	mbgl	Dry	0.70	0.87	0.43	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	3.47	3.33	2.37	Dry	Dry	Dry	Dry	Dry	Dry	Dry
16-Nov-10	mbgl	Dry	0.70	0.85	0.34	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	3.47	3.35	2.46	Dry	Dry	Dry	Dry	Dry	Dry	Dry
20-Dec-10	mbgl	Dry	0.65	0.81	0.32	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	3.52	3.39	2.48	Dry	Dry	Dry	Dry	Dry	Dry	Dry
25-Jan-11	mbgl	Dry	0.61	0.72	0.30	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	3.56	3.50	2.50	Dry	Dry	Dry	Dry	Dry	Dry	Dry

RI - Reinstated

Water level data from 1 m piezometers (continued)

Piezometer number		**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**
National Grid Reference (SK)		68049	68189	67913	67736	67841	67955	68142	68205	68209
		93996	93829	93880	93722	93461	93479	93482	93618	93832
Base of piezometer (mbgl)		0.65	1.00	0.40	1.00	1.00	1.00	1.00	1.00	1.00
Ground level (mAOD)		5.22	3.30	5.74	6.02	3.30	3.30	3.30	3.30	3.12
Date of measurement										
23-Feb-10	mbgl	Dry	0.53	Dry	0.21	0.51	0.33	0.65	0.54	0.38
	mAOD	Dry	2.77	Dry	5.81	2.79	2.97	2.65	2.76	2.74
23-Mar-10	mbgl	Dry	0.62	Dry	0.16	0.60	0.48	0.77	0.61	0.39
	mAOD	Dry	2.68	Dry	5.86	2.7	2.82	2.53	2.69	2.73
26-Apr-10	mbgl	Dry	Dry	Dry	RI	0.78	0.77	RI	RI	RI
	mAOD	Dry	Dry	Dry	RI	2.52	2.53	RI	RI	RI
25-May-10	mbgl	Dry	Dry	Dry	0.56	Dry	RI	RI	RI	RI
	mAOD	Dry	Dry	Dry	5.46	Dry	RI	RI	RI	RI
27-Jun-10	mbgl	Dry	Dry	Dry	0.57	Dry	Dry	Dry	Dry	Dry
	maOD	Dry	Dry	Dry	5.45	Dry	Dry	Dry	Dry	Dry
27-Jul-10	mbgl	Dry	Dry	Dry	0.61	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	5.41	Dry	Dry	Dry	Dry	Dry
24-Aug-10	mbgl	Dry	Dry	Dry	0.67	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	5.35	Dry	Dry	Dry	Dry	Dry
27-Sep-10	mbgl	Dry	Dry	Dry	0.59	Dry	Dry	Dry	0.95	Dry
	mAOD	Dry	Dry	Dry	5.43	Dry	Dry	Dry	2.35	Dry
26-Oct-10	mbgl	Dry	Dry	Dry	0.61	Dry	Dry	Dry	0.95	Dry
	mAOD	Dry	Dry	Dry	5.39	Dry	Dry	Dry	2.35	Dry
16-Nov-10	mbgl	Dry	Dry	Dry	0.64	Dry	Dry	Dry	0.96	Dry
	mAOD	Dry	Dry	Dry	5.36	Dry	Dry	Dry	2.34	Dry
20-Dec-10	mbgl	Dry	Dry	Dry	0.52	Dry	Dry	Dry	0.87	Dry
	mAOD	Dry	Dry	Dry	5.48	Dry	Dry	Dry	2.43	Dry
25-Jan-11	mbgl	Dry	Dry	Dry	0.46	Dry	Dry	Dry	0.72	Dry
	mAOD	Dry	Dry	Dry	5.56	Dry	Dry	Dry	2.58	Dry
RI - Reinstated										

Water level data from 2 m piezometers

Piezometer number		7	12	17	18	19	20	21	22	25	27	28
National Grid Reference (SK)		67814	67656	67635	67472	67510	67668	67669	67802	68443	68609	68711
		94170	94056	93657	93652	93439	93473	93681	93814	94393	94524	94483
Base of piezometer (mbgl)		1.70	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.55	2.00	2.00
Ground level (mAOD)		7.30	8.30	5.32	5.14	2.48	3.30	6.16	6.54	5.30	4.69	4.30
Date of measurement												
23-Feb-10	mbgl	Dry	1.05	0.58	0.61	1.01	0.57	0.47	0.53	0.64	1.05	UW
	mAOD	Dry	7.25	4.74	4.53	1.47	2.73	5.69	6.01	4.66	3.64	UW
23-Mar-10	mbgl	Dry	1.16	0.64	0.79	1.05	0.77	0.50	0.59	0.70	1.10	UW
	mAOD	Dry	7.14	4.68	4.35	1.43	2.53	5.66	5.95	4.60	3.59	UW
26-Apr-10	mbgl	Dry	1.21	0.88	1.04	RI	RI	0.72	1.12	0.89	1.39	Dry
	mAOD	Dry	7.09	4.44	4.1	RI	RI	5.44	5.42	4.41	3.30	Dry
25-May-10	mbgl	Dry	1.41	1.01	1.29	1.08	1.16	0.75	1.43	0.91	1.61	Dry
	mAOD	Dry	6.89	4.31	3.85	1.40	2.14	5.41	5.11	4.39	3.08	Dry
27-Jun-10	mbgl	Dry	Dry	1.08	1.33	1.11	1.23	0.78	1.59	0.93	1.72	Dry
	maOD	Dry	Dry	4.24	3.81	1.37	1.77	5.38	4.95	4.37	2.97	Dry
27-Jul-10	mbgl	Dry	Dry	1.06	1.28	1.20	1.29	0.84	1.83	0.95	1.77	Dry
	mAOD	Dry	Dry	4.26	3.86	1.28	2.01	5.32	4.71	4.35	2.92	Dry
24-Aug-10	mbgl	Dry	Dry	0.71	DAM	1.19	1.11	0.82	Dry	1.14	1.37	Dry
	mAOD	Dry	Dry	4.61		1.19	2.19	5.34	Dry	4.16	3.32	Dry
27-Sep-10	mbgl	Dry	Dry	1.02		1.06	1.06	0.79	1.87	0.96	1.23	1.02
	mAOD	Dry	Dry	4.30		1.42	2.24	5.37	4.67	4.34	3.46	3.28
26-Oct-10	mbgl	Dry	Dry	1.01		1.08	1.12	0.77	1.88	0.86	1.21	0.98
	mAOD	Dry	Dry	4.31		1.40	2.18	5.39	4.66	4.44	3.48	3.32
16-Nov-10	mbgl	Dry	Dry	1.01		1.10	1.14	0.71	1.89	0.81	1.19	1.04
	mAOD	Dry	Dry	4.31		1.38	2.16	5.45	4.65	4.49	3.50	3.26
20-Dec-10	mbgl	Dry	Dry	0.92		1.01	1.03	0.64	1.67	0.79	1.09	1.06
	mAOD	Dry	Dry	4.40		1.47	2.27	5.52	4.87	4.51	3.60	3.24
25-Jan-11	mbgl	Dry	Dry	0.85		0.97	0.87	0.58	1.52	0.74	1.04	1.11
	mAOD	Dry	Dry	4.47		1.51	2.43	5.58	5.02	4.56	3.65	3.19

RI - Reinstated
UW - Underwater
DAM - Damaged

Water level data from 2 m piezometers (continued)

Piezometer number		29	30	31	34	35	36	38	41	42	46	47
National Grid Reference (SK)		68823	68831	68836	68846	68784	68710	68568	68634	68738	68574	68416
		94440	94401	94360	94263	94306	94360	94442	94173	94084	93986	93945
Base of piezometer (mbgl)		2.00	2.00	1.60	2.00	2.00	1.65	1.60	1.90	2.00	2.00	2.00
Ground level (mAOD)		3.30	3.30	3.30	3.30	3.30	4.10	4.94	4.30	3.30	4.17	4.20
Date of measurement												
23-Feb-10	mbgl	UW	UW	0.11	0.32	0.68	0.23	0.22	0.51	0.52	0.36	0.67
	mAOD	UW	UW	3.19	2.98	2.62	3.87	4.72	3.79	2.78	4.34	3.53
23-Mar-10	mbgl	UW	UW	0.15	0.51	0.76	0.29	0.25	0.60	0.64	0.41	0.83
	mAOD	UW	UW	3.15	2.79	2.54	3.81	4.69	3.70	2.66	3.76	3.37
26-Apr-10	mbgl	RI	0.62	0.79	RI	1.02	0.53	RI	0.93	0.88	RI	1.03
	mAOD	RI	2.68	2.51	RI	2.28	3.57	RI	3.37	2.42	RI	3.17
25-May-10	mbgl	1.26	0.89	Dry	0.84	RI	0.52	RI	1.03	0.95	1.02	1.33
	mAOD	2.04	2.41	Dry	2.46	RI	3.58	RI	3.27	2.35	3.15	2.87
27-Jun-10	mbgl	1.33	1.03	Dry	1.07	1.02	0.54	0.45	1.28	1.23	1.07	1.46
	maOD	1.97	2.27	Dry	2.23	2.28	3.56	4.49	3.02	2.07	3.10	2.74
27-Jul-10	mbgl	1.38	1.25	Dry	1.43	1.13	0.58	0.49	1.74	1.43	1.18	1.67
	mAOD	1.92	2.05	Dry	1.6	2.17	3.52	4.45	1.56	1.87	2.99	2.53
24-Aug-10	mbgl	1.40	1.40	1.78	1.60	1.42	0.7	0.5	Dry	1.44	1.29	1.74
	mAOD	1.90	1.90	1.52	1.7	1.88	3.40	4.44	Dry	1.86	2.88	2.46
27-Sep-10	mbgl	0.88	1.20	1.53	1.05	1.03	0.54	0.42	Dry	1.32	0.96	1.33
	mAOD	2.42	2.1	1.77	2.25	2.27	3.56	4.52	Dry	1.98	3.21	2.87
26-Oct-10	mbgl	0.87	0.76	1.32	0.93	0.95	0.53	0.41	Dry	1.18	0.95	1.17
	mAOD	2.43	2.54	1.98	2.37	2.35	3.57	4.53	Dry	2.12	3.22	3.03
16-Nov-10	mbgl	0.88	0.64	1.15	0.82	0.83	0.51	0.39	Dry	1.13	0.92	1.02
	mAOD	2.42	2.66	2.15	2.48	2.47	3.59	4.55	Dry	2.17	3.25	3.18
20-Dec-10	mbgl	0.83	0.53	0.82	0.59	0.78	0.45	0.33	Dry	0.95	0.71	0.92
	mAOD	2.47	2.77	2.48	2.71	2.52	3.65	4.61	Dry	2.35	3.46	3.28
25-Jan-11	mbgl	0.77	0.48	0.66	0.52	0.72	0.41	0.32	Dry	0.82	0.64	0.84
	mAOD	2.53	2.82	2.64	2.78	2.58	3.69	4.62	Dry	2.48	3.53	3.36
RI - Reinstated UW - Underwater												

Water level data from 2 m piezometers (continued)

Piezometer number		**48**	**49**	**52**	**54**	**59**	**60**	**61**	**62**	**63**	**64**
National Grid Reference (SK)		68275	68730	68276	68370	67736	67841	67955	68142	68205	68209
		93836	93990	94176	94020	93722	93461	93479	93482	93618	93832
Base of piezometer (mbgl)		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Ground level (mAOD)		2.80	3.30	5.05	4.30	6.02	3.30	3.30	3.30	3.30	3.12
Date of measurement											
23-Feb-10	mbgl	0.74	0.59	0.72	0.44	0.68	0.53	0.49	0.61	0.46	0.48
	mAOD	2.10	2.71	4.33	3.86	5.34	2.77	2.81	2.69	2.84	2.64
23-Mar-10	mbgl	0.90	0.70	0.85	0.56	0.84	0.60	0.66	0.86	0.64	0.64
	mAOD	1.9	2.60	4.2	3.74	5.18	2.70	2.64	2.44	2.66	2.48
26-Apr-10	mbgl	1.01	0.76	Dry	0.87	RI	0.80	0.86	RI	RI	RI
	mAOD	1.79	2.54	Dry	3.43	RI	2.50	2.44	RI	RI	RI
25-May-10	mbgl	1.33	1.20	Dry	1.11	1.26	1.18	RI	RI	RI	RI
	mAOD	1.47	2.1	Dry	3.19	4.76	2.12	RI	RI	RI	RI
27-Jun-10	mbgl	1.25	1.23	Dry	1.52	1.13	1.53	1.62	1.73	1.13	1.24
	maOD	1.65	2.07	Dry	2.78	4.92	1.77	1.68	1.57	2.17	1.88
27-Jul-10	mbgl	1.18	1.31	Dry	1.63	1.05	1.74	1.80	1.90	1.29	1.38
	mAOD	1.62	1.99	Dry	2.67	4.97	1.56	1.50	1.40	2.01	1.74
24-Aug-10	mbgl	1.20		Dry	1.71	1.18	1.57	1.76	1.48	1.40	1.64
	mAOD	1.60		Dry	2.59	4.84	1.73	1.54	1.82	1.90	1.48
27-Sep-10	mbgl	0.98		Dry	1.37	1.10	1.33	1.30	1.28	1.04	1.42
	mAOD	1.82		Dry	2.93	4.92	1.97	2.00	2.02	2.26	1.70
26-Oct-10	mbgl	0.90		Dry	1.22	1.12	1.23	1.23	1.19	1.02	1.41
	mAOD	1.9		Dry	3.08	4.90	2.07	2.07	2.11	2.28	1.71
16-Nov-10	mbgl	0.96		Dry	1.05	1.16	1.19	1.20	1.17	1.01	1.42
	mAOD	1.84		Dry	3.25	4.86	2.11	2.10	2.13	2.29	1.70
20-Dec-10	mbgl	0.88		Dry	0.86	0.91	0.99	1.03	1.04	0.92	1.34
	mAOD	1.92		Dry	3.44	5.10	2.31	2.27	2.26	2.38	1.78
25-Jan-11	mbgl	0.82		Dry	0.83	0.85	0.87	0.88	0.87	0.79	1.08
	mAOD	1.98		Dry	3.47	5.17	2.43	2.42	2.43	2.51	2.04
RI - Reinstated											

Water level data from 3 m piezometers

Piezometer number		**17**	**18**	**19**	**20**	**22**	**30**	**34**	**35**	**42**	**47**	**49**
National Grid Reference (SK)		67635	67472	67510	67668	67802	68831	68846	68784	68738	68416	68730
		93657	93652	93439	93473	93814	94401	94263	94306	94084	93945	93990
Base of piezometer (mbgl)		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Ground level (mAOD)		5.32	5.14	2.48	3.30	6.54	3.30	3.30	3.30	3.30	4.20	3.30
Date of measurement												
23-Feb-10	mbgl	0.88	1.23	1.04	0.98	1.13	UW	0.48	0.83	0.57	0.62	0.84
	mAOD	4.44	3.91	1.44	2.32	5.41	UW	2.82	2.17	2.73	3.58	2.46
23-Mar-10	mbgl	0.94	1.37	1.15	1.00	1.28	UW	0.63	1.06	0.72	0.83	1.18
	mAOD	4.38	3.77	2.33	3.30	5.26	UW	2.67	1.94	2.58	3.37	2.12
26-Apr-10	mbgl	1.22	1.55	RI	RI	1.62	0.76	RI	1.34	0.94	1.03	1.02
	mAOD	4.10	3.59	RI	RI	4.94	2.54	RI	1.96	2.36	3.17	2.28
25-May-10	mbgl	1.43	1.89	1.08	1.17	1.85	0.94	1.02	RI	1.09	1.45	1.54
	mAOD	3.89	3.25	2.40	2.13	4.69	2.36	2.28	RI	2.21	2.85	1.46
27-Jun-10	mbgl	1.59	1.92	1.34	1.28	1.95	1.18	1.26	1.44	1.27	1.56	1.63
	maOD	3.73	3.22	1.14	2.02	4.59	2.12	2.04	1.86	2.03	2.64	1.67
27-Jul-10	mbgl	1.76	1.96	1.51	1.52	Dry	1.25	1.42	1.51	1.48	1.79	1.69
	mAOD	3.56	3.18	0.97	1.78	Dry	2.05	1.88	1.79	1.82	2.41	1.61
24-Aug-10	mbgl	1.59	DAM	1.43	1.43	1.96	1.39	1.51	1.60	1.53	1.84	
	mAOD	3.73		1.05	1.87	4.58	1.91	1.79	1.70	1.77	2.36	
27-Sep-10	mbgl	1.42		1.35	1.21	2.01	1.10	1.16	1.49	1.44	1.77	
	mAOD	3.90		1.13	2.09	4.53	2.10	2.14	1.51	1.86	2.43	
26-Oct-10	mbgl	1.47		1.18	1.24	2.02	0.88	0.93	1.34	1.35	1.44	
	mAOD	3.85		1.30	2.06	4.52	2.42	2.37	1.96	1.95	2.76	
16-Nov-10	mbgl	1.52		1.12	1.20	2.01	0.74	0.74	1.25	1.28	1.02	
	mAOD	3.80		1.36	3.10	4.53	2.56	2.56	2.05	2.02	3.18	
20-Dec-10	mbgl	1.39		1.08	1.16	1.95	0.67	0.70	1.11	1.07	0.83	
	mAOD	3.93		1.40	2.14	4.59	2.63	2.60	2.19	2.23	3.37	
25-Jan-11	mbgl	1.26		1.01	1.09	1.76	0.62	0.65	1.08	0.86	0.67	
	mAOD	4.06		1.47	2.21	4.78	2.68	2.65	2.22	2.44	3.53	

RI - Reinstated
UW - Underwater
DAM - Damaged

Water level data from 3 m piezometers

Piezometer number		51	59	60	61	62	63	64
National Grid Reference (SK)		68412	67736	67841	67955	68142	68205	68209
		93715	93722	93461	93479	93482	93618	93832
Base of piezometer (mbgl)		3.00	3.00	3.00	3.00	3.00	3.00	3.00
Ground level (mAOD)		3.30	6.02	3.30	3.30	3.30	3.30	3.12
Date of measurement								
23-Feb-10	mbgl	0.75	1.32	0.67	0.76	0.79	0.65	0.54
	mAOD	2.25	4.70	2.33	2.24	2.51	1.65	2.58
23-Mar-10	mbgl	0.93	1.53	0.64	0.86	0.87	0.77	0.64
	mAOD	2.37	4.49	2.66	2.44	2.43	2.53	2.48
26-Apr-10	mbgl	0.58	RI	0.78	1.06	RI	RI	RI
	mAOD	2.72	RI	2.52	2.24	RI	RI	RI
25-May-10	mbgl	0.79	1.36	1.18	RI	RI	RI	RI
	mAOD	2.51	4.66	2.12	RI	RI	RI	RI
27-Jun-10	mbgl	0.92	1.34	1.42	1.33	1.23	1.12	1.08
	maOD	2.38	4.68	1.88	1.97	2.07	2.18	2.04
27-Jul-10	mbgl	1.04	1.38	1.76	1.57	1.41	1.32	1.37
	mAOD	2.26	4.64	1.54	1.73	1.89	1.98	1.75
24-Aug-10	mbgl		1.38	1.54	1.60	1.44	1.42	1.64
	mAOD		4.64	1.76	1.70	1.86	1.88	1.48
27-Sep-10	mbgl		1.32	1.35	1.51	1.23	1.12	1.48
	mAOD		4.70	1.95	1.79	2.07	1.88	1.64
26-Oct-10	mbgl		1.29	1.28	1.52	1.22	1.09	1.31
	mAOD		4.73	2.02	1.78	2.08	2.21	1.81
16-Nov-10	mbgl		1.16	1.23	1.45	1.17	1.13	1.18
	mAOD		4.86	2.07	1.85	2.13	2.17	1.94
20-Dec-10	mbgl		1.21	1.06	1.22	1.04	0.96	0.84
	mAOD		4.81	2.24	2.08	2.26	2.34	2.28
25-Jan-11	mbgl		1.08	0.81	1.07	0.98	0.91	0.77
	mAOD		4.94	2.49	2.23	2.32	2.39	2.35
RI - Reinstated								

Water environment data from piezometers

Piezometer number		P9	P12	P17	P18	P19	P20	P21	P22	P25	P27	P28
National Grid Reference (SK)		67666	67656	67635	67472	67510	67668	67669	67802	68443	68609	68711
		94203	94056	93657	93652	93439	93473	93681	93814	94393	94524	94483
Date of measurement												
26-Feb-10	pH	4.4	4	3.7	3.9	3.5	3.9	3.7	3.8	6.1	6.3	
	ORP (mV)	523	236	83	76	-116	68	203	119	187	126	
	Conductivity (µs/cm)	121	205	237	331	383	54	459	349	131	785	
	Temperature (°C)	6.2	5.8	6.2	5.2	6.2	6.1	6.6	5.8	7.3	5.7	
26-Mar-10	pH	4.8	4.2	3.1	3.5	3.6	3.5	3.8	3.6		6	
	ORP (mV)	313	194	179	-44	-177	6	216	149		181	
	Conductivity (µs/cm)	298	272	506	468	529	108	621	520		1229	
	Temperature (°C)	6.7	6	6.7	5.8	6.6	6.3	7	6.1		6	
27-Apr-10	pH			6.2	5.5			6.8	6.2	6.5	5.8	3.7
	ORP (mV)			6	2			51	189	-13	79	148
	Conductivity (µs/cm)			132	105			207	713	226	113	541
	Temperature (°C)			8	8.8			9.4	13.5	8.1	9.3	10.1
26-May-10	pH			7.1	6.9	6.9	6.6	7.4	6.5	7		5.3
	ORP (mV)			43	-16	47	69	169	21	-13		160
	Conductivity (µs/cm)			160	121	181	1246	1	951	87		1049
	Temperature (°C)			13.6	13.4	12.2	11.2	10.7	10.8	12.3		15.2
28-Jun-10	pH			6.9	7	6.8	6.6	7.1	6.3			
	ORP (mV)			111	54	23	45	103	46			
	Conductivity (µs/cm)			145	93	224	1013	275	402			
	Temperature (°C)			14.3	14.2	13.5	12.8	12.3	11.9			
28-Jul-10	pH			7	7	6.6	6.7	7.3	5.9			
	ORP (mV)			125	113	-2	32	96	92			
	Conductivity (µs/cm)			0	1	441	563	428	189			
	Temperature (°C)			15.8	15.9	14.2	13.3	19.2	13.9			
25-Aug-10	pH			7.6		7.1		7.6		7.5	7.2	
	ORP (mV)			5		18		14		61	29	
	Conductivity (µs/cm)			1047		1969		838		93	265	
	Temperature (°C)			16		15.1		16.1		16.3	14.4	
28-Sep-10	pH			7.4		6.8	6.6	7.4	6.9	7	6.8	6.6
	ORP (mV)			-6		44	42	11	18	47	10	177
	Conductivity (µs/cm)			1223		1856	1617	806	1408	531	1211	
	Temperature (°C)			13.1		12.1	12.1	12.6	11.7	9.4	11.6	13.4
27-Oct-10	pH			7.2		6.6	6.5	7.2	6.6	7.2	6.9	
	ORP (mV)			34		87	21	46	54	55	14	
	Conductivity (µs/cm)			897		1605	1552	501	1326	782	1123	
	Temperature (°C)			8.3		8.4	7.6	6.8	8.3	6.6	8.4	
17-Nov-10	pH			7		6.4	6.2	7.1	6.5	7	6.7	
	ORP (mV)			19		37	0	26	17	65	32	
	Conductivity (µs/cm)			564		1532	1487	55	1147	790	1063	
	Temperature (°C)			4.8		3.6	5.1	1.9	5.9	2.6	3.6	
20-Dec-10	pH			5.6		6.1	5.2	6.7	5.8	6.5	6.1	
	ORP (mV)			62		12	23	112	55	49	77	
	Conductivity (µs/cm)			310		1447	1145	546	906	514	744	
	Temperature (°C)			5.1		3.5	5	2.8	5.6	3.1	3.8	
25-Jan-11	pH			5.1		5.7	4.7	6.2	5.2	6.2	5.9	
	ORP (mV)			100		-17	56	167	101	22	62	
	Conductivity (µs/cm)			488		1069	948	374	753	389	853	
	Temperature (°C)			4.8		4.3	4.9	3.5	4.2	3.3	4.1	

Water environment data from piezometers (continued)

Piezometer number		**P29**	**P30**	**P31**	**P32**	**P34**	**P35**	**P36**	**P37**	**P38**	**P39**	**P41**
National Grid Reference (SK)		68823	68831	68836	68750	68846	68784	68710	68630	68568	68436	68634
		94440	94401	94360	94423	94263	94306	94360	94426	94442	94337	94173
Date of measurement												
26-Feb-10	pH					4.1	4.5	4.3		4	4.2	
	ORP (mV)					24	12	61		114	142	
	Conductivity (µs/cm)					152	53	329		106	515	
	Temperature (°C)					5.6	5.6	6.3		5.9	4.8	
26-Mar-10	pH					4.2	3.9	3.8		4.1	3.9	4.6
	ORP (mV)					3	43	67		109	166	170
	Conductivity (µs/cm)					192	24	384		78	488	1640
	Temperature (°C)					5.9	6.3	6.6		6	5.1	4.5
27-Apr-10	pH	3.7	5.2	4.1	3.4		8.1	6.3	5.8	4.4	4.7	3.9
	ORP (mV)	148	176	174	224		154	115	174	212	62	123
	Conductivity (µs/cm)	541	636	264	82		398	91	50	190	187	1493
	Temperature (°C)	10.1	10.1	9.9	12.6		8.1	8.9	12	10.5	7.9	9.7
26-May-10	pH	5.3	6	4.8		6.1		6.7	6.5		5.6	
	ORP (mV)	160	-21	58		68		-23	21		36	
	Conductivity (µs/cm)	1049	370	1945		383		251	223		966	
	Temperature (°C)	15.2	10.6	10.1		11.6		11.5	12.5		11.6	
28-Jun-10	pH		6	4.2		6	7.2	6.6		4.7		
	ORP (mV)		-45	85		43	66	-11		107		
	Conductivity (µs/cm)		1013	1679		441	547	482		436		
	Temperature (°C)		13.5	11.6		12.6	10.2	13		12.2		
28-Jul-10	pH		6.2	4.3		5.9	6.4	6.4		5.3		
	ORP (mV)		-82	61		26	19	-7		-4		
	Conductivity (µs/cm)		1876	1668		506	854	1459		985		
	Temperature (°C)		16.3	13.4		14.7	13.8	15.8		15.4		
25-Aug-10	pH	6.5	6.7	5.9		6.7	7.1	7.2		6.5		
	ORP (mV)	12	-3	92		97	-7	24		22		
	Conductivity (µs/cm)	1252	410	267		481	0	173		147		
	Temperature (°C)	16.4	14.8	13.6		13.6	13.3	15		14.4		
28-Sep-10	pH	7	6.7	5.9		6.6	7	7.1		6.4		
	ORP (mV)	141	-1	-70		65	-11	6		1		
	Conductivity (µs/cm)	1225	1447	257		545	936	188		232		
	Temperature (°C)	12.8	13	12.8		13.1	12.7	13.1		12.4		
27-Oct-10	pH	6.4	6.2	5.6		6.2	6.9	7		6.8		
	ORP (mV)	151	54	48		121	54	55		58		
	Conductivity (µs/cm)	1345	1006	549		329	414	215		671		
	Temperature (°C)	6.7	7.2	6.9		5.4	6.2	8.2		7.2		
17-Nov-10	pH	5.8	5.9	5.2		5.1	6.6	6.8	6.9	6.6		
	ORP (mV)	168	159	139		196	73	79	92	107		
	Conductivity (µs/cm)	643	996	967		145	0	298	60	870		
	Temperature (°C)	0.2	0.7	1.3		0.6	3.4	2.5	0.2	0.6		
20-Dec-10	pH	5.2	5.4	4.8		4.9	6.2	6.2	6.3	5.8		
	ORP (mV)	205	168	177		218	138	113	134	139		
	Conductivity (µs/cm)	1124	875	921		172	246	265	85	643		
	Temperature (°C)	0.5	0.8	0.5		1.4	2.5	1.6	2.3	1.4		
25-Jan-11	pH	4.6	4.8	4.7		4.7	5.4	5.9	6.1	5.3		
	ORP (mV)	171	149	203		199	156	156	184	173		
	Conductivity (µs/cm)	836	905	894		186	317	342	152	492		
	Temperature (°C)	1.4	1.7	1.3		1.2	1.8	1.2	1.6	1.9		

Water environment data from piezometers (continued)

Piezometer number		P42	P43	P46	P47	P48	P49	P50	P51	P52	P55	P57
National Grid Reference (SK)		68738	68349	68574	68416	68275	68730	68705	68412	68276	68154	68189
		94084	94265	93986	93945	93836	93990	93851	93715	94176	94094	93829
Date of measurement												
26-Feb-10	pH	3.8	3.9	3.6	3.8	3.9	4.1	4.1		3.8		4
	ORP (mV)	65	123	157	162	183	331	21		192		206
	Conductivity (µs/cm)	1003	661	44	1007	142	203	768		83		-18
	Temperature (°C)	5.7	4.7	5.2	5.5	5.7	4.3	4.2		4.6		6.1
26-Mar-10	pH	3.9	4.1	3.2	3.7	3.9	4.4	4.4		3.2		3.9
	ORP (mV)	41	159	172	170	167	234	-36		173		-43
	Conductivity (µs/cm)	1541	514	10	933	135	195	885		280		277
	Temperature (°C)	6	5.1	5.6	5.9	7	4.4	6.8		4.7		6.4
27-Apr-10	pH	5.6	4.9		5.5	3.9	6.2		6		4.3	
	ORP (mV)	28	62		155	209	165		-32		158	
	Conductivity (µs/cm)	203	1		248	111	267		144		123	
	Temperature (°C)	9.7	10.4		9.5	7.6	8.2		8		13.1	
26-May-10	pH	6.2		6.5	6.3	7.2	6.6		6.6			
	ORP (mV)	6		58	126	25	99		-6			
	Conductivity (µs/cm)	647		407	270	600	271		1			
	Temperature (°C)	10.7		11.2	10.6	11.7	10.1		12.1			
28-Jun-10	pH	5.8		6.2	6.1	7	6.7		6.8			
	ORP (mV)	24		33	94	54	105		-23			
	Conductivity (µs/cm)	632		628	447	481	224		129			
	Temperature (°C)	12.7		13.4	13.8	14.1	10.6		12.9			
28-Jul-10	pH	6		5.9	6	6.9	6.9		7			
	ORP (mV)	5.8		5	80	-14	88		13			
	Conductivity (µs/cm)	699		1892	742	330	213		101			
	Temperature (°C)	15.3		16	15.6	16.5	11.5		13.2			
25-Aug-10	pH	6.9		6.9	6.9	7.4						
	ORP (mV)	15		27	56	29						
	Conductivity (µs/cm)	0		266	418	1219						
	Temperature (°C)	15.6		14.7	14.6	14.4						
28-Sep-10	pH	6.2		6.6	6.8	7.3					4.3	
	ORP (mV)	54		22	40	25					174	
	Conductivity (µs/cm)	365		181	925	646					510	
	Temperature (°C)	12.7		13.7	13.3	13.2					14	
27-Oct-10	pH	6.3		6.2	6.9	7						
	ORP (mV)	76		55	53	42						
	Conductivity (µs/cm)	1145		110	1005	455						
	Temperature (°C)	5.4		7.7	7.9	7.6						
17-Nov-10	pH	6.6		6.5	6.7	7.1						
	ORP (mV)	110		107	75	76						
	Conductivity (µs/cm)	1320		114	1190	317						
	Temperature (°C)	2.2		2	1.7	2.6						
20-Dec-10	pH	6.1		6.2	6.3	7						
	ORP (mV)	88		94	93	87						
	Conductivity (µs/cm)	1193		91	1086	234						
	Temperature (°C)	3.4		2.3	2.1	2.6						
25-Jan-11	pH	5.4		5.8	5.9	6.7						
	ORP (mV)	73		112	127	103						
	Conductivity (µs/cm)	1016		78	951	229						
	Temperature (°C)	3.1		2.9	3.2	3.1						

Water environment data from piezometers and boreholes

Piezometer / borehole number		P59	P60	P61	P62	P63	P64	B1	B3	B4	B6
National Grid Reference (SK)		67736	67841	67955	68142	68205	68209	67648	68060	66838	67844
		93722	93461	93479	93482	93618	93832	94054	94041	94257	93460
Date of measurement											
26-Feb-10	pH	3.8	3.8	3.9	3.7	3.9	3.7		5.7	5	4.6
	ORP (mV)	162	146	96	102	88	99		181	-103	126
	Conductivity (µs/cm)	172	209	381	224	213	227		312	513	431
	Temperature (°C)	6.3	3.7	4.4	5.1	5.2	4.8		5.9	5.3	5.4
26-Mar-10	pH	3.9	3.6	3.6	3.6	3.9	3.7		6.9	5.3	4.9
	ORP (mV)	141	175	116	109	96	145		186	-70	154
	Conductivity (µs/cm)	144	215	1438	292	358	161		283	656	633
	Temperature (°C)	6.5	3.4	5	6	5.9	5.4		6.4	6.4	6.5
27-Apr-10	pH		3.8	3.6				7.7	7	5.9	5.9
	ORP (mV)		303	294				164	200	-39	165
	Conductivity (µs/cm)		115	457				0	572	175	104
	Temperature (°C)		8.8	8.6				10.7	10.7	9.7	8.5
26-May-10	pH		5.5					7.8	8.1	6.4	7.2
	ORP (mV)		11					116	149	-30	22
	Conductivity (µs/cm)		67					281	511	271	466
	Temperature (°C)		10.3					11	10.7	10.3	10.1
28-Jun-10	pH	6.1	6	6.2	5.7	4.1	4.3		7.5		7
	ORP (mV)	58	-9	116	43	55	86		177		-11
	Conductivity (µs/cm)	1221	24	237	191	206	234		567		331
	Temperature (°C)	13.2	13.3	12.1	12	11.9	12		11.2		11.1
28-Jul-10	pH	6.3	6.5	5.9	6	3.9	4.2		7.1		6.8
	ORP (mV)	17	-27	26	-15	174	129		106		-39
	Conductivity (µs/cm)	1416	8	1	1573	1917	854		765		215
	Temperature (°C)	15.7	15.2	13.3	13.1	14	13.6		12.3		12.4
25-Aug-10	pH	7.3		7	6.8	5.4	7		8.1	6.9	
	ORP (mV)	-8		29	86	128	6		85	12	
	Conductivity (µs/cm)	905		1346	706	1	1708		982	132	
	Temperature (°C)	14.6		15.9	15.9	14	13		14	12.4	
28-Sep-10	pH	7.2	6.8	6.6	6.7	6	7		7.7	7.2	
	ORP (mV)	-4	14	10	46	79	27		29	-8	
	Conductivity (µs/cm)	1149	1634	1822	1068	1877	1856		895	141	
	Temperature (°C)	13.1	12.2	12.1	12.2	13.1	13.1		10.6	11.6	
27-Oct-10	pH	7	6.6	6.5	6.4	6.1	6.8		7.6	6.5	
	ORP (mV)	23	23	33	33	84	45		43	52	
	Conductivity (µs/cm)	1003	1210	1554	971	1773	1435		784	87	
	Temperature (°C)	8.5	7.6	7.9	8.6	8.3	7.7		7.7	4.4	
17-Nov-10	pH	6.8	6.6	6.6	6.7	6.6	6.7		7.2	6.4	
	ORP (mV)	0	40	40	25	65	68		27	101	
	Conductivity (µs/cm)	846	709	1127	714	1609	1022		715	62	
	Temperature (°C)	6.7	5.2	4.6	3.7	3.6	3.9		5	3.2	
20-Dec-10	pH	6.1	6.2	6.1	6.2	5.8	5.8		6.6	6.2	
	ORP (mV)	53	67	88	53	67	101		43	134	
	Conductivity (µs/cm)	569	518	712	497	1342	765		532	98	
	Temperature (°C)	4.1	4.4	3.3	3.7	4.3	4.1		4.2	3.9	
25-Jan-11	pH	5.5	5.4	5.4	5.8	5.2	5.1		6.1	6	
	ORP (mV)	77	95	104	84	36	45		68	106	
	Conductivity (µs/cm)	428	347	543	302	904	542		444	136	
	Temperature (°C)	3.8	3.6	2.9	3.1	3.5	3.8		3.9	3.6	

APPENDIX 2:
OVER QUARRY WATER ENVIRONMENT DATA

Groundwater level data from boreholes

Borehole number		1	2	3	4	5	6
National Grid Reference (SK)		38385	38918	39576	38718	38773	38232
		74118	73441	74292	72539	74630	74374
Ground level (mAOD)		1.95	2.50	2.50	2.50	1.50	1.50
Date of measurement							
23-Feb-10	mbgl	3.51	2.41	1.02	1.86	1.73	1.71
	mAOD	-1.56	0.09	1.48	0.64	-0.23	-0.21
23-Mar-10	mbgl	3.64	2.36	1.06	1.56	1.77	1.74
	mAOD	-1.69	0.14	1.44	0.94	-0.27	-0.24
28-Apr-10	mbgl	4.01	2.38	0.93	2.02	1.94	1.69
	mAOD	-2.06	0.12	1.57	0.48	-0.44	-0.19
27-May-10	mbgl	4.00	1.87	1.01	2.03	2.07	2.03
	mAOD	-2.05	0.63	1.49	0.47	-0.57	-0.53
29-Jun-10	mbgl	DbEO	1.99	0.94	2.22	2.21	2.37
	maOD		0.51	1.56	0.28	-0.71	-0.87
29-Jul-10	mbgl		2.07	0.96	2.47	2.31	2.89
	mAOD		0.43	1.54	0.03	-0.81	-1.39
26-Aug-10	mbgl		2.03	0.74	2.26	2.13	3.02
	mAOD		0.47	1.76	0.24	-0.63	-1.52
29-Sep-10	mbgl		2.24	0.93	3.43	2.33	3.27
	mAOD		0.26	1.57	-0.93	-0.83	-1.77
28-Oct-10	mbgl		2.64	0.91	2.67	2.66	3.51
	mAOD		-0.14	1.59	-0.17	-1.66	-2.21
18-Nov-10	mbgl		2.69	0.94	2.62	2.86	3.54
	mAOD		-0.19	1.56	-0.12	-1.36	-2.24
22-Dec-10	mbgl		2.67	0.98	2.54	2.91	3.62
	mAOD		-0.17	1.52	-0.04	-1.41	-2.12
27-Jan-11	mbgl		2.73	1.12	2.41	2.93	3.64
	mAOD		-0.23	1.38	0.09	-1.43	-2.14
DbEO - Destroyed by extraction operations							

Water level data from 1 m piezometers

Piezometer number		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
		38980	39054	38955	38832	38629	38411	39155	39366	39078	39097	38859
National Grid Reference (SK)		74025	73889	74154	74198	74237	74117	73776	73925	74241	73691	73691
Base of piezometer (mbgl)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ground level (mAOD)		2.30	2.30	2.30	2.30	2.30	2.03	2.30	2.30	2.30	2.30	2.30
Date of measurement												
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
23-Mar-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
28-Apr-10	mbgl	Dry	Dry	Dry	DbEO	DbEO	DbEO	DbEO	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry					Dry	Dry	Dry	Dry
27-May-10	mbgl	Dry	Dry	Dry					Dry	Dry	Dry	0.97
	mAOD	Dry	Dry	Dry					Dry	Dry	Dry	1.33
29-Jun-10	mbgl	Dry	Dry	Dry					Dry	Dry	Dry	0.97
	maOD	Dry	Dry	Dry					Dry	Dry	Dry	1.33
29-Jul-10	mbgl	Dry	Dry	Dry					Dry	Dry	Dry	0.97
	mAOD	Dry	Dry	Dry					Dry	Dry	Dry	1.33
26-Aug-10	mbgl	Dry	Dry	Dry					Dry	Dry	Dry	0.97
	mAOD	Dry	Dry	Dry					Dry	Dry	Dry	1.33
29-Sep-10	mbgl	Dry	Dry	Dry					Dry	Dry	Dry	0.97
	mAOD	Dry	Dry	Dry					Dry	Dry	Dry	1.33
28-Oct-10	mbgl	Dry	Dry	Dry					Dry	Dry	Dry	0.97
	mAOD	Dry	Dry	Dry					Dry	Dry	Dry	1.33
18-Nov-10	mbgl	Dry	Dry	Dry					Dry	Dry	Dry	0.97
	mAOD	Dry	Dry	Dry					Dry	Dry	Dry	1.33
22-Dec-10	mbgl	Dry	Dry	Dry					Dry	Dry	Dry	0.97
	mAOD	Dry	Dry	Dry					Dry	Dry	Dry	1.33
27-Jan-11	mbgl	Dry	Dry	Dry					Dry	Dry	Dry	0.97
	mAOD	Dry	Dry	Dry					Dry	Dry	Dry	1.33

BbEO - Destroyed by extraction operations
DAM - Damaged

Water level data from 1 m piezometers

Piezometer number		**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
		38795	38732	38989	38890	38793	39172	39123	39083	38898	38763	38652
National Grid Reference (SK)		73737	73864	73658	73813	73971	74141	74459	73558	73430	73318	73399
Base of piezometer (mbgl)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	1.00
Ground level (mAOD)		2.30	2.30	2.30	2.30	2.30	2.30	1.30	2.30	2.30	2.30	2.30
Date of measurement												
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	0.81	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	0.49	Dry	Dry	Dry	Dry
23-Mar-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	0.84	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	0.46	Dry	Dry	Dry	Dry
28-Apr-10	mbgl	DbEO	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27-May-10	mbgl		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Jun-10	mbgl		DbEO	Dry	DbEO	DbEO	Dry	Dry	Dry	Dry	Dry	Dry
	maOD			Dry			Dry	Dry	Dry	Dry	Dry	Dry
29-Jul-10	mbgl			Dry			Dry	Dry	Dry	Dry	Dry	Dry
	mAOD			Dry			Dry	Dry	Dry	Dry	Dry	Dry
26-Aug-10	mbgl			Dry			Dry	DAM	Dry	Dry	Dry	Dry
	mAOD			Dry			Dry		Dry	Dry	Dry	Dry
29-Sep-10	mbgl			Dry			Dry		Dry	Dry	Dry	Dry
	mAOD			Dry			Dry		Dry	Dry	Dry	Dry
28-Oct-10	mbgl			Dry			Dry		Dry	Dry	Dry	Dry
	mAOD			Dry			Dry		Dry	Dry	Dry	Dry
18-Nov-10	mbgl			Dry			Dry		Dry	Dry	Dry	Dry
	mAOD			Dry			Dry		Dry	Dry	Dry	Dry
22-Dec-10	mbgl			Dry			Dry		Dry	Dry	Dry	Dry
	mAOD			Dry			Dry		Dry	Dry	Dry	Dry
27-Jan-11	mbgl			Dry			Dry		Dry	Dry	Dry	Dry
	mAOD			Dry			Dry		Dry	Dry	Dry	Dry

BbEO - Destroyed by extraction operations
DAM - Damaged

Water level data from 1 m piezometers

Piezometer number		23	24	25	26	27	28	29	30	31	32	33
		38541	38860	38936	39007	38700	38626	38587	38559	38547	38449	38325
National Grid Reference (SK)		73489	73262	73205	73151	73191	73066	72919	72803	72639	72520	72597
Base of piezometer (mbgl)		1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.90	1.00	0.80	1.00
Ground level (mAOD)		1.30	1.30	1.30	2.28	1.30	1.30	1.40	1.40	1.30	1.50	1.30
Date of measurement												
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
23-Mar-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
28-Apr-10	mbgl	0.94	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	0.36	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27-May-10	mbgl	0.64	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	0.66	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Jun-10	mbgl	0.83	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	maOD	0.47	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Jul-10	mbgl	0.92	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	0.38	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
26-Aug-10	mbgl	0.74	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	0.56	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Sep-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
28-Oct-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
18-Nov-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
22-Dec-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27-Jan-11	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry

Water level data from 1 m piezometers (continued)

Piezometer number		**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**
National Grid Reference (SK)		38170	38702	38812	38786	38753	38718	38230	38290	38349	38404	38445
		72688	72863	72811	72735	72642	72537	72819	72953	73089	73221	73310
Base of piezometer (mbgl)		1.00	1.00	1.00	0.80	1.00	0.90	1.00	1.00	1.00	1.00	1.00
Ground level (mAOD)		1.30	1.30	1.54	1.72	1.36	1.40	1.30	1.30	1.30	1.30	1.30
Date of measurement												
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
23-Mar-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
28-Apr-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27-May-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Jun-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	maOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Jul-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
26-Aug-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Sep-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
28-Oct-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
18-Nov-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
22-Dec-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27-Jan-11	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry

Water level data from 1 m piezometers (continued)

Piezometer number		45	46	47	48	49	50	51	52	53	54	55
		38529	38795	38705	38636	38602	39084	39154	39094	39159	39012	38777
National Grid Reference (SK)		73487	73309	73183	73056	72912	73093	73038	74370	74571	74596	74630
Base of piezometer (mbgl)		1.00	0.60	1.00	1.00	0.60	1.00	1.00	1.00	1.00	1.00	1.00
Ground level (mAOD)		1.30	1.70	1.30	1.30	1.70	2.30	2.30	1.25	1.30	1.30	1.30
Date of measurement												
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.93	0.95
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.37	0.35
23-Mar-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.99	0.98
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.31	0.32
28-Apr-10	mbgl	0.96	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.72	0.98	0.95
	mAOD	0.34	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.58	0.32	0.35
27-May-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.52	0.73	0.71
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.78	0.57	0.59
29-Jun-10	mbgl	0.95	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.61	0.86	0.82
	maOD	0.35	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.69	0.44	0.48
29-Jul-10	mbgl	0.81	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.77	0.97	0.97
	mAOD	0.49	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.53	0.33	0.33
26-Aug-10	mbgl	0.73	Dry	Dry	Dry	Dry	Dry	Dry	DAM	0.73	Dry	Dry
	mAOD	0.57	Dry	Dry	Dry	Dry	Dry	Dry		0.57	Dry	Dry
29-Sep-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry
28-Oct-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry
18-Nov-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry
22-Dec-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry
27-Jan-11	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry		Dry	Dry	Dry

BbEO - Destroyed by extraction operations

DAM - Damaged

Water level data from 1 m piezometers (continued)

Piezometer number		**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**
		38547	38517	38488	38460	38423	38401	38317	38221	38262	38401	39281	39234
National Grid Reference (SK)		74548	74456	74360	74265	74154	74122	74217	74327	74384	74488	74042	73920
Base of piezometer (mbgl)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ground level (mAOD)		1.30	0.30	0.30	0.30	0.72	0.87	0.30	0.30	0.30	0.30	1.30	1
Date of measurement													
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
23-Mar-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
28-Apr-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	RI
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	RI
27-May-10	mbgl	0.89	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.83	Dry	Dry	0.85
	mAOD	0.41	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.83	Dry	Dry	0.45
29-Jun-10	mbgl	Dry	Dry	Dry	DbEO	DbEO	DbEO	DbEO	DbEO	Dry	Dry	Dry	Dry
	maOD	Dry	Dry	Dry						Dry	Dry	Dry	Dry
29-Jul-10	mbgl	Dry	Dry	Dry						Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry						Dry	Dry	Dry	Dry
26-Aug-10	mbgl	Dry	Dry	Dry						Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry						Dry	Dry	Dry	Dry
29-Sep-10	mbgl	Dry	Dry	Dry						Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry						Dry	Dry	Dry	Dry
28-Oct-10	mbgl	Dry	Dry	Dry						Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry						Dry	Dry	Dry	Dry
18-Nov-10	mbgl	Dry	Dry	Dry						Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry						Dry	Dry	Dry	Dry
22-Dec-10	mbgl	Dry	Dry	Dry						Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry						Dry	Dry	Dry	Dry
27-Jan-11	mbgl	Dry	Dry	Dry						Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry						Dry	Dry	Dry	Dry
BbEO - Destroyed by extraction operations													

Water level data from 2 m piezometers

Piezometer number		1	2	3	4	5	6	7	8	10	11	14
		38980	39054	38955	38832	38629	38411	39155	39366	39097	38859	38989
National Grid Reference (SK)		74025	73889	74154	74198	74237	74117	73776	73925	73691	73691	73658
Base of piezometer (mbgl)		1.72	1.86	2.00	2.00	2.00	1.72	2.00	2.00	2.00	2.00	2.00
Ground level (mAOD)		2.30	2.30	2.30	2.30	2.30	2.03	2.30	2.30	2.30	2.30	2.30
Date of measurement												
23-Feb-10	mbgl	1.65	1.43	Dry	Dry	Dry	Dry	1.18	1.34	1.59	1.92	1.63
	mAOD	0.65	0.87	Dry	Dry	Dry	Dry	1.12	0.96	0.71	0.38	0.67
23-Mar-10	mbgl	1.67	1.51	Dry	Dry	Dry	Dry	1.18	1.36	1.55	1.98	1.66
	mAOD	0.63	0.79	Dry	Dry	Dry	Dry	1.12	0.94	0.75	0.32	0.64
28-Apr-10	mbgl	1.57	1.47	Dry	Dry	Dry	Dry	1.15	1.33	1.52	1.92	1.61
	mAOD	0.73	0.83	Dry	Dry	Dry	Dry	1.15	0.97	0.78	0.38	0.69
27-May-10	mbgl	1.31	1.09	1.10	Dry	Dry	Dry	1.01	1.12	1.23	1.58	1.36
	mAOD	0.99	1.21	1.20	Dry	Dry	Dry	1.29	1.18	1.07	0.72	0.94
29-Jun-10	mbgl	1.35	1.12	DbEO	DbEO	DbEO	DbEO	1.06	1.16	1.29	1.66	1.41
	maOD	0.95	1.18					1.24	1.14	1.01	0.64	0.89
29-Jul-10	mbgl	1.47	1.25					1.13	1.25	1.37	1.72	1.52
	mAOD	0.83	1.05					1.17	1.05	0.93	1.66	0.78
26-Aug-10	mbgl	1.46	1.26					1.22	1.15	Dry	1.64	1.39
	mAOD	0.84	1.04					1.08	1.15	Dry	0.66	0.91
29-Sep-10	mbgl	Dry	1.62					1.31	1.48	Dry	Dry	Dry
	mAOD	Dry	0.68					0.99	0.82	Dry	Dry	Dry
28-Oct-10	mbgl	Dry	Dry					1.37	1.53	Dry	Dry	Dry
	mAOD	Dry	Dry					0.93	0.77	Dry	Dry	Dry
18-Nov-10	mbgl	Dry	Dry					1.48	1.54	Dry	Dry	Dry
	mAOD	Dry	Dry					0.82	0.76	Dry	Dry	Dry
22-Dec-10	mbgl	Dry	Dry					1.53	1.58	Dry	Dry	Dry
	mAOD	Dry	Dry					0.77	0.72	Dry	Dry	Dry
27-Jan-11	mbgl	1.70	1.82					1.38	1.47	Dry	Dry	Dry
	mAOD	0.60	0.58					0.92	0.83	Dry	Dry	Dry
BbEO - Destroyed by extraction operations												

Water level data from 2 m piezometers (continued)

Piezometer number		**17**	**18**	**23**	**24**	**25**	**26**	**27**	**28**	**31**	**34**	**40**
National Grid Reference (SK)		39172 74141	39123 74459	38541 73489	38860 73262	38936 73205	39007 73151	38700 73191	38626 73066	38547 72639	38170 72688	38230 72819
Base of piezometer (mbgl)		1.90	2.00	2.00	2.00	1.50	1.80	1.70	1.50	1.80	2.00	2.00
Ground level (mAOD)		2.30	1.30	2.30	2.30	2.30	3.28	2.30	2.30	2.30	2.30	2.30
Date of measurement												
23-Feb-10	mbgl	1.71	1.05	1.92	1.84	Dry	1.33	Dry	Dry	Dry	Dry	Dry
	mAOD	0.59	1.25	0.38	0.46	Dry	1.95	Dry	Dry	Dry	Dry	Dry
23-Mar-10	mbgl	1.53	1.00	1.99	1.97	Dry	1.43	Dry	Dry	Dry	Dry	Dry
	mAOD	0.77	1.30	0.31	0.33	Dry	1.85	Dry	Dry	Dry	Dry	Dry
28-Apr-10	mbgl	1.84	1.57	1.64	Dry	Dry	1.41	Dry	Dry	Dry	Dry	Dry
	mAOD	0.46	0.73	0.66	Dry	Dry	1.87	Dry	Dry	Dry	Dry	Dry
27-May-10	mbgl	1.31	Dry	1.25	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	0.99	Dry	1.05	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Jun-10	mbgl	1.43	1.54	1.36	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	maOD	0.87	0.76	0.94	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Jul-10	mbgl	1.43	1.65	1.46	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	0.87	0.65	0.84	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
26-Aug-10	mbgl	1.57	DAM	1.41	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	0.73		0.89	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
29-Sep-10	mbgl	1.89		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	0.41		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
28-Oct-10	mbgl	Dry		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
18-Nov-10	mbgl	Dry		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
22-Dec-10	mbgl	Dry		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27-Jan-11	mbgl	Dry		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
	mAOD	Dry		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
DAM - Damaged												

Water level data from 2 m piezometers (continued)

Piezometer number		41	42	43	44	45	48	53	54	55	56	57
National Grid Reference (SK)		38290	38349	38404	38445	38529	38636	39159	39012	38777	38547	38517
		72953	73089	73221	73310	73487	73056	74571	74596	74630	74548	74456
Base of piezometer (mbgl)		2.00	2.00	2.00	2.00	2.00	1.60	2.00	2.00	2.00	2.00	2.00
Ground level (mAOD)		2.30	2.30	2.30	2.30	2.30	2.30	1.30	1.30	1.30	1.30	1.30
Date of measurement												
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	1.78	Dry	1.53	1.71	1.53	1.51	Dry
	mAOD	Dry	Dry	Dry	Dry	0.52	Dry	-0.23	-0.41	-0.23	-0.21	Dry
23-Mar-10	mbgl	Dry	Dry	Dry	Dry	1.88	Dry	1.69	1.47	1.35	1.78	Dry
	mAOD	Dry	Dry	Dry	Dry	0.42	Dry	-0.39	-0.17	-0.05	-0.48	Dry
28-Apr-10	mbgl	Dry	Dry	Dry	Dry	1.64	Dry	0.89	1.60	1.34	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	0.66	Dry	0.41	-0.3	-0.04	Dry	Dry
27-May-10	mbgl	1.93	Dry	Dry	Dry	Dry	Dry	0.66	1.46	1.19	1.81	Dry
	mAOD	0.37	Dry	Dry	Dry	Dry	Dry	0.64	-0.16	0.11	-0.51	Dry
29-Jun-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	0.89	1.66	1.23	Dry	Dry
	maOD	Dry	Dry	Dry	Dry	Dry	Dry	0.41	-0.36	0.07	Dry	Dry
29-Jul-10	mbgl	Dry	Dry	Dry	Dry	1.27	Dry	0.89	1.88	1.47	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	1.03	Dry	0.41	-0.58	-0.17	Dry	Dry
26-Aug-10	mbgl	Dry	Dry	Dry	Dry	1.25	Dry	0.91	1.71	1.43	1.94	Dry
	mAOD	Dry	Dry	Dry	Dry	1.05	Dry	0.39	-0.41	-0.13	-0.64	Dry
29-Sep-10	mbgl	Dry	Dry	Dry	Dry	1.57	Dry	1.22	Dry	1.79	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	0.73	Dry	0.08	Dry	-0.49	Dry	Dry
28-Oct-10	mbgl	Dry	Dry	Dry	Dry	1.95	Dry	1.29	Dry	1.99	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	0.35	Dry	0.01	Dry	-0.69	Dry	Dry
18-Nov-10	mbgl	Dry	Dry	Dry	Dry	1.98	Dry	1.31	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	0.32	Dry	-0.01	Dry	Dry	Dry	Dry
22-Dec-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	1.38	Dry	Dry	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	-0.08	Dry	Dry	Dry	Dry
27-Jan-11	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	1.42	Dry	1.92	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	-0.12	Dry	-0.62	Dry	Dry

Water level data from 2 m piezometers (continued)

Piezometer number		**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**
National Grid Reference (SK)		38488	38460	38423	38401	38317	38221	38262	38401	39281	39234
		74360	74265	74154	74122	74217	74327	74384	74488	74042	73920
Base of piezometer (mbgl)		2.00	2.00	2.00	2.00	2.00	1.50	1.90	2.00	1.90	1.85
Ground level (mAOD)		1.30	1.30	1.72	1.87	1.30	1.30	1.30	1.30	2.30	2.30
Date of measurement											
23-Feb-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	1.65	Dry	1.53	1.16
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	-0.35	Dry	0.77	1.14
23-Mar-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	1.70	Dry	1.40	1.22
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	-0.4	Dry	0.90	1.08
28-Apr-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	1.29	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	1.01	Dry
27-May-10	mbgl	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.97	Dry	Dry
	mAOD	Dry	Dry	Dry	Dry	Dry	Dry	Dry	0.33	Dry	Dry
29-Jun-10	mbgl	Dry	Dry	Dry	DbEO	DbEO	DbEO	Dry	Dry	1.45	1.16
	maOD	Dry	Dry	Dry				Dry	Dry	0.85	1.14
29-Jul-10	mbgl	Dry	Dry	Dry				Dry	Dry	1.17	0.95
	mAOD	Dry	Dry	Dry				Dry	Dry	1.13	1.35
26-Aug-10	mbgl	Dry	Dry	Dry				Dry	Dry	1.13	0.86
	mAOD	Dry	Dry	Dry				Dry	Dry	1.17	1.44
29-Sep-10	mbgl	Dry	Dry	Dry				Dry	Dry	1.54	1.23
	mAOD	Dry	Dry	Dry				Dry	Dry	0.76	1.07
28-Oct-10	mbgl	Dry	Dry	Dry				Dry	Dry	1.56	1.30
	mAOD	Dry	Dry	Dry				Dry	Dry	0.74	1.00
18-Nov-10	mbgl	Dry	Dry	Dry				Dry	Dry	1.56	1.38
	mAOD	Dry	Dry	Dry				Dry	Dry	0.74	0.92
22-Dec-10	mbgl	Dry	Dry	Dry				Dry	Dry	1.59	1.43
	mAOD	Dry	Dry	Dry				Dry	Dry	0.71	0.87
27-Jan-11	mbgl	Dry	Dry	Dry				Dry	Dry	1.54	1.37
	mAOD	Dry	Dry	Dry				Dry	Dry	0.76	0.93
BbEO - Destroyed by extraction operations											

Water environment data from piezometers

Piezometer number		P1	P2	P3	P7	P8	P10	P11	P14	P17	P18	P23
National Grid Reference (TL)		38980	39054	38955	39155	39366	39097	38859	38989	39172	39123	38541
		74025	73889	74154	73776	73925	73691	73691	73658	74141	74459	73489
Date of measurement												
24-Feb-10	pH	6.7	5.6		6.8	8.3	7.2		6.7	7.8	7.1	
	ORP (mV)	214	112		55	325	142		193	152	185	
	Conductivity (µs/cm)	343	1541		432	417	414		457	1438	431	
	Temperature (°C)	5.4	5.3		5.6	6.1	5.8		5.9	6.2	5.8	
24-Mar-10	pH	6.6	5.9		7.1	8.5	7.4		6.9	8	7.2	
	ORP (mV)	164	86		61	230	112		188	113	167	
	Conductivity (µs/cm)	289	1419		393	328	386		304	1530	337	
	Temperature (°C)	6.2	6.3		6.2	6.6	6.2		6.4	7.3	6.4	
29-Apr-10	pH	8.6			8.3	8.5	8.7	8.3	8.5	8.4		7.9
	ORP (mV)	154			66	47	147	181	155	73		119
	Conductivity (µs/cm)	41			130	60	138	1	26	58		24
	Temperature (°C)	13.2			11.6	9.6	12.7	11.7	10.1	10.9		9.5
28-May-10	pH	6.9	6.7	7	6.7	7	6.9	6.8	6.8	6.7		7.3
	ORP (mV)	67	-1	121	25	123	-19	4	1	17		91
	Conductivity (µs/cm)	274	1865	376	764	1237	1037	244	1412	465		269
	Temperature (°C)	14.3	14	11.3	12.3	12.2	12.8	12.2	12.1	13.4		13.1
30-Jun-10	pH	7	6.8		7.2	7.3	7		6.9	7.3	7	7.4
	ORP (mV)	8	-36		-13	10	-31		-15	1	21	103
	Conductivity (µs/cm)	53	1444		856	1465	1426		205	346	236	1016
	Temperature (°C)	16.1	15.8		13.5	13.3	13.4		13.2	12.8	15.2	12
30-Jul-10	pH	7.1	6.9		6.9	7.1	7.1		7	6.9	6.9	7.2
	ORP (mV)	-68	-55		-38	-42	-49		-36	-6	-41	116
	Conductivity (µs/cm)	1	1136		1713	1599	1704		316	254	1	1640
	Temperature (°C)	18.1	18		14.3	14.1	15		14.8	11.4	18.4	11.4
27-Aug-10	pH	7.4	7.5		7.1	7.2		7.2	7.4	7.2		7.7
	ORP (mV)	-57	-68		-22	9		-40	-6	-17		50
	Conductivity (µs/cm)	1154	547		1281	1255		1803	335	1002		1647
	Temperature (°C)	22.8	22.8		16.5	16.2		17.9	17	20		18.9
30-Sep-10	pH		7.4		7	7.3						
	ORP (mV)		20		-18	-37						
	Conductivity (µs/cm)		0		1408	1467						
	Temperature (°C)		15.6		13.3	12.8						
29-Oct-10	pH				7	7						
	ORP (mV)				121	382						
	Conductivity (µs/cm)				998	516						
	Temperature (°C)				6.7	5.9						
19-Nov-10	pH				6.8	6.9						
	ORP (mV)				170	82						
	Conductivity (µs/cm)				1083	1002						
	Temperature (°C)				5.8	6.7						
23-Dec-10	pH				6.8	7.2						
	ORP (mV)				112	118						
	Conductivity (µs/cm)				743	412						
	Temperature (°C)				6.4	5.7						
28-Jan-11	pH				6.9	7.5						
	ORP (mV)				78	62						
	Conductivity (µs/cm)				649	44						
	Temperature (°C)				4.9	5.3						

Water environment data from piezometers (continued)

Piezometer / borehole number		P24	P26	P45	P52	P53	P54	P55	P56	P66	P67
National Grid Reference (TL)		38860	39007	38529	39094	39159	39012	38777	38547	39281	39234
		73262	73151	73487	74370	74571	74596	74630	74548	74042	73920
Date of measurement											
25-Feb-10	pH	8	6.2	5.3		6.4	7.4	7	6.9	7.5	7.2
	ORP (mV)	78	131	216		236	162	259	14	168	123
	Conductivity (µs/cm)	65	316	273		327	448	763	87	412	276
	Temperature (°C)	5.8	5.6	5.7		5.4	6.1	5.7	5.8	6	5.8
24-Mar-10	pH	8.3	6.6	5.4		6.9	7.8	7.2	7.2	7.8	7.6
	ORP (mV)	99	144	198		196	136	202	2	136	208
	Conductivity (µs/cm)	93	317	213		775	276	504	939	276	252
	Temperature (°C)	6.5	6.5	6.6		5.9	6.5	6.4	6.4	6.5	6.6
29-Apr-10	pH			6.9	8.9	8.1	8.2	8.7	8.6	8.8	7.3
	ORP (mV)			175	201	139	70	63	32	24	101
	Conductivity (µs/cm)			14	0	147	132	36	44	119	243
	Temperature (°C)			9.5	17.3	10.2	10.7	10.9	11.8	10.3	9.2
28-May-10	pH			7.7		6.5	6.5	6.9	6.9	6.9	7
	ORP (mV)			146		38	68	13	17	-7	-1
	Conductivity (µs/cm)			469		1557	1871	1394	1251	1450	231
	Temperature (°C)			14.6		12.4	10.3	11.3	10.9	13	13.6
30-Jun-10	pH			7.5		7.1	6.6	6.9		7	7
	ORP (mV)			154		-3	44	-12		-13	-23
	Conductivity (µs/cm)			832		1341	1059	1456		1563	435
	Temperature (°C)			16.3		15.6	13.7	12.6		15.1	14
30-Jul-10	pH			7.3		6.8	6.7	6.9		7.1	7.1
	ORP (mV)			150		-42	-2	-38		-21	-44
	Conductivity (µs/cm)			1112		1158	131	1683		1763	1799
	Temperature (°C)			18.5		17.5	17.3	14.9		17.2	14.5
27-Aug-10	pH			7.7		7.6	7.3	7.2		7.3	7.2
	ORP (mV)			102		-18	-22	-22		58	-8
	Conductivity (µs/cm)			1688		1011	1515	1598		1236	1333
	Temperature (°C)			19.2		18	17.6	16.6		18.1	16.7
30-Sep-10	pH			7.5		7.1		7.1		7.4	7.3
	ORP (mV)			54		99		16		18	-37
	Conductivity (µs/cm)			904		1305		1388		2	1467
	Temperature (°C)			14.4		15.1		16		13.1	12.6
29-Oct-10	pH					7.3					
	ORP (mV)					93					
	Conductivity (µs/cm)					142					
	Temperature (°C)					10.4					
19-Nov-10	pH					6.9					
	ORP (mV)					208					
	Conductivity (µs/cm)					497					
	Temperature (°C)					6.8					
23-Dec-10	pH					7.3					
	ORP (mV)					153					
	Conductivity (µs/cm)					288					
	Temperature (°C)					6.3					
28-Jan-11	pH					7.2					
	ORP (mV)					214					
	Conductivity (µs/cm)					561					
	Temperature (°C)					6.3					

Water environment data from boreholes

Piezometer / borehole number		B1	B2	B3	B4	B5
National Grid Reference (TL)		38385	38918	39576	38718	38773
		74118	73441	74292	72539	74630
Date of measurement						
25-Feb-10	pH	9.6	7.3	8.3	7.1	7.5
	ORP (mV)	25	188	197	201	178
	Conductivity (µs/cm)	214	15	168	388	216
	Temperature (°C)	6.4	6.2	6.1	5.4	7.6
24-Mar-10	pH	10.2	7.7	9.4	7.5	8.3
	ORP (mV)	86	145	230	219	160
	Conductivity (µs/cm)	195	-59	161	329	234
	Temperature (°C)	7.5	6.7	6.2	6.6	6.5
29-Apr-10	pH		8.5	8.2	8	9.5
	ORP (mV)		11	99	218	98
	Conductivity (µs/cm)		18	83	23	33
	Temperature (°C)		9.7	11.4	9.5	9.8
28-May-10	pH	7.5	7.5	7.2	7.2	
	ORP (mV)	66	-33	142	150	
	Conductivity (µs/cm)	134	85	279	297	
	Temperature (°C)	13.2	13.1	12.3	12.5	
30-Jun-10	pH		7.6	7	7.1	
	ORP (mV)		-30	143	167	
	Conductivity (µs/cm)		562	673	495	
	Temperature (°C)		14	14.1	13	
30-Jul-10	pH		7.5	6.9	7	
	ORP (mV)		-23	157	192	
	Conductivity (µs/cm)		1207	1821	1098	
	Temperature (°C)		15.7	15.8	13.4	
27-Aug-10	pH		7.6	7.2	7.5	
	ORP (mV)		-20	163	150	
	Conductivity (µs/cm)		847	1730	1655	
	Temperature (°C)		19.1	16.4	15.4	
30-Sep-10	pH		7.6	7.4	7.3	
	ORP (mV)		-40	12	51	
	Conductivity (µs/cm)		611	645	1004	
	Temperature (°C)		16	12.5	11.9	
29-Oct-10	pH		7.5	6.8	7.1	
	ORP (mV)		-83	183	114	
	Conductivity (µs/cm)		431	874	675	
	Temperature (°C)		9.1	10.2	8.5	
19-Nov-10	pH		7.6	6.3	7.2	
	ORP (mV)		-108	221	16	
	Conductivity (µs/cm)		561	1375	224	
	Temperature (°C)		7.7	8.5	7.1	
23-Dec-10	pH		7.3	7.1	7.1	
	ORP (mV)		25	304	158	
	Conductivity (µs/cm)		219	249	337	
	Temperature (°C)		6.8	7.3	6.4	
28-Jan-11	pH		7.1	8.2	7	
	ORP (mV)		238	145	251	
	Conductivity (µs/cm)		45	198	416	
	Temperature (°C)		6	6.2	5.7	