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A report to Charnwood Borough Council on the suitability of proposed new cemetery at Allendale Road as part of an Environment Agency T2 Audit

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D1.0




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Charnwood Borough Council

An Environment Agency T2 Assessment for a proposed new cemetery off Allendale Road, Loughborough, Leicestershire. LE11 2HU.
Grid Ref: 454048; 317358

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1.0 Executive summary

The site is considered to be **high risk** with the risk mainly attributed to the high predicted burial numbers.

Given that burials are likely to be into either the superficial deposits or the weathered bedrock, and given that these materials are only moderately or slowly permeable the risk to groundwater is likely to be low. The source of pollutants is present in the form of burials, the receptor is present in the form of the groundwater but the pathway, though viable, is likely to be inefficient due to the reduced permeability of the soil and especially through the clay-dominated subsoil. Groundwater has been struck at between 6 and 7m bgl in boreholes within 2.5 km of the site but this is likely to be groundwater that is limited in extent and associated mainly with localised layers of sand and gravel or larger fractures within the bedrock. No groundwater was struck in any of the trial pits excavated to a minimum of 3m depth. It is possible that underlying groundwater is in hydraulic continuity with the nearest surface water and may contribute to baseflow in this stream but this is not certain. To ascertain the nature and extent of any risk more precisely, flux modelling of the major pollutants ammonium and nitrate is recommended.

By way of grave-specific mitigation, the addition of Zeolitic compounds could be added to the base of graves. Zeolites such as Clinoptilolite or Bentonite clays have CEC values exceeding 150 meq/l and when placed in the base of the grave will absorb significant amounts of Ammonium via cation exchange processes in addition to the existing capacity of the clay soil (Pivato et al Waste Management Review 2004) (Rozic et al 2009 Bioinformatics).

Calculations would suggest that at least 90% of the human nitrogen (1.8 kg) release could be absorbed by 150 kg of Clinoptilolite or a high CEC clay material such as Bentonite.

2.0 Introduction

Cemetery Development Services Ltd has been asked to carry out a Tier 2 site screening assessment for a proposed new cemetery off Allendale Rd, Loughborough, Leicestershire. This site will be considered on the basis of groundwater risk and as part of this, a T2 study based on the criteria required by the Environment Agency has been carried out. This is because sites that do not meet the requirements of the Environment Agency should be ruled out at an early stage since the Agency as Primary Consultees are able to prevent any site being developed should the site be deemed to represent too great a risk in respect to water pollution.

The proposed development area has been assessed on a 1 km area of influence: grid reference 454048; 317358, nearest postcode: LE11 2HU. The site is calculated as being approximately 3 hectares (7.4 acres).

Figure 1a. OS map of the site

Figure 1b. Aerial photograph of the site, (site boundary marked in red)

This report will review the site proposed for use as a burial facility in accordance with the requirements of the Environment Agency's Tier 2 survey. For the purposes of this study the anticipated burial rate for this site is estimated as being in approximately 60 per year.

3.0 Background

New cemetery developments or extensions to existing cemeteries can be very emotive. However, these concerns are often disproportionate to the actual environmental risk.

Whilst the Local Planning Authority is the principal controlling body in determining approval for new sites or site extensions, significant information is required to ensure that the environmental risks are examined and that the Environment Agency's views are considered. Therefore, measures to prevent pollution must be undertaken and reported. Any regulatory decision-making is based on sound scientific knowledge. On this basis, a review of potential pollution from cemeteries was undertaken by the Environment Agency in collaboration with the British Geological Survey.

The aim was to review old and new cemeteries and measure the effects of contamination from viruses, bacteria and other microbiological pathogens and to assess the potential of chemical

contaminants affecting groundwater supplies from decomposition processes. Preliminary results showed that the operating cemetery examined in the study (25 years old) did show some evidence of bacterial contaminants in groundwater derived from corpses. However, no viruses were detected and the overall contaminant loading was found to be low. The studies found that degradation and attenuation was occurring indicating that potential risks were low. Whilst the outcome of this research found contaminant risk to be low, it should be reviewed in the context that natural attenuation processes may have been optimum at these sites. Therefore, to optimise natural attenuation and reduce the risk of possible groundwater contamination, a series of guidelines have been drawn up that are directly applicable to cemeteries.

Failure to manage and reduce any environmental risk to a minimum may result in action being taken under the Groundwater Regulations 1998 and the Anti-pollution Works Notice Regulations 1999.

3.1 Groundwater protection policy

Initial risk screening starts with the tools contained in the Agency's publication, Policy and Practice for the Protection of Groundwater in cemeteries and in the latest GP3 guidance notes.

Tools include Groundwater Vulnerability and Source Protection Zone (SPZ's) maps. These maps highlight where there are likely to be particular risks posed to groundwater from surface activities. Groundwater Vulnerability (GWV) Maps show the damage from pollution to groundwater and the relative importance of the aquifer to water supplies. Risk assessment is made with reference to soil leaching potential and the levels of water tables above major and minor aquifers.

Source Protection Zones are delineated areas around groundwater abstractions used for public consumption and defined by travel, time of biological or chemical contaminants.

The zones are classified in three groups:

Zone 1 High risk
Zone 2 Intermediate to high risk
Zone 3 Intermediate risk

The Environment Agency would be opposed to large graveyards within Zone 1 of an SPZ.

Whilst groundwater is a major part of policy concerns, other water point sources are also considered as requiring an evaluation of risk. These sources include surface water in the form of ditches, spring lines and surface run-off.

The factors influencing the risk of groundwater vulnerability include:

- Soil nature and type
    - Physical, mechanical and chemical properties
- Geomorphology
    - Depth to water table and or height above aquifers
    - Groundwater flow mechanisms
    - Aquifer type
- Abstractions
- SPZ's
- Proximity to water courses, ditches and drains

Therefore, prior to any consent being given by the Environment Agency, an assessment of risk should be undertaken. The degree of assessment is measured through a series of stages namely:

- Hazard identification
- Identification of consequences
- Magnitude of consequences
- Probability of consequences
- Significance of risk

3.2 Tiered risk assessment

There are 3 Tiers of Risk assessment. The associated size and position of the site will in-part determine which Tier is appropriate**.**

Tier 1
Desktop study of all appropriate documentation including GWV and SPZ maps, topographical, hydrological and geomorphologic maps. After adopting a systematic approach to the assessment of risk, a weighting can be given which is assessed as low, medium or high. If the overall risk is low, the proposal may be accepted by the Agency without further detailed assessment. However, the following practical guidelines would be recommended as appropriate controls to minimize pollution risk:

- 250 m distance from groundwater supply
- 30 m minimum distance from groundwater or spring
- 10 m distance from field drains
- No burials in standing water

For the purposes of this screening study, a T1 assessment is being made of each site. This will be augmented by on-site investigation at the preferred two sites following the conclusion of this study.

Tier 2
Should the risks not be clearly defined by the desktop study then further “ground truthing” might need to be undertaken. This may include field studies and monitoring of groundwater within the proposed area, comprising of the installation of up to three boreholes.
In this case, once the final preferred sites are identified the Environment Agency will be contacted with the site details and asked for a view as to whether boreholes or trial pits will be needed.

Tier 3
If the risk is considered high, i.e. the number of yearly burials exceeds 1,000; a full audit will be required. This would include, but not be limited to, a detailed site investigation including boreholes and monthly monitoring.

3.3 Water Resources Act 1991 – S161A Anti-Pollution Works Notices

The EA has powers under s161A of the Water Resources Act 1991 and the Anti-Pollution Works Regulations 1999, allowing Works Notices to be served to prevent or remedy pollution of controlled waters and under the Groundwater Regulations 1998 to prevent pollution of groundwater.

3.4 Groundwater Regulations 1998

Burial of human corpses can result in discharge of listed substances to groundwater. They are, therefore, covered by the requirements of the Groundwater Regulations. Individual burials spaced out over time will only release trivial amounts of listed substances.

These are considered to fall under the *de minimis exemption.* Large numbers of burials (>100 per annum) in a short time or the cumulative effects of many individual burials may cause groundwater pollution. In this case, the EA will, where appropriate, use their powers under the Groundwater Regulations to control or prohibit the burial. This has specific relevance to policy P12-2 but will apply more generally.

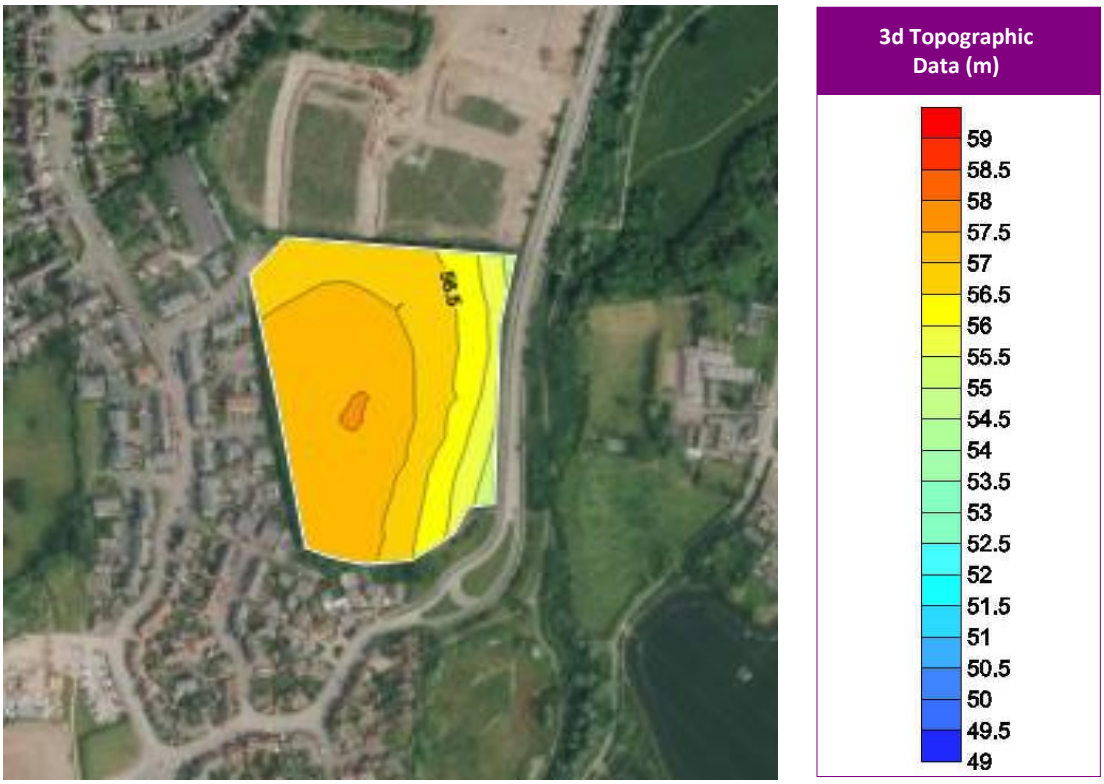
4.0 Site investigation

British Geological Survey and Cranfield University data was used in this report.

4.1 Topography and surface drainage

The site is currently amenity grassland and is located to the south of a further area of amenity land with Allendale Road to the east and south east with housing to the south west and along the western edge.

The site falls from the south west to the north east at a general grade of around 0.7% which is very gentle. According to OS data there are no water features on the site however a wet ditch or stream runs along the eastern edge of Allendale Road linking a pond to the north of Grange farm with a smaller pond south of Renals Farm.



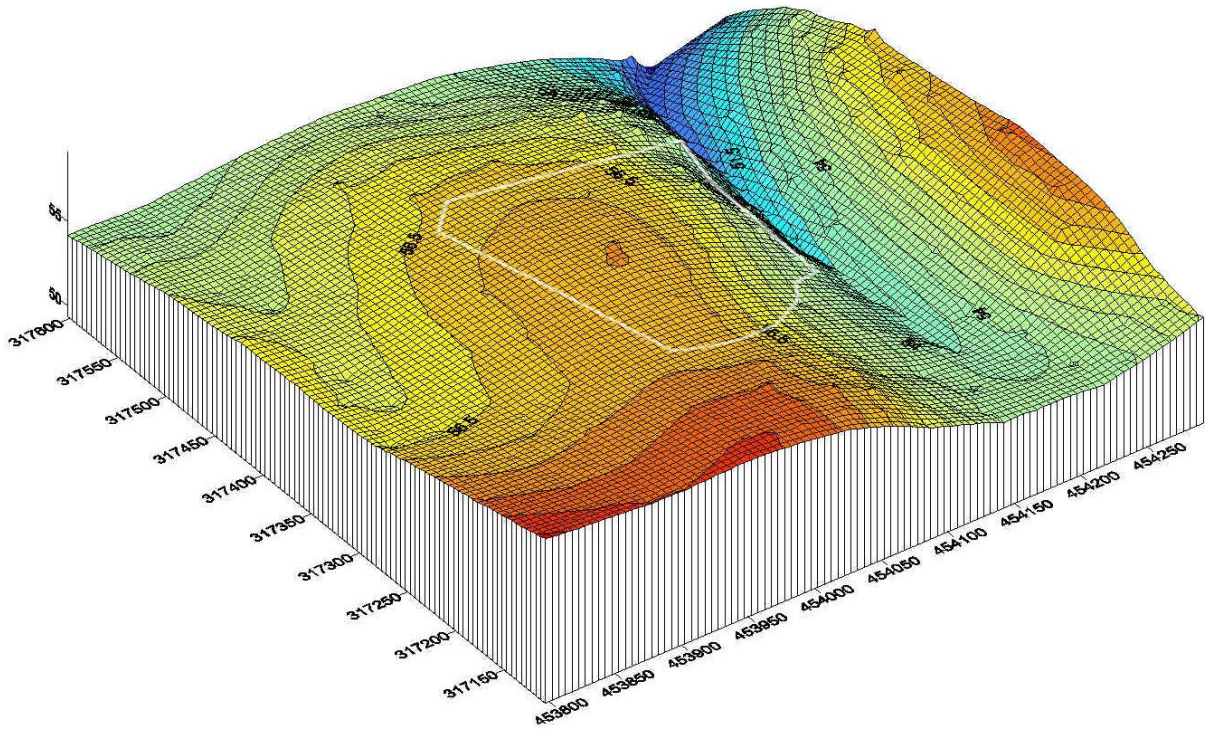


Figure 2. Topography of the site

4.2 Soil type

The Soil Survey of England and Wales map the site as containing soils belonging to the Curtisden Association (572i), as described in Table 1 and Figure 3.

Figure 3. Soil Associations in the vicinity of the site

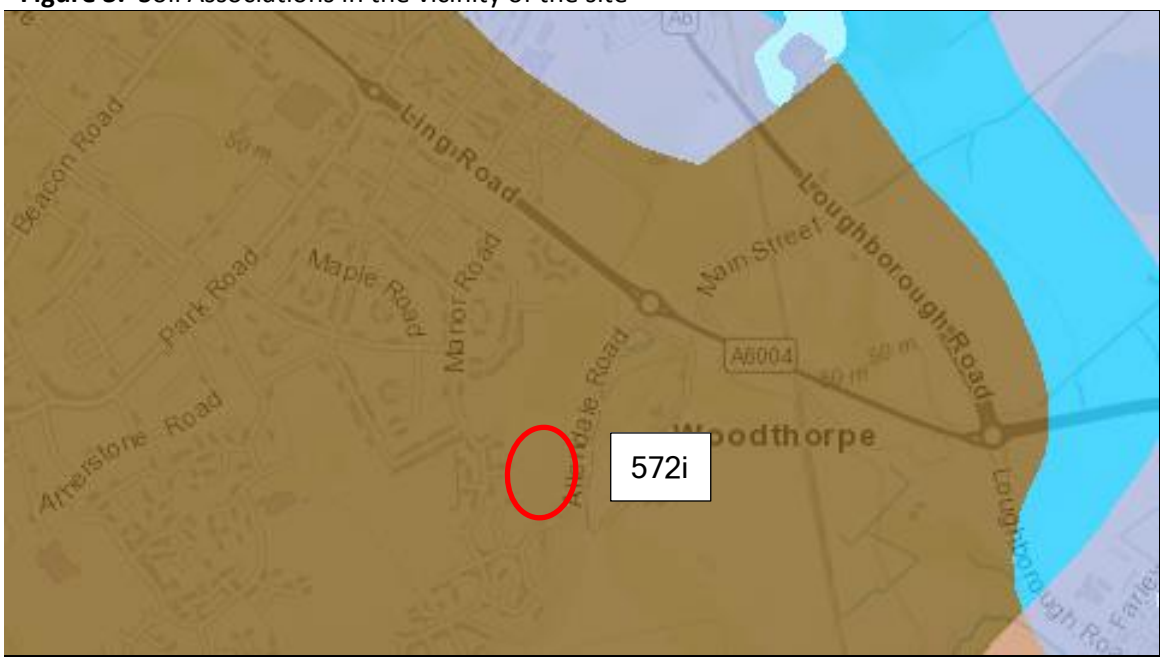


Table 1. Soil Associations in the vicinity of the site

Soil Association	Sub Groups	Description
511f Coombe 1	Cranbrook Stanway Bearsted Atrim	Silty soils over siltstone with slowly permeable subsoils and slight seasonal waterlogging. Some similar well drained soils. Some well drained coarse loamy soils over sandstone. Slumping possible locally.

This type of soil is generally suitable for cemeteries but may have some local issues with seepage from more permeable lenses within the subsoil which could flood graves if significant.

4.2.1 Site investigations

Site investigations were undertaken on 6th September 2017 with 6 trial pits dug to approximately 3.0 metres within and close to the area designated as a potential cemetery (Figure 5). Figure 4 shows the profiles of the pits excavated.

Figure 4. Trial pit soil profiles

Pit 1 profile | Pit 2 profile

Pit 3 profile

Pit 4 profile

Pit 5 profile

Pit 6 profile

The site was dry on day of the assessment following a period of average rainfall. The soils over the site were clay dominated being typically silty sandy clays. There was no evidence of the Birstall Member on the site as true sands and gravels but the upper 1m or so was a friable sandy clay rather than a much siltier clay or straight clay. The integrate between the superficial deposits and the underlying weathered would therefore appear to be gradual with a shallower depth of superficials than anticipated rom the geological mapping.

Figure 5. Trail pit location

4.3 Geology

The following headings cover the aspects of geology of the immediate area of the proposed development.

4.3.1 Artificial ground

This is ground at or near the surface that has been modified by man. It includes ground that has been deposited (Made Ground), landscaped, disturbed, excavated (Worked Ground) or some combination of these (Figure 6).

No Artificial Ground has been recorded by BGS up to the time of map compilation and Ordnance Survey maps, both current and historic, show no previous development of the site.

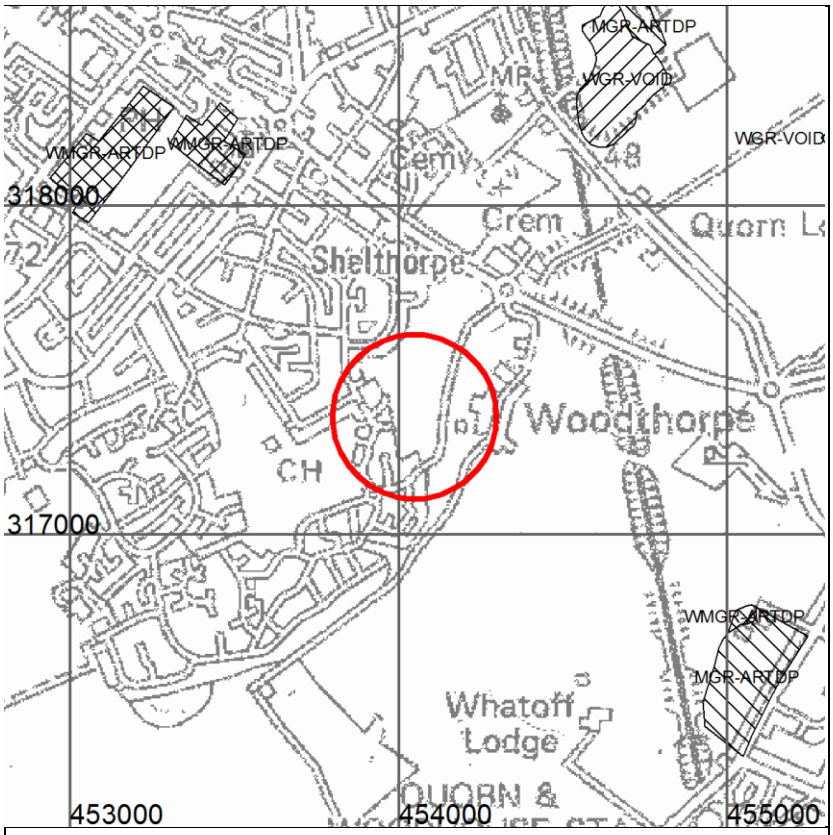


Figure 6. Artificial ground in the vicinity of the site

Search area indicated in red

Key to Artificial ground:

Map colour	Computer Code	Name of geological unit	Composition
	MGR-ARTDP	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT
	WGR-VOID	WORKED GROUND (UNDIVIDED)	VOID
	WMGR-ARTDP	INFILLED GROUND	ARTIFICIAL DEPOSIT

4.3.2 Superficial deposits

These are relatively young geological deposits formerly known as 'Drift', which lie on the bedrock in many areas. They include deposits such as unconsolidated sands and gravels formed by rivers and clayey tills formed by glacial action. They may be overlain by landslide deposits, by artificial deposits or both (Figure 7).

The site is almost entirely underlain by the Birstall Member (Soar Valley Formation) which is composed of sand and gravel with minor clay and silt lenses. The Birstall Member is comprised of a series of spatially isolated deposits that represent areas of ancient flood deposits (river terraces) during the Pleistocene. No boreholes prove the thickness of the Birstall Member at the site, though a borehole (SK51NW94 at 453910, 319670), located approximately 2.2 km to the NNW of the site (situated in another patch of the Birstall Member), has a thickness of 4 m. As such, it is likely that the Birstall Member at the site is likely to have a maximum thickness of ~4 m. The mapped margins of the Birstall Members coincide closely with the site boundary, though the Birstall Member is absent in the southeast corner of the site. The Birstall Member is likely to be thinner towards the mapped margins, perhaps ~1 m.

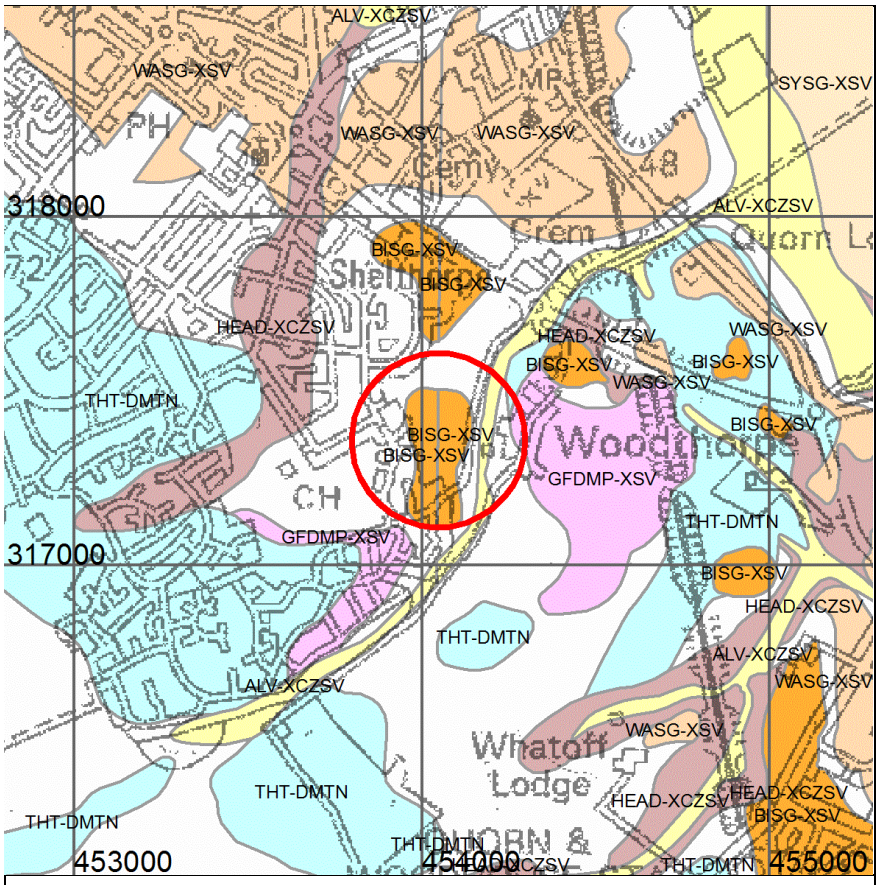


Figure 7. Superficial deposits in the vicinity of the site

Search area indicated in red

Key to Superficial deposits:

Map colour	Computer Code	Name of geological unit	Composition
	HEAD-XCZSV	HEAD	CLAY, SILT, SAND AND GRAVEL
	ALV-XCZSV	ALLUVIUM	CLAY, SILT, SAND AND GRAVEL
	SYSG-XSV	SYSTON MEMBER	SAND AND GRAVEL
	WASG-XSV	WANLIP MEMBER	SAND AND GRAVEL
	BISG-XSV	BIRSTALL MEMBER	SAND AND GRAVEL
	GFDMP-XSV	GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE	SAND AND GRAVEL
	THT-DMTN	THRUSSINGTON MEMBER	DIAMICTON

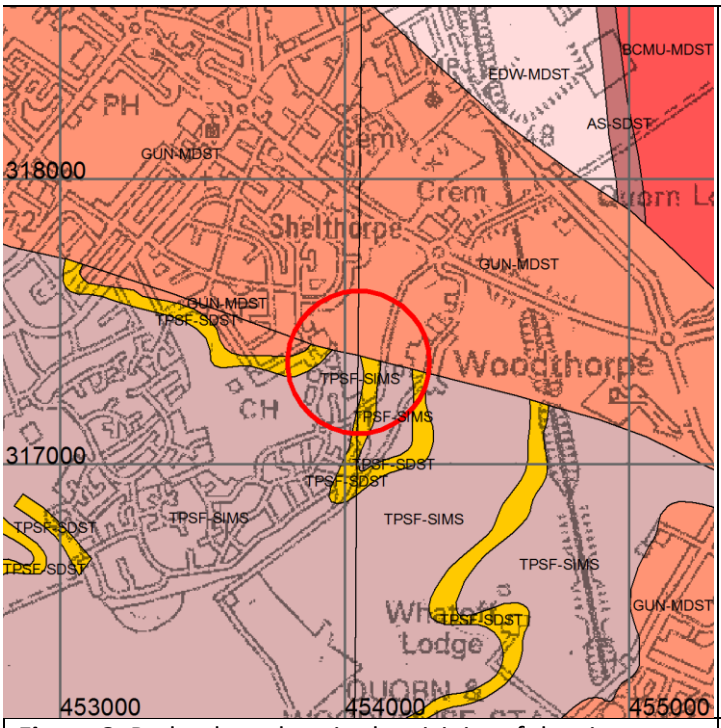
4.3.3 Rockhead depth

Rockhead at the site is likely to be between 0 and 4 m directly underlying the Birstall Member where it is present. Where the Birstall Member isn't present (southeast corner) bedrock is considered present at the surface.

4.3.4 Bedrock geology

The geology of the site is complicated by a mapped fault that is shown running WNW-ESE. This fault has juxtaposed slightly older rocks in the southern part of the site against younger in the northern. The northern third of the site is underlain by the Triassic Gunthorpe Member of the Sidmouth Mudstone Formation (part of the Mercia Mudstone Group). This is a red brown mudstone with

subordinate dolomitic siltstone and fine-grained, greenish-grey sandstone, with common gypsum veins and nodules.



Search area indicated in red

Fault

Coal, ironstone or mineral vein

Note: Faults are shown for illustration and to aid Interpretation of the map. Because these maps are generalised from more detailed versions not all such features are shown and their absence on the map face does not necessarily mean that none are Present. Coals, ironstone beds and mineral veins occur only in certain rock types and regions of the UK; if present here, they will be described within the 'Bedrock' section.

Figure 8. Bedrock geology in the vicinity of the site

Search area indicated in red

Key to Bedrock geology:

Map colour	Computer Code	Name of geological unit	Rock type
	BCMU-MDST	BRANSCOMBE MUDSTONE FORMATION	MUDSTONE
	AS-SDST	ARDEN SANDSTONE FORMATION	SANDSTONE
	EDW-MDST	EDWALTON MEMBER	MUDSTONE
	GUN-MDST	GUNTHORPE MEMBER	MUDSTONE
	TPSF-SDST	TARPORLEY SILTSTONE FORMATION	SANDSTONE
	TPSF-SIMS	TARPORLEY SILTSTONE FORMATION	SILTSTONE, MUDSTONE AND SANDSTONE

The Gunthorpe Member has a full thickness locally of ~70 m, though at the site the Gunthorpe Member is more likely to have a thickness of ~50 m. Underlying the Gunthorpe Member is the Radcliffe Member, also of the Sidmouth Mudstone Formation. The Radcliffe Member is predominately a mudstone and siltstone with occasional very fine-grained sandstones lenses. The unit is primarily red-brown coloured though may locally be pinkish red, red and sometimes green. The Radcliffe Member has a thickness of 5 – 15 m regionally. Beneath the Radcliffe Member is the Tarporley Siltstone Formation, another formation of the Mercia Mudstone Group. The Tarporley Siltstone is at depth in the northern part of the site but, due to the present fault, it directly underlies the superficial deposits of the Birstall Member in the southern part of the site. The Tarporley Siltstone Formation is composed of reddish-brown, interlaminated and interbedded, mudstones, siltstones and, fine- to medium-grained sandstones in approximately equal proportions. Locally the sandstone units contain abundant
mudstone clasts and are commonly less than 0.5 m thick; though composite stacked sandstone units may cumulatively reach thicknesses of ~5 m. The sandstone units may also contain gypsum veins. The

Tarporley Siltstone Formation becomes generally sandier towards the bottom of the unit and has a thickness locally of 40 – 60 m.

The Tarporley Siltstone Formation is underlain by the Sherwood Sandstone Group. The Sherwood Sandstone is a yellow-white to red-brown sandstone that may contain minor amounts of mudstone or conglomerates. The Sherwood Sandstone is likely to have a thickness of ~200 m.

4.3.5 Schematic geological cross-section

This sketch (Figure 9) represents an interpretation of the geometrical relationships of the main rock units described in the text. It is not to scale. The blue line indicates 'rockhead'; that is the base of superficial deposits. This is the 'geological rockhead', as distinct from the 'engineering rockhead', which is the base of 'engineering soil' (in the sense of BS5930:1999).

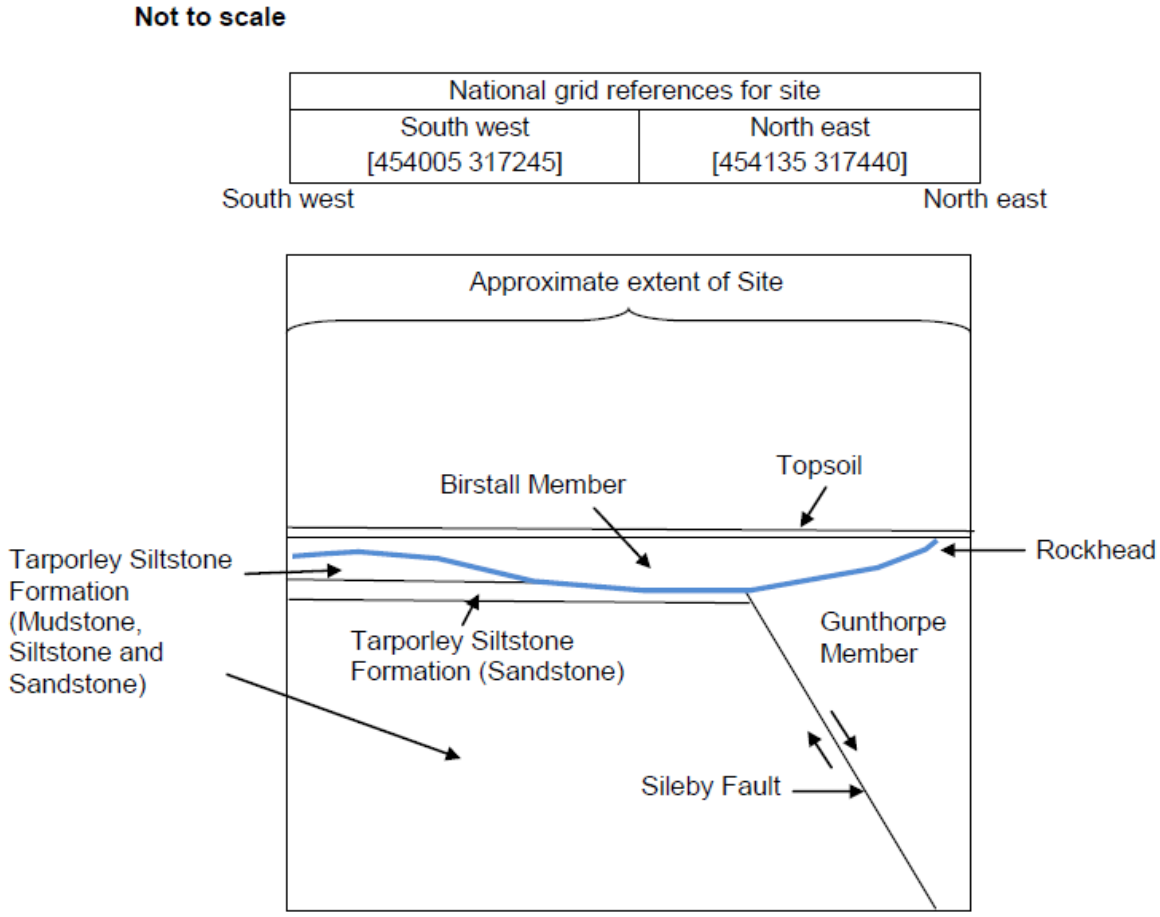
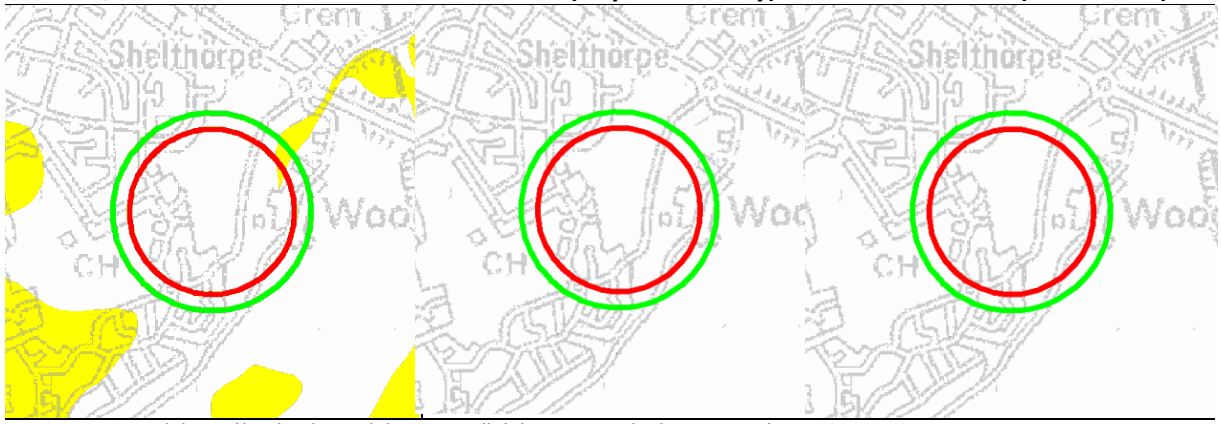


Figure 9. A schematic representation of the underlying geology of the site

4.4 Additional geological considerations

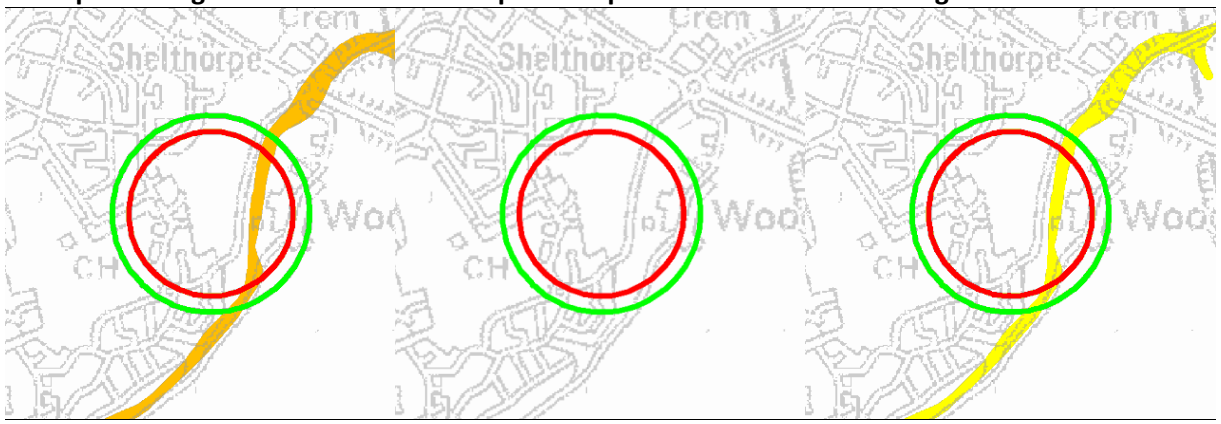
Figure 10. A summary of the geological hazards associated with the site

Shrink / Swell **Landslides (slope instability)** **Soluble rocks (dissolution)**



The hazard levels are described as A (least) to E (greatest), or as 'No Hazard'. Levels A and B are not considered significant and are not shown on the maps.

Compressible ground **Collapsible deposits** **Running sand**



The geological hazards found on the site are explained in Table 2.

Table 2. Geohazard summary

Geological hazard	May be significant within site area	Comments
Potential Natural Ground Stability Hazards		
Shrink-Swell	No	Level C = Potential for hazard to become active is at a level where it should be considered in decisions about construction, building maintenance and land use. This hazard is associated with the deposits of Till located to the NE and SW, outside of the site area.
Landslides (slope instability)	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Soluble Rocks (dissolution)	No	Level A = Potential for hazard to be active is either zero or insignificant.
Compressible Ground	No	Level D = Significant potential for hazard to become active that requires site-specific advice on the level of hazard related to building type and environment. This hazard is associated with the alluvium deposits located to the east, outside of the site area.
Collapsible Deposits	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Running Sand	No	Level C = Potential for hazard to become active is at a level where it should be considered in decisions about construction, building maintenance and land use. This hazard is associated with the alluvium deposits located to the east, outside of the site area.
Other Potential Hazards		
Mining	No	None.
Flooding	Yes	The various formations and members of the Mercia Mudstone Formation have a high component of clay within them. As such, they drain water very slowly. During periods of excessive rainfall the lower infiltration rates of these rocks can lead to localised areas of flooding. The Environment Agency and local authorities can provide advice on such issues.
Natural Land Gas	No	Unlikely to encounter gas from bedrock and coal mining; unlikely to encounter gas from peat.
Radon		Level of protective measures: NO

4.5 Hydrogeology

In lowland areas of the UK with little topographic variation, groundwater is likely to be found at shallow depths of only a few metres. Water table fluctuations will be small as they will be constrained by the ground surface and the base level of the local perennial streams and rivers.

In upland areas, precipitation is usually high and the dominantly metamorphic and igneous rocks often have relatively shallow groundwater levels.

This is due to preferential groundwater storage in near-surface weathered and fractured zones with limited drainage into the underlying un-weathered lower permeability rock. Exceptions can occur where higher permeability rocks, such as sandstone or limestone, allow faster through flow of groundwater towards the nearest stream or other discharge point.

Perched water tables occur where a less permeable horizon (e.g. a clay layer) in an otherwise permeable sequence retains a body of groundwater above the level of the regional water table. They usually occur at shallow depths in alluvial and glacial sediments and can be difficult to identify or to delimit.

An aquifer becomes confined when it is overlain by a less permeable horizon that restricts the upward movement of groundwater. When this less permeable horizon is penetrated (e.g. by drilling), the groundwater level rises above where struck to a level controlled by the hydrostatic pressure. If this is above ground level, overflowing artesian conditions will be encountered. Confined conditions should be anticipated, where possible, in order to plan for the problems they can generate.

Individual sites will always require more detailed assessments to determine the specific impact on groundwater resources. The maps represent conditions only at the ground surface. Where the soil and/or underlying formations have been disturbed or removed the vulnerability class may have been changed and site specific data will be required. Sites in urban areas and restored or current mineral workings are classified as having high (urban) soil leaching potential until proved otherwise.

The site is located on Environment Agency groundwater vulnerability map, sheet 23, Leicestershire.

No boreholes are near to site; the closest are site investigation boreholes c.1.1 km to east. One appeared to strike water between 6.5 and 10.0 m below ground level, no rest water level given. No other information available.

No boreholes are near to site; the closest are site investigation boreholes c.1.8 km to south. One struck “trace” of water at 6.1 m below ground level, no rest water level given. All other boreholes dry (deepest 6.5 m).

The Environment Agency now use their Aquifer Designation Dataset (http://apps.environment-agency.gov.uk/wiyby/117020.aspx) for Groundwater Protection matters, rather than the Groundwater Vulnerability maps. The Groundwater Vulnerability maps include information on Soil Leaching Potential, so we continue to reference them. The Aquifer Designation Dataset classifies superficial deposits in addition to bedrock.

At this site:
- the Birstall Member is classed as a Secondary A Aquifer,
- the Gunthorpe Member is classed as a Secondary B Aquifer,
- the Tarporley Siltstone Member is classed as a Secondary B Aquifer, apart from the mapped sandstone horizons which are designated as Secondary A Aquifers.

The definitions of these designations are:
- Secondary A - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers;

- Secondary B - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

It is possible that water will be present in the Birstall Member, perched upon the underlying lower permeability Gunthorpe Member and Tarporley Siltstone Formation. In periods of high surface water runoff water levels in the Birstall Member could be close to the surface since drainage of water through the underlying lower permeability formations could be slow (particularly through the Gunthorpe Member). In the south-east corner of the site, where the Birstall Member directly overlies the mapped sandstone unit within the Tarporley Siltstone Formation, the potential for groundwater drainage depends greatly on the localised geometry of the Birstall Member deposit, and thus the geometry of rockhead. Any groundwater within the Birstall Member would be likely to drain eastwards with the level controlled by the rockhead and there is therefore the potential for seepages along the eastern margin of the site, although none have been mapped.

Faults can form zones of different permeability to the surrounding rocks. We have no information about the impact on the hydrogeology of the fault that crosses the site.

The hydrological information for the site is summarised in Table 3.

Table 3. Hydrogeology summary

Geological unit	Groundwater potential	Water level and strikes	Quality	EA groundwater vulnerability classification
Birstall Member (Soar Valley Formation)	Sand and gravel deposit, likely to be very permeable	No information (no boreholes) but likely to contain groundwater. Groundwater within this deposit will be in hydraulic continuity with the underlying sandstone bed (part of the Tarporley Siltstone Formation) present at rockhead in the south-east quadrant of the site.	No information but may be similar to local surface water but more mineralised	Superficial deposits are not classified.
Gunthorpe Member (Sidmouth Mudstone Formation)	Generally regarded as a non-aquifer but with the possibility of some small quantities of groundwater within some sandy / sandstone horizons	No borehole information in the search area. If water is encountered in more permeable horizons, it may rise above the level at which it was first struck	No information but any groundwater present may be highly mineralised	Classified as a non-aquifer however some groundwater flow through these rocks may occur and should be considered when assessing the risk associated with persistent pollutants

Tarporley Siltstone Formation	The formation as a whole is not highly permeable but small quantities of groundwater may be encountered in fractures and more permeable horizons. The mapped sandstone bed which is at rockhead in the south east is likely to be permeable and contain some groundwater	No borehole information in the search area. If water is encountered in more permeable horizons beneath lower permeability siltstone beds it may rise above the level it was first struck	No information but any groundwater present may be highly mineralised	Classified as a non-aquifer however some groundwater flow through these rocks may occur and should be considered when assessing the risk associated with persistent pollutants

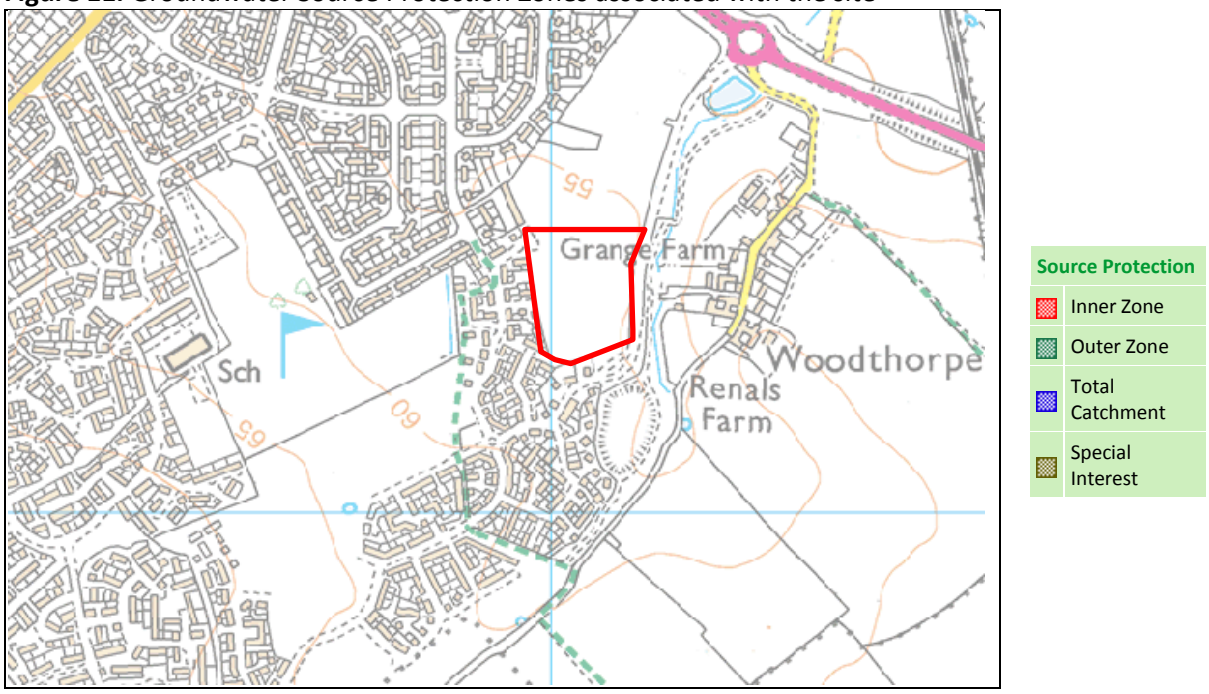
4.5.1 Groundwater vulnerability

This section reviews all components of hydrology, geology and top soil surface water drainage to assess risk notably to groundwater.

4.5.2 Source Protection Zones

The position of the site relative to current ground water protection zones is shown in Figure 11.

Figure 11. Groundwater Source Protection Zones associated with the site



Source Protection Zones (SPZs) provide an indication of the risk to groundwater supplies that may result from potentially polluting activities and accidental releases of pollutants. Generally the closer the activity or release is to a groundwater source the greater the risk. Three zones (an inner, outer and total catchment) are usually defined although a fourth zone (zone of special interest) is occasionally defined.

The Agency has subdivided groundwater source catchments into four zones. Two of these are determined by the travel time of potential pollutants, the third by the source catchment area itself and the fourth is a "Zone of Special Interest". This fourth zone highlights areas where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

- *Zone I (Inner Protection Zone)* - This zone is defined by a travel time of 50-days or less from any point within the zone at, or below, the water table. Additionally, the zone has, as a minimum, a 50-meter radius. It is based principally on biological decay criteria and is designed to protect against the transmission of toxic chemicals and water-borne disease.
- *Zone II (Outer Protection Zone)* - This zone is defined by the 400-day travel time, or 25% of the source catchment area, whichever is larger. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants.
- *Zone III (Total catchment)* - This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source.
- *Zone of Special Interest* - For some groundwater sources an additional Zone of Special Interest may be defined.
  These zones highlight areas (mainly on non-aquifers) where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

The proposed development site lies outside any Groundwater Source Protection Zone.

4.5.3 Aquifer vulnerability

The Groundwater Vulnerability maps are produced at 1:100,000 scale. They show, by means of colour coding, those areas of the country where water-bearing rocks (aquifers) are present. They also show the vulnerability of groundwater to pollution. The aquifers are classified into major, minor and non-aquifers according to their physical properties and their consequent value as a resource.

The classification of the land surface reflects the ability of contaminants to leach through the covering soils and pose a potential risk to groundwater at depth. The maps also indicate areas where the presence of low permeability drift may provide additional groundwater protection.

These maps can therefore be used for an initial screening assessment of the vulnerability of groundwater to contaminants applied to the surface of the ground. They do not provide all information relevant to the determination of vulnerability, such as the depth to water table or nature of the drift deposits. Site-specific information would always be needed for a detailed assessment of vulnerability at a given location. The original groundwater vulnerability maps were produced some time ago.

Groundwater Vulnerability Maps provide information on how significant the ground waters are likely to be and if they are vulnerable to pollution occurring at the land surface. The maps have descriptions on them to explain the different aquifer and soil types.

Areas shown as "major aquifers" have strategic significance for water resource; they often support large abstractions for the public water supply.

Minor aquifers have a more localised significance to domestic, agricultural and industrial users (although they may still be used for drinking water). Non-aquifers do not store significant amounts

of groundwater. However, in some areas they can support local supplies: e.g. small springs feeding individual properties.

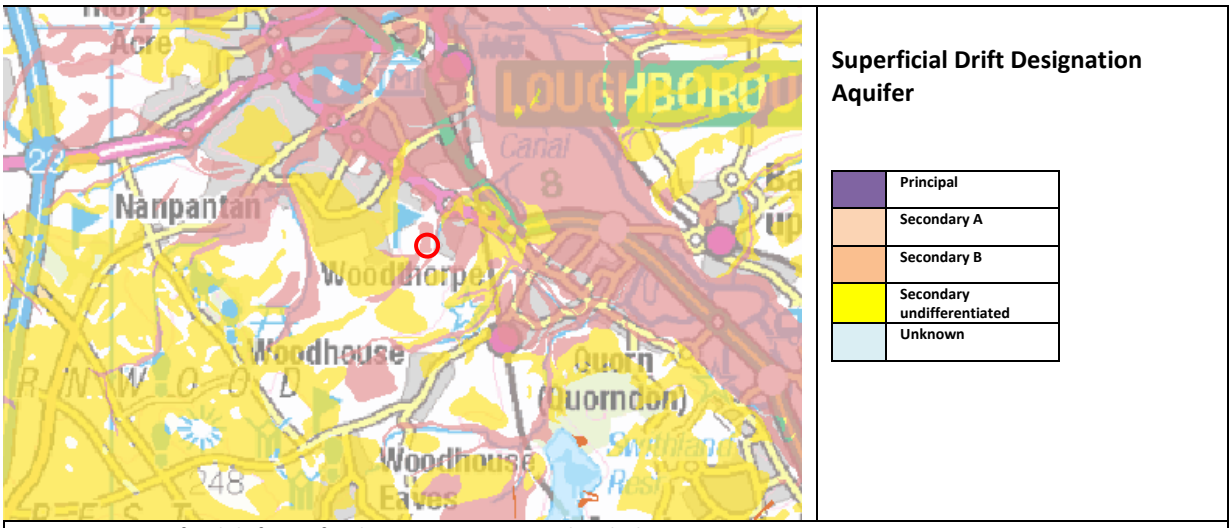


Figure 12. Superficial drift aquifer designation associated with the site

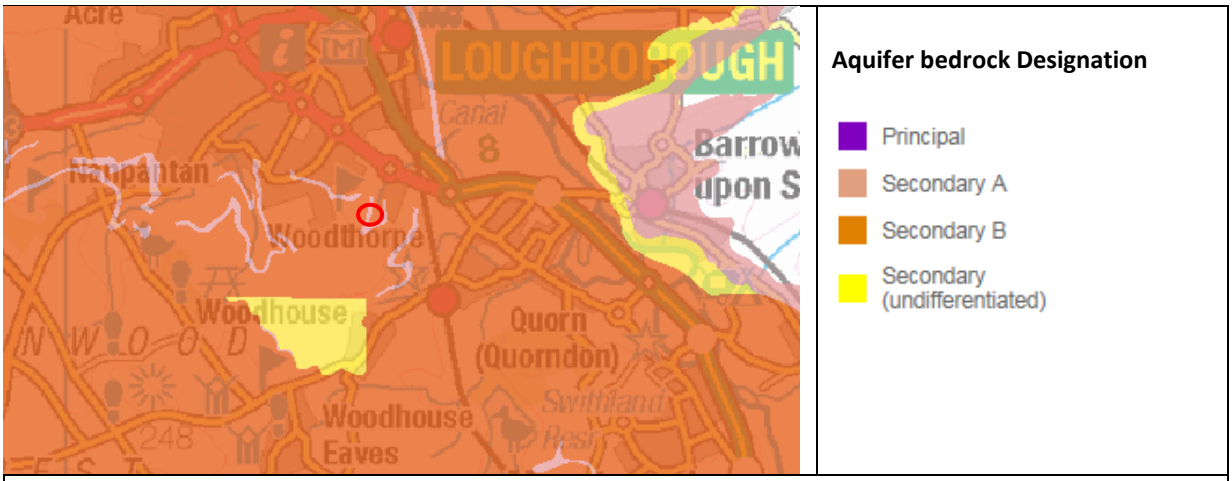


Figure 13. Bedrock aquifer designation

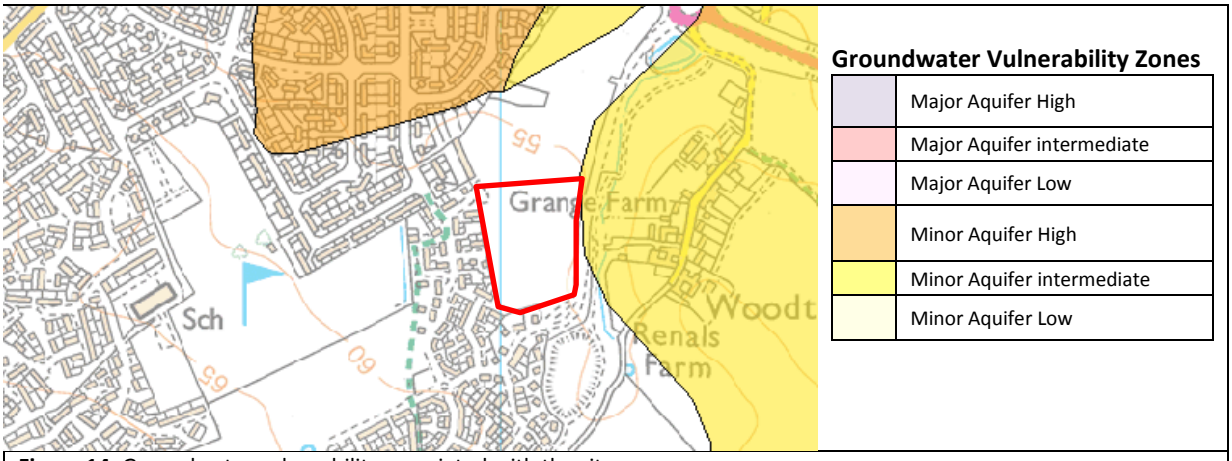


Figure 14. Groundwater vulnerability associated with the site

Groundwater Vulnerability Maps provide information on how significant the ground waters are likely to be and if they are vulnerable to pollution occurring at the land surface. The maps have

descriptions on them to explain the different aquifer and soil types. Areas shown as "major aquifers" have strategic significance for water resources, they often support large abstractions for the public water supply. Minor aquifers have a more localised significance to domestic, agricultural and industrial users (although they may still be used for drinking water). Non-aquifers do not store significant amounts of groundwater. However, in some areas they can support local supplies: e.g. small springs feeding individual properties.

Major and minor aquifers may be important in contributing to the base-flow of streams and rivers. The maps show where groundwater is protected from above by rocks with a low permeability, such as glacial clay. They also show the characteristics of the soil above.

Superficial drift deposits which overlay the solid geological strata can sometimes be substantial in thickness. They are often variable in composition changing from highly permeable outwash gravels to low permeability clays over short distances both laterally and vertically. The presence of permeable drift deposits is recognised as Minor Aquifers except where these overlie a Major Aquifer and they then assume the status of a Major Aquifer.

The site is over a Secondary A aquifer associated with the superficial deposits and a Secondary B aquifer associated with the bedrock geology. The site is classed as being over a minor aquifer with low vulnerability. The site is not within a surface or ground water safeguard zone. The site is within a surface water Nitrate Vulnerable Zone.

4.5.4 Flood risk

The site is within Flood Zone 1 land which is very low risk – less than 1 in 1000 in any given year (Figure 15). The site is not covered by flood warnings issued by the Environment Agency.

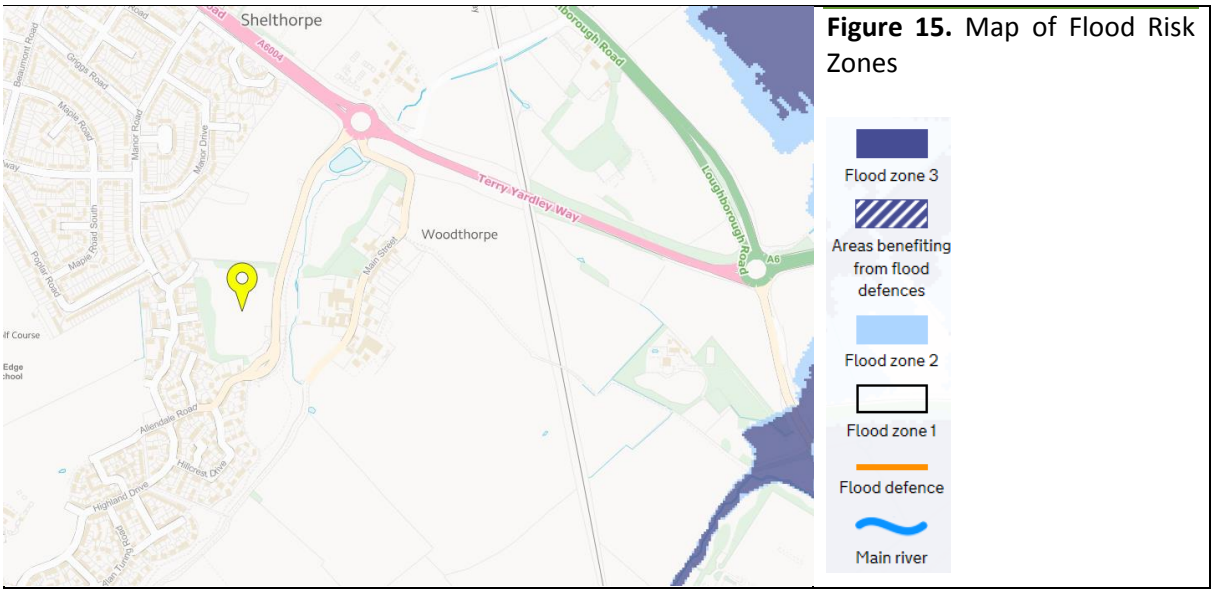


Figure 15. Map of Flood Risk Zones

If areas of impermeable surfaces such as buildings, roads etc. are constructed on a greenfield site, a surface water management system designed in accordance with the principles of Sustainable Urban Drainage Schemes (SUDS) will be required.

4.5.5 Wells in the vicinity of the site

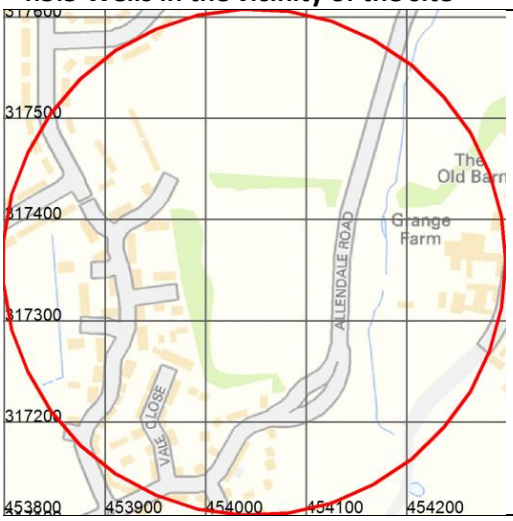


Figure 16. Well records
Number of records within a 300 m radius of the centre of the site: 0

Search area indicated in red

4.5.6 Boreholes in the vicinity of the site

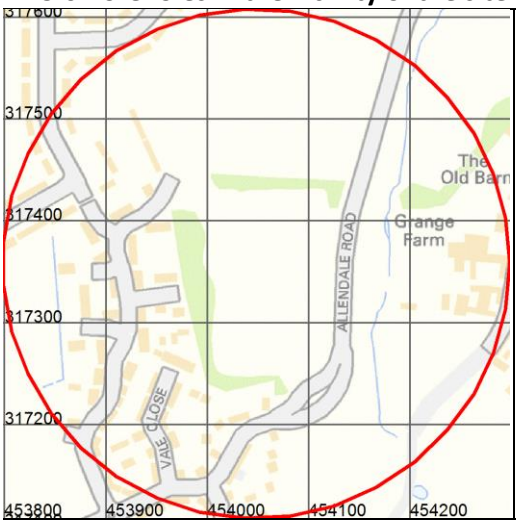


Figure 17. Borehole records
Number of records within a 300 m radius of the centre of the site: 0

Search area indicated in red

4.6 Meteorological data

The agro climatic index number for this site is 22w with a mean annual rainfall of 661 mm, the Standard Average Annual Rainfall (SAAR) for the site itself is 640 mm.

4.7 Surface water issues

The site has a very low risk of surface water flooding within it. No flood depths are given for the site based on the EA mapping though this does not mean that localised surface water flooding cannot occur (Figure 18). Very Low risk is less than 0.1% chance of surface water flooding occurring in any year. The main reason for this is likely to be the relatively free-draining nature of the topsoil and the slope allowing water to shed off the surface to lower lying areas. Regardless of this, any works which might increase the risk of flooding on or off site need to be identified and the risks assessed and mitigated using a suitable SUDS compliant approach.

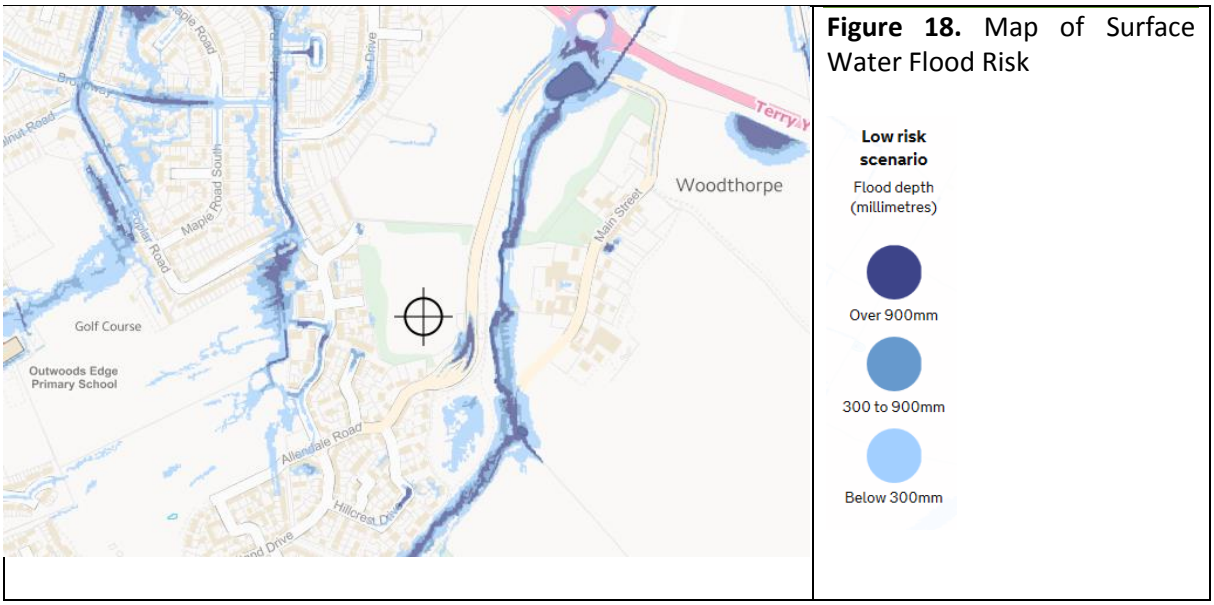


Figure 18. Map of Surface Water Flood Risk

5.0 Pollutant risk

Due to the approximately 60 per annum number of full burials at the site, the cumulative ammoniacal nitrogen concentrations are likely to be moderate to high with similar levels of total organic compounds (TOC).

Pathogens

There has been some evidence from recent studies of the occurrence of Enterococci and Clostridium bacteria found in drainage water of cemeteries. Enterococci are bacteria that are commonly found in the bowel of normal healthy individuals. They can cause a range of illnesses including urinary tract infections, bacteraemia (blood stream infections) and wound infections.

The two most common species of Enterococci are E. faecalis and E. faecium. During the mid-1980s, enterococci with resistance to glycopeptide antibiotics such as vancomycin and teicoplanin emerged, termed glycopeptide-resistant enterococci (GRE). Most GRE are E. faecium.

Due to the nature of the soil and geomorphology, there may be some movement of pathogenic organisms, notably Pseudomonas aeruginosa and Faecal streptococci, which may leach because of the relatively freely draining soils. However pathogens tend to be short lived away from the host and if there is no immediate ground water risk or potable well supply, the risk may be considered low. The subsoil is slowly permeable as is the underlying bedrock which further mitigates this risk.

Given the existing soil conditions, oxidative decomposition is likely to be high due to the relatively free-draining nature of the topsoil. Post-burial accumulation of water around a coffin is possible on these soils as at burial depth the subsoil is likely to be slowly permeable if it is formed within the weathered bedrock material and this might have an impact on re-opening graves following prolonged wet periods.

6.0 Depth of burial

Based on data from the British Geological Survey, the site is overlain by soils derived from the superficial deposits and the weathered bedrock. Typically the soils from these deposits in this area are moderately freely drained. Soil depth is in excess of 3m as proved by the trial pits and is easy to

dig, dry to this depth and stable. The trial pits showed a topsoil dominated by sandy clay rather than sands and gravels. As such surface water drainage is likely to be a little slower than otherwise expected. Implications on burial depth are minimal, however.

7.0 Archaeology

It is recommended that consultation with the county archaeological team be undertaken to ascertain any archaeological interest in the area.

8.0 Risk evaluation

Assessment of general hazards

The potential of a number of pollutant pathways and the degree of associated risk assessed numerically on a 0-10 score with 10 being the highest risk is shown in Table 4. From the resultant data, the final values are assessed against burial number and a determinant of risk calculated from EA flow charts and nomographs.

Table 4. Summary of pollution risk associated with the site

Risk	Assessment High, moderate, Low	Comment	Score
Burials per annum	High	Expected to be around 60 per annum	
Drift / superficial data	Moderate	Clayey Silty Sand and gravel	6-5
Drift thickness	High	Drift between 0 and 3 m generally	8-7
Proximity to water course	High	The nearest water body is some 31m to the east in the form of a wet ditch or stream	8-7
Proximity to land drains	Moderate	Amenity land may have been drained	6-5
Depth to Water Table	High	Boreholes suggest groundwater is below 6m from surface	8-7
Proximity to Wells or potable water source	Very Low	No wells within 500 m radius	2-1
Flow mechanism	Moderate	Intergranular in superficials, fracture flow in bedrock	6-5
Aquifers	Low	Minor aquifer – low vulnerability	4-3
SPZ	Very Low	The site for development lies outside any SPZ	2-1
Met data	Moderate	Annual rainfall moderate	N/A
Proximity to housing	Low	Residential housing in close proximity of the site	N/A
SSSI	Low		N/A
Archaeology	Low	None observed but will require district archaeologist assessment	N/A
		Total	**50-41**

Table 4 is assessed using the groundwater vulnerability-ranking criteria in Table 5. The total score comes to 50-41 and is considered as a moderate to high risk. These data are then assessed against the burial rate of 60 per annum on the groundwater risk nomograph p.37 of PP223. The final assessment of risk for this site according to the nomograph (Figure 19), would class it as being **high**.

Table 5. Groundwater ranking

Ranking	Very Low 2-1	Low 4-3	Moderate 6-5	High 8-7	Very High 10-9
Drift Type	Clay	Silt	Silty sand	Sand/gravel	Absent
Drift Thickness	>5 m	>3-5 m	3 m	0-3 m	Absent
Depth to water Table	>25 m	11 – 25 m	10 m	5 – 9 m	<5m
Flow mechanism	Intergranular				Fissured
Proximity to wells					Within 250 m from private potable supply
Aquifer type	Non Aquifer		Minor aquifer		Major aquifer
Abstractions and SPZs	Outside Zone 3	Within Zone 3	Close to boundary of Zone 2	Within Zone 2	Within Zone 1
Water courses and springs		>100 m	>50 <70 m	>30 <50 m	<30 m
Drains	>100 m	>40 <100 m	30 – 40 m	>10 <30 m	<10 m

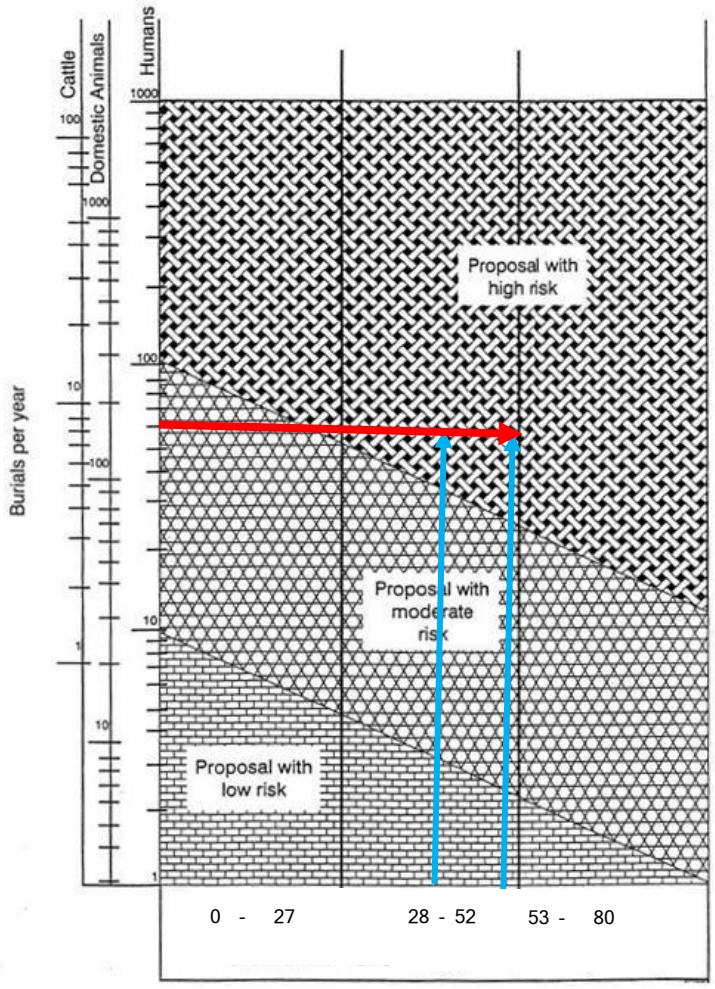


Figure 19. Groundwater risk nomograph

9.0 Conclusion

The site is considered to be **high risk** with the risk mainly attributed to the high predicted burial numbers.

Given that burials are likely to be into either the superficial deposits or the weathered bedrock, and given that these materials are only moderately or slowly permeable the risk to groundwater is likely to be low. The source of pollutants is present in the form of burials, the receptor is present in the form of the groundwater but the pathway, though viable, is likely to be inefficient due to the reduced permeability of the soil and especially through the clay-dominated subsoil. Groundwater has been struck at between 6 and 7m bgl in boreholes within 2.5 km of the site but this is likely to be groundwater that is limited in extent and associated mainly with localised layers of sand and gravel or larger fractures within the bedrock. No groundwater was struck in any of the trial pits excavated to a minimum of 3m depth. It is possible that underlying groundwater is in hydraulic continuity with the nearest surface water and may contribute to baseflow in this stream but this is not certain. To ascertain the nature and extent of any risk more precisely, flux modelling of the major pollutants ammonium and nitrate is recommended.

By way of grave-specific mitigation, the addition of Zeolitic compounds could be added to the base of graves. Zeolites such as Clinoptilolite or Bentonite clays have CEC values exceeding 150 meq/l and when placed in the base of the grave will absorb significant amounts of Ammonium via cation exchange processes in addition to the existing capacity of the clay soil (Pivato et al Waste Management Review 2004) (Rozic et al 2009 Bioinformatics).

Calculations would suggest that at least 90% of the human nitrogen (1.8 kg) release could be absorbed by 150 kg of Clinoptilolite or a high CEC clay material such as Bentonite.

10.0 Reporting details

Report Author:	Mr Alex Vickers
Verification:	Mr Justin Smith
Date:	03.10.17

Cemetery Development Services - Terms and Conditions

Cemetery Development Services (CDS)
Terms and Conditions for the Supply of Services

Interpretation

In these Conditions
AGREED FEE means the charges agreed between CDS and the Client in relation to the Specified Service
CLIENT means the person named on the Specification Sheet for whom CDS has agreed to provide the Specified Service in accordance with these Conditions
CONTRACT means the contract for the provision of the Specified Service
DOCUMENT includes, in addition to a document in writing, any map, plan, graph, drawing or photograph, any film, negative, tape or other device embodying visual images and any disc, tape or other device embodying any other data
INPUT MATERIAL means any Documents or other materials, and any data or other information provided by the Client relating to the Specified Service
OUTPUT MATERIAL means any Documents or other materials, and any data or other information provided by CDS relating to the Specified Service
SPECIFICATION SHEET means the sheet to which these Conditions are appended
SPECIFIED SERVICE means the service relating to geophysical surveys of land to be provided by CDS for the Client and referred to in the Specification Sheet
CDS means CDS (registered in England under number 05089827) or its subsidiary as stated on the Specification Sheet
The headings in these Conditions are for convenience only and shall not affect their interpretation.

Supply of the Specified Service

CDS shall provide the Specified Service to the Client subject to these Conditions. Any changes or additions to the Specified Service or these Conditions must be agreed in writing by CDS and the Client.
The Client shall allow CDS adequate access to its property at reasonable times and for so long as is necessary to enable CDS to provide the Specified Service in accordance with the Contract.
The Client shall at its own expense supply CDS with all necessary Documents or other materials, and all necessary data or other information relating to the Specified Service, within sufficient time to enable CDS to provide the Specified Service in accordance with the Contract. The Client shall ensure the accuracy of all Input Material.
CDS shall have no liability for any loss or damage, however caused, to the Input Material. All Output Material shall be at the sole risk of the Client from the time of delivery to or to the order of the Client.
The Specified Service shall be provided in accordance with the Specification Sheet subject to these Conditions.
Further details about the Specified Service, and advice or recommendations about its provision or utilisation, which are not given in CDS's brochure or other promotional literature, may be made available on written request.
CDS may correct any typographical or other errors or omissions in any brochure, promotional literature, quotation or other document relating to the provision of the Specified Service without any liability to the Client.
CDS may at any time without notifying the Client make any changes to the Specified Service which are necessary to comply with any applicable safety or other statutory requirements, or which do not materially affect the nature or quality of the Specified Service.

Charges

Subject to any special terms agreed, the Client shall pay the Agreed Fee and any additional sums which are agreed between CDS and the Client for the provision of the Specified Service or which, in CDS's sole discretion, are reasonably incurred as a result of the Client's instructions or lack of instructions, the inaccuracy of any Input Material or any other cause attributable to the Client.
All charges quoted to the Client for the provision of the Specified Service are exclusive of any Value Added Tax, for which the Client shall be additionally liable at the applicable rate from time to time.
CDS shall be entitled to invoice the Client on completion of the Specified Service.
The Agreed Fee and any additional sums payable shall be paid by the Client (together with any applicable Value Added Tax, and without any set-off or other deduction) within 30 days of the date of CDS's invoice.
If payment is not made on the due date, CDS shall be entitled, without limiting any other rights it may have, to charge interest on the outstanding amount (both before and after any judgment) at the rate of 4 % above the base rate from time to time of Barclays Bank plc from the due date until the outstanding amount is paid in full.

Rights in Input Material and Output Material

The property and any copyright or other intellectual property rights in:
any Input Material shall belong to the Client
any Output Material and any amendments or variations to the Input Material made by CDS shall, unless otherwise agreed in writing between the Client and CDS, belong to CDS, subject only to the right of the Client to use the Output Material for the purposes of utilising the Specified Service.
Any Input Material or other information provided by the Client which is so designated by the Client and any Output Material shall be kept confidential by CDS, and all Output Material or other information provided by CDS which is so designated by CDS shall be kept confidential by the Client; but the foregoing shall not apply to any Documents or other materials, data or other information which are public knowledge at the time when they are so provided by either party, and shall cease to apply if at any future time they become public knowledge through no fault of the other party.
The Client warrants that any Input Material and its use by CDS for the purpose of providing the Specified Service will not infringe the copyright or other rights of any third party, and the Client shall indemnify CDS against any loss, damages, costs, expenses or other claims arising from any such infringement.

Warranties and Liability

CDS warrants to the Client that the Specified Service will be provided using reasonable care and skill and, as far as reasonably possible, in accordance with the Specification and at the intervals and within the times referred to in the Specification Sheet. Where CDS supplies in connection with the provision of the Specified Service any goods (including Output Material) supplied by a third party, CDS does not give any warranty, guarantee or other term as to their quality, fitness for purpose or otherwise, but shall, where possible, assign to the Client the benefit of any warranty, guarantee or indemnity given by the person supplying the goods to CDS.
CDS shall have no liability to the Client for any loss, damage, costs, expenses or other claims for compensation arising from any Input Material or instructions supplied by the Client which are incomplete, incorrect, inaccurate, illegible, out of sequence or in the wrong form, or arising from their late arrival or non-arrival, or any other fault of the Client.
Except in respect of death or personal injury caused by CDS's negligence, or as expressly provided in these Conditions, CDS shall not be liable to the Client by reason of any representation (unless fraudulent), or any implied warranty, condition or other term, or any duty at common law, or under the express terms of the Contract, for any loss of profit or any indirect, special or consequential loss, damage, costs, expenses or other claims (whether caused by the negligence of CDS, its servants or agents or otherwise) which arise out of or in connection with the provision of the Specified Service or their use by the Client, and the entire liability of CDS under or in connection with the Contract shall not exceed the amount of CDS's charges for the provision of the Specified Service, except as expressly provided in these Conditions.
CDS shall not be liable to the Client or be deemed to be in breach of the Contract by reason of any delay in performing, or any failure to perform, any of CDS's obligations in relation to the Specified Service, if the delay or failure was due to any cause beyond CDS's reasonable control.

Termination

Either party may (without limiting any other remedy) at any time terminate the Contract by giving written notice to the other if the other commits any breach of these Conditions and (if capable of remedy) fails to remedy the breach within 30 days after being required by written notice to do so.

Insolvency of Client

This clause applies if:
the Client makes any voluntary arrangement with its creditors or (being an individual or firm) becomes bankrupt or (being a company) becomes subject to an administration order or goes into liquidation (otherwise than for the purposes of amalgamation or reconstruction); or
an encumbrancer takes possession, or a receiver is appointed, of any of the property or assets of the Client; or
the Client ceases, or threatens to cease, to carry on business; or
CDS reasonably apprehends that any of the events mentioned above is about to occur in relation to the Client and notifies the Client accordingly.
If this clause applies then, without prejudice to any other right or remedy available to CDS, CDS shall be entitled to cancel the Contract or suspend any further provision of services under the Contract without any liability to the Client, and if the Services have been provided but not paid for the price shall become immediately due and payable notwithstanding any previous agreement or arrangement to the contrary.

General

These Conditions (together with the terms, if any, set out in the Specification Sheet) constitute the entire agreement between the parties, supersede any previous agreement or understanding and may not be varied except in writing between the parties. All other terms and conditions, express or implied by statute or otherwise, are excluded to the fullest extent permitted by law.
Any notice required or permitted to be given by either party to the other under these Conditions shall be in writing addressed to the other party at its registered office or principal place of business or such other address as may at the relevant time have been notified pursuant to this provision to the party giving the notice.
No failure or delay by either party in exercising any of its rights under the Contract shall be deemed to be a waiver of that right, and no waiver by either party of any breach of the Contract by the other shall be considered as a waiver of any subsequent breach of the same or any other provision.
If any provision of these Conditions is held by any competent authority to be invalid or unenforceable in whole or in part, the validity of the other provisions of these Conditions and the remainder of the provision in question shall not be affected.
Any dispute arising under or in connection with these Conditions or the provision of the Specified Service shall be referred to arbitration by a single arbitrator appointed by agreement or (in default) nominated on the application of either party by the President for the time being of Institute of Arbitrators.
English law shall apply to the Contract, and the parties agree to submit to the non-exclusive jurisdiction of the English courts.

Cemetery Development Services Limited
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A report to Charnwood Borough Council on the suitability of proposed new cemetery at a site off the Nanpanton Road, Nanpanton as part of an Environment Agency T2 Audit

March 2018
D1.0




Company Directors: JJ Smith

Registered Office: 28-31 The Stables
Wrest Park, Silsoe
Bedfordshire
MK45 4HR

Registered No: 5048077

Vat No. 0836 4504 25

Charnwood Borough Council

An Environment Agency T2 Assessment for a proposed new cemetery at a site off the Nanpanton Road, Nanpanton, Leicestershire, LE11 3YE. Grid Ref: 451950; 317221

Contents

Tables

Figures

1.0 Executive summary

The site is considered to be **high risk** with the risk mainly attributed to the predicted burial numbers generally and the presence of wet ditches on the western and northern boundaries of the site. In the areas where glacial till overlies the siltstone, the risks are likely to be much lower as there is no significant perched water within the till based on the trial pits and water movement through the subsoil is likely to be very slow. The trial pits struck no permeable deposits or lenses within or within 1m of burial depth thus the risk to local surface waters is also likely to be quite low however fo the key risks te risk to local surface water is likely to be greater than the risk to groundwater at this site.

As the soils are very poorly drained, water may gather around burials making re-opening potentially difficult. This can be mitigated by compacting backfill over recent burials firmly to reduce the risk of infiltration through the disturbed back-fill material.

The site has two wet ditches along the boundaries which would require a minimum 10m no burial zone and one ditch may class as a tertiary river, in which case it may require a 30 m no burial zone. The site has two large aqueducts and a high pressure gas main running through the centre of the site and it is likely that this will also require a 10 m no dig zone either side of the nearest service, thus much of the site cannot be used for burials.

By way of grave-specific mitigation if needed, the addition of Zeolitic compounds could be added to the base of graves. Zeolites such as Clinoptilolite have CEC values exceeding 150 meq/l and when placed in the base of the grave will absorb significant amounts of Ammonium via cation exchange processes in addition to the existing capacity of the clay soil (Rozic et al 2009).

Calculations would suggest that at least 90% of the human nitrogen (1.8 kg) release could be absorbed by 150 kg of Clinoptilolite or a high CEC clay material such as Bentonite.

2.0 Introduction

Cemetery Development Services Ltd. has been asked to carry out a Tier 2 site screening assessment for a new cemetery located on land off Nanpanton Road, Nanpanton, and Loughborough. This site will be considered on the basis of groundwater risk and as part of this, a T2 study based on the criteria required by the Environment Agency has been carried out. This is because sites that do not meet the requirements of the Environment Agency should be ruled out at an early stage since the Agency as Primary Consultees are able to prevent any site being developed should the site be deemed to represent too great a risk in respect to water pollution.

The proposed development area has been assessed on a 1 km area of influence: grid reference 451950; 317221, nearest postcode: LE11 3YE. The site is calculated as being approximately 14 hectares (34.6 acres).

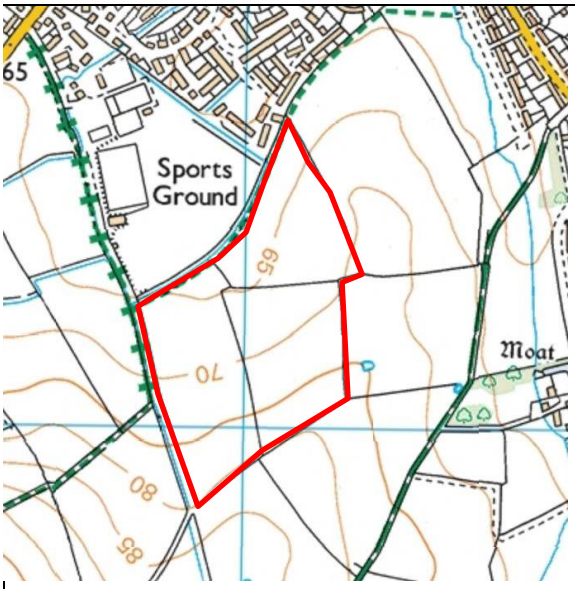


Figure 1a. Map of the site.

Figure 1b. Aerial photograph of the site, (site boundary marked in red).

This report will review the site proposed for use as a burial facility in accordance with the requirements of the Environment Agency's Tier 2 survey. For the purposes of this study the anticipated burial rate for this site is estimated as being in approximately 60 per year.

3.0 Background

New cemetery developments or extensions to existing cemeteries can be very emotive. However, these concerns are often disproportionate to the actual environmental risk.

Whilst the Local Planning Authority is the principal controlling body in determining approval for new sites or site extensions, significant information is required to ensure that the environmental risks are examined and that the Environment Agency's views are considered. Therefore, measures to prevent pollution must be undertaken and reported. Any regulatory decision-making is based on sound scientific knowledge. On this basis, a review of potential pollution from cemeteries was undertaken by the Environment Agency in collaboration with the British Geological Survey.

The aim was to review old and new cemeteries and measure the effects of contamination from viruses, bacteria and other microbiological pathogens and to assess the potential of chemical

contaminants affecting groundwater supplies from decomposition processes. Preliminary results showed that the operating cemetery examined in the study (25 years old) did show some evidence of bacterial contaminants in groundwater derived from corpses. However, no viruses were detected and the overall contaminant loading was found to be low. The studies found that degradation and attenuation was occurring indicating that potential risks were low. Whilst the outcome of this research found contaminant risk to be low, it should be reviewed in the context that natural attenuation processes may have been optimum at these sites. Therefore, to optimise natural attenuation and reduce the risk of possible groundwater contamination, a series of guidelines have been drawn up that are directly applicable to cemeteries.

Failure to manage and reduce any environmental risk to a minimum may result in action being taken under the Groundwater Regulations 1998 and the Anti-pollution Works Notice Regulations 1999.

3.1 Groundwater protection policy

Initial risk screening starts with the tools contained in the Agency's publication, Policy and Practice for the Protection of Groundwater in cemeteries and in the latest GP3 guidance notes.

Tools include Groundwater Vulnerability and Source Protection Zone (SPZ's) maps. These maps highlight where there are likely to be particular risks posed to groundwater from surface activities. Groundwater Vulnerability (GWV) Maps show the damage from pollution to groundwater and the relative importance of the aquifer to water supplies. Risk assessment is made with reference to soil leaching potential and the levels of water tables above major and minor aquifers.

Source Protection Zones are delineated areas around groundwater abstractions used for public consumption and defined by travel, time of biological or chemical contaminants.

The zones are classified in three groups:

Zone 1 High risk
Zone 2 Intermediate to high risk
Zone 3 Intermediate risk

The Environment Agency would be opposed to large graveyards within Zone 1 of an SPZ.

Whilst groundwater is a major part of policy concerns, other water point sources are also considered as requiring an evaluation of risk. These sources include surface water in the form of ditches, spring lines and surface run-off.

The factors influencing the risk of groundwater vulnerability include:

- Soil nature and type
    - Physical, mechanical and chemical properties
- Geomorphology
    - Depth to water table and or height above aquifers
    - Groundwater flow mechanisms
    - Aquifer type
- Abstractions
- SPZ's
- Proximity to water courses, ditches and drains

Therefore, prior to any consent being given by the Environment Agency, an assessment of risk should be undertaken. The degree of assessment is measured through a series of stages namely:

- Hazard identification
- Identification of consequences
- Magnitude of consequences
- Probability of consequences
- Significance of risk

3.2 Tiered risk assessment

There are 3 Tiers of Risk assessment. The associated size and position of the site will in-part determine which Tier is appropriate**.**

Tier 1
Desktop study of all appropriate documentation including GWV and SPZ maps, topographical, hydrological and geomorphologic maps. After adopting a systematic approach to the assessment of risk, a weighting can be given which is assessed as low, medium or high. If the overall risk is low, the proposal may be accepted by the Agency without further detailed assessment. However, the following practical guidelines would be recommended as appropriate controls to minimize pollution risk:

- 250 m distance from groundwater supply
- 30 m minimum distance from groundwater or spring
- 10 m distance from field drains
- No burials in standing water

Tier 2
Should the risks not be clearly defined by the desktop study then further "ground truthing" might need to be undertaken. This may include field studies and monitoring of groundwater within the proposed area, comprising of the installation of up to three boreholes.

Tier 3
If the risk is considered high, i.e. the number of yearly burials exceeds 1,000; a full audit will be required. This would include, but not be limited to, a detailed site investigation including boreholes and monthly monitoring.

3.3 Water Resources Act 1991 – S161A Anti-Pollution Works Notices

The EA has powers under s161A of the Water Resources Act 1991 and the Anti-Pollution Works Regulations 1999, allowing Works Notices to be served to prevent or remedy pollution of controlled waters and under the Groundwater Regulations 1998 to prevent pollution of groundwater.

3.4 Groundwater Regulations 1998

Burial of human corpses can result in discharge of listed substances to groundwater. They are, therefore, covered by the requirements of the Groundwater Regulations. Individual burials spaced out over time will only release trivial amounts of listed substances.

These are considered to fall under the *de minimis exemption.* Large numbers of burials (>100 per annum) in a short time or the cumulative effects of many individual burials may cause groundwater

pollution. In this case, the EA will, where appropriate, use their powers under the Groundwater Regulations to control or prohibit the burial. This has specific relevance to policy P12-2 but will apply more generally.

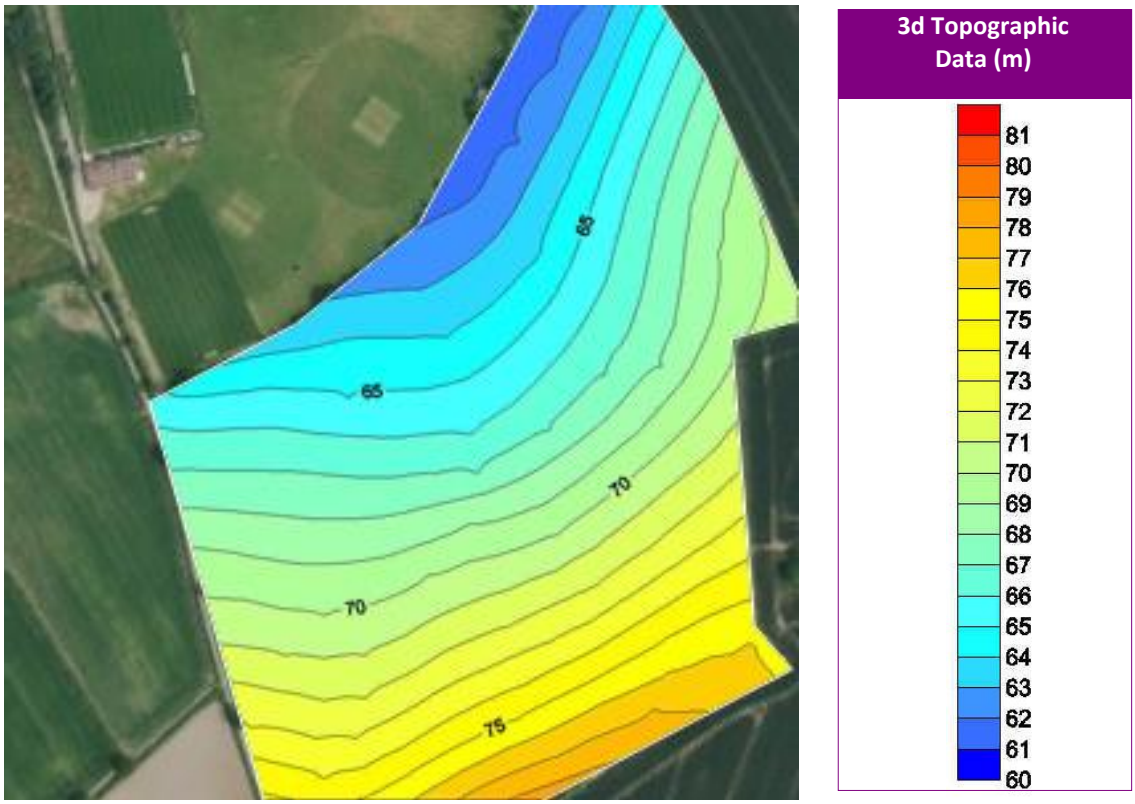
4.0 Site investigation

British Geological Survey and Cranfield University data was used in this report.

4.1 Topography and surface drainage

The site is currently in arable production and is bounded on all sides by further arable fields with the exception of the north which is a sportsfield. A small track runs along the western border and the site comprises three separate fields and includes a small copse. The site falls from the south to the north at a general grade of around 3.4% which is a moderate slope. According to OS data there are no water features on the site however a wet ditch flows along the western boundary between the site and the sportsground and away to the west as well as along the western boundary flowing to the north. This ditch becomes a small stream some 100m below the site. A small pond is located some 40 m beyond the eastern boundary of the site, in an adjacent field. The site has two large aqueducts and a high pressure gas main running under it through the centre of the site in an approximate south to north direction.

The site falls from the south to the north at an average grade of around 3.5% and it also falls from the east to the centre of the site and from the west to the centre of the site at an average grade of around 1.7%.



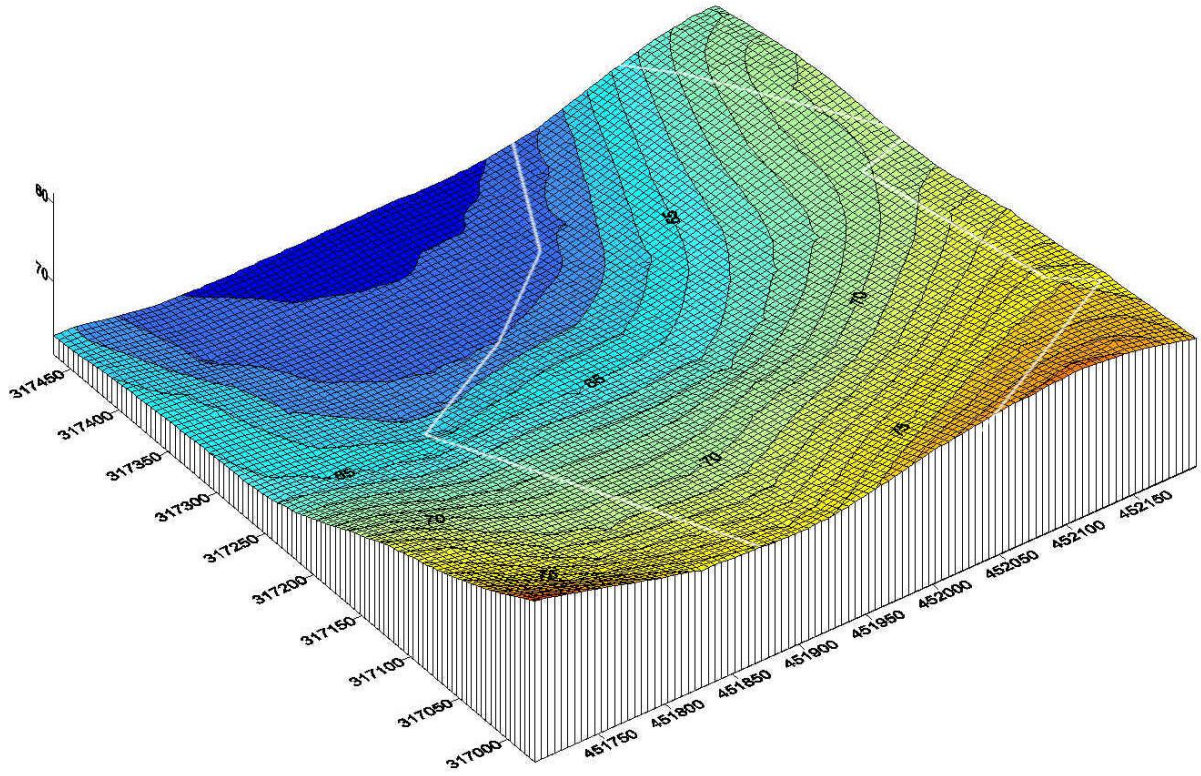


Figure 2. Topography of the site.

4.2 Soil type

The Soil Survey of England and Wales map the site as containing soils belonging to the Whimple 3 Association as described in Table 1 and Figure 3.

Figure 3. Soil Associations in the vicinity of the site.

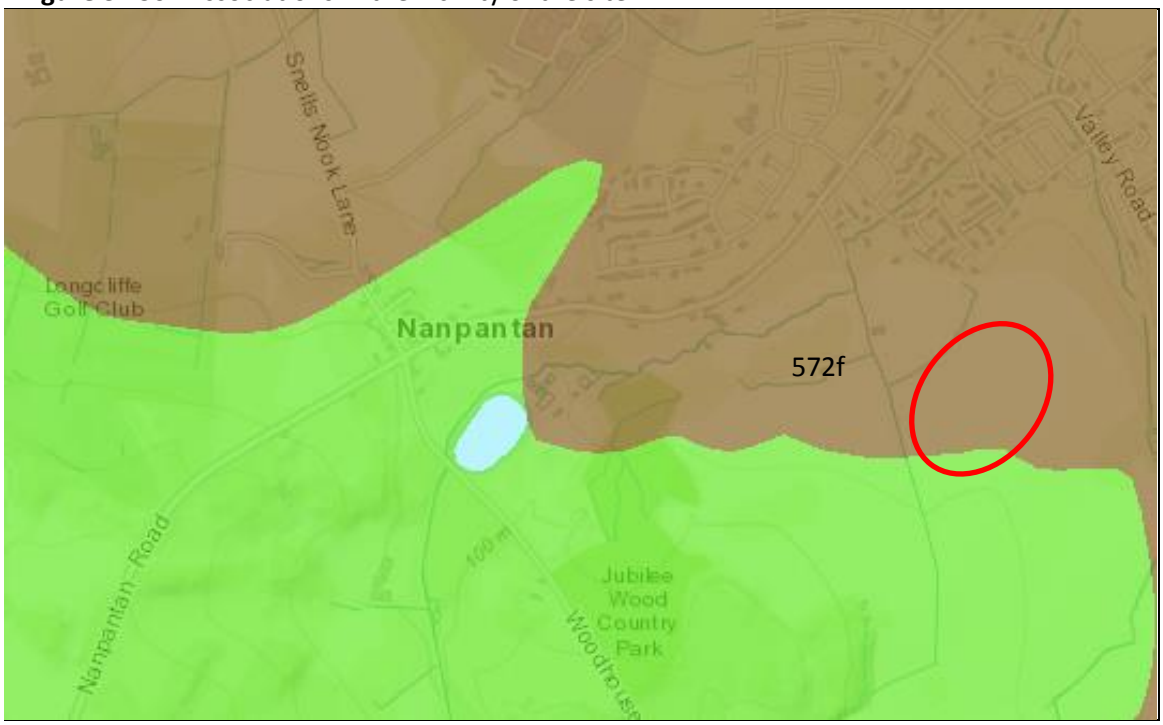


Table 1. Soil Associations in the vicinity of the site.

Soil Association	Sub Groups	Description
572f Whimple 3	Whimple Worcester Brockhurst	Reddish fine loamy or fine silty over clayey soils with slowly permeable subsoils and slight seasonal waterlogging. Some similar clayey soils on brows. Slowly permeable seasonally waterlogged fine loamy and fine silty over clayey soils on lower slopes.

The soils on site belong to the Whimple 3 Association (572f). These soils tend to be silty or fine loamy in characteristics but with clay dominated subsoils. Often these soils have poor surface water drainage in winter and especially when worked or trafficked as silty soils are very prone to mechanical damage. Effective compaction management can significantly improve surface water drainage rates in amenity grassland settings.

This type of soil is generally suitable for cemeteries but may have some local issues with seepage from more permeable lenses within the subsoil which could flood graves if significant. Surface water drainage issues can be significant in very wet periods which may make accessing graves difficult at times but this can be improved with appropriate land drainage and good design.

4.2.1 Trial pits

Site investigations were undertaken on 6th March 2018 with 5 trial pits dug to approximately 3.5 metres depth (Figure 5). Figure 4 shows the profiles of the pits excavated.

Figure 4. Trial pit soil profiles

Pit 1 profile. | Pit 2 profile.

Pit 3 profile.

Pit 4 profile.

Pit 5 profile.

Figure 5. Trial pit locations.

Due to the presence of major regional services running north to south through the centre of the site and comprising two large aqueducts and one high pressure gas main no pits were dug within 50 m either side of the nearest service. This means that the pits have been excavated close to the periphery of the site, however the soils were very similar so in this case it is suggested that the pits are representative of the soils on the site as a whole. In addition, the services are such that no burials will be permitted within at least 10 m or possibly 20m of the peripheral service lines thus most of the centre of the site cannot be used for burials anyway.

The pits were dug following a period of prolonged rainfall and the site was very wet, with saturated topsoil throughout. Significant areas of standing water were present at the base of the slope and these were avoided during the digs however it does clearly indicate the difficulties in surface water management associated with this site in wet periods. The pits were dug to a minimum of 2.9m below ground level (bgl) ensuring that the soil was examined to at least 1m below normal double burial depth.

All the pits excavated showed very similar morphology with a topsoil layer varying between 280 and 350 mm overlying a weathered silty clay subsoil, often with good soil structure. This was underlain at varying depths by weathered Tarporley Siltstone which continued to the base of the pits. The siltstone was friable, shaley and incompetently bedded. It varied between deep red layers and lighter green layers. In all cases the pits were dry to depth however in Pit 5 there was considerable surface water flow into the pit from the base of the topsoil. The topsoil was saturated and water flowed into the pit from many points. This

suggests that an effective surface water drainage system will be needed for this site to minimise the risk of graves being flooded by surface water when in preparation during the winter.

The only other water encountered was when a clay field drain was damaged during the excavation of Pit 1.

No alluvium was struck in any trial pit and it appears that this deposit is restricted to the sportsfields north of the site.

4.3 Geology

The following headings cover the aspects of geology of the immediate area of the proposed development.

4.3.1 Artificial ground

This is ground at or near the surface that has been modified by man. It includes ground that has been deposited (Made Ground), landscaped, disturbed, excavated (Worked Ground) or some combination of these (Figure 6). No Artificial ground is mapped within the site area.

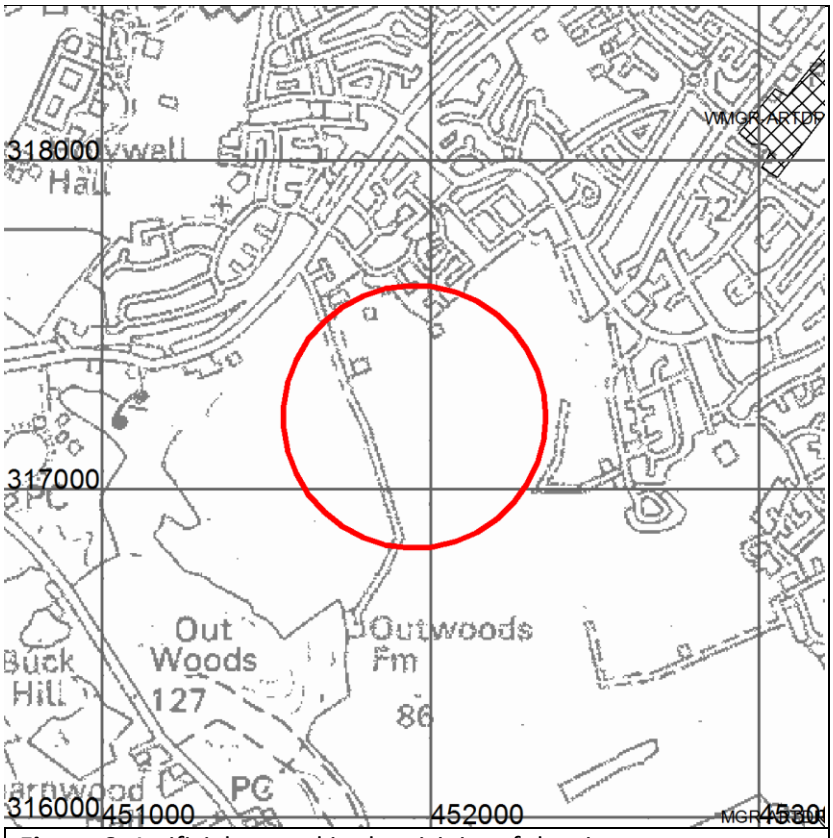


Figure 6. Artificial ground in the vicinity of the site.
Search area indicated in red

Key to Artificial ground:

Map colour	Computer Code	Name of geological unit	Composition
	MGR-ARTDP	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT
	WGR-VOID	WORKED GROUND (UNDIVIDED)	VOID
	WMGR-ARTDP	INFILLED GROUND	ARTIFICIAL DEPOSIT

4.3.2 Superficial deposits

These are relatively young geological deposits formerly known as 'Drift', which lie on the bedrock in many areas. They include deposits such as unconsolidated sands and gravels formed by rivers and clayey tills formed by glacial action. They may be overlain by landslide deposits, by artificial deposits or both (Figure 7).

Two types of superficial deposits have been recorded near or on the site. The northern part may have some limited coverage by alluvium, though this is mainly associated with the sportsground to the north. Alluvium is a fluvial deposit formed from sediments laid down by rivers, usually within the last 11,500 years (Holocene epoch). The alluvium has been cored by a series of borehole situated c. 1.8-2 km to the northeast. These boreholes indicate that the alluvium is composed of sandy clay and silt with occasional pebbles, gravelly sand and sandy gravel. Here the deposit is up to 2 m thick over weathered bedrock. Unfortunately, no borehole closer to the site has penetrated this deposit and as such, the thickness and composition of the alluvium at the site could reasonably differ. It is expected however, that the alluvium is no more than 2 m thick.

The southern part of the site is locally covered by a thin deposit of glacial till, which caps the ridge immediately south of the proposed development. The till, of Quaternary age, belongs to the Thrussington Member of the Wolston Formation, and was deposited during the Anglian glaciation. The Thrussington Member is primarily comprised of firm to stiff, red-brown to grey coloured, variably sandy or silty clay. It commonly also contains gravel and larger cobbles interspersed throughout the unit. The Thrussington Member south of the site is not penetrated by any boreholes, but the geological setting suggests that the Thrussington Member is not is likely to be more than 2-3 metres thick, although further east in Loughborough the Thrussington Member can reach thicknesses of up to 8 m.

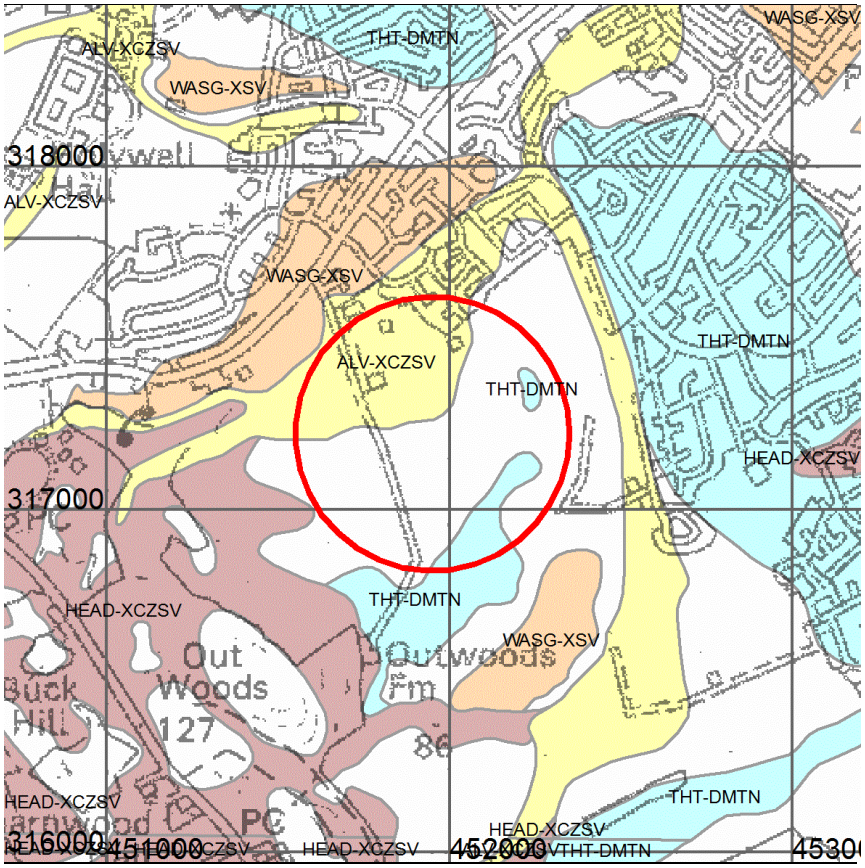


Figure 7. Superficial deposits in the vicinity of the site.

Search area indicated in red

Key to Superficial deposits:

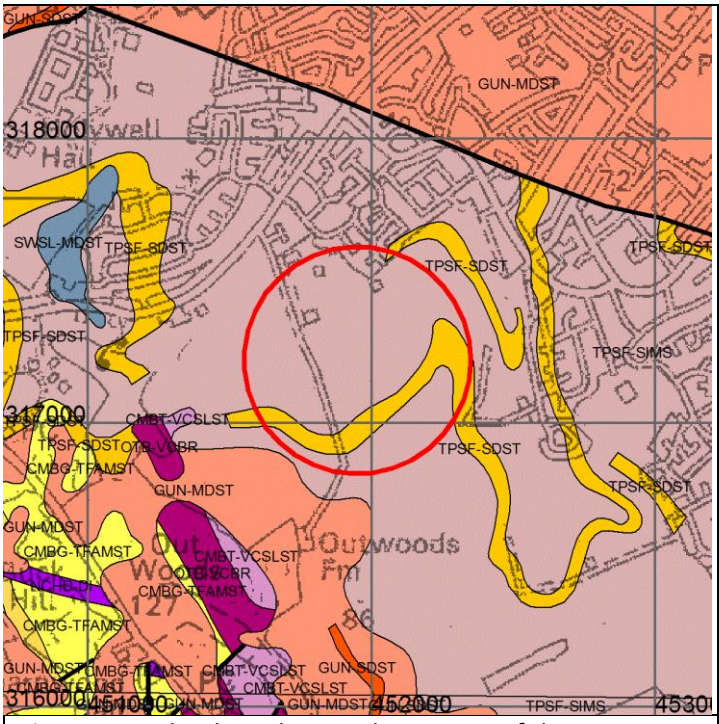
Map colour	Computer Code	Name of geological unit	Composition
	ALV-XCZSV	ALLUVIUM	CLAY, SILT, SAND AND GRAVEL
	WASG-XSV	WANLIP MEMBER	SAND AND GRAVEL
	THT-DMTN	THRUSSINGTON MEMBER	DIAMICTON
	HEAD-XCZSV	HEAD	CLAY, SILT, SAND AND GRAVEL

4.3.3 Rockhead depth

Rockhead is situated at the surface where no superficial deposits are recorded (central part of the search area) and directly below the alluvium or Thrussington Member where these are present. The depth to the rock-head is thus likely to be variable but less than 2 m.

4.3.4 Bedrock geology

The site is underlain by the Tarporley Siltstone Formation of the Mercia Mudstone Group. The Tarporley Siltstone Formation is a Triassic aged deposit that is primarily comprised of red-brown siltstones, mudstones and sandstones. The Tarporley Siltstone locally has a relative thick sandstone bed that has been identified on BGS maps (golden coloured unit on Figure 8). This sandstone bed passes through the site and will be sandstone rich and siltstone poor relative the remaining parts of the Tarporley Siltstone. Locally the Tarporley Siltstone has a thickness of up to 50 m, it is likely that at the site the Tarporley Siltstone is relatively thin, with a thickness of up to 40 m.



Search area indicated in red

Fault

Coal, ironstone or mineral vein

Note: Faults are shown for illustration and to aid Interpretation of the map. Because these maps are generalised from more detailed versions not all such features are shown and their absence on the map face does not necessarily mean that none are Present. Coals, ironstone beds and mineral veins occur only in certain rock types and regions of the UK; if present here, they will be described within the 'Bedrock' section.

Figure 8. Bedrock geology in the vicinity of the site.

Search area indicated in red

Key to Bedrock geology:

Map colour	Computer Code	Name of geological unit	Rock type
	GUN-MDST	GUNTHORPE MEMBER	MUDSTONE
	GUN-SDST	GUNTHORPE MEMBER	SANDSTONE
	TPSF-SDST	TARPORLEY SILTSTONE FORMATION	SANDSTONE
	TPSF-SIMS	TARPORLEY SILTSTONE FORMATION	SILTSTONE, MUDSTONE AND SANDSTONE
	SWSL-MDST	SWITHLAND FORMATION	MUDSTONE
	CMBG-TFAMST	BUCK HILLS MEMBER	TUFFACEOUS-MUDSTONE
	CMBG-TFASST	BUCK HILLS MEMBER	TUFFACEOUS-SANDSTONE
	CMBT-VCSLST	BRADGATE FORMATION	VOLCANICLASTIC-SILTSTONE
	NCHD-DI	NORTH CHARNWOOD DIORITE	DIORITE
	OTB-VCBR	OUTWOODS BRECCIA MEMBER	VOLCANICLASTIC-BRECCIA

Beneath the Tarporley Siltstone is the Triassic Sherwood Sandstone Group. The Sherwood Sandstone is a yellow to red-brown clean sandstone. It is likely to have a thickness of >200 m locally. The boundary between the Sherwood Sandstone and the overlying Tarporley Siltstone can be gradational with the red-brown siltstone dominated Tarporley Siltstone slowly changing into the more yellow sandstone beds of the Sherwood Sandstone. However, the boundary may also be abrupt with a sudden change from one unit to the other.

There is no evidence of any surface mining locally. There is no evidence of any major faulting.

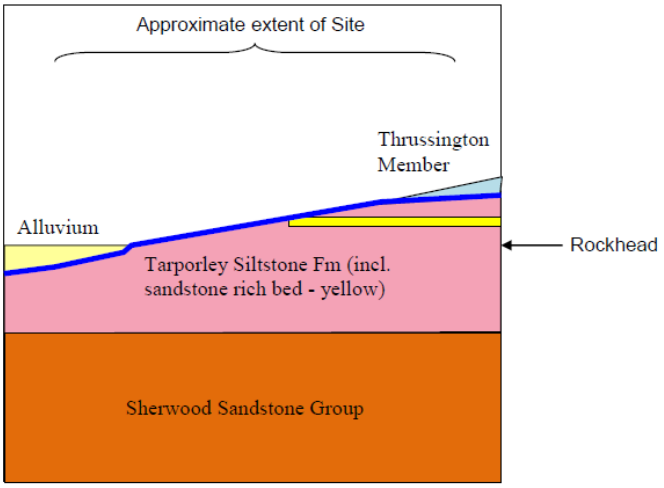
4.3.5 Schematic geological cross-section

This sketch (Figure 9) represents an interpretation of the geometrical relationships of the main rock units described in the text. It is not to scale. The blue line indicates 'rockhead'; that is the base of superficial deposits. This is the 'geological rockhead', as distinct from the 'engineering rockhead', which is the base of 'engineering soil' (in the sense of BS5930:1999).

Figure 9. A schematic representation of the underlying geology.

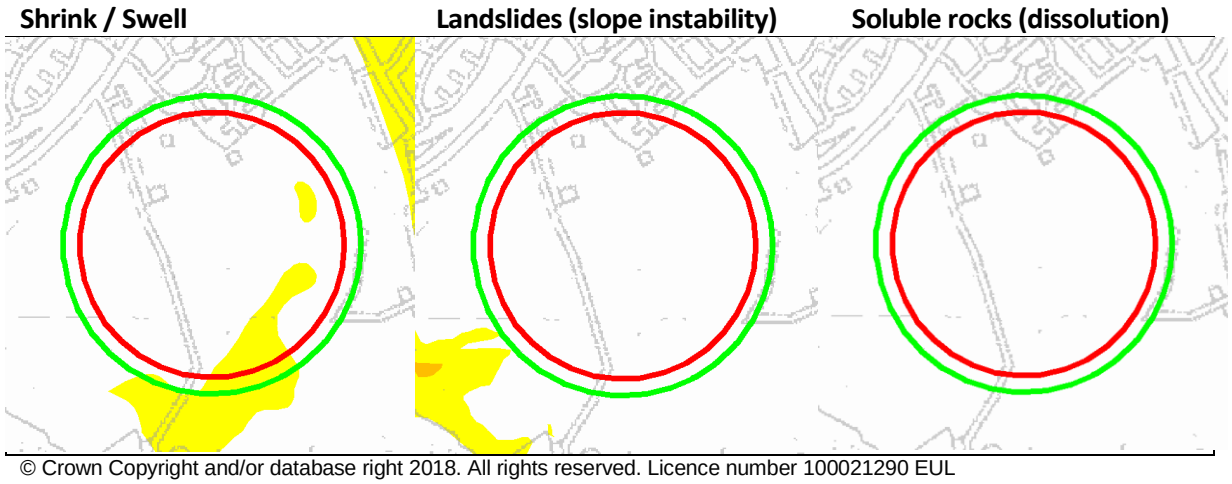
Not to scale

National grid references for site	
North 451800, 317600	South 452100, 316800

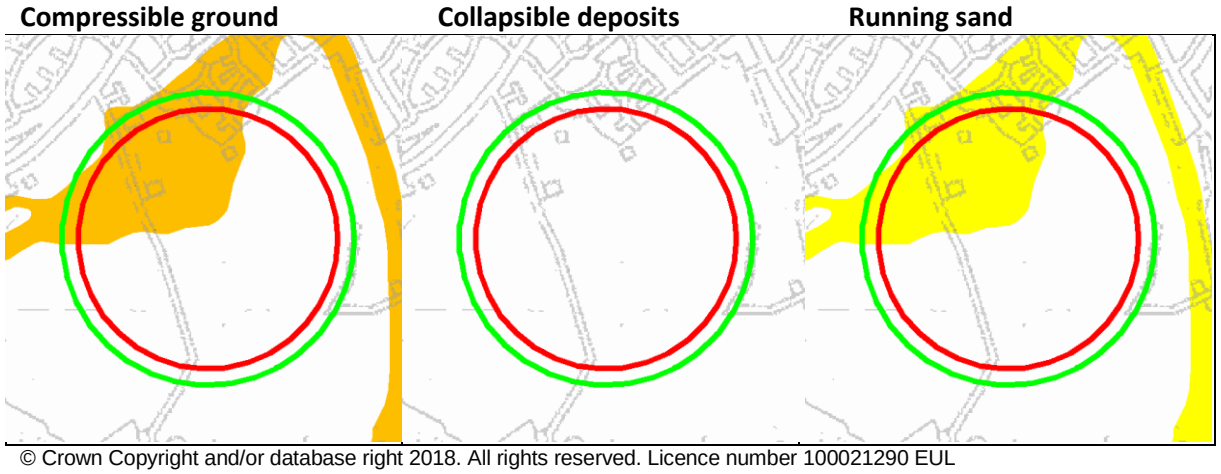


4.4 Additional geological considerations

Figure 10. A summary of the geological hazards associated with the site.



The hazard levels are described as A (least) to E (greatest), or as 'No Hazard'. Levels A and B are not considered significant and are not shown on the maps.



The geological hazards found on the site are explained in Table 2.

Table 2. Geohazard summary

Geological hazard	May be significant within site area	Comments
Potential Natural Ground Stability Hazards		
Shrink-Swell	Yes	Level C = Potential for hazard to become active is at a level where it should be considered in decisions about construction, building maintenance and land use. This risk is associated with the clay rich Thrussington Member to the south of the site
Landslides (slope instability)	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Soluble Rocks (dissolution)	No	Level A = Potential for hazard to be active is either zero or insignificant.
Compressible Ground	Yes	Level D = Significant potential for hazard to become active that requires site-specific advice on the level of hazard related to building type and environment. The hazard is linked with the superficial alluvium deposits to the north of the site (mainly over sportsfields).
Collapsible Deposits	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Running Sand	Yes	Level C = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances. Running sands occurs whereby water-rich loose sand is contained within impermeable clay and silts. When these sand units are penetrated during building or coring the release of pressure can cause the sand to flow to surface leaving small voids liable to collapse. Due to the nature of this risk it is only associated with superficial deposits that are a mix of sand and clay/silt. Being derived from silty or sandy bedrock, both the alluvium and Thrussington Member have such a composition.
Other Potential Hazards		
Mining	No	None.
Flooding	Yes	The presence of alluvium along the northern boundary suggests that this section of the site may be at risk from flooding.
Natural Land Gas	No	Unlikely to encounter gas from bedrock and coal mining; unlikely to encounter gas from peat.
Radon		Level of protective measures: **NO**

4.5 Hydrogeology

In lowland areas of the UK with little topographic variation, groundwater is likely to be found at shallow depths of only a few metres. Water table fluctuations will be small as they will be constrained by the ground surface and the base level of the local perennial streams and rivers.

In upland areas, precipitation is usually high and the dominantly metamorphic and igneous rocks often have relatively shallow groundwater levels.

This is due to preferential groundwater storage in near-surface weathered and fractured zones with limited drainage into the underlying un-weathered lower permeability rock. Exceptions can occur where higher permeability rocks, such as sandstone or limestone, allow faster through flow of groundwater towards the nearest stream or other discharge point.

Perched water tables occur where a less permeable horizon (e.g. a clay layer) in an otherwise permeable sequence retains a body of groundwater above the level of the regional water table. They usually occur at shallow depths in alluvial and glacial sediments and can be difficult to identify or to delimit.

An aquifer becomes confined when it is overlain by a less permeable horizon that restricts the upward movement of groundwater. When this less permeable horizon is penetrated (e.g. by drilling), the groundwater level rises above where struck to a level controlled by the hydrostatic pressure. If this is above ground level, overflowing artesian conditions will be encountered. Confined conditions should be anticipated, where possible, in order to plan for the problems they can generate.

Individual sites will always require more detailed assessments to determine the specific impact on groundwater resources. The maps represent conditions only at the ground surface. Where the soil and/or underlying formations have been disturbed or removed the vulnerability class may have been changed and site specific data will be required. Sites in urban areas and restored or current mineral workings are classified as having high (urban) soil leaching potential until proved otherwise.

There are no boreholes within 1 km of the site hence the information in Table 3 is mainly generic. Four trial boreholes in Nanpantan, 1.3 km to the west of the site, all struck water at the top of a sandstone horizon within the Tarporley Siltstone Formation encountered at depths of 6.5-7.6 m below surface (83.4-83.9 m above OD). However there is no information on the final water level.

The regional direction of groundwater flow in the Sherwood Sandstone Group is north-eastwards.
The hydrological information for the site is summarised in Table 3.

Table 3. Hydrogeology summary

Geological unit	Groundwater potential	Water level and strikes	Quality	EA groundwater vulnerability classification
Alluvium	Some groundwater may be present in the more permeable sand and gravel horizons at least for part of the year	Shallow and likely to be in hydraulic conductivity with the Wood Brook	Similar composition, but more mineralised than water in the brook.	Medium vulnerability secondary aquifer.
Till	Low permeability, unless subordinate sand and gravel horizons encountered	As till is thin, if water present will be encountered within a few meters of the ground surface	No information, but water from glacial deposits is often hard and ferruginous.	Medium vulnerability secondary aquifer.
Tarporley Siltstone Formation	Some groundwater likely to be present in the siltstone and sandstone units, particularly the mapped sandstone unit that traverses the site.	Water levels within the siltstone and sandstone horizons may rise above where first struck. Water level possibly within a few metres of the ground surface.	Groundwater present within siltstone and sandstone horizons may be of good quality but likely to be hard.	Secondary B aquifer associated with the siltstone and sandstone units.
Sherwood Sandstone Group	Important aquifer with both intergranular and fracture flow.	Water may rise above level where first struck, possibly to about 70m above OD, so potentially artesian conditions below lower lying parts of the site.	Likely to be potable but hard with total dissolved solids content of up to 800 mg/l or even higher.	Principal aquifer.

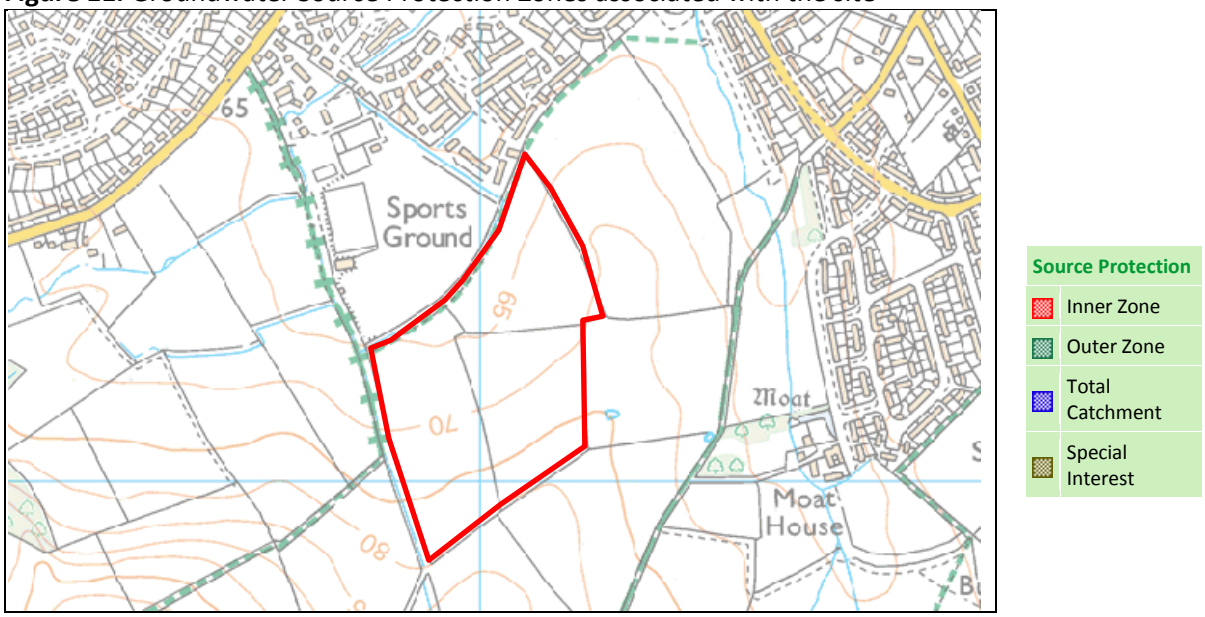
4.5.1 Groundwater vulnerability

This section reviews all components of hydrology, geology and top soil surface water drainage to assess risk notably to groundwater.

4.5.2 Source Protection Zones

The position of the site relative to current ground water protection zones is shown in Figure 11.

Figure 11. Groundwater Source Protection Zones associated with the site



Source Protection Zones (SPZs) provide an indication of the risk to groundwater supplies that may result from potentially polluting activities and accidental releases of pollutants. Generally the closer the activity or release is to a groundwater source the greater the risk. Three zones (an inner, outer and total catchment) are usually defined although a fourth zone (zone of special interest) is occasionally defined.

The Agency has subdivided groundwater source catchments into four zones. Two of these are determined by the travel time of potential pollutants, the third by the source catchment area itself and the fourth is a "Zone of Special Interest". This fourth zone highlights areas where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

- *Zone I (Inner Protection Zone)* - This zone is defined by a travel time of 50-days or less from any point within the zone at, or below, the water table. Additionally, the zone has, as a minimum, a 50-meter radius. It is based principally on biological decay criteria and is designed to protect against the transmission of toxic chemicals and water-borne disease.
- *Zone II (Outer Protection Zone)* - This zone is defined by the 400-day travel time, or 25% of the source catchment area, whichever is larger. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants.
- *Zone III (Total catchment)* - This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source.
- *Zone of Special Interest* - For some groundwater sources an additional Zone of Special Interest may be defined.
  These zones highlight areas (mainly on non-aquifers) where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

The proposed development site lies outside any Groundwater Source Protection Zone.

4.5.3 Aquifer vulnerability

The Groundwater Vulnerability maps are produced at 1:100,000 scale. They show, by means of colour coding, those areas of the country where water-bearing rocks (aquifers) are present. They also show the vulnerability of groundwater to pollution. The aquifers are classified into major, minor and non-aquifers according to their physical properties and their consequent value as a resource.

The classification of the land surface reflects the ability of contaminants to leach through the covering soils and pose a potential risk to groundwater at depth. The maps also indicate areas where the presence of low permeability drift may provide additional groundwater protection.

These maps can therefore be used for an initial screening assessment of the vulnerability of groundwater to contaminants applied to the surface of the ground. They do not provide all information relevant to the determination of vulnerability, such as the depth to water table or nature of the drift deposits. Site-specific information would always be needed for a detailed assessment of vulnerability at a given location. The original groundwater vulnerability maps were produced some time ago.

Groundwater Vulnerability Maps provide information on how significant the ground waters are likely to be and if they are vulnerable to pollution occurring at the land surface. The maps have descriptions on them to explain the different aquifer and soil types.

Areas shown as "major aquifers" have strategic significance for water resource; they often support large abstractions for the public water supply.

Minor aquifers have a more localised significance to domestic, agricultural and industrial users (although they may still be used for drinking water). Non-aquifers do not store significant amounts of groundwater. However, in some areas they can support local supplies: e.g. small springs feeding individual properties.

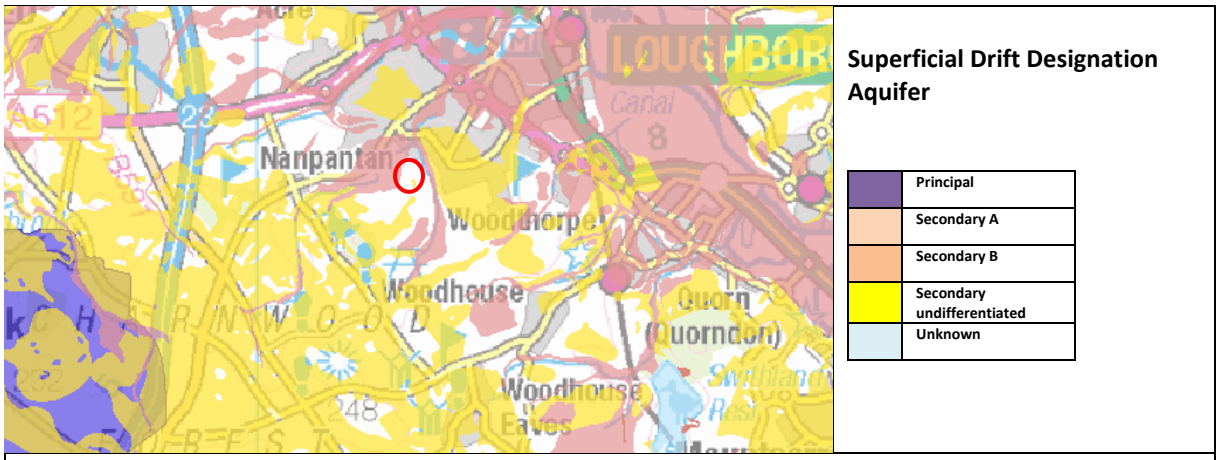


Figure 12. Superficial drift aquifer designation

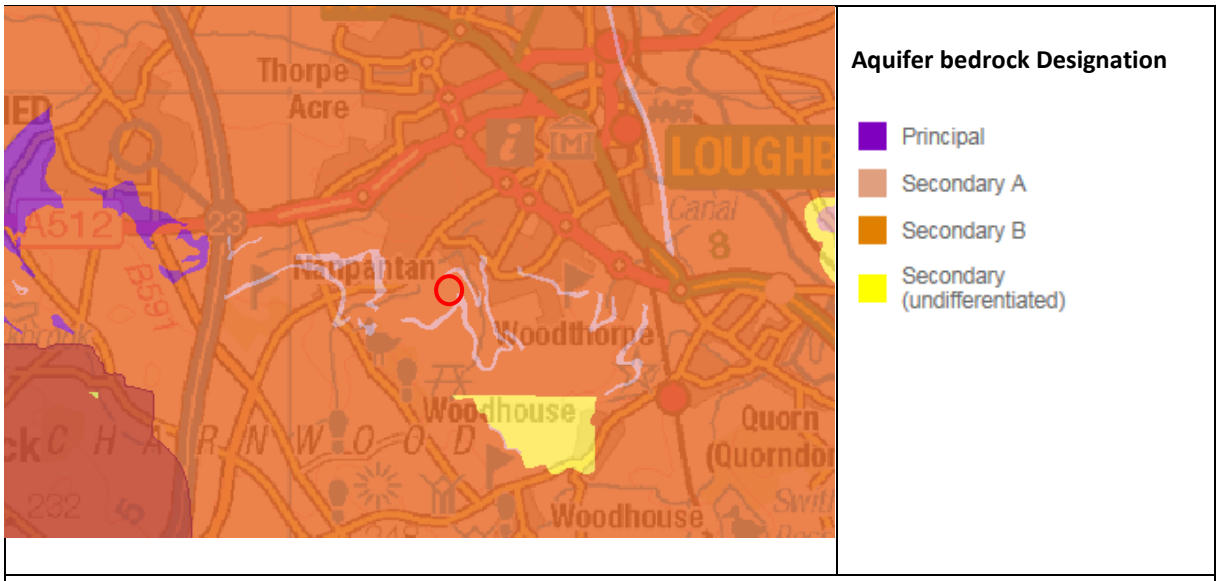


Figure 13. Bedrock aquifer designation

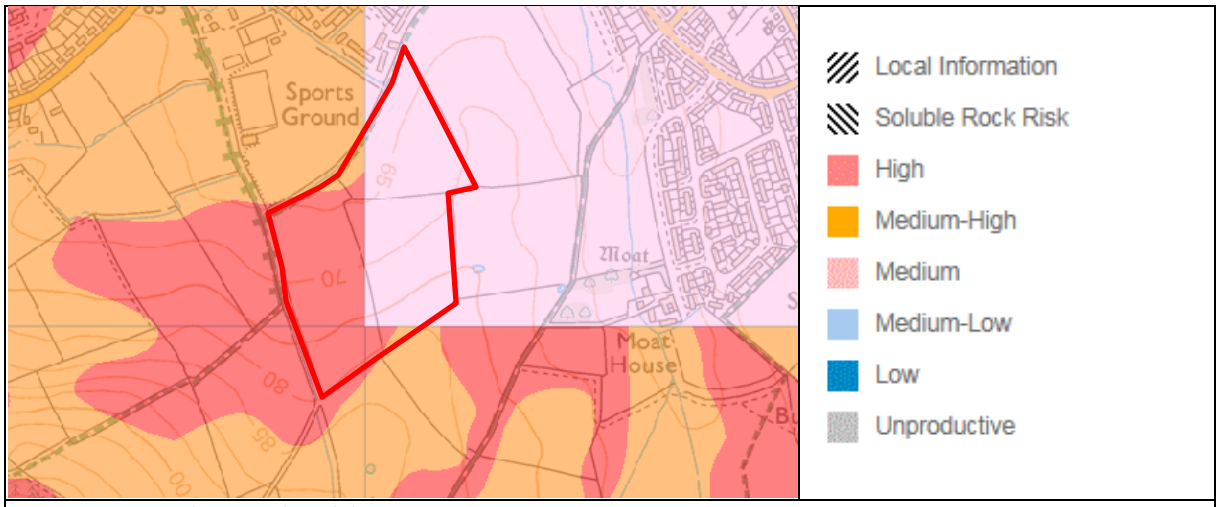


Figure 14. Groundwater vulnerability

Groundwater Vulnerability Maps provide information on how significant the ground waters are likely to be and if they are vulnerable to pollution occurring at the land surface. The maps have descriptions on them to explain the different aquifer and soil types. Areas shown as "major aquifers" have strategic significance for water resources, they often support large abstractions for the public water supply. Minor aquifers have a more localised significance to domestic, agricultural and industrial users (although they may still be used for drinking water). Non-aquifers do not store significant amounts of groundwater. However, in some areas they can support local supplies: e.g. small springs feeding individual properties.

Major and minor aquifers may be important in contributing to the base-flow of streams and rivers. The maps show where groundwater is protected from above by rocks with a low permeability, such as glacial clay. They also show the characteristics of the soil above.

Superficial drift deposits which overlay the solid geological strata can sometimes be substantial in thickness. They are often variable in composition changing from highly permeable outwash gravels to low permeability clays over short distances both laterally and vertically. The presence of permeable drift deposits is recognised as Minor Aquifers except where these overlie a Major Aquifer and they then assume the status of a Major Aquifer.

The site is over a non aquifer associated with the superficial deposits and a Secondary B Aquifer associated with the bedrock. The site is classed partially as high vulnerability and partially as medium-high vulnerability in respect to groundwater pollution. The site is within a Surface Water Nitrate Vulnerable Zone but is not within a Drinking Water Safeguard Zone.

4.5.4 Flood risk

The site is within Flood Zone 1 land which is very low risk – less than 1 in 1000 in any given year (Figure 15). The site is not covered by flood warnings issued by the Environment Agency.

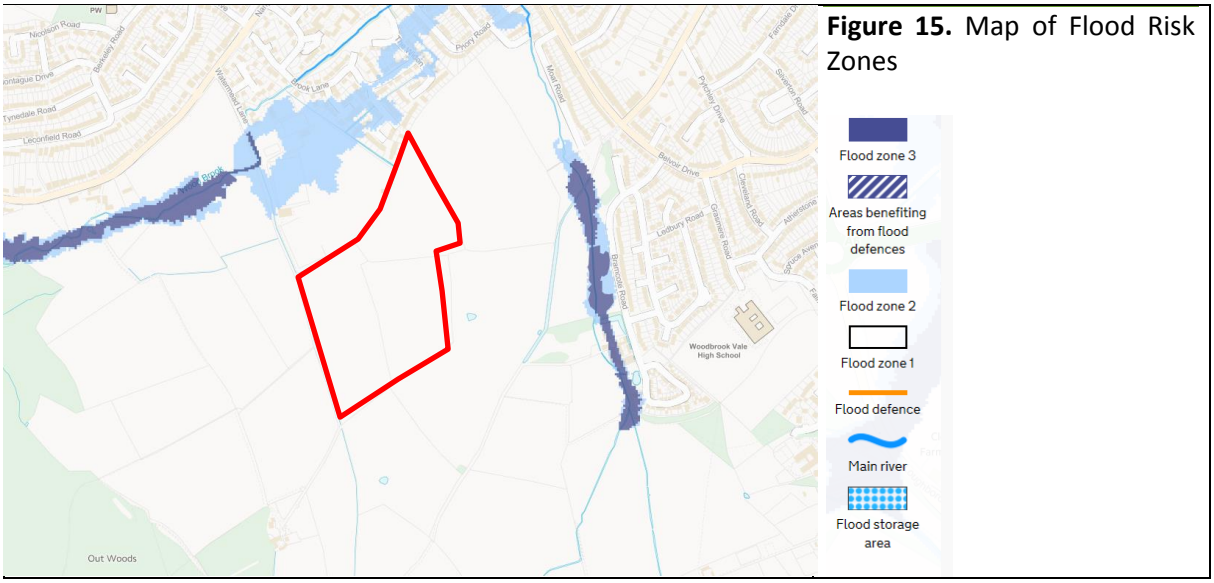


Figure 15. Map of Flood Risk Zones

If areas of impermeable surfaces such as buildings, roads etc. are constructed on a greenfield site, a surface water management system designed in accordance with the principles of Sustainable Urban Drainage Schemes (SUDS) will be required.

4.5.5 Wells in the vicinity of the site

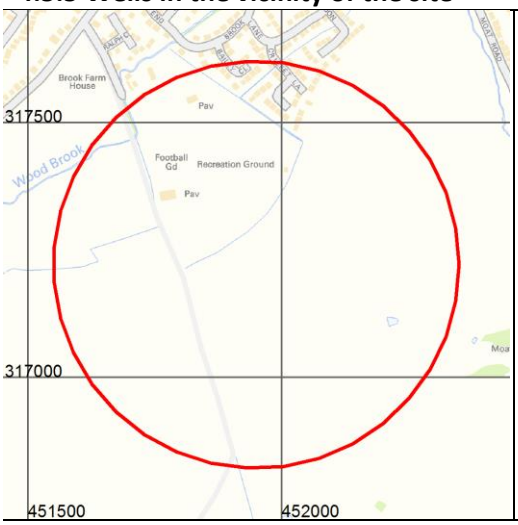


Figure 16. Well records
Number of records within a 300 m radius of the centre of the site: 0

Search area indicated in red

4.5.6 Boreholes in the vicinity of the site

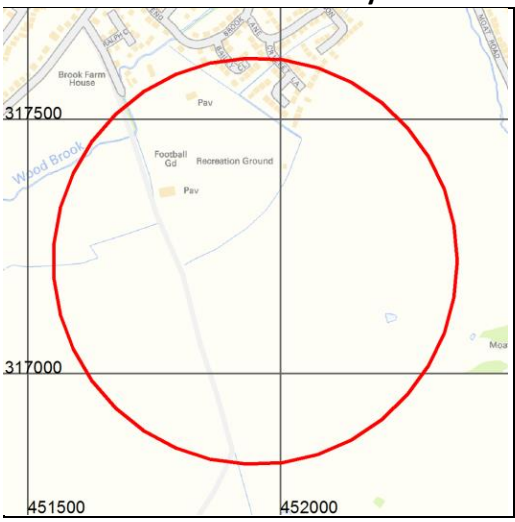


Figure 17. Borehole records
Number of records within map area: 0
Search area indicated in red

4.6 Meteorological data

The agro climatic index number for this site is 22E with a mean annual rainfall of 627 mm, the Standard Average Annual Rainfall (SAAR) for the site itself is 660 mm.

4.7 Surface water issues

The site generally has a very low risk of surface water flooding with the exception of the areas shown in Figure 18. There is a shallow thalweg running through the westerly section of the site where there is a low risk (1% chance of flooding occurring in a given year) of flooding to generally no more than 300 mm deep. This flows to an area near the centre of the northern boundary of the site where surface water may gather and pond to as deep as 900 mm. This area has the highest risk of flooding to a depth of up to 300 mm (a greater than 3.3% chance each year of flooding occurring). Poor surface water drainage associated with these soils is likely to lead to wet conditions under foot frequently through the winter and where depressions occur in the surface water may remain for some time. The areas with higher risk of surface water flooding may require enhanced drainage or localised land raising to make them suitable for burials.

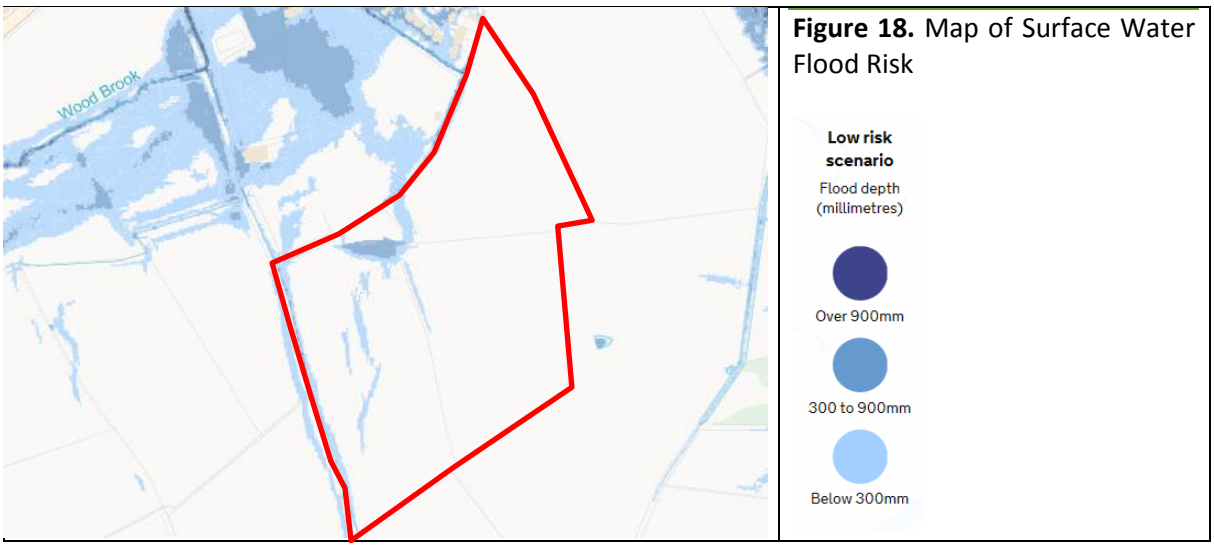


Figure 18. Map of Surface Water Flood Risk

5.0 Pollutant risk

Due to the approximately 60 per annum number of full burials at the site, the cumulative ammoniacal nitrogen concentrations are likely to be high with similar levels of total organic compounds (TOC).

Pathogens

There has been some evidence from recent studies of the occurrence of Enterococci and Clostridium bacteria found in drainage water of cemeteries. Enterococci are bacteria that are commonly found in the bowel of normal healthy individuals. They can cause a range of illnesses including urinary tract infections, bacteraemia (blood stream infections) and wound infections.

The two most common species of Enterococci are E. faecalis and E. faecium. During the mid-1980s, enterococci with resistance to glycopeptide antibiotics such as vancomycin and teicoplanin emerged, termed glycopeptide-resistant enterococci (GRE). Most GRE are E. faecium.

Due to the nature of the soil and geomorphology, there is unlikely to be much movement of pathogenic organisms, notably Pseudomonas aeruginosa and Faecal streptococci, other than where burials coincide with any sand lenses that connect to the adjacent watercourses. However pathogens tend to be short lived away from the host and if there is no immediate ground water risk or potable well supply, the risk may therefore be considered acceptably low. This site is underlain by a non-aquifer associated with the superficial deposits and a Secondary B Aquifer associated with the bedrock geology. This suggests limited risk to any underlying groundwater as the superficial deposits (where present) and the slowly permeable Tarporley Siltstone provide good protection to the Principal Aquifer within the Sherwood Sandstone. Any sand or gravel lenses within burial depth in the Siltstone or superficial deposits are likely to be in hydraulic continuity with the water providing base flow to the adjacent streams however the trial pits did not encounter any such lenses thus the risk is considered low.

Post-burial accumulation of water around a coffin is likely to be an issue in these soils and to minimise the risks thereafter faced on re-opening a grave it is suggested that backfill over a new burial be compacted well to minimise infiltration through to the burial itself.

6.0 Depth of burial

Based on data from the British Geological Survey, the site is overlain by soils derived from clays and silts. Typically such soils are poorly drained and prone to structural damage if worked when wet. Digging is unlikely to be impacted by the presence of hard rock but running sands may prevent burials if perched water is encountered in any sandy lenses which may occur within burial depth, however none were found in the trial pits.

7.0 Archaeology

It is recommended that consultation with the county archaeological team be undertaken to ascertain any archaeological interest in the area.

8.0 Risk evaluation

Assessment of general hazards

The potential of a number of pollutant pathways and the degree of associated risk assessed numerically on a 0-10 score with 10 being the highest risk is shown in Table 4. From the resultant data, the final values are assessed against burial number and a determinant of risk calculated from EA flow charts and nomographs.

T able 4. Summary of pollution risk associated with the site

Risk	Assessment High, moderate, Low	Comment	Score
Burials per annum	Moderate	Expected to be around 60 per annum	
Drift / superficial data	Moderate	Partial cover of till	6-5
Drift thickness	High	Cover variable and thin	8-7
Proximity to water course	Very High	Wet ditch present along western and northern boundaries	10-9
Proximity to land drains	High	Land has previously been drained	8-7
Depth to Water Table	Very low	Water not likely to be present within Tarporley Siltstone which is around 40 m thick in this location.	2-1
Proximity to Wells or potable water source	Very Low	No wells within 500 m radius	2-1
Flow mechanism	Low	Generally Intergranular flow through clay and silt.	4-3
Aquifers	Moderate	Minor aquifer with moderate vulnerability	6-5
SPZ	Very Low	The site for development lies outside any SPZ	2-1
Met data	Moderate	Annual rainfall moderate	N/A
Proximity to housing	Low	Residential housing in close proximity of the site	N/A
SSSI	Low		N/A
Archaeology	Low	None observed but will require County Archaeologist assessment	N/A
		Total	**48-39**

Table 4 is assessed using the groundwater vulnerability-ranking criteria in Table 5. The total score comes to 48-39 and is considered as a moderate risk. These data are then assessed against the burial rate of 60 per annum on the groundwater risk nomograph p.37 of PP223. The final assessment of risk for this site according to the nomograph (Figure 19), would class it as being **high**.

Table 5. Groundwater ranking

Ranking	Very Low 2-1	Low 4-3	Moderate 6-5	High 8-7	Very High 10-9
Drift Type	Clay	Silt	Silty sand	Sand/gravel	Absent
Drift Thickness	>5 m	>3-5 m	3 m	0-3 m	Absent
Depth to water Table	>25 m	11 – 25 m	10 m	5 – 9 m	<5m
Flow mechanism	Intergranular				Fissured
Proximity to wells					Within 250 m from private potable supply
Aquifer type	Non Aquifer		Minor aquifer		Major aquifer
Abstractions and SPZs	Outside Zone 3	Within Zone 3	Close to boundary of Zone 2	Within Zone 2	Within Zone 1
Water courses and springs		>100 m	>50 <70 m	>30 <50 m	<30 m
Drains	>100 m	>40 <100 m	30 – 40 m	>10 <30 m	<10 m

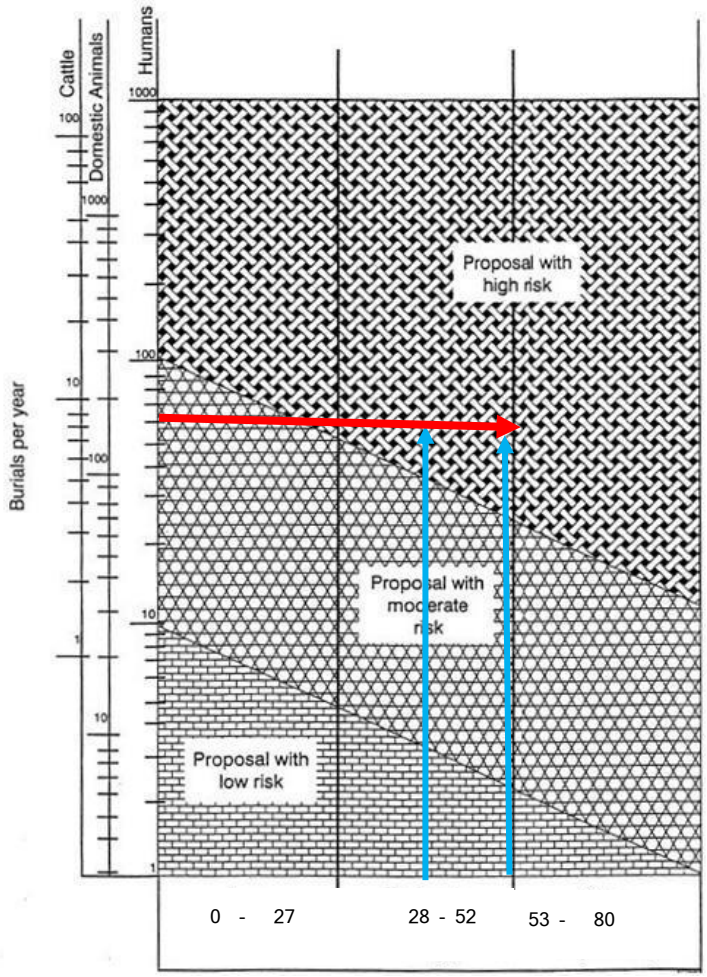


Figure 19. Groundwater risk nomograph

9.0 Conclusion

The site is considered to be **high risk** with the risk mainly attributed to the predicted burial numbers generally and the presence of wet ditches on the western and northern boundaries of the site. In the areas where glacial till overlies the siltstone, the risks are likely to be much lower as there is no significant perched water within the till based on the trial pits and water movement through the subsoil is likely to be very slow. The trial pits struck no permeable deposits or lenses within or within 1m of burial depth thus the risk to local surface waters is also likely to be quite low however fo the key risks te risk to local surface water is likely to be greater than the risk to groundwater at this site.

As the soils are very poorly drained, water may gather around burials making re-opening potentially difficult. This can be mitigated by compacting backfill over recent burials firmly to reduce the risk of infiltration through the disturbed back-fill material.

The site has two wet ditches along the boundaries which would require a minimum 10m no burial zone and one ditch may class as a tertiary river, in which case it may require a 30 m no burial zone. The site has two large aqueducts and a high pressure gas main running through the centre of the site and it is likely that this will also require a 10 m no dig zone either side of the nearest service, thus much of the site could not be used for burials.

By way of grave-specific mitigation if needed, the addition of Zeolitic compounds could be added to the base of graves. Zeolites such as Clinoptilolite have CEC values exceeding 150 meq/l and when placed in the base of the grave will absorb significant amounts of Ammonium via cation exchange processes in addition to the existing capacity of the clay soil (Rozic et al 2009).

Calculations would suggest that at least 90% of the human nitrogen (1.8 kg) release could be absorbed by 150 kg of Clinoptilolite or a high CEC clay material such as Bentonite.

10.0 Reporting details

Report Author:	Mr Alex Vickers
Verification:	Mr Justin Smith
Date:	22.3.18

Cemetery Development Services - Terms and Conditions

Cemetery Development Services (CDS)
Terms and Conditions for the Supply of Services

Interpretation

In these Conditions
AGREED FEE means the charges agreed between CDS and the Client in relation to the Specified Service
CLIENT means the person named on the Specification Sheet for whom CDS has agreed to provide the Specified Service in accordance with these Conditions
CONTRACT means the contract for the provision of the Specified Service
DOCUMENT includes, in addition to a document in writing, any map, plan, graph, drawing or photograph, any film, negative, tape or other device embodying visual images and any disc, tape or other device embodying any other data
INPUT MATERIAL means any Documents or other materials, and any data or other information provided by the Client relating to the Specified Service
OUTPUT MATERIAL means any Documents or other materials, and any data or other information provided by CDS relating to the Specified Service
SPECIFICATION SHEET means the sheet to which these Conditions are appended
SPECIFIED SERVICE means the service relating to geophysical surveys of land to be provided by CDS for the Client and referred to in the Specification Sheet
CDS means CDS (registered in England under number 05089827) or its subsidiary as stated on the Specification Sheet
The headings in these Conditions are for convenience only and shall not affect their interpretation.

Supply of the Specified Service

CDS shall provide the Specified Service to the Client subject to these Conditions. Any changes or additions to the Specified Service or these Conditions must be agreed in writing by CDS and the Client.
The Client shall allow CDS adequate access to its property at reasonable times and for so long as is necessary to enable CDS to provide the Specified Service in accordance with the Contract.
The Client shall at its own expense supply CDS with all necessary Documents or other materials, and all necessary data or other information relating to the Specified Service, within sufficient time to enable CDS to provide the Specified Service in accordance with the Contract. The Client shall ensure the accuracy of all Input Material.
CDS shall have no liability for any loss or damage, however caused, to the Input Material. All Output Material shall be at the sole risk of the Client from the time of delivery to or to the order of the Client.
The Specified Service shall be provided in accordance with the Specification Sheet subject to these Conditions.
Further details about the Specified Service, and advice or recommendations about its provision or utilisation, which are not given in CDS's brochure or other promotional literature, may be made available on written request.
CDS may correct any typographical or other errors or omissions in any brochure, promotional literature, quotation or other document relating to the provision of the Specified Service without any liability to the Client.
CDS may at any time without notifying the Client make any changes to the Specified Service which are necessary to comply with any applicable safety or other statutory requirements, or which do not materially affect the nature or quality of the Specified Service.

Charges

Subject to any special terms agreed, the Client shall pay the Agreed Fee and any additional sums which are agreed between CDS and the Client for the provision of the Specified Service or which, in CDS's sole discretion, are reasonably incurred as a result of the Client's instructions or lack of instructions, the inaccuracy of any Input Material or any other cause attributable to the Client.
All charges quoted to the Client for the provision of the Specified Service are exclusive of any Value Added Tax, for which the Client shall be additionally liable at the applicable rate from time to time.
CDS shall be entitled to invoice the Client on completion of the Specified Service.
The Agreed Fee and any additional sums payable shall be paid by the Client (together with any applicable Value Added Tax, and without any set-off or other deduction) within 30 days of the date of CDS's invoice.
If payment is not made on the due date, CDS shall be entitled, without limiting any other rights it may have, to charge interest on the outstanding amount (both before and after any judgment) at the rate of 4 % above the base rate from time to time of Barclays Bank plc from the due date until the outstanding amount is paid in full.

Rights in Input Material and Output Material

The property and any copyright or other intellectual property rights in:
any Input Material shall belong to the Client
any Output Material and any amendments or variations to the Input Material made by CDS shall, unless otherwise agreed in writing between the Client and CDS, belong to CDS, subject only to the right of the Client to use the Output Material for the purposes of utilising the Specified Service.
Any Input Material or other information provided by the Client which is so designated by the Client and any Output Material shall be kept confidential by CDS, and all Output Material or other information provided by CDS which is so designated by CDS shall be kept confidential by the Client; but the foregoing shall not apply to any Documents or other materials, data or other information which are public knowledge at the time when they are so provided by either party, and shall cease to apply if at any future time they become public knowledge through no fault of the other party.
The Client warrants that any Input Material and its use by CDS for the purpose of providing the Specified Service will not infringe the copyright or other rights of any third party, and the Client shall indemnify CDS against any loss, damages, costs, expenses or other claims arising from any such infringement.

Warranties and Liability

CDS warrants to the Client that the Specified Service will be provided using reasonable care and skill and, as far as reasonably possible, in accordance with the Specification and at the intervals and within the times referred to in the Specification Sheet. Where CDS supplies in connection with the provision of the Specified Service any goods (including Output Material) supplied by a third party, CDS does not give any warranty, guarantee or other term as to their quality, fitness for purpose or otherwise, but shall, where possible, assign to the Client the benefit of any warranty, guarantee or indemnity given by the person supplying the goods to CDS.
CDS shall have no liability to the Client for any loss, damage, costs, expenses or other claims for compensation arising from any Input Material or instructions supplied by the Client which are incomplete, incorrect, inaccurate, illegible, out of sequence or in the wrong form, or arising from their late arrival or non-arrival, or any other fault of the Client.
Except in respect of death or personal injury caused by CDS's negligence, or as expressly provided in these Conditions, CDS shall not be liable to the Client by reason of any representation (unless fraudulent), or any implied warranty, condition or other term, or any duty at common law, or under the express terms of the Contract, for any loss of profit or any indirect, special or consequential loss, damage, costs, expenses or other claims (whether caused by the negligence of CDS, its servants or agents or otherwise) which arise out of or in connection with the provision of the Specified Service or their use by the Client, and the entire liability of CDS under or in connection with the Contract shall not exceed the amount of CDS's charges for the provision of the Specified Service, except as expressly provided in these Conditions.
CDS shall not be liable to the Client or be deemed to be in breach of the Contract by reason of any delay in performing, or any failure to perform, any of CDS's obligations in relation to the Specified Service, if the delay or failure was due to any cause beyond CDS's reasonable control.

Termination

Either party may (without limiting any other remedy) at any time terminate the Contract by giving written notice to the other if the other commits any breach of these Conditions and (if capable of remedy) fails to remedy the breach within 30 days after being required by written notice to do so.

Insolvency of Client

This clause applies if:
the Client makes any voluntary arrangement with its creditors or (being an individual or firm) becomes bankrupt or (being a company) becomes subject to an administration order or goes into liquidation (otherwise than for the purposes of amalgamation or reconstruction); or
an encumbrancer takes possession, or a receiver is appointed, of any of the property or assets of the Client; or
the Client ceases, or threatens to cease, to carry on business; or
CDS reasonably apprehends that any of the events mentioned above is about to occur in relation to the Client and notifies the Client accordingly.
If this clause applies then, without prejudice to any other right or remedy available to CDS, CDS shall be entitled to cancel the Contract or suspend any further provision of services under the Contract without any liability to the Client, and if the Services have been provided but not paid for the price shall become immediately due and payable notwithstanding any previous agreement or arrangement to the contrary.

General

These Conditions (together with the terms, if any, set out in the Specification Sheet) constitute the entire agreement between the parties, supersede any previous agreement or understanding and may not be varied except in writing between the parties. All other terms and conditions, express or implied by statute or otherwise, are excluded to the fullest extent permitted by law.
Any notice required or permitted to be given by either party to the other under these Conditions shall be in writing addressed to the other party at its registered office or principal place of business or such other address as may at the relevant time have been notified pursuant to this provision to the party giving the notice.
No failure or delay by either party in exercising any of its rights under the Contract shall be deemed to be a waiver of that right, and no waiver by either party of any breach of the Contract by the other shall be considered as a waiver of any subsequent breach of the same or any other provision.
If any provision of these Conditions is held by any competent authority to be invalid or unenforceable in whole or in part, the validity of the other provisions of these Conditions and the remainder of the provision in question shall not be affected.
Any dispute arising under or in connection with these Conditions or the provision of the Specified Service shall be referred to arbitration by a single arbitrator appointed by agreement or (in default) nominated on the application of either party by the President for the time being of Institute of Arbitrators.
English law shall apply to the Contract, and the parties agree to submit to the non-exclusive jurisdiction of the English courts.

Cemetery Development Services Limited
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A report to Charnwood Borough Council on the suitability of proposed new cemetery at Shelthorpe Golf Course as part of an Environment Agency T2 Audit

March 2018
D1.0




Company Directors: JJ Smith

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Wrest Park, Silsoe
Bedfordshire
MK45 4HR

Registered No: 5048077

Vat No. 0836 4504 25

Charnwood Borough Council

An Environment Agency T2 Assessment for a proposed new cemetery at Shelthorpe Golf Course, Loughborough, Leicestershire, LE11 2JS. Grid Ref: 453523; 317470

Contents

Tables

Figures

1.0 Executive summary

The site is considered to be **moderate to high risk in the south and eastern sections** of the site and **moderate risk in the northern section** with the risk mainly attributed to the predicted burial numbers generally, the presence of a culverted watercourse through the centre of the site and the likely presence of groundwater within 5m of the surface within the head deposits in the southern and eastern sections. In the areas where glacial till overlies the siltstone, the risks are likely to be much lower as there is no significant perched water within the till based on the trial pits and water movement through the subsoil is likely to be very slow. Based on this, if this site is to be considered for burials it is recommended that only the northern section of the site is suitable as the remaining section offers a possible risk to groundwater and adjacent surface waters and would also be practically difficult to bury into due to the presence of hard rock at, or close to, burial depth and the presence of (slowly) running sands.

Where burials take place into the glacial till soils, water may gather around burials making re-opening potentially difficult. This can be mitigated by compacting backfill over recent burials firmly to reduce the risk of infiltration through the disturbed back-fill material.

By way of grave-specific mitigation if needed, the addition of Zeolitic compounds could be added to the base of graves. Zeolites such as Clinoptilolite have CEC values exceeding 150 meq/l and when placed in the base of the grave will absorb significant amounts of Ammonium via cation exchange processes in addition to the existing capacity of the clay soil (Rozic et al 2009).

Calculations would suggest that at least 90% of the human nitrogen (1.8 kg) release could be absorbed by 150 kg of Clinoptilolite or a high CEC clay material such as Bentonite.

2.0 Introduction

Cemetery Development Services Ltd. has been asked to carry out a Tier 2 site screening assessment for a new cemetery located on the current site of Shelthorpe Golf Course, Loughborough. This site will be considered on the basis of groundwater risk and as part of this, a T2 study based on the criteria required by the Environment Agency has been carried out. This is because sites that do not meet the requirements of the Environment Agency should be ruled out at an early stage since the Agency as Primary Consultees are able to prevent any site being developed should the site be deemed to represent too great a risk in respect to water pollution.

The proposed development area has been assessed on a 1 km area of influence: grid reference 453523; 317470, nearest postcode: LE11 2JS. The site is calculated as being approximately 9.4 hectares (23.2 acres).

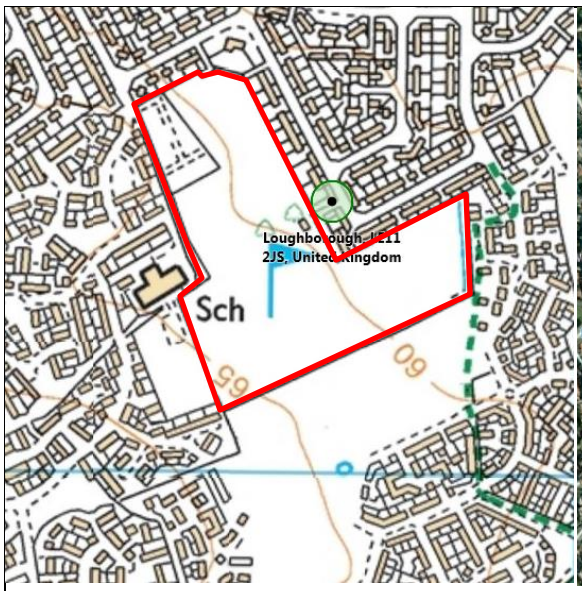


Figure 1a. Map of the site.

Figure 1b. Aerial photograph of the site, (site boundary marked in red).

This report will review the site proposed for use as a burial facility in accordance with the requirements of the Environment Agency's Tier 2 survey. For the purposes of this study the anticipated burial rate for this site is estimated as being in approximately 60 per year.

3.0 Background

New cemetery developments or extensions to existing cemeteries can be very emotive. However, these concerns are often disproportionate to the actual environmental risk.

Whilst the Local Planning Authority is the principal controlling body in determining approval for new sites or site extensions, significant information is required to ensure that the environmental risks are examined and that the Environment Agency's views are considered. Therefore, measures to prevent pollution must be undertaken and reported. Any regulatory decision-making is based on sound scientific knowledge. On this basis, a review of potential pollution from cemeteries was undertaken by the Environment Agency in collaboration with the British Geological Survey.

The aim was to review old and new cemeteries and measure the effects of contamination from viruses, bacteria and other microbiological pathogens and to assess the potential of chemical

contaminants affecting groundwater supplies from decomposition processes. Preliminary results showed that the operating cemetery examined in the study (25 years old) did show some evidence of bacterial contaminants in groundwater derived from corpses. However, no viruses were detected and the overall contaminant loading was found to be low. The studies found that degradation and attenuation was occurring indicating that potential risks were low. Whilst the outcome of this research found contaminant risk to be low, it should be reviewed in the context that natural attenuation processes may have been optimum at these sites. Therefore, to optimise natural attenuation and reduce the risk of possible groundwater contamination, a series of guidelines have been drawn up that are directly applicable to cemeteries.

Failure to manage and reduce any environmental risk to a minimum may result in action being taken under the Groundwater Regulations 1998 and the Anti-pollution Works Notice Regulations 1999.

3.1 Groundwater protection policy

Initial risk screening starts with the tools contained in the Agency's publication, Policy and Practice for the Protection of Groundwater in cemeteries and in the latest GP3 guidance notes.

Tools include Groundwater Vulnerability and Source Protection Zone (SPZ's) maps. These maps highlight where there are likely to be particular risks posed to groundwater from surface activities. Groundwater Vulnerability (GWV) Maps show the damage from pollution to groundwater and the relative importance of the aquifer to water supplies. Risk assessment is made with reference to soil leaching potential and the levels of water tables above major and minor aquifers.

Source Protection Zones are delineated areas around groundwater abstractions used for public consumption and defined by travel, time of biological or chemical contaminants.

The zones are classified in three groups:

Zone 1 High risk
Zone 2 Intermediate to high risk
Zone 3 Intermediate risk

The Environment Agency would be opposed to large graveyards within Zone 1 of an SPZ.

Whilst groundwater is a major part of policy concerns, other water point sources are also considered as requiring an evaluation of risk. These sources include surface water in the form of ditches, spring lines and surface run-off.

The factors influencing the risk of groundwater vulnerability include:

- Soil nature and type
    - Physical, mechanical and chemical properties
- Geomorphology
    - Depth to water table and or height above aquifers
    - Groundwater flow mechanisms
    - Aquifer type
- Abstractions
- SPZ's
- Proximity to water courses, ditches and drains

Therefore, prior to any consent being given by the Environment Agency, an assessment of risk should be undertaken. The degree of assessment is measured through a series of stages namely:

- Hazard identification
- Identification of consequences
- Magnitude of consequences
- Probability of consequences
- Significance of risk

3.2 Tiered risk assessment

There are 3 Tiers of Risk assessment. The associated size and position of the site will in-part determine which Tier is appropriate**.**

Tier 1
Desktop study of all appropriate documentation including GWV and SPZ maps, topographical, hydrological and geomorphologic maps. After adopting a systematic approach to the assessment of risk, a weighting can be given which is assessed as low, medium or high. If the overall risk is low, the proposal may be accepted by the Agency without further detailed assessment. However, the following practical guidelines would be recommended as appropriate controls to minimize pollution risk:

- 250 m distance from groundwater supply
- 30 m minimum distance from groundwater or spring
- 10 m distance from field drains
- No burials in standing water

For the purposes of this screening study, a T1 assessment is being made of each site. This will be augmented by on-site investigation at the preferred two sites following the conclusion of this study.

Tier 2
Should the risks not be clearly defined by the desktop study then further "ground truthing" might need to be undertaken. This may include field studies and monitoring of groundwater within the proposed area, comprising of the installation of up to three boreholes.
In this case, once the final preferred sites are identified the Environment Agency will be contacted with the site details and asked for a view as to whether boreholes or trial pits will be needed.

Tier 3
If the risk is considered high, i.e. the number of yearly burials exceeds 1,000; a full audit will be required. This would include, but not be limited to, a detailed site investigation including boreholes and monthly monitoring.

3.3 Water Resources Act 1991 – S161A Anti-Pollution Works Notices

The EA has powers under s161A of the Water Resources Act 1991 and the Anti-Pollution Works Regulations 1999, allowing Works Notices to be served to prevent or remedy pollution of controlled waters and under the Groundwater Regulations 1998 to prevent pollution of groundwater.

3.4 Groundwater Regulations 1998

Burial of human corpses can result in discharge of listed substances to groundwater. They are, therefore, covered by the requirements of the Groundwater Regulations. Individual burials spaced out over time will only release trivial amounts of listed substances.

These are considered to fall under the *de minimis exemption.* Large numbers of burials (>100 per annum) in a short time or the cumulative effects of many individual burials may cause groundwater pollution. In this case, the EA will, where appropriate, use their powers under the Groundwater Regulations to control or prohibit the burial. This has specific relevance to policy P12-2 but will apply more generally.

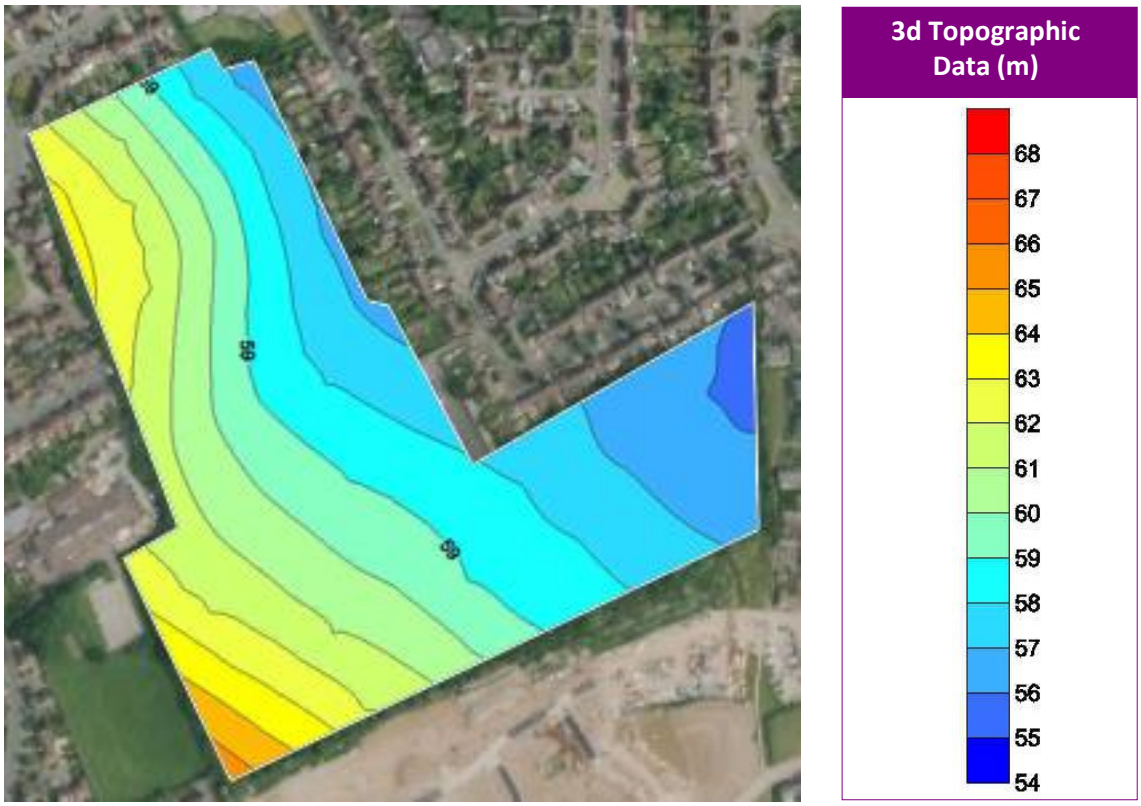
4.0 Site investigation

British Geological Survey and Cranfield University data was used in this report.

4.1 Topography and surface drainage

The site is currently an 18-hole pitch and putt golf course. It is a mix of grassland and woodland and is surrounded to the north, west and east by established residential developments, to the south west by a school and school playing field and to the south by a new housing development. According to the OS maps there is a wet ditch running along the south eastern boundary and there is a small pond to the south but this appears to have been filled during the recent building works in this area.

The site falls from the south west to the north east at an average grade of around 2.8%.



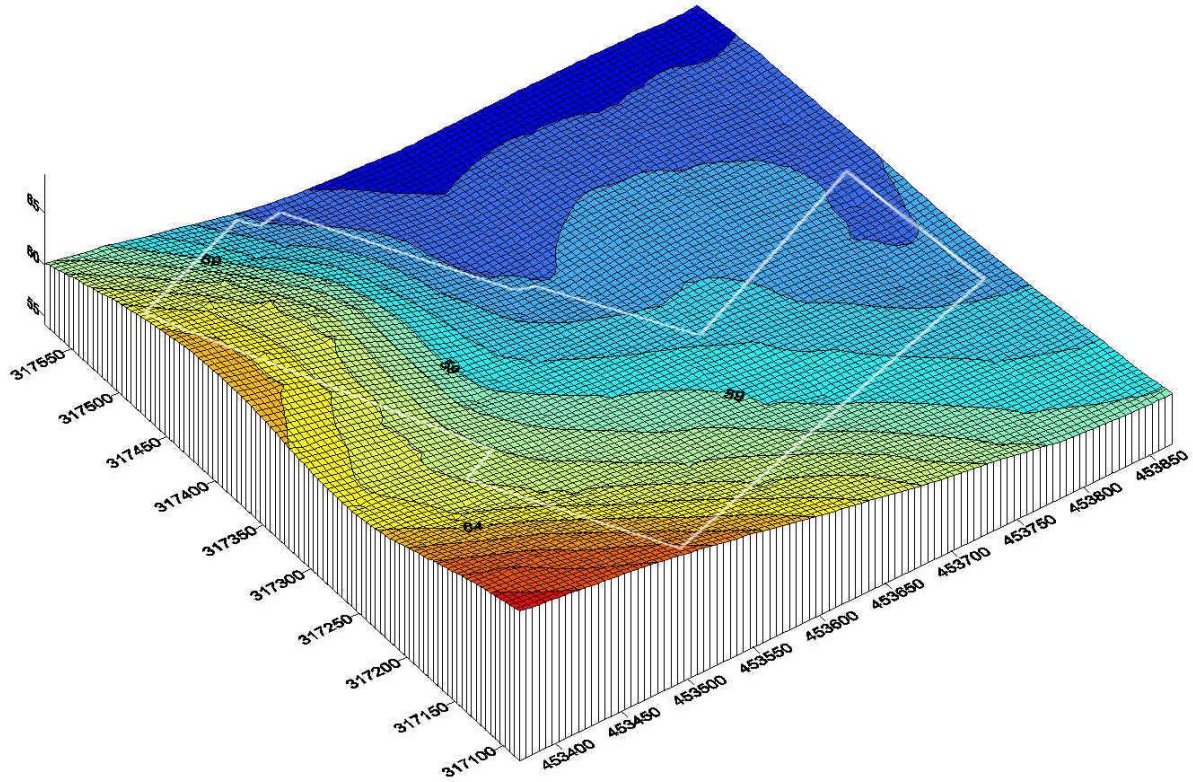


Figure 2. Topography of the site.

4.2 Soil type

The Soil Survey of England and Wales map the site as containing soils belonging to the Whimple 3 Association as described in Table 1 and Figure 3.

Figure 3. Soil Associations in the vicinity of the site.

Table 1. Soil Associations in the vicinity of the site.

Soil Association	Sub Groups	Description
572f Whimple 3	Whimple Worcester Brockhurst	Reddish fine loamy or fine silty over clayey soils with slowly permeable subsoils and slight seasonal waterlogging. Some similar clayey soils on brows. Slowly permeable seasonally waterlogged fine loamy and fine silty over clayey soils on lower slopes.

The soils on site belong to the Whimple 3 Association (572f). These soils tend to be silty or fine loamy in characteristics but with clay dominated subsoils. Often these soils have poor surface water drainage in winter and especially when worked or trafficked as silty soils are very prone to mechanical damage. Effective compaction management can significantly improve surface water drainage rates in amenity grassland settings.

This type of soil is generally suitable for cemeteries but may have some local issues with seepage from more permeable lenses within the subsoil which could flood graves if significant. This can only be confirmed by digging trial pits. Surface water drainage issues can be significant in very wet periods which may make accessing graves difficult at times but this can be improved with appropriate land drainage and good design.

4.2.1 Trial pits

Site investigations were undertaken on 27th February 2018 with 3 trial pits dug to approximately 3.5 metres depth (Figure 5). Figure 4 shows the profiles of the pits excavated.

Figure 4. Trial pit soil profiles

Pit 1 profile.

Pit 2 profile.

Pit 3 profile.

Pit 4 profile.

Pit 5 profile.

Figure 5. Trial pit locations.

Due to the size of the excavator available it was not possible to dig below 2.2m thus it is not possible to be conclusive regarding soil conditions in the full 1m below normal burial depth as this would have required a pit to be excavated to a depth of at least 2.8m. The soils reflect the variation in parent material found over the site.

Pits 1 and 2 are directly into glacial till over the Tarporley Siltstone formation and are clay-dominated in both the topsoil and subsoil. Both these pits were dry to depth though Pit 2 did show some very minor seepage at 1.1m from a very thin sandy layer. This seepage was not enough to cause any practical issues and is unlikely to be anything other than some perched localised water held in a coarser, hydraulically isolated layer in the subsoil.

Pits 3 and 4 were located in area where there was some superficial head deposits running through the site. The produced a sand-dominated topsoil and upper 1.6 to 1.8m depth of subsoil. In Pit 3 the pit was stopped at 1.6m as a layer of very hard sandstone was struck. It was not possible to dig through this layer with the machine available. There was slow seepage from a 20 cm layer of sand immediately over the hard sandstone, probably from water perched within the sand over the hard sandstone. Flow rates were slow and flow occurred as slumping rather than running sand. It is possible that within this area if graves are left for an extended period that the sides would collapse. More importantly, however, the presence on the

indurated sandstone in this location makes digging graves difficult from a practical point of view. In Pit 4 there was no layer of hard sandstone and the sandier head material occurred directly over the underling Tarporley Sandstone Formation at a depth of 1.8m. Water seeped into the pit from multiple points and from all sides from below 1.3m. Though flow rates were not rapid, the mix of slumping sand and water was sufficient to flood the pit at the base when left for 10 minutes. The water was flowing in from a mix of thin saturated sandier layers perched over slightly finer sandy clay layers at around 1.3m and from the sandy clay itself in the 20 – 30 cm over the interface with the Tarporley Siltstone from more significant perched water. It is unlikely that such water is a major groundwater resource but it is likely to be connected to local surface waters that run through and around the site and as such could be a conduit for pollution from burials into the local surface waters. As such there is a potential risk from burials within this part of the site.

The final pit was excavated into an area where the head deposits were thinning, thus the weathered Tarporley Siltstone was struck at a depth of 0.8m. In this case there was some limited seepage into the pit at this interface, with additional seepage from a layer of slightly coarser clayey sand at 1.7m but also directly into the base of the pit from the weathered Tarporley Siltstone suggesting that in this location at least, there was a range of perched groundwater able to flow into any pit excavated. Seepage rates in this location were slow which is typical from subsoils with very fine pores and unlikely to flood a grave unless the grave was excavated several days in advance and left. It is possible that the water in the sandier layers in this pit is in connection with the ditch that runs along the western boundary of the site in this location.

Based on the trial pit digs and bearing in mind the restricted depth of excavation possible, the northern third of the site which is covered in glacial till over the Tarporley Siltstone is more suited to burials than the southern third where the head deposits are thicker.

4.3 Geology

The following headings cover the aspects of geology of the immediate area of the proposed development.

4.3.1 Artificial ground

This is ground at or near the surface that has been modified by man. It includes ground that has been deposited (Made Ground), landscaped, disturbed, excavated (Worked Ground) or some combination of these (Figure 6). No Artificial ground is mapped within the site area; however, the site currently encompasses a golf course and allotment gardens so some degree of landscaping is to be expected. Historic OS maps dated 1884 to 1938 show no significant previous development of the site.

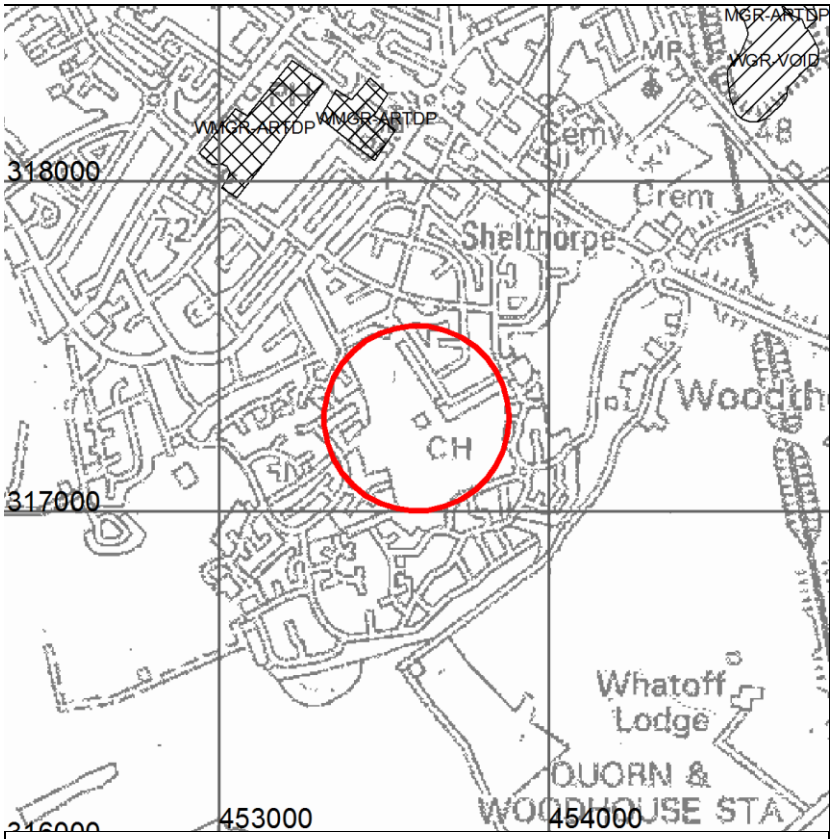


Figure 6. Artificial ground in the vicinity of the site.
Search area indicated in red

Key to Artificial ground:

Map colour	Computer Code	Name of geological unit	Composition
	MGR-ARTDP	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT
	WGR-VOID	WORKED GROUND (UNDIVIDED)	VOID
	WMGR-ARTDP	INFILLED GROUND	ARTIFICIAL DEPOSIT

4.3.2 Superficial deposits

These are relatively young geological deposits formerly known as 'Drift', which lie on the bedrock in many areas. They include deposits such as unconsolidated sands and gravels formed by rivers and clayey tills formed by glacial action. They may be overlain by landslide deposits, by artificial deposits or both (Figure 7).

The north-western corner of the site is underlain by the Thrussington Member of the Wolston Formation of Pleistocene age. This glacial till is distinctively red-brown in colour and composed of clay, stones and sand. The Thrussington Member is typically 1 to 7 m thick. This unit may be susceptible to shrink-swell behaviour.

Head is present adjacent to and probably overlying the glacial till, following a small valley running south-west to north-east across the site. Head is a solifluction deposit of Quaternary age composed of poorly sorted sand, gravel, silt and clay. The Head is likely to be 1 to 3 m thick within the site area.

The south-west corner of the site contains Glaciofluvial Deposits of Mid Pleistocene age. These deposits consist of sand and gravel and are likely to be 1 to 2 m thick in the site area.

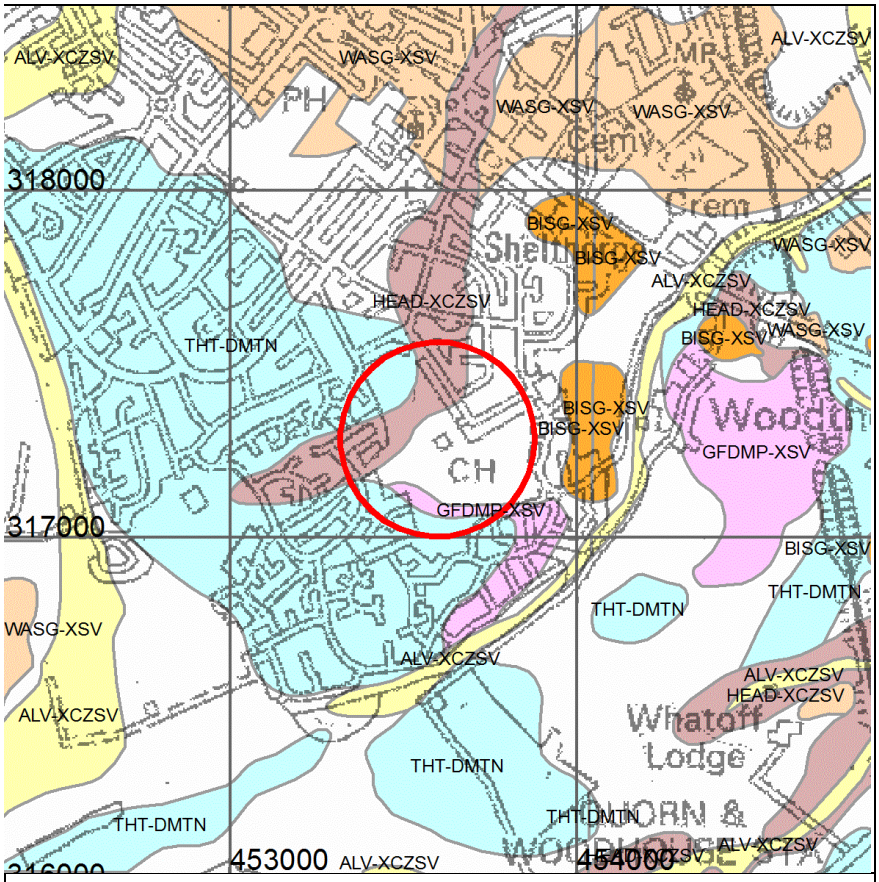


Figure 7. Superficial deposits in the vicinity of the site.

Search area indicated in red

Key to Superficial deposits:

Map colour	Computer Code	Name of geological unit	Composition
	HEAD-XCZSV	HEAD	CLAY, SILT, SAND AND GRAVEL
	ALV-XCZSV	ALLUVIUM	CLAY, SILT, SAND AND GRAVEL
	WASG-XSV	WANLIP MEMBER	SAND AND GRAVEL
	BISG-XSV	BIRSTALL MEMBER	SAND AND GRAVEL
	GFDMP-XSV	GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE	SAND AND GRAVEL
	THT-DMTN	THRUSSINGTON MEMBER	DIAMICTON

4.3.3 Rockhead depth

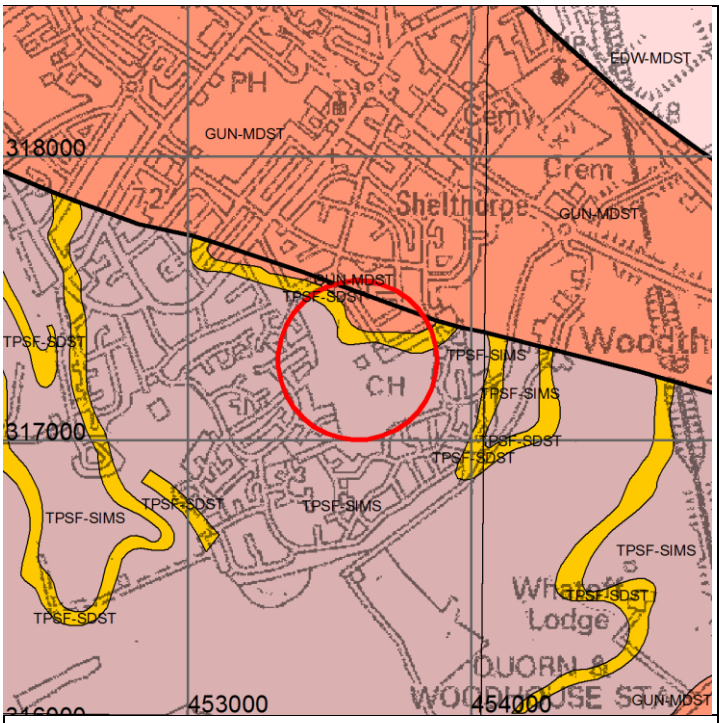
Bedrock is mapped at outcrop in most of the southern and eastern half of the site and therefore in this area, rockhead is expected to be at or near the surface. Beneath the mapped superficial deposits, the depth to rockhead is not known with any degree of certainty, but it is likely to be in the range of 1 to 5 m.

4.3.4 Bedrock geology

The site is underlain by the Tarporley Siltstone Formation of Triassic age. This formation is composed of red-brown and green-grey siltstones and mudstones with paler grey-brown sandstones. A distinct unit of sandstone mapped within the Tarporley Siltstone Formation crosses the northern and eastern

parts of the site, and is likely to be approximately 2 m thick. Overall, the Tarporley Siltstone Formation is likely to be up to 50 m thick in this area.

The Bedrock geological map, shown below, suggests the presence of the Gunthorpe Member of the Sidmouth Mudstone Formation at the northern edge of the site but this is an error and in fact the Tarporley Siltstone Formation continues up to the fault mapped immediately north of the site.



Search area indicated in red

Fault

Coal, ironstone or mineral vein

Note: Faults are shown for illustration and to aid Interpretation of the map. Because these maps are generalised from more detailed versions not all such features are shown and their absence on the map face does not necessarily mean that none are Present. Coals, ironstone beds and mineral veins occur only in certain rock types and regions of the UK; if present here, they will be described within the 'Bedrock' section.

Figure 8. Bedrock geology in the vicinity of the site.
Search area indicated in red

Key to Bedrock geology:

Map colour	Computer Code	Name of geological unit	Rock type
	EDW-MDST	EDWALTON MEMBER	MUDSTONE
	GUN-MDST	GUNTHORPE MEMBER	MUDSTONE
	TPSF-SDST	TARPORLEY SILTSTONE FORMATION	SANDSTONE
	TPSF-SIMS	TARPORLEY SILTSTONE FORMATION	SILTSTONE, MUDSTONE AND SANDSTONE

The west-east trending Sileby Fault is mapped along the northern boundary of the site therefore it is possible that smaller unmapped faults might occur within the site area. It is important to understand the nature of geological faults, and the uncertainties which attend their mapped position at the surface. Faults are planes of movement along which adjacent blocks of rock strata have moved relative to each other. They commonly consist of zones, perhaps up to several tens of metres wide, containing several to many fractures. The portrayal of such faults as a single line on the geological map is therefore a generalisation. Geological faults in this area are of ancient origin, are today mainly inactive, and are thought to present no threat to property.

4.3.5 Schematic geological cross-section

This sketch (Figure 9) represents an interpretation of the geometrical relationships of the main rock units described in the text. It is not to scale. The blue line indicates 'rockhead'; that is the base of superficial deposits. This is the 'geological rockhead', as distinct from the 'engineering rockhead', which is the base of 'engineering soil' (in the sense of BS5930:1999).

Not to scale

National grid references for site	
North 453528, 317542	South 453524, 317102

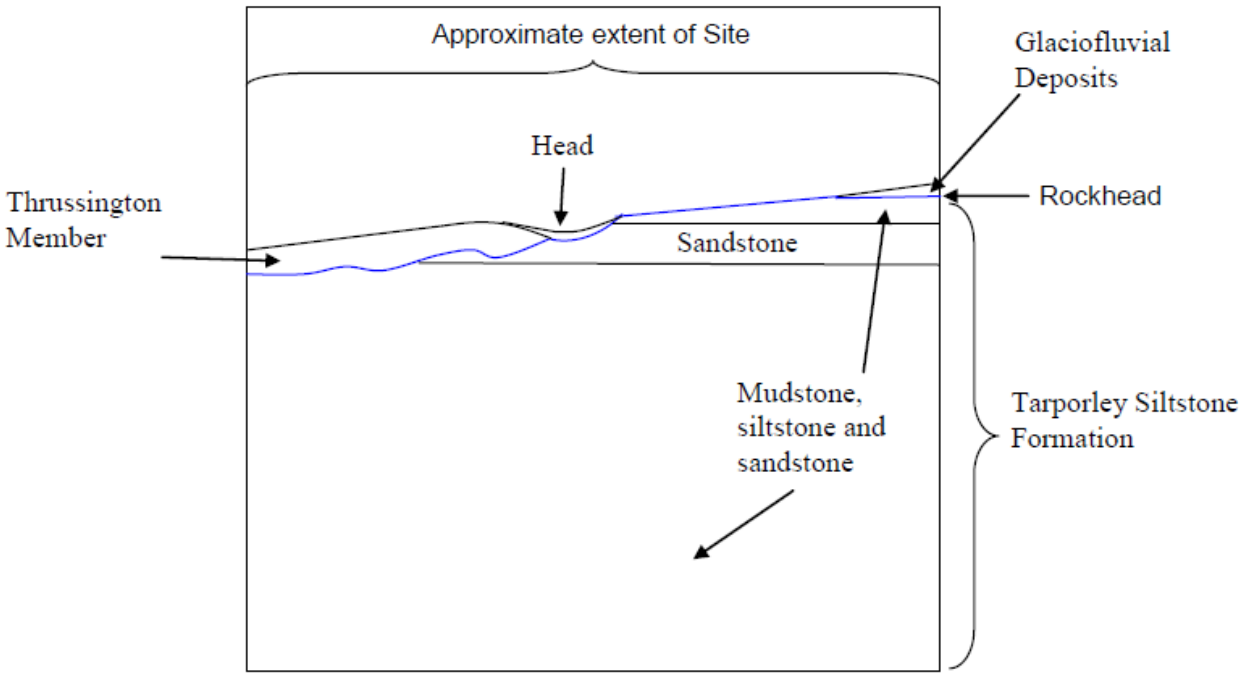
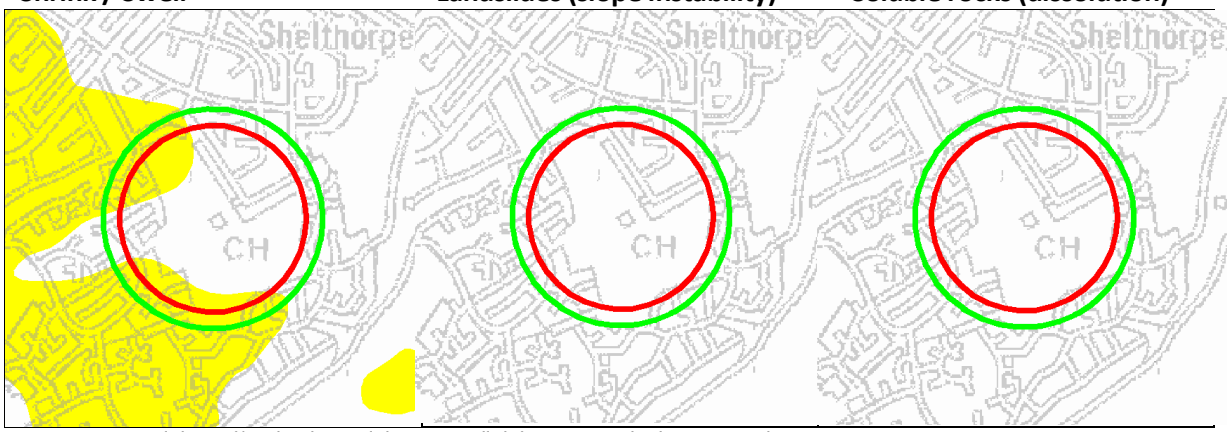


Figure 9. A schematic representation of the underlying geology.

4.4 Additional geological considerations

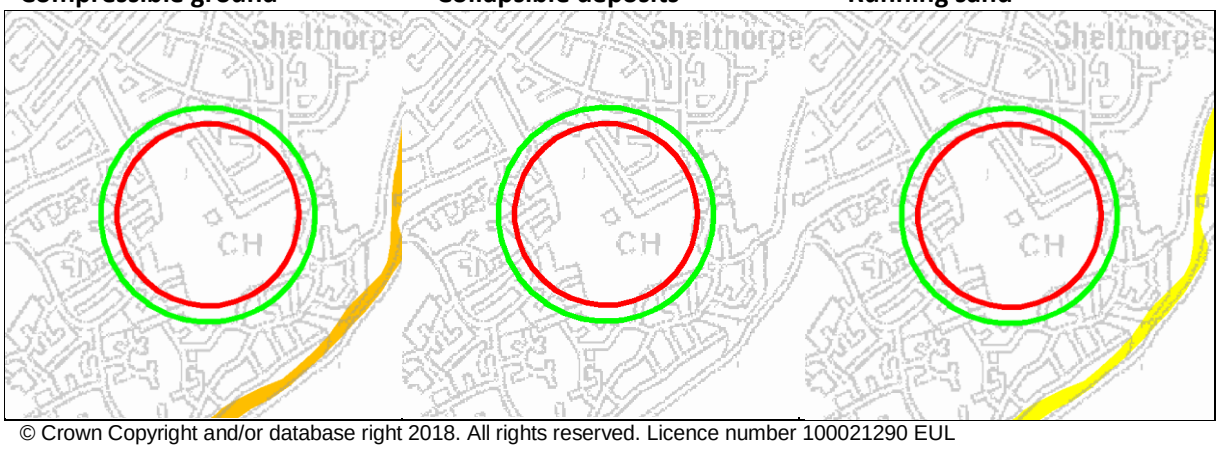
Figure 10. A summary of the geological hazards associated with the site.

Shrink / Swell **Landslides (slope instability)** **Soluble rocks (dissolution)**



The hazard levels are described as A (least) to E (greatest), or as 'No Hazard'. Levels A and B are not considered significant and are not shown on the maps.

Compressible ground **Collapsible deposits** **Running sand**



The geological hazards found on the site are explained in Table 2.

Table 2. Geohazard summary

Geological hazard	May be significant within site area	Comments
Potential Natural Ground Stability Hazards		
Shrink-Swell	Yes	Level C = Potential for hazard to become active is at a level where it should be considered in decisions about construction, building maintenance and land use.
Landslides (slope instability)	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Soluble Rocks (dissolution)	No	Level A = Potential for hazard to be active is either zero or insignificant.
Compressible Ground	No	Level A = Potential for hazard to be active is either zero or insignificant.
Collapsible Deposits	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Running Sand	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Other Potential Hazards		
Mining	No	None
Flooding	Yes	There is the potential for groundwater flooding to occur at the surface within the northern end of the site.
Natural Land Gas	No	Unlikely to encounter gas from bedrock and coal mining; unlikely to encounter gas from peat.
Radon		Level of protective measures: **NO**

4.5 Hydrogeology

In lowland areas of the UK with little topographic variation, groundwater is likely to be found at shallow depths of only a few metres. Water table fluctuations will be small as they will be constrained by the ground surface and the base level of the local perennial streams and rivers.

In upland areas, precipitation is usually high and the dominantly metamorphic and igneous rocks often have relatively shallow groundwater levels.

This is due to preferential groundwater storage in near-surface weathered and fractured zones with limited drainage into the underlying un-weathered lower permeability rock. Exceptions can occur where higher permeability rocks, such as sandstone or limestone, allow faster through flow of groundwater towards the nearest stream or other discharge point.

Perched water tables occur where a less permeable horizon (e.g. a clay layer) in an otherwise permeable sequence retains a body of groundwater above the level of the regional water table. They usually occur at shallow depths in alluvial and glacial sediments and can be difficult to identify or to delimit.

An aquifer becomes confined when it is overlain by a less permeable horizon that restricts the upward movement of groundwater. When this less permeable horizon is penetrated (e.g. by drilling), the groundwater level rises above where struck to a level controlled by the hydrostatic pressure. If this is above ground level, overflowing artesian conditions will be encountered. Confined conditions should be anticipated, where possible, in order to plan for the problems they can generate.

Individual sites will always require more detailed assessments to determine the specific impact on groundwater resources. The maps represent conditions only at the ground surface. Where the soil and/or underlying formations have been disturbed or removed the vulnerability class may have been changed and site specific data will be required. Sites in urban areas and restored or current mineral workings are classified as having high (urban) soil leaching potential until proved otherwise.

The site lies on the Environment Agency's Groundwater Vulnerability Map of Leicestershire (Sheet 30). However, this was based on older geological mapping and classified the area as Non Aquifer (undifferentiated Mercia Mudstone Group). These maps have now been superseded by Aquifer Designation maps that are consistent with the Water Framework Directive, the explanation of which can be found at: http://apps.environment-agency.gov.uk/wiyby/117020.aspx.

These classify the superficial head and glaciofluvial deposits as secondary A aquifers and the Thrussington Member as a secondary (undifferentiated) aquifer; the Tarporley Siltstone Formation bedrock is a secondary B aquifer with the mapped sandstone horizons within it a secondary A aquifer.

The hydrological information for the site is summarised in Table 3.

Table 3. Hydrogeology summary

Geological unit	Groundwater potential	Water level and strikes	Quality	EA groundwater vulnerability classification
Head	May contain small amounts of groundwater with intergranular flow	No information but if any present, water may be encountered at shallow depths as along the valley.	No information.	Secondary A aquifer.
Glacio-fluvial deposits.	Permeable sands and gravels with intergranular flow. Occurs under higher ground, so may drain easily, but likely to contain some residual groundwater for at least part of year.	Water likely to drain out around margins of deposit, but thin saturated zone likely to be present at least for part of the year.	No information, but water from glacial deposits is often ferrunginous.	Secondary A aquifer.

Thrussington Member	Not generally regarded as an aquifer but capable of containing small amounts of groundwater if more sandy / gravelly horizons present.	Likely to be dry, unless sand and gravel horizons present.	Any groundwater present may be ferrunginous and mineralised due to low permeability.	Low permeability superficial deposits.
Tarporley Siltstone Formation	Some groundwater likely to be present in the siltstone and sandstone units, particularly the mapped sandstone unit that traverses the site.	Water levels within the siltstone and sandstone horizons may rise above where first struck. Water level possibly within a few metres of the ground surface.	Groundwater present within siltstone and sandstone horizons may be of good quality but likely to be hard.	Secondary B aquifer associated with the siltstone and sandstone units

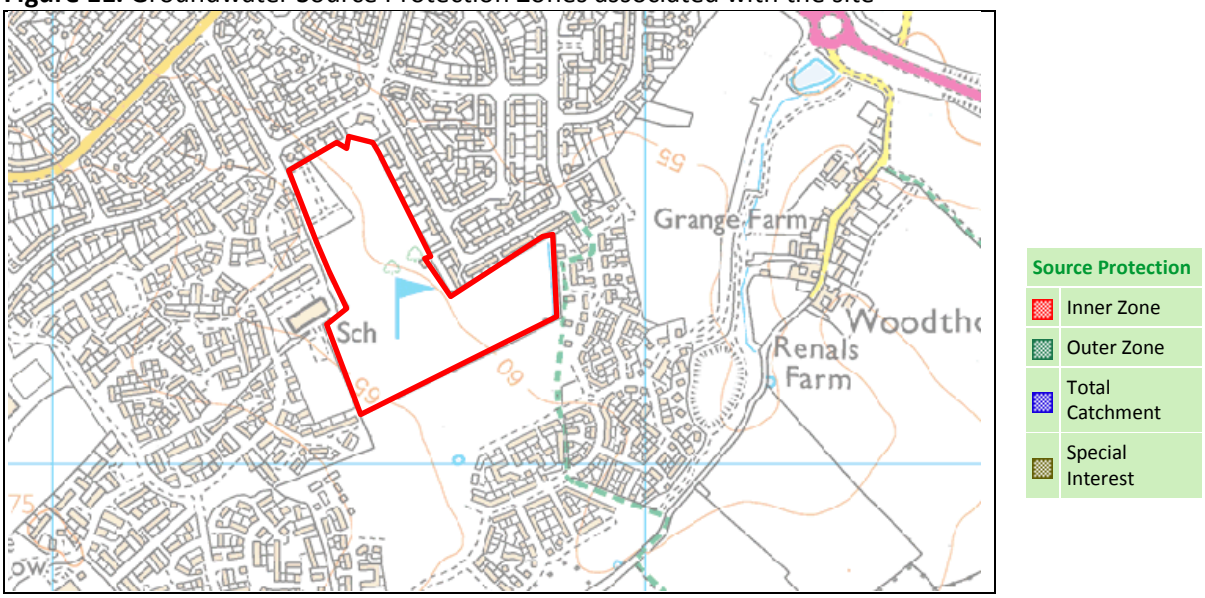
4.5.1 Groundwater vulnerability

This section reviews all components of hydrology, geology and top soil surface water drainage to assess risk notably to groundwater.

4.5.2 Source Protection Zones

The position of the site relative to current ground water protection zones is shown in Figure 11.

Figure 11. Groundwater Source Protection Zones associated with the site



Source Protection Zones (SPZs) provide an indication of the risk to groundwater supplies that may result from potentially polluting activities and accidental releases of pollutants. Generally the closer the activity or release is to a groundwater source the greater the risk. Three zones (an inner, outer

and total catchment) are usually defined although a fourth zone (zone of special interest) is occasionally defined.

The Agency has subdivided groundwater source catchments into four zones. Two of these are determined by the travel time of potential pollutants, the third by the source catchment area itself and the fourth is a "Zone of Special Interest". This fourth zone highlights areas where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

- *Zone I (Inner Protection Zone)* **-** This zone is defined by a travel time of 50-days or less from any point within the zone at, or below, the water table. Additionally, the zone has, as a minimum, a 50-meter radius. It is based principally on biological decay criteria and is designed to protect against the transmission of toxic chemicals and water-borne disease.
- *Zone II (Outer Protection Zone)* **-** This zone is defined by the 400-day travel time, or 25% of the source catchment area, whichever is larger. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants.
- *Zone III (Total catchment)* **-** This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source.
- *Zone of Special Interest* **-** For some groundwater sources an additional Zone of Special Interest may be defined.
  These zones highlight areas (mainly on non-aquifers) where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

The proposed development site lies outside any Groundwater Source Protection Zone.

4.5.3 Aquifer vulnerability

The Groundwater Vulnerability maps are produced at 1:100,000 scale. They show, by means of colour coding, those areas of the country where water-bearing rocks (aquifers) are present. They also show the vulnerability of groundwater to pollution. The aquifers are classified into major, minor and non-aquifers according to their physical properties and their consequent value as a resource.

The classification of the land surface reflects the ability of contaminants to leach through the covering soils and pose a potential risk to groundwater at depth. The maps also indicate areas where the presence of low permeability drift may provide additional groundwater protection.

These maps can therefore be used for an initial screening assessment of the vulnerability of groundwater to contaminants applied to the surface of the ground. They do not provide all information relevant to the determination of vulnerability, such as the depth to water table or nature of the drift deposits. Site-specific information would always be needed for a detailed assessment of vulnerability at a given location. The original groundwater vulnerability maps were produced some time ago.

Groundwater Vulnerability Maps provide information on how significant the ground waters are likely to be and if they are vulnerable to pollution occurring at the land surface. The maps have descriptions on them to explain the different aquifer and soil types.

Areas shown as "major aquifers" have strategic significance for water resource; they often support large abstractions for the public water supply.

Minor aquifers have a more localised significance to domestic, agricultural and industrial users (although they may still be used for drinking water). Non-aquifers do not store significant amounts of groundwater. However, in some areas they can support local supplies: e.g. small springs feeding individual properties.

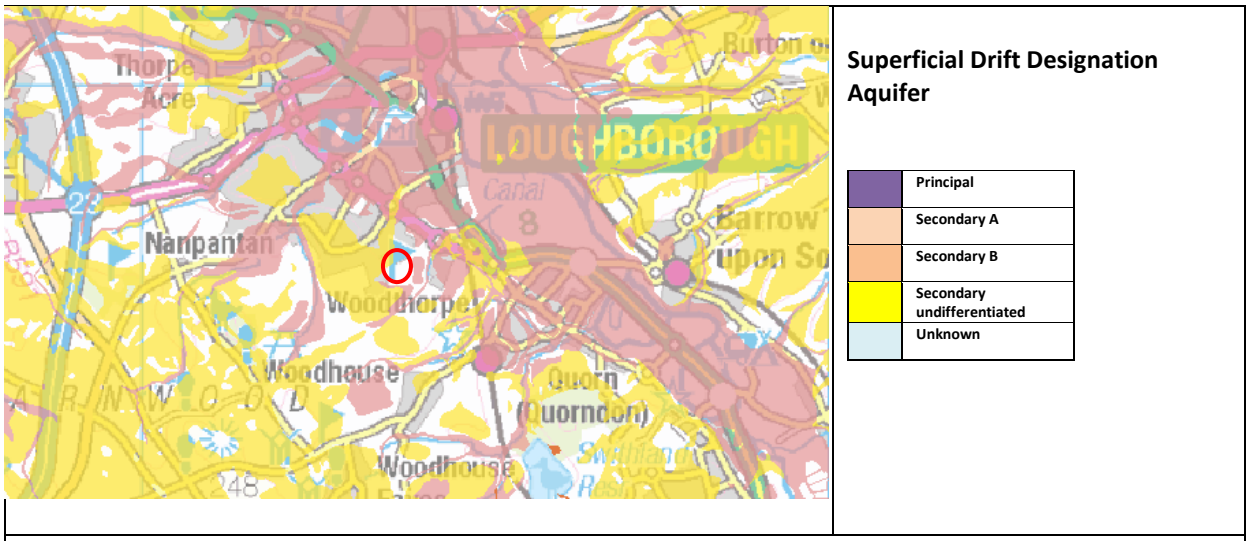


Figure 12. Superficial drift aquifer designation

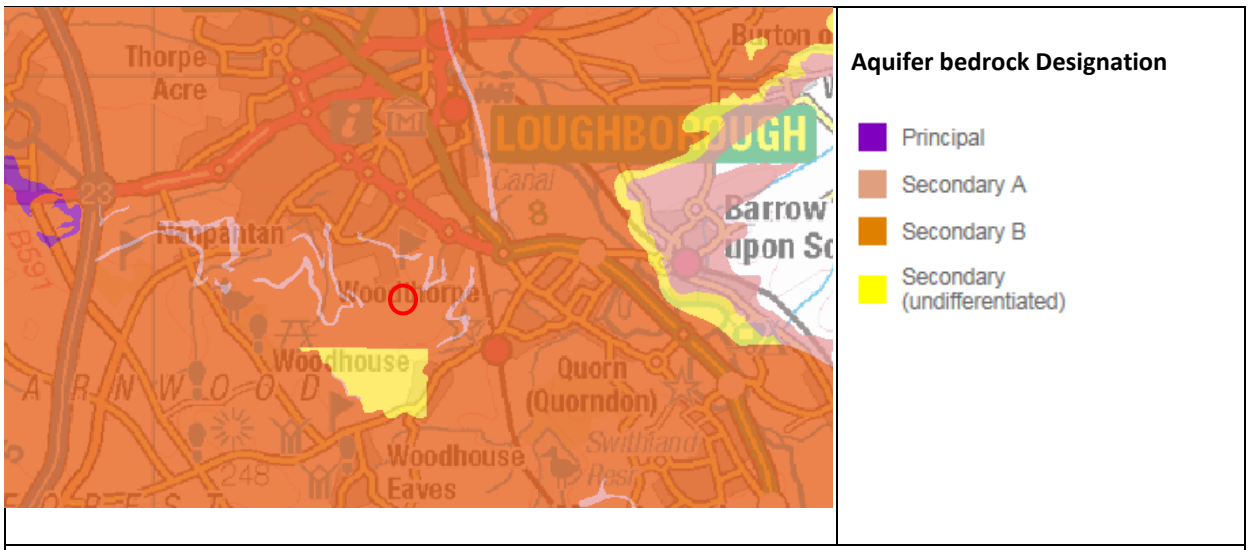


Figure 13. Bedrock aquifer designation

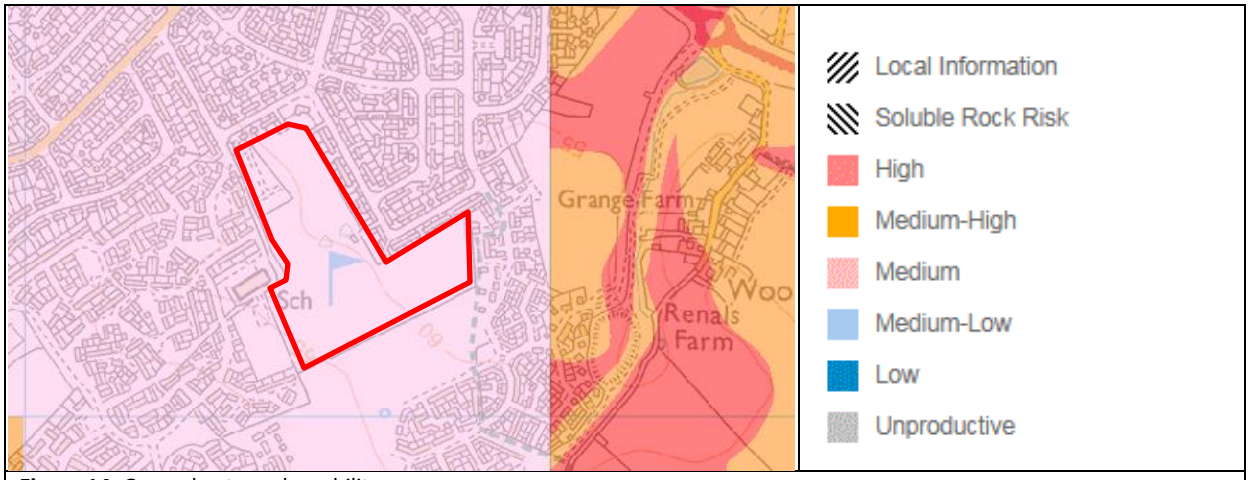


Figure 14. Groundwater vulnerability

Groundwater Vulnerability Maps provide information on how significant the ground waters are likely to be and if they are vulnerable to pollution occurring at the land surface. The maps have descriptions on them to explain the different aquifer and soil types. Areas shown as "major aquifers" have strategic significance for water resources, they often support large abstractions for the public water supply. Minor aquifers have a more localised significance to domestic, agricultural and industrial users (although they may still be used for drinking water). Non-aquifers do not store significant amounts of groundwater. However, in some areas they can support local supplies: e.g. small springs feeding individual properties.

Major and minor aquifers may be important in contributing to the base-flow of streams and rivers. The maps show where groundwater is protected from above by rocks with a low permeability, such as glacial clay. They also show the characteristics of the soil above.

Superficial drift deposits which overlay the solid geological strata can sometimes be substantial in thickness. They are often variable in composition changing from highly permeable outwash gravels to low permeability clays over short distances both laterally and vertically. The presence of permeable drift deposits is recognised as Minor Aquifers except where these overlie a Major Aquifer and they then assume the status of a Major Aquifer.

The site is over a non aquifer associated with the superficial deposits and a Secondary B Aquifer associated with the bedrock. The site is classed as medium vulnerability in respect to groundwater pollution. The site within a Surface Water Nitrate Vulnerable Zone but is not within a Drinking Water Safeguard Zone.

4.5.4 Flood risk

The site is within Flood Zone 1 land which is very low risk – less than 1 in 1000 in any given year (Figure 15). The site is not covered by flood warnings issued by the Environment Agency.

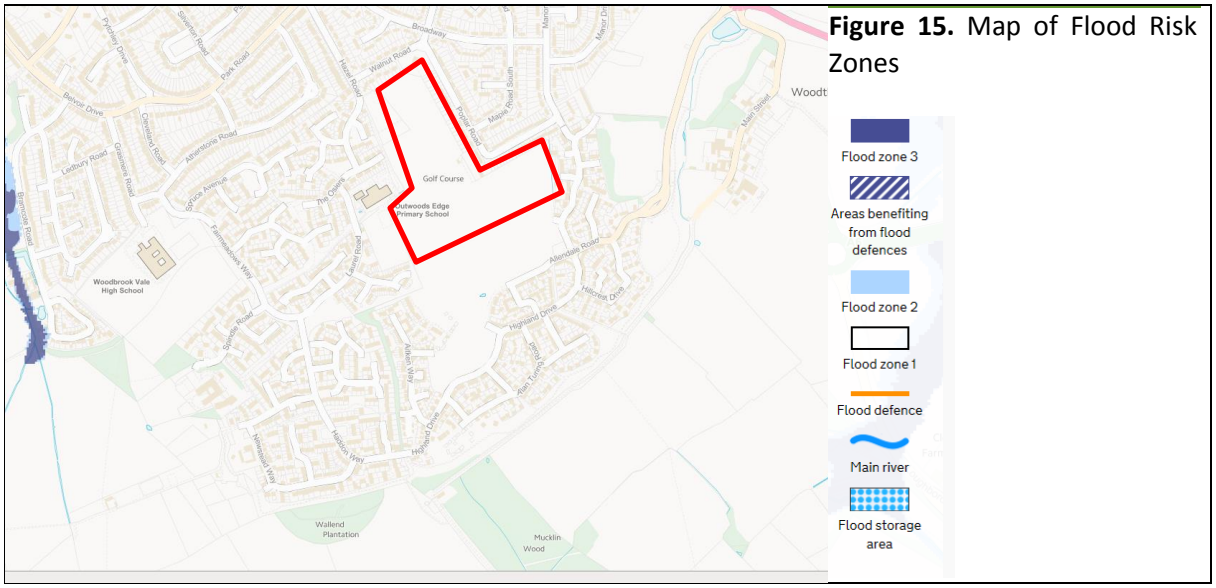


Figure 15. Map of Flood Risk Zones

If areas of impermeable surfaces such as buildings, roads etc. are constructed on a greenfield site, a surface water management system designed in accordance with the principles of Sustainable Urban Drainage Schemes (SUDS) will be required.

4.5.5 Wells in the vicinity of the site

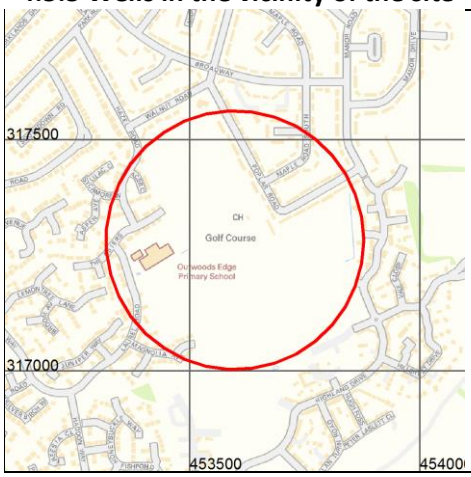


Figure 16. Well records
Number of records within a 300 m radius of the centre of the site: 0

Search area indicated in red

4.5.6 Boreholes in the vicinity of the site

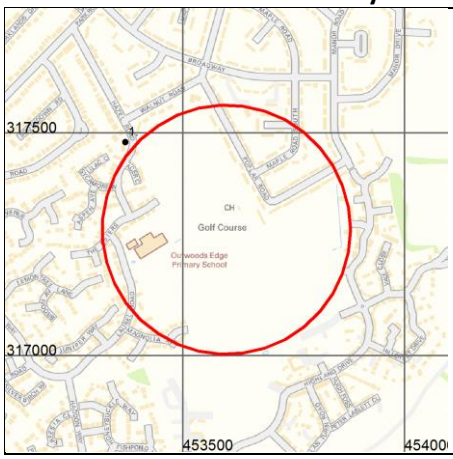


Figure 17. Borehole records
Number of records within map area: 1
SK51NW1
Search area indicated in red

4.6 Meteorological data

The agro climatic index number for this site is 22E with a mean annual rainfall of 627 mm, the Standard Average Annual Rainfall (SAAR) for the site itself is 649 mm.

4.7 Surface water issues

The site generally has a very low risk of surface water flooding with the exception of the areas shown in Figure 18. There is a strip through the centre of the site and along with south eastern boundary where there is a low risk (1% chance of flooding occurring in a given year) of flooding to generally no more than 300 mm deep, though in some places it could be as deep as 900 mm along the eastern boundary. Within these areas there are narrow strips along the eastern boundary which have a high risk of flooding from surface water (a greater than 3.3% chance each year of flooding occurring). Poor surface water drainage associated with these soils is likely to lead to wet conditions under foot frequently through the winter however and where depressions occur in the surface water will pond in these locations and may remain for some time. Any works which might increase the risk of flooding on or off site need to be identified and the risks assessed and mitigated using a suitable SUDS compliant approach. The areas with higher risk of surface water flooding may require enhanced drainage or localised land raising to make them suitable for burials.

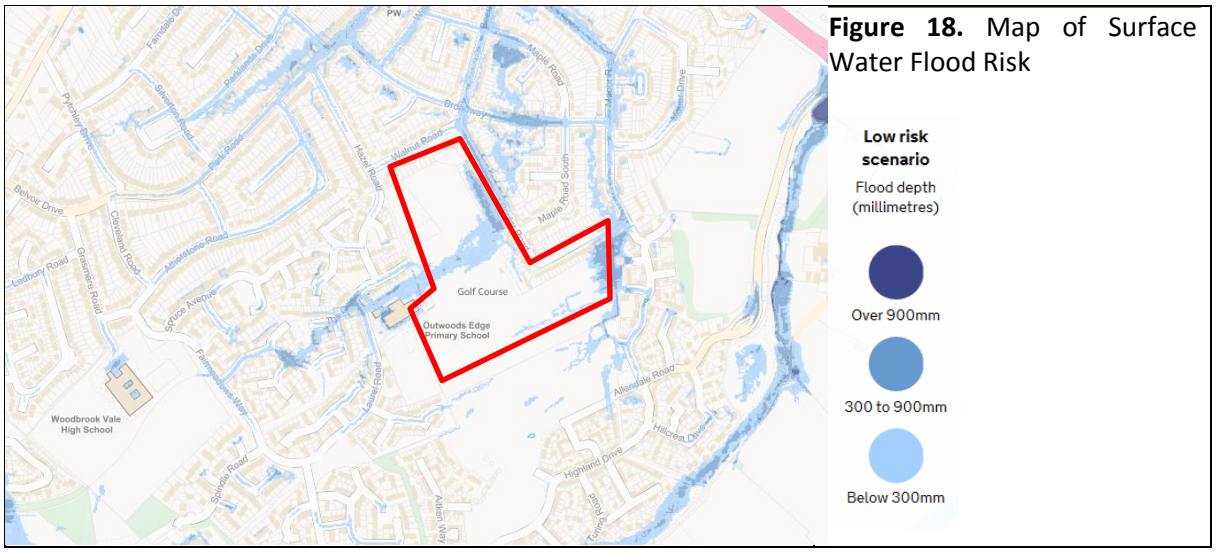


Figure 18. Map of Surface Water Flood Risk

5.0 Pollutant risk

Due to the approximately 60 per annum number of full burials at the site, the cumulative ammoniacal nitrogen concentrations are likely to be high with similar levels of total organic compounds (TOC).

Pathogens

There has been some evidence from recent studies of the occurrence of Enterococci and Clostridium bacteria found in drainage water of cemeteries. Enterococci are bacteria that are commonly found in the bowel of normal healthy individuals. They can cause a range of illnesses including urinary tract infections, bacteraemia (blood stream infections) and wound infections.

The two most common species of Enterococci are E. faecalis and E. faecium. During the mid-1980s, enterococci with resistance to glycopeptide antibiotics such as vancomycin and teicoplanin emerged, termed glycopeptide-resistant enterococci (GRE). Most GRE are E. faecium.

Due to the nature of the soil and geomorphology, there is unlikely to be much movement of pathogenic organisms, notably Pseudomonas aeruginosa and Faecal streptococci, other than where burials coincide with any sand lenses that connect to the adjacent watercourses. However pathogens tend to be short lived away from the host and if there is no immediate ground water risk or potable well supply, the risk may therefore be considered acceptably low. This site is underlain by a Secondary A Aquifer in relation to the limited extent of the Head deposits and a Secondary B Aquifer associated with the Tarporley Siltstone Formation. Pollutants entering groundwater within the area of head deposits is likely to be in hydraulic continuity with the water providing base flow to the adjacent streams. The Secondary B Aquifer associated with the siltstone is well protected by the thickness of the siltstone deposits over the water table and the poorly permeable nature of the weathered siltstone deposits generally and as such the site is classed as being moderately vulnerable.

Post-burial accumulation of water around a coffin is likely to be an issue in these soils and to minimise the risks thereafter faced on re-opening a grave it is suggested that backfill over a new burial be compacted well to minimise infiltration through to the burial itself.

6.0 Depth of burial

Based on data from the British Geological Survey, the site is overlain by soils derived from clays and silts. Typically such soils are poorly drained and prone to structural damage if worked when wet. Digging is unlikely to be impacted by the presence of hard rock but running sands may prevent burials if perched water is encountered in any sandy lenses which may occur within burial depth. There appears to be a layer of hard, indurated sandstone running through part of the site and in Pit 3 this was too hard and extensive to dig through. It is possible that in areas affected by this layer it may be difficult to dig graves through the layer and burying directly over it could increase pollution risk to any perched water over this layer.

7.0 Archaeology

It is recommended that consultation with the county archaeological team be undertaken to ascertain any archaeological interest in the area.

8.0 Risk evaluation

Assessment of general hazards

The potential of a number of pollutant pathways and the degree of associated risk assessed numerically on a 0-10 score with 10 being the highest risk is shown in Table 4. From the resultant data, the final values are assessed against burial number and a determinant of risk calculated from EA flow charts and nomographs.

Table 4. Summary of pollution risk associated with the site

Risk	Assessment High, moderate, Low	Comment	Score
Burials per annum	Moderate	Expected to be around 60 per annum	
Drift / superficial data	Moderate	Silty sand head deposits	6-5
Drift thickness	High	Trial pits indicate a drift depth of 1-3m	8-7
Proximity to water course	Very High	Wet ditch present along south eastern site boundary and wet ditch flowing through centre of site	10-9
Proximity to land drains	High	Land has previously been drained	8-7
Depth to Water Table	Moderate	Occasional water strikes within superficials but volumes low and extent variable.	6-5
Proximity to Wells or potable water source	Very Low	No wells within 500 m radius	2-1
Flow mechanism	Low	Generally Intergranular flow through clay, silt and sand, though flow rates may be locally fast.	4-3
Aquifers	Moderate	Minor aquifer with moderate vulnerability	6-5
SPZ	Very Low	The site for development lies outside any SPZ	2-1
Met data	Moderate	Annual rainfall moderate	N/A
Proximity to housing	Low	Residential housing in close proximity of the site	N/A
SSSI	Low		N/A
Archaeology	Low	None observed but will require County Archaeologist assessment	N/A
		Total	**52-43**

Table 4 is assessed using the groundwater vulnerability-ranking criteria in Table 5. The total score comes to 52-43 and is considered as a moderate risk. These data are then assessed against the burial rate of 60 per annum on the groundwater risk nomograph p.37 of PP223. The final assessment of risk for this site according to the nomograph (Figure 19), would class it as being **moderate to high**.

Table 5. Groundwater ranking

Ranking	Very Low 2-1	Low 4-3	Moderate 6-5	High 8-7	Very High 10-9
Drift Type	Clay	Silt	Silty sand	Sand/gravel	Absent
Drift Thickness	>5 m	>3-5 m	3 m	0-3 m	Absent
Depth to water Table	>25 m	11 – 25 m	10 m	5 – 9 m	<5m
Flow mechanism	Intergranular				Fissured
Proximity to wells					Within 250 m from private potable supply
Aquifer type	Non Aquifer		Minor aquifer		Major aquifer
Abstractions and SPZs	Outside Zone 3	Within Zone 3	Close to boundary of Zone 2	Within Zone 2	Within Zone 1
Water courses and springs		>100 m	>50 <70 m	>30 <50 m	<30 m
Drains	>100 m	>40 <100 m	30 – 40 m	>10 <30 m	<10 m

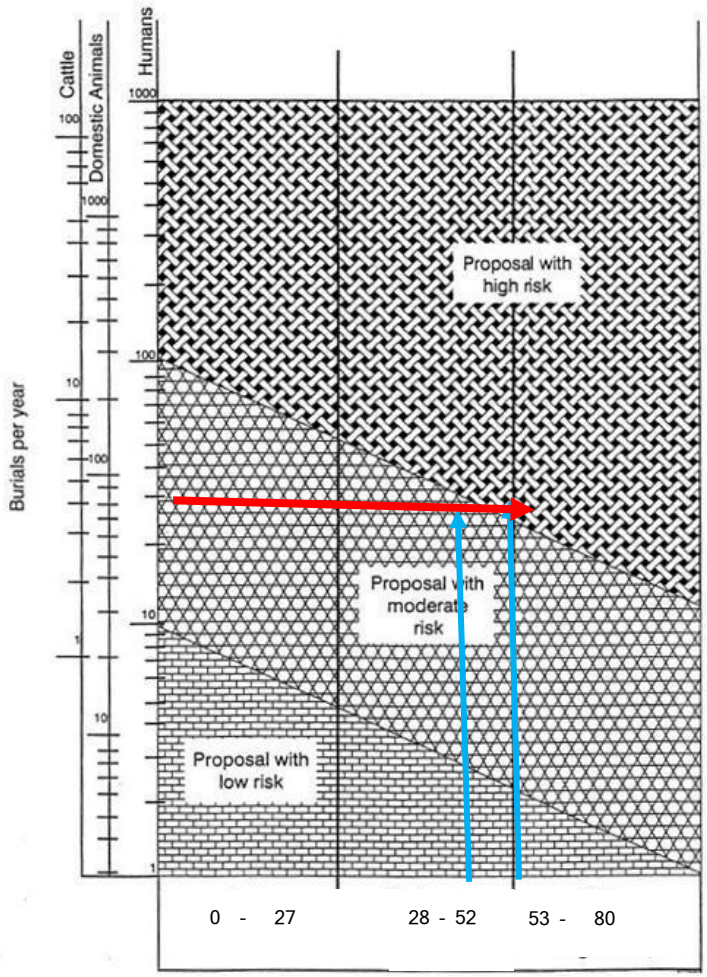


Figure 19. Groundwater risk nomograph

9.0 Conclusion

The site is considered to be **moderate to high risk in the south and eastern sections** of the site and **moderate risk in the northern section** with the risk mainly attributed to the predicted burial numbers generally, the presence of a culverted watercourse through the centre of the site and the likely presence of groundwater within 5m of the surface within the head deposits in the southern and eastern sections. In the areas where glacial till overlies the siltstone, the risks are likely to be much lower as there is no significant perched water within the till based on the trial pits and water movement through the subsoil is likely to be very slow. Based on this, if this site is to be considered for burials it is recommended that only the northern section of the site is suitable as the remaining section offers a possible risk to groundwater and adjacent surface waters and would also be practically difficult to bury into due to the presence of hard rock at, or close to, burial depth and the presence of (slowly) running sands.

Where burials take place into the glacial till soils, water may gather around burials making re-opening potentially difficult. This can be mitigated by compacting backfill over recent burials firmly to reduce the risk of infiltration through the disturbed back-fill material.

By way of grave-specific mitigation if needed, the addition of Zeolitic compounds could be added to the base of graves. Zeolites such as Clinoptilolite have CEC values exceeding 150 meq/l and when placed in the base of the grave will absorb significant amounts of Ammonium via cation exchange processes in addition to the existing capacity of the clay soil (Rozic et al 2009).

Calculations would suggest that at least 90% of the human nitrogen (1.8 kg) release could be absorbed by 150 kg of Clinoptilolite or a high CEC clay material such as Bentonite.

10.0 Reporting details

Report Author:	Mr Alex Vickers
Verification:	Mr Justin Smith
Date:	5.3.18

Cemetery Development Services - Terms and Conditions

Cemetery Development Services (CDS)
Terms and Conditions for the Supply of Services

Interpretation

In these Conditions
AGREED FEE means the charges agreed between CDS and the Client in relation to the Specified Service
CLIENT means the person named on the Specification Sheet for whom CDS has agreed to provide the Specified Service in accordance with these Conditions
CONTRACT means the contract for the provision of the Specified Service
DOCUMENT includes, in addition to a document in writing, any map, plan, graph, drawing or photograph, any film, negative, tape or other device embodying visual images and any disc, tape or other device embodying any other data
INPUT MATERIAL means any Documents or other materials, and any data or other information provided by the Client relating to the Specified Service
OUTPUT MATERIAL means any Documents or other materials, and any data or other information provided by CDS relating to the Specified Service
SPECIFICATION SHEET means the sheet to which these Conditions are appended
SPECIFIED SERVICE means the service relating to geophysical surveys of land to be provided by CDS for the Client and referred to in the Specification Sheet
CDS means CDS (registered in England under number 05089827) or its subsidiary as stated on the Specification Sheet
The headings in these Conditions are for convenience only and shall not affect their interpretation.

Supply of the Specified Service

CDS shall provide the Specified Service to the Client subject to these Conditions. Any changes or additions to the Specified Service or these Conditions must be agreed in writing by CDS and the Client.
The Client shall allow CDS adequate access to its property at reasonable times and for so long as is necessary to enable CDS to provide the Specified Service in accordance with the Contract.
The Client shall at its own expense supply CDS with all necessary Documents or other materials, and all necessary data or other information relating to the Specified Service, within sufficient time to enable CDS to provide the Specified Service in accordance with the Contract. The Client shall ensure the accuracy of all Input Material.
CDS shall have no liability for any loss or damage, however caused, to the Input Material. All Output Material shall be at the sole risk of the Client from the time of delivery to or to the order of the Client.
The Specified Service shall be provided in accordance with the Specification Sheet subject to these Conditions.
Further details about the Specified Service, and advice or recommendations about its provision or utilisation, which are not given in CDS's brochure or other promotional literature, may be made available on written request.
CDS may correct any typographical or other errors or omissions in any brochure, promotional literature, quotation or other document relating to the provision of the Specified Service without any liability to the Client.
CDS may at any time without notifying the Client make any changes to the Specified Service which are necessary to comply with any applicable safety or other statutory requirements, or which do not materially affect the nature or quality of the Specified Service.

Charges

Subject to any special terms agreed, the Client shall pay the Agreed Fee and any additional sums which are agreed between CDS and the Client for the provision of the Specified Service or which, in CDS's sole discretion, are reasonably incurred as a result of the Client's instructions or lack of instructions, the inaccuracy of any Input Material or any other cause attributable to the Client.
All charges quoted to the Client for the provision of the Specified Service are exclusive of any Value Added Tax, for which the Client shall be additionally liable at the applicable rate from time to time.
CDS shall be entitled to invoice the Client on completion of the Specified Service.
The Agreed Fee and any additional sums payable shall be paid by the Client (together with any applicable Value Added Tax, and without any set-off or other deduction) within 30 days of the date of CDS's invoice.
If payment is not made on the due date, CDS shall be entitled, without limiting any other rights it may have, to charge interest on the outstanding amount (both before and after any judgment) at the rate of 4 % above the base rate from time to time of Barclays Bank plc from the due date until the outstanding amount is paid in full.

Rights in Input Material and Output Material

The property and any copyright or other intellectual property rights in:
any Input Material shall belong to the Client
any Output Material and any amendments or variations to the Input Material made by CDS shall, unless otherwise agreed in writing between the Client and CDS, belong to CDS, subject only to the right of the Client to use the Output Material for the purposes of utilising the Specified Service.
Any Input Material or other information provided by the Client which is so designated by the Client and any Output Material shall be kept confidential by CDS, and all Output Material or other information provided by CDS which is so designated by CDS shall be kept confidential by the Client; but the foregoing shall not apply to any Documents or other materials, data or other information which are public knowledge at the time when they are so provided by either party, and shall cease to apply if at any future time they become public knowledge through no fault of the other party.
The Client warrants that any Input Material and its use by CDS for the purpose of providing the Specified Service will not infringe the copyright or other rights of any third party, and the Client shall indemnify CDS against any loss, damages, costs, expenses or other claims arising from any such infringement.

Warranties and Liability

CDS warrants to the Client that the Specified Service will be provided using reasonable care and skill and, as far as reasonably possible, in accordance with the Specification and at the intervals and within the times referred to in the Specification Sheet. Where CDS supplies in connection with the provision of the Specified Service any goods (including Output Material) supplied by a third party, CDS does not give any warranty, guarantee or other term as to their quality, fitness for purpose or otherwise, but shall, where possible, assign to the Client the benefit of any warranty, guarantee or indemnity given by the person supplying the goods to CDS.
CDS shall have no liability to the Client for any loss, damage, costs, expenses or other claims for compensation arising from any Input Material or instructions supplied by the Client which are incomplete, incorrect, inaccurate, illegible, out of sequence or in the wrong form, or arising from their late arrival or non-arrival, or any other fault of the Client.
Except in respect of death or personal injury caused by CDS's negligence, or as expressly provided in these Conditions, CDS shall not be liable to the Client by reason of any representation (unless fraudulent), or any implied warranty, condition or other term, or any duty at common law, or under the express terms of the Contract, for any loss of profit or any indirect, special or consequential loss, damage, costs, expenses or other claims (whether caused by the negligence of CDS, its servants or agents or otherwise) which arise out of or in connection with the provision of the Specified Service or their use by the Client, and the entire liability of CDS under or in connection with the Contract shall not exceed the amount of CDS's charges for the provision of the Specified Service, except as expressly provided in these Conditions.
CDS shall not be liable to the Client or be deemed to be in breach of the Contract by reason of any delay in performing, or any failure to perform, any of CDS's obligations in relation to the Specified Service, if the delay or failure was due to any cause beyond CDS's reasonable control.

Termination

Either party may (without limiting any other remedy) at any time terminate the Contract by giving written notice to the other if the other commits any breach of these Conditions and (if capable of remedy) fails to remedy the breach within 30 days after being required by written notice to do so.

Insolvency of Client

This clause applies if:
the Client makes any voluntary arrangement with its creditors or (being an individual or firm) becomes bankrupt or (being a company) becomes subject to an administration order or goes into liquidation (otherwise than for the purposes of amalgamation or reconstruction); or
an encumbrancer takes possession, or a receiver is appointed, of any of the property or assets of the Client; or
the Client ceases, or threatens to cease, to carry on business; or
CDS reasonably apprehends that any of the events mentioned above is about to occur in relation to the Client and notifies the Client accordingly.
If this clause applies then, without prejudice to any other right or remedy available to CDS, CDS shall be entitled to cancel the Contract or suspend any further provision of services under the Contract without any liability to the Client, and if the Services have been provided but not paid for the price shall become immediately due and payable notwithstanding any previous agreement or arrangement to the contrary.

General

These Conditions (together with the terms, if any, set out in the Specification Sheet) constitute the entire agreement between the parties, supersede any previous agreement or understanding and may not be varied except in writing between the parties. All other terms and conditions, express or implied by statute or otherwise, are excluded to the fullest extent permitted by law.
Any notice required or permitted to be given by either party to the other under these Conditions shall be in writing addressed to the other party at its registered office or principal place of business or such other address as may at the relevant time have been notified pursuant to this provision to the party giving the notice.
No failure or delay by either party in exercising any of its rights under the Contract shall be deemed to be a waiver of that right, and no waiver by either party of any breach of the Contract by the other shall be considered as a waiver of any subsequent breach of the same or any other provision.
If any provision of these Conditions is held by any competent authority to be invalid or unenforceable in whole or in part, the validity of the other provisions of these Conditions and the remainder of the provision in question shall not be affected.
Any dispute arising under or in connection with these Conditions or the provision of the Specified Service shall be referred to arbitration by a single arbitrator appointed by agreement or (in default) nominated on the application of either party by the President for the time being of Institute of Arbitrators.
English law shall apply to the Contract, and the parties agree to submit to the non-exclusive jurisdiction of the English courts.

Cemetery Development Services Limited
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A report to Charnwood Borough Council on the suitability of a proposed site for a new cemetery at Hathern, Leicestershire as part of an Environment Agency T2 Audit

January 2018
D1.0




Company Directors: JJ Smith

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MK45 4HR

Registered No: 5048077

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Charnwood Borough Council

An Environment Agency T2 assessment for a proposed new cemetery at Hathern, Leicestershire, LE12 5HU.
Grid Ref: 449812; 321816

Contents

Tables

Figures

1.0 Executive summary

The site is considered to be **High risk** with the risk mainly attributed to the predicted burial numbers.

Given that burials are likely to be into the silt and clay-dominated superficial deposits and that no groundwater was struck within 3.5m of the surface (1.7m of the base of a double burial) the risk to groundwater is somewhat mitigated as the silty clay is slowly permeable and will increase pollutant retention time and will also remove some ammonium through cation exchange. Though the source of pollutants is present in the form of burials and the receptor is present in the form of the groundwater and any surface water which it might feed, the pathway is likely to be slow and tortuous due to the presence of the silty clay. To ascertain the nature and extent of any risk more precisely, flux modelling of the major pollutants ammonium and nitrate will be required.

Some low volume perched water was struck towards the top of the hill which may make burials in this area practically difficult. In addition, the presence of an infilled pit at the top of the site further reduces the utility of this area for burials though this area could be used for a car park or similar infrastructure. This is because the nature of the infill is uncertain and it may contain perched water within it making burials difficult.

Where burials take place only in the silty clay dominated soils, water may gather around burials making re-opening potentially difficult. This can be mitigated by compacting backfill over recent burials firmly to reduce the risk of infiltration through the disturbed back-fill material.

By way of grave-specific mitigation if needed, the addition of Zeolitic compounds could be added to the base of graves. Zeolites such as Clinoptilolite have CEC values exceeding 150 meq/l and when placed in the base of the grave will absorb significant amounts of Ammonium via cation exchange processes in addition to the existing capacity of the clay soil (Rozic et al 2009).

Calculations would suggest that at least 90% of the human nitrogen (1.8 kg) release could be absorbed by 150 kg of Clinoptilolite or a high CEC clay material such as Bentonite.

The site has complex micro-topography which would require extensive groundworks to create a surface which works efficiently as a cemetery. This will add cost and complexity to the project.

2.0 Introduction

Cemetery Development Services Ltd. has been asked to carry out a Tier 2 site screening assessment for a new cemetery on the edge of Hathern, Leicestershire. This site will be considered on the basis of groundwater risk and as part of this, a T2 study based on the criteria required by the Environment Agency has been carried out. This is because sites that do not meet the requirements of the Environment Agency should be ruled out at an early stage since the Agency as Primary Consultees are able to prevent any site being developed should the site be deemed to represent too great a risk in respect to water pollution.

The proposed development area has been assessed on a 1 km area of influence: grid reference 449812; 321816, nearest postcode: LE12 5HU. The site is calculated as being approximately 7.48 hectares (18.48 acres).

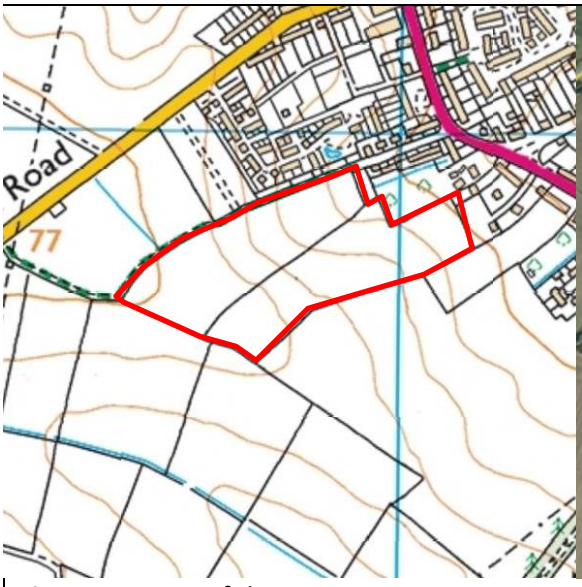


Figure 1a. Map of the site.

Figure 1b. Aerial photograph of the site, (site boundary marked in red).

This report will review the site proposed for use as a burial facility in accordance with the requirements of the Environment Agency's Tier 2 survey. For the purposes of this study the anticipated burial rate for this site is estimated as being in approximately 60 per year.

3.0 Background

New cemetery developments or extensions to existing cemeteries can be very emotive. However, these concerns are often disproportionate to the actual environmental risk.

Whilst the Local Planning Authority is the principal controlling body in determining approval for new sites or site extensions, significant information is required to ensure that the environmental risks are examined and that the Environment Agency's views are considered. Therefore, measures to prevent pollution must be undertaken and reported. Any regulatory decision-making is based on sound scientific knowledge. On this basis, a review of potential pollution from cemeteries was undertaken by the Environment Agency in collaboration with the British Geological Survey.

The aim was to review old and new cemeteries and measure the effects of contamination from viruses, bacteria and other microbiological pathogens and to assess the potential of chemical

contaminants affecting groundwater supplies from decomposition processes. Preliminary results showed that the operating cemetery examined in the study (25 years old) did show some evidence of bacterial contaminants in groundwater derived from corpses. However, no viruses were detected and the overall contaminant loading was found to be low. The studies found that degradation and attenuation was occurring indicating that potential risks were low. Whilst the outcome of this research found contaminant risk to be low, it should be reviewed in the context that natural attenuation processes may have been optimum at these sites. Therefore, to optimise natural attenuation and reduce the risk of possible groundwater contamination, a series of guidelines have been drawn up that are directly applicable to cemeteries.

Failure to manage and reduce any environmental risk to a minimum may result in action being taken under the Groundwater Regulations 1998 and the Anti-pollution Works Notice Regulations 1999.

3.1 Groundwater protection policy

Initial risk screening starts with the tools contained in the Agency's publication, Policy and Practice for the Protection of Groundwater in cemeteries and in the latest GP3 guidance notes.

Tools include Groundwater Vulnerability and Source Protection Zone (SPZ's) maps. These maps highlight where there are likely to be particular risks posed to groundwater from surface activities. Groundwater Vulnerability (GWV) Maps show the damage from pollution to groundwater and the relative importance of the aquifer to water supplies. Risk assessment is made with reference to soil leaching potential and the levels of water tables above major and minor aquifers.

Source Protection Zones are delineated areas around groundwater abstractions used for public consumption and defined by travel, time of biological or chemical contaminants.

The zones are classified in three groups:

Zone 1 High risk
Zone 2 Intermediate to high risk
Zone 3 Intermediate risk

The Environment Agency would be opposed to large graveyards within Zone 1 of an SPZ.

Whilst groundwater is a major part of policy concerns, other water point sources are also considered as requiring an evaluation of risk. These sources include surface water in the form of ditches, spring lines and surface run-off.

The factors influencing the risk of groundwater vulnerability include:

- Soil nature and type
    - Physical, mechanical and chemical properties
- Geomorphology
    - Depth to water table and or height above aquifers
    - Groundwater flow mechanisms
    - Aquifer type
- Abstractions
- SPZ's
- Proximity to water courses, ditches and drains

Therefore, prior to any consent being given by the Environment Agency, an assessment of risk should be undertaken. The degree of assessment is measured through a series of stages namely:

- Hazard identification
- Identification of consequences
- Magnitude of consequences
- Probability of consequences
- Significance of risk

3.2 Tiered risk assessment

There are 3 Tiers of Risk assessment. The associated size and position of the site will in-part determine which Tier is appropriate**.**

Tier 1
Desktop study of all appropriate documentation including GWV and SPZ maps, topographical, hydrological and geomorphologic maps. After adopting a systematic approach to the assessment of risk, a weighting can be given which is assessed as low, medium or high. If the overall risk is low, the proposal may be accepted by the Agency without further detailed assessment. However, the following practical guidelines would be recommended as appropriate controls to minimize pollution risk:

- 250 m distance from groundwater supply
- 30 m minimum distance from groundwater or spring
- 10 m distance from field drains
- No burials in standing water

For the purposes of this screening study, a T1 assessment is being made of each site. This will be augmented by on-site investigation at the preferred two sites following the conclusion of this study.

Tier 2
Should the risks not be clearly defined by the desktop study then further “ground truthing” might need to be undertaken. This may include field studies and monitoring of groundwater within the proposed area, comprising of the installation of up to three boreholes.
In this case, once the final preferred sites are identified the Environment Agency will be contacted with the site details and asked for a view as to whether boreholes or trial pits will be needed.

Tier 3
If the risk is considered high, i.e. the number of yearly burials exceeds 1,000; a full audit will be required. This would include, but not be limited to, a detailed site investigation including boreholes and monthly monitoring.

3.3 Water Resources Act 1991 – S161A Anti-Pollution Works Notices

The EA has powers under s161A of the Water Resources Act 1991 and the Anti-Pollution Works Regulations 1999, allowing Works Notices to be served to prevent or remedy pollution of controlled waters and under the Groundwater Regulations 1998 to prevent pollution of groundwater.

3.4 Groundwater Regulations 1998

Burial of human corpses can result in discharge of listed substances to groundwater. They are, therefore, covered by the requirements of the Groundwater Regulations. Individual burials spaced out over time will only release trivial amounts of listed substances.

These are considered to fall under the *de minimis exemption.* Large numbers of burials (>100 per annum) in a short time or the cumulative effects of many individual burials may cause groundwater pollution. In this case, the EA will, where appropriate, use their powers under the Groundwater Regulations to control or prohibit the burial. This has specific relevance to policy P12-2 but will apply more generally.

4.0 Site investigation

British Geological Survey and Cranfield University data was used in this report.

4.1 Topography and surface drainage

The site is currently in arable production and is bounded on all sides by further arable fields with the exception of the north west which is a mix of pasture and allotments and the east which is low density residential and woodland / gardens. The site falls from the south west to the north east at a general grade of around 4% which is a moderate slope. Within the general fall, however are a series of smaller, complex cross falls to small valley features within each field. This means the site will require significant land engineering to maximise its potential as a cemetery and to minimise loss of useful burial space. According to OS data there are no water features on the site however a wet ditch flows away to the north east from the north eastern boundary with another wet ditch flowing away to the north west from the north western boundary. A small pond is indicated as being to the immediate north of the site adjacent to the footpath but this is not evident on recent aerial photography and may have been filled in.

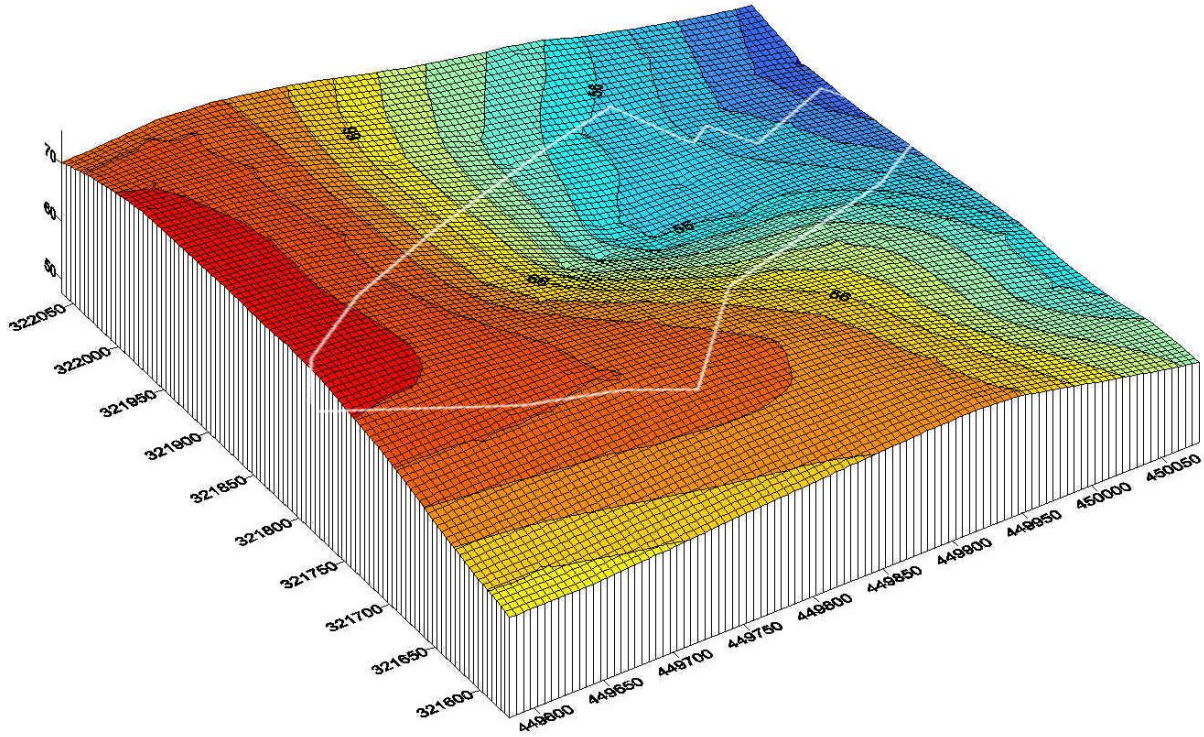


Figure 2. Topography of the site.

4.2 Soil type

The Soil Survey of England and Wales map the site as containing soils belonging to the Flint Association as described in Table 1 and Figure 3.

Figure 3. Soil Associations in the vicinity of the site.

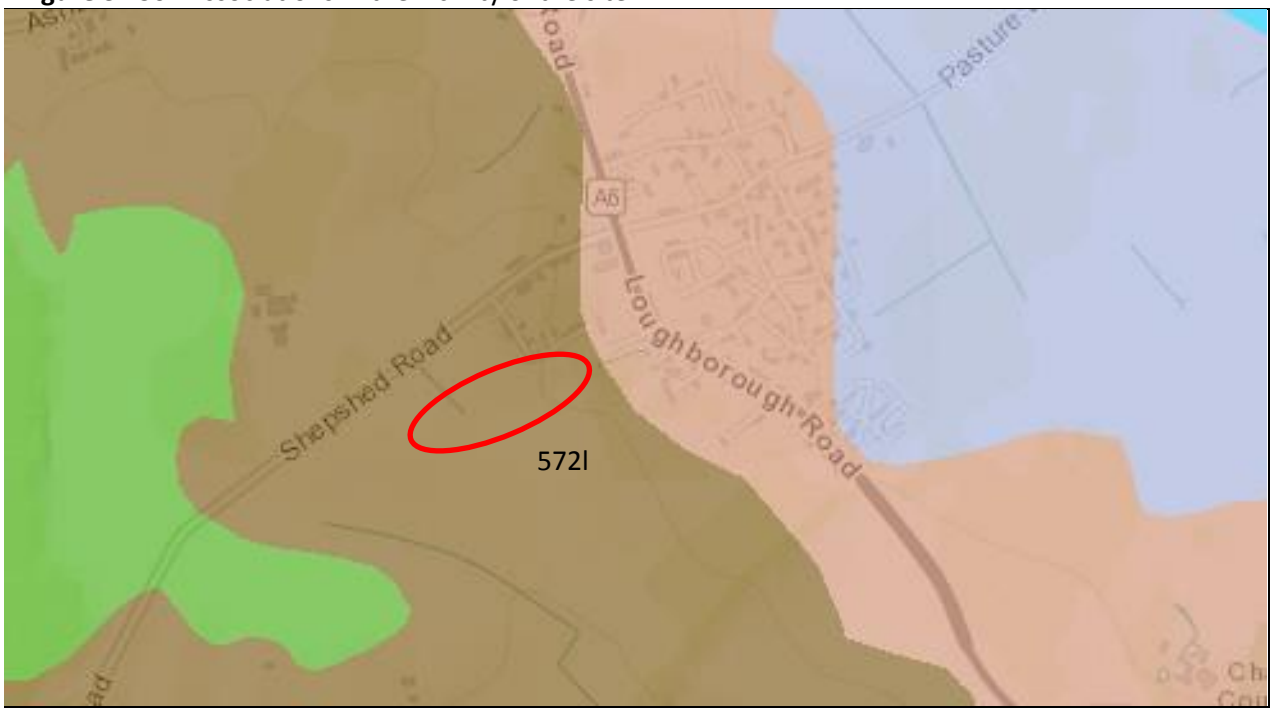


Table 1. Soil Associations in the vicinity of the site.

Soil Association	Sub Groups	Description
572l Flint	Flint Salwick Salop	Reddish fine loamy over clayey soils with slowly permeable subsoils and slight seasonal waterlogging. Some similar fine loamy soils and some slowly permeable seasonally waterlogged fine loamy over clayey soils.

The soils on site belong to the Flint Association (572l). These soils are generally silty soils formed over silt and mudstones with slowly permeable subsoils and slight to moderate seasonal waterlogging. These soils can be prone to slumping.

This type of soil is generally suitable for cemeteries but may have some local issues with seepage from more permeable lenses within the subsoil which could flood graves if significant. This can only be confirmed by digging trial pits.

4.2.1 Trial pits

Site investigations were undertaken on 8th January 2018 with 8 trial pits dug to approximately 3.0-3.1 metres depth (Figure 5). Figure 4 shows the profiles of the pits excavated.

Figure 4. Trial pit soil profiles

Pit 1 profile. | Pit 2 profile.

Pit 3 profile.

Pit 4 profile.

Pit 5 profile.

Pit 6 profile.

Pit 7 profile.	Pit 8 profile.

Figure 5. Trial pit locations.

The soils were generally typical of those described as belonging to the Curtisden Association, being typically clay and silt dominated (SILTY CLAY LOAMS and CLAY LOAMS) however in some locations where sand lenses extended to the surface the topsoils were SANDY CLAY LOAMS. The subsoils were typically SILTY

SANDY CLAYS but in some locations where sand lenses were struck the subsoils were SANDS or CLAYEY SANDS.

Pits 1 and 2 were similar in form, having very wet (saturated in the Case of Pit 2) topsoil over increasingly drier subsoils. Below 800 mm depth the subsoil becomes weathered silt and mudstones which were very well fractured and loose in places with layers of predominantly greenish gray silt and mudstone interbedded with deep red silt and mudstones. In both pits the material became drier, less plastic and more friable with depth. Pit 1 was dry to depth as was Pit 2, however in Pit 2 some slight flow of water from the saturated topsoil was observed entering the pit though the volume was low and the flow rate very slow. Pit 2 was located in the lowest part of the site and received much of the surface water flow from the rest of the field. With some drainage and diversion of surface water flow routes much of this surface water can be managed but if this site were to be developed into a cemetery it is recommended that the area around Pit 2 be used to locate attenuation ponds or basins in as part of any site SUDS schemes rather than for burials as the risk of surface inundation of graves in this location is high.

Pit 3 was also located towards the base of the slope, though not in the very lowest part of the site. This pit varied in that there was approximately 1.8m of glacial till and colluvial deposits over the underlying weather silt and mudstones. Within the glacial till and colluvial deposits there were distinct layers and lenses of sand within the upper 1.8m. These were irregular in shape and discontinuous in both length and depth rather than being discrete horizons within either the soil or superficial geology. These overlay the clay and silt dominated material below and as such may have held perched water within them though in this case the sands were dry and no flow occurred from this layer into the pit itself, with the pit remaining dry for 15 minutes post excavation with no sign of any seepage into it.

Pit 4 was located in a midslope area immediately below a significant change in slope. This pit was similar to Pit 3 but with a shallower depth of overlying glacial till and colluvium. In this pit there was very slight, irregular seepage into the pit at 2.44m bgl, but flow rates were very slow with little water making it into the base of the pit. The water seemed to be coming from a slightly stonier layer within the weathered silt and mudstones but it was difficult to be certain as flow was so slow and it may just have been a small pocket of water around a large cobble within this material.

Pit 5 was located towards the top of the slope, close to the northern boundary and hedge line. This pit was comprised predominantly of glacial till overlying weathered silt and mudstone at a depth of 2.35m. A clay field drain was struck during excavation which flowed into the pit but otherwise the pit remained dry. The pipe flowed for approximately 20 minutes before flow slowed. Again the pit became drier with depth but in this case also became more dense and more compact to depth. The pit contained occasional stones, cobbles and boulders of rounded sandstone.

Pit 6 and Pit 7 were both located on the crest of the hill and were similar in composition with layers of glacial till extending to the base of the pit with no silt and mudstones encountered. In Pit 6 significant lenses of sand were struck between 520 mm and 2.4m deep. The lenses were of variable thickness and length and did not occur in distinct horizons. The sand was an orange brown fine sand and had thin layers of finer material within it.

In Pit 6 the sand began to run when the pit was extended below 2.4m in depth. This marked the boundary between the sand lenses and more uniform silty clay material below. The sands above had some limited perched water within it and though the sand was running, flow rates were slow and the layer within the pit affected was no more than 40 cm thick. Given the very confined lateral extent of this feature it is likely the groundwater encountered is locally perched and hydraulically isolated and as such is unlikely to pose a risk to adjacent surface waters.

Pit 7 also had some small, irregular sand lenses within it but in this case the pit was dry to depth with no flow observed into the pit at all.

The final pit was excavated in the midslope of the lower field and again comprised glacial till to the base of the pit at 3.07m. This pit was dominated by silty Sandy clays with occasional stones, cobbles and boulders of rounded sandstone and some chalk. There was a more distinct sand layer between 2.47m and 2.82m depth but this layer was dry. Indeed the entire pit remained dry with no seepage observed.

As expected, some small sand lenses were observed in most of the pits however with the exception of Pit 6 all were dry suggesting that any perched water on this site is of limited extent and volume. Based on this and given the presence of significant amounts of clay to depth the site is likely to be well suited to use as a cemetery in respect to minimizing pollution risk to groundwater and adjacent surface waters. That said, the complex and in places steep slopes will make it hard to use efficiently for burials without a significant amount of cut and fill works to re-shape the site. It is possible that given presence of some water-bearing lenses that small sections of the site might not be suitable for burials – especially around Pit 6.

4.3 Geology

The following headings cover the aspects of geology of the immediate area of the proposed development.

4.3.1 Artificial ground

This is ground at or near the surface that has been modified by man. It includes ground that has been deposited (Made Ground), landscaped, disturbed, excavated (Worked Ground) or some combination of these (Figure 6).

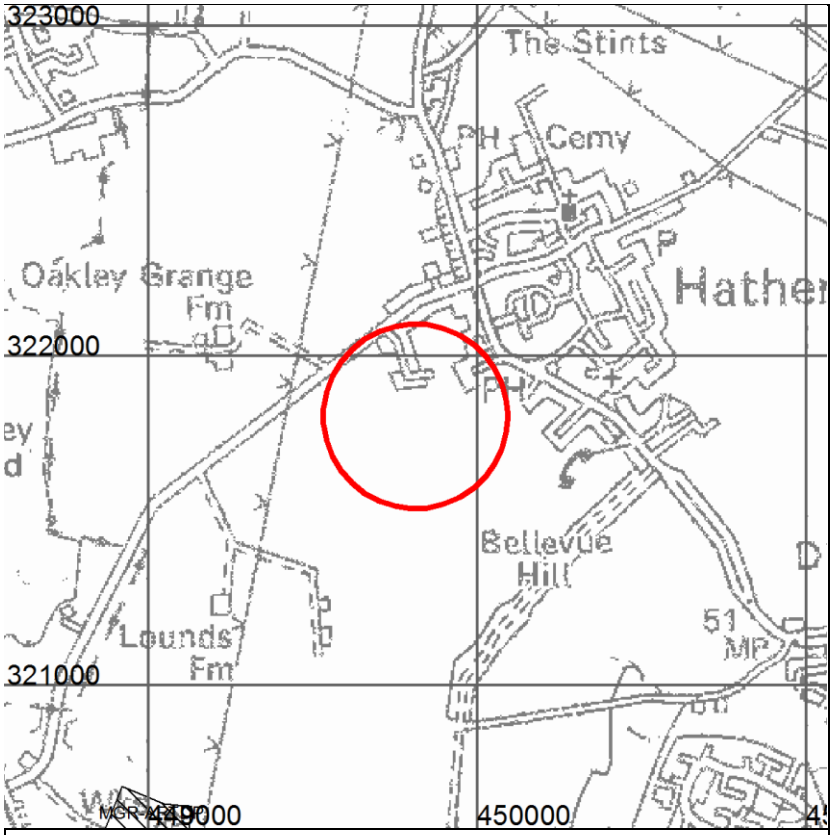


Figure 6. Artificial ground in the vicinity of the site.
Search area indicated in red

Map colour	Computer Code	Name of geological unit	Composition
	MGR-ARTDP	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT
	WGR-VOID	WORKED GROUND (UNDIVIDED)	VOID
	WMGR-ARTDP	INFILLED GROUND	ARTIFICIAL DEPOSIT

No Artificial ground is shown on the 1:50,000 scale data in this report within the site area and historic maps dated 1883 to 1938 show no development of the site. However, a more detailed, more recent map (1:10,000 scale) shows an area of Worked Ground within the centre of the site. This has been removed from the 1:50,000 scale data shown above because the area is too small to be shown clearly
at that scale. This Worked Ground represents a disused clay pit which is no longer visible on aerial photographs of the area. Elevation data show that the pit is represented by a depression in the ground surface, however it is likely that the pit was originally larger. The pit sides are likely to have degraded but the pit may also have been partially, or fully, infilled with industrial or agricultural waste with unknown and variable composition. It should be borne in mind that such deposits may well be highly variable in character and potentially locally compressible if consisting of constructional fill (e.g. crushed brick, wood, etc.). This area occurs at the top of the slope, at the north western boundary. It is still used as a site for agricultural waste to be stored and should not be used for burials but rather for a car park should this site be developed.

4.3.2 Superficial deposits

These are relatively young geological deposits formerly known as 'Drift', which lie on the bedrock in many areas. They include deposits such as unconsolidated sands and gravels formed by rivers and clayey tills formed by glacial action. They may be overlain by landslide deposits, by artificial deposits or both (Figure 7).

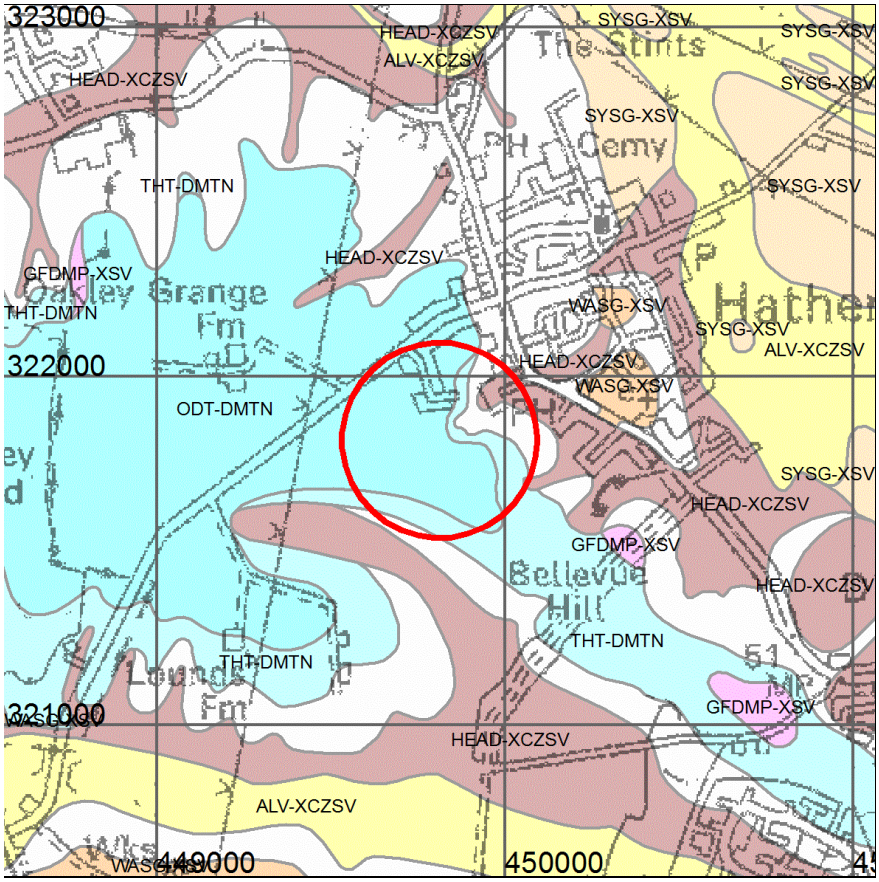


Figure 7. Superficial deposits in the vicinity of the site.

Search area indicated in red

Key to Superficial deposits:

Map colour	Computer Code	Name of geological unit	Composition
	HEAD-XCZSV	HEAD	CLAY, SILT, SAND AND GRAVEL
	ALV-XCZSV	ALLUVIUM	CLAY, SILT, SAND AND GRAVEL
	SYSG-XSV	SYSTON MEMBER	SAND AND GRAVEL
	WASG-XSV	WANLIP MEMBER	SAND AND GRAVEL
	GFDMP-XSV	GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE	SAND AND GRAVEL
	ODT-DMTN	OADBY MEMBER	DIAMICTON
	THT-DMTN	THRUSSINGTON MEMBER	DIAMICTON

The western two thirds of the site is underlain by glacial till (a mixture of clay, pebbles and sand), divided into two members of the Wolston Formation of Pleistocene age. The Oadby Member is a grey, chalky till and overlies the Thrussington Member which is distinctively red-brown. The thickness of these tills is likely to vary but could be expected to be up to about 15 m in total. Till can be prone to shrink-swell behaviour.

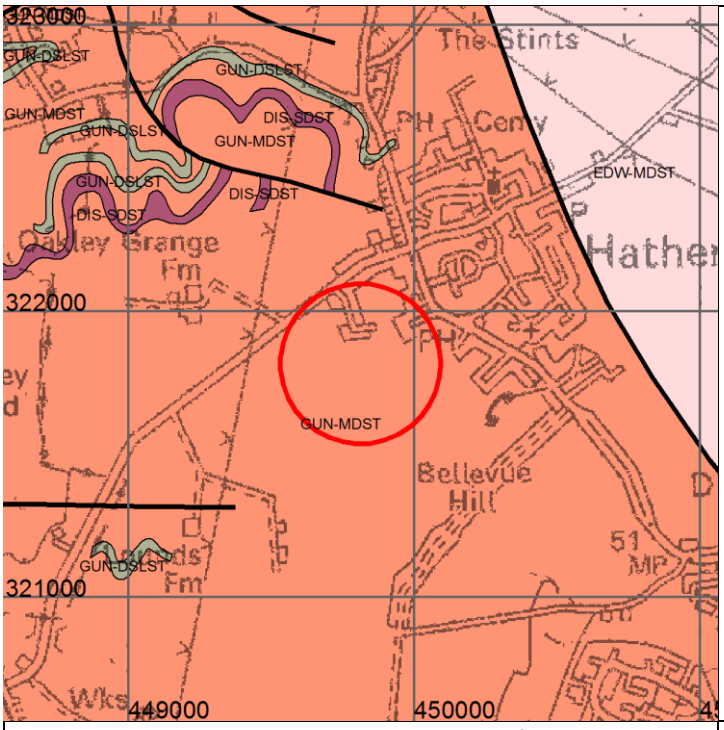
Head is present at the eastern edge of the site. This is a solifluction deposit of Quaternary age composed of poorly sorted sand, gravel, silt and clay. Within the site area, Head would not be expected to be more than about 1-3 m in thickness.

4.3.3 Rockhead depth

Bedrock is mapped at outcrop across the eastern third of the site, where rockhead is expected to be at or near the surface. Where superficial deposits are mapped, the depth to rockhead (base of superficial deposits) is not known with any degree of certainty, but it is likely to be in the range of 1 to 15 m, increasing westwards.

4.3.4 Bedrock geology

The site is underlain by the Gunthorpe Member of the Sidmouth Mudstone Formation (Mercia Mudstone Group) of Triassic age. The Gunthorpe Member consists of redbrown mudstone with subordinate dolomitic siltstone and fine-grained sandstone horizons, being greenish grey with common gypsum veins and nodules. It is likely in this area that the Gunthorpe Member is up to 75 m thick.



Search area indicated in red

Fault

Coal, ironstone or mineral vein

Note: Faults are shown for illustration and to aid Interpretation of the map. Because these maps are generalised from more detailed versions not all such features are shown and their absence on the map face does not necessarily mean that none are Present. Coals, ironstone beds and mineral veins occur only in certain rock types and regions of the UK; if present here, they will be described within the 'Bedrock' section.

Figure 8. Bedrock geology in the vicinity of the site.

Search area indicated in red

Key to Bedrock geology:

Map colour	Computer Code	Name of geological unit	Rock type
	EDW-MDST	EDWALTON MEMBER	MUDSTONE
	GUN-MDST	GUNTHORPE MEMBER	MUDSTONE
	GUN-DSLST	GUNTHORPE MEMBER	SILTSTONE, DOLOMITIC
	DIS-SDST	DISEWORTH SANDSTONE	SANDSTONE

4.3.5 Schematic geological cross-section

This sketch (Figure 9) represents an interpretation of the geometrical relationships of the main rock units described in the text. It is not to scale. The blue line indicates 'rockhead'; that is the base of superficial deposits. This is the 'geological rockhead', as distinct from the 'engineering rockhead', which is the base of 'engineering soil' (in the sense of BS5930:1999).

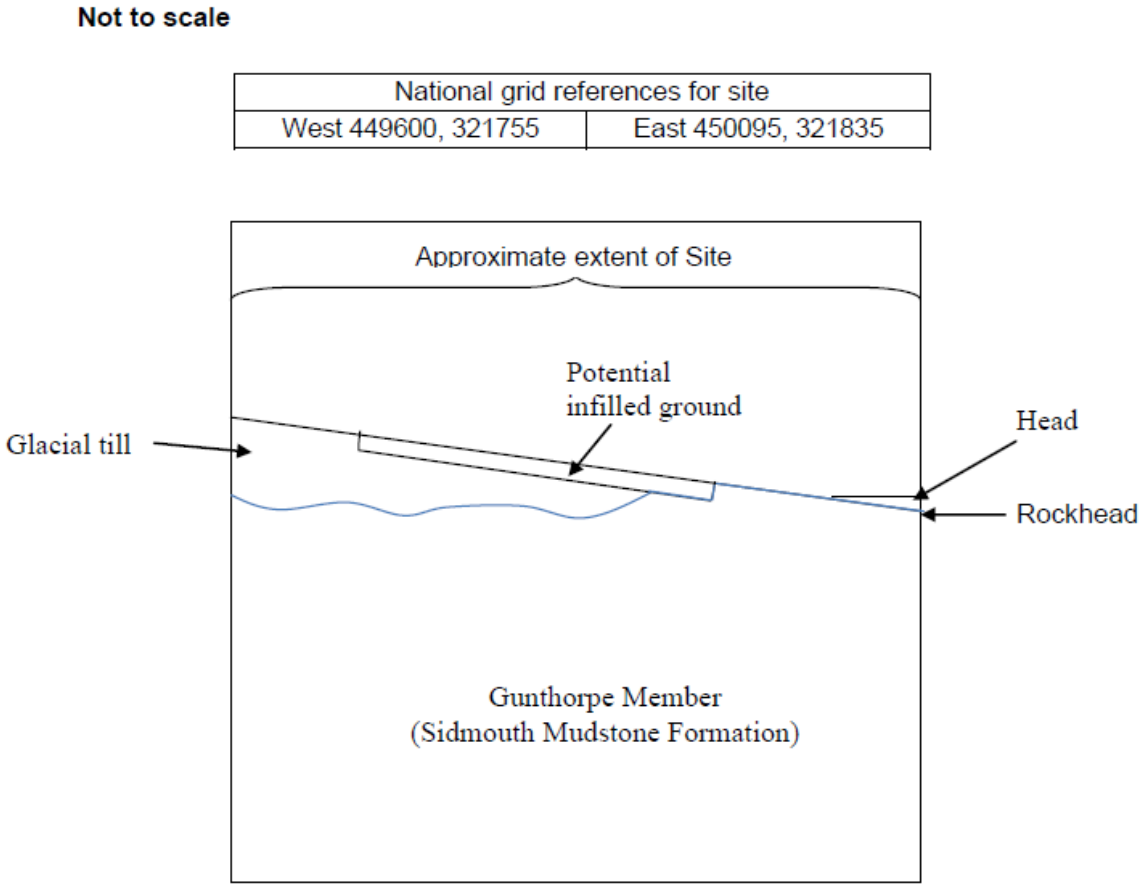
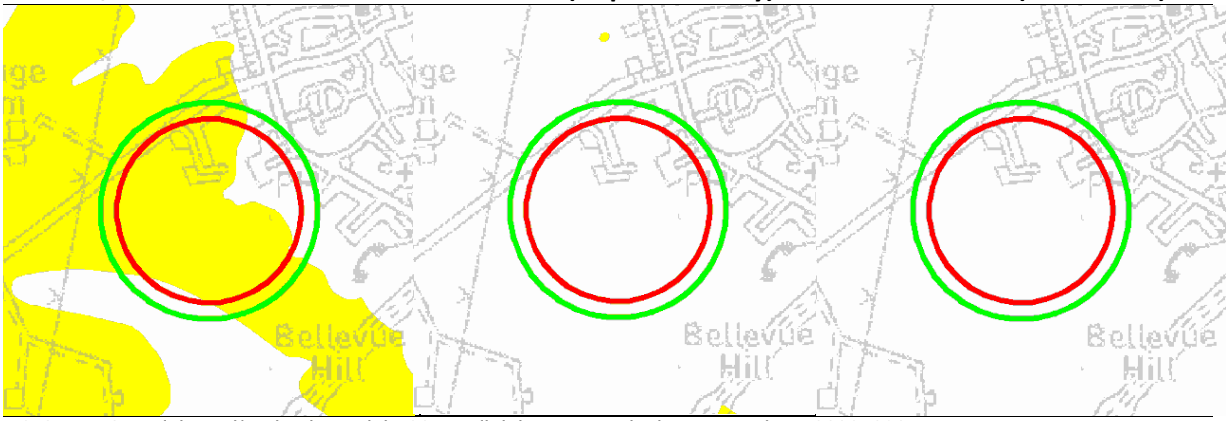


Figure 9. A schematic representation of the underlying geology.

4.4 Additional geological considerations

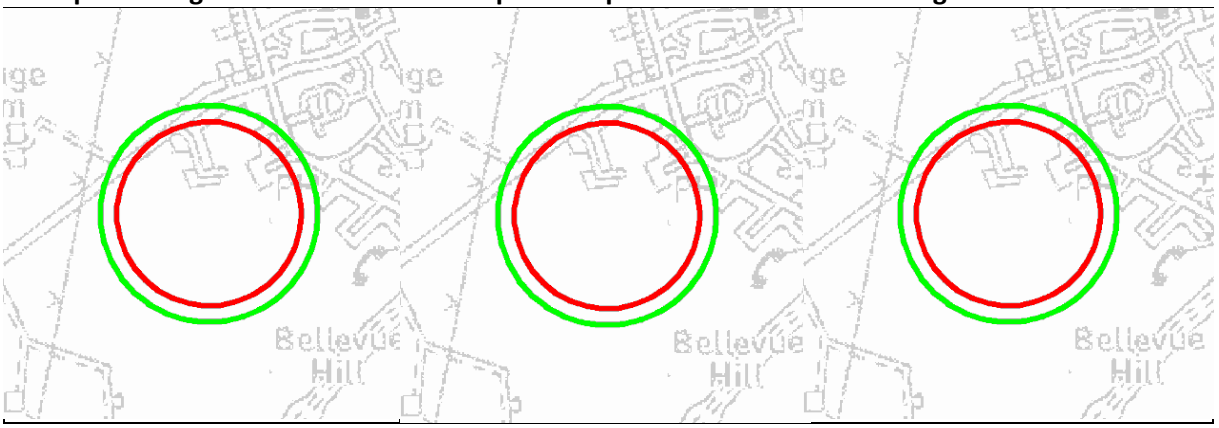
Figure 10. A summary of the geological hazards associated with the site.

Shrink / Swell **Landslides (slope instability)** **Soluble rocks (dissolution)**



The hazard levels are described as A (least) to E (greatest), or as 'No Hazard'. Levels A and B are not considered significant and are not shown on the maps.

Compressible ground **Collapsible deposits** **Running sand**



The geological hazards found on the site are explained in Table 2.

Table 2. Geohazard summary

Geological hazard	May be significant within site area	Comments
Potential Natural Ground Stability Hazards		
Shrink-Swell	Yes	Level C = Potential for hazard to become active is at a level where it should be considered in decisions about construction, building maintenance and land use.
Landslides (slope instability)	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Soluble Rocks (dissolution)	No	Level A = Potential for hazard to be active is either zero or insignificant.
Compressible Ground	Yes	Level C = Potential for hazard to become active is at a level where it should be considered in decisions about construction, building maintenance and land use. This relates to the potentially infilled ground explained in the Artificial Ground section.
Collapsible Deposits	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Running Sand	No	Level B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
Other Potential Hazards		
Mining	No	None.
Flooding	No	None.
Natural Land Gas	No	Unlikely to encounter gas from bedrock and coal mining; unlikely to encounter gas from peat.
Radon		Level of protective measures: **NO**

4.5 Hydrogeology

In lowland areas of the UK with little topographic variation, groundwater is likely to be found at shallow depths of only a few metres. Water table fluctuations will be small as they will be constrained by the ground surface and the base level of the local perennial streams and rivers.

In upland areas, precipitation is usually high and the dominantly metamorphic and igneous rocks often have relatively shallow groundwater levels.

This is due to preferential groundwater storage in near-surface weathered and fractured zones with limited drainage into the underlying un-weathered lower permeability rock. Exceptions can occur where higher permeability rocks, such as sandstone or limestone, allow faster through flow of groundwater towards the nearest stream or other discharge point.

Perched water tables occur where a less permeable horizon (e.g. a clay layer) in an otherwise permeable sequence retains a body of groundwater above the level of the regional water table.

They usually occur at shallow depths in alluvial and glacial sediments and can be difficult to identify or to delimit.

An aquifer becomes confined when it is overlain by a less permeable horizon that restricts the upward movement of groundwater. When this less permeable horizon is penetrated (e.g. by drilling), the groundwater level rises above where struck to a level controlled by the hydrostatic pressure. If this is above ground level, overflowing artesian conditions will be encountered. Confined conditions should be anticipated, where possible, in order to plan for the problems they can generate.

Individual sites will always require more detailed assessments to determine the specific impact on groundwater resources. The maps represent conditions only at the ground surface. Where the soil and/or underlying formations have been disturbed or removed the vulnerability class may have been changed and site specific data will be required. Sites in urban areas and restored or current mineral workings are classified as having high (urban) soil leaching potential until proved otherwise.

The site lies on the Environment Agency's Groundwater Vulnerability Map of Leicestershire (Sheet 30). These maps have now been superseded by Aquifer Designation maps that are consistent with the Water Framework Directive, the explanation of which can be found at: http://apps.environment-agency.gov.uk/wiyby/117020.aspx. These classify the superficial deposits of head and glacial till, (Oadby Member and Thrussington Member) as secondary (undifferentiated) aquifers and the Gunthorpe Member bedrock as a secondary B aquifer.

The contents of any Infilled Ground, are unknown and extend to an unknown depth. It is possible that they may contain some groundwater, possibly contained by surrounding low permeability clay till and bedrock. However, it is also possible that some groundwater may move from the area of Infilled Ground, via more-permeable horizons, into other parts of the site. The two "issues" marked on the map (see "Setting" section above) appear within head deposits along valleys. They may purely be surface water related or could include a component of groundwater (indicating some potential for water movement through head deposits).

There is no borehole information in the vicinity. A line of site investigation-type boreholes along the M1 into till, about 1.5 km to west of the site, were all recorded as dry down to a maximum depth of 16.3 m. There are no mapped sandstone and siltstone horizons in the Gunthorpe Member present at the ground surface within the confines of the site.

The hydrological information for the site is summarised in Table 3.

Table 3. Hydrogeology summary

Geological unit	Groundwater potential	Water level and strikes	Quality	EA groundwater vulnerability classification
Potential infilled ground.	Unknown, will depend on composition of infill. If infill more permeable than the directly underlying till and bedrock, then it may contain some perched groundwater.	Unknown, but some possibly shallow groundwater may be present.	Unknown, but depending on nature of infill could potentially be of poor quality (contaminated).	Not classified.
Head	May contain small amounts of groundwater with intergranular flow.	No information, but if present water may be encountered at shallow depths along valley.	No information	Not shown on map.
Oadby Member Thrussington Member	Not generally regarded as an aquifer, but may contain some groundwater in more sandy / gravelly horizons.	Likely to be dry unless sand and gravel horizons present.	No information but likely to be ferrunginous and may be mineralised due to low permeability.	Low permeability superficial deposits, however some groundwater flow may still occur and this should be taken into consideration when assessing persistent pollutants.
Gunthorpe Member (Sidmouth Mudstone Formation)	Not generally regarded as an aquifer but may contain groundwater in subordinate sandstone and siltstone horizons.	No information available, however some groundwater may be contained in the subordinate sandstone and siltstone horizons. Water levels may rise above where first struck.	No information, but likely to be hard and mineralised due to presence of gypsum in the rock.	Non-aquifer however some groundwater flow may still occur and this should be taken into consideration when assessing persistent pollutants.

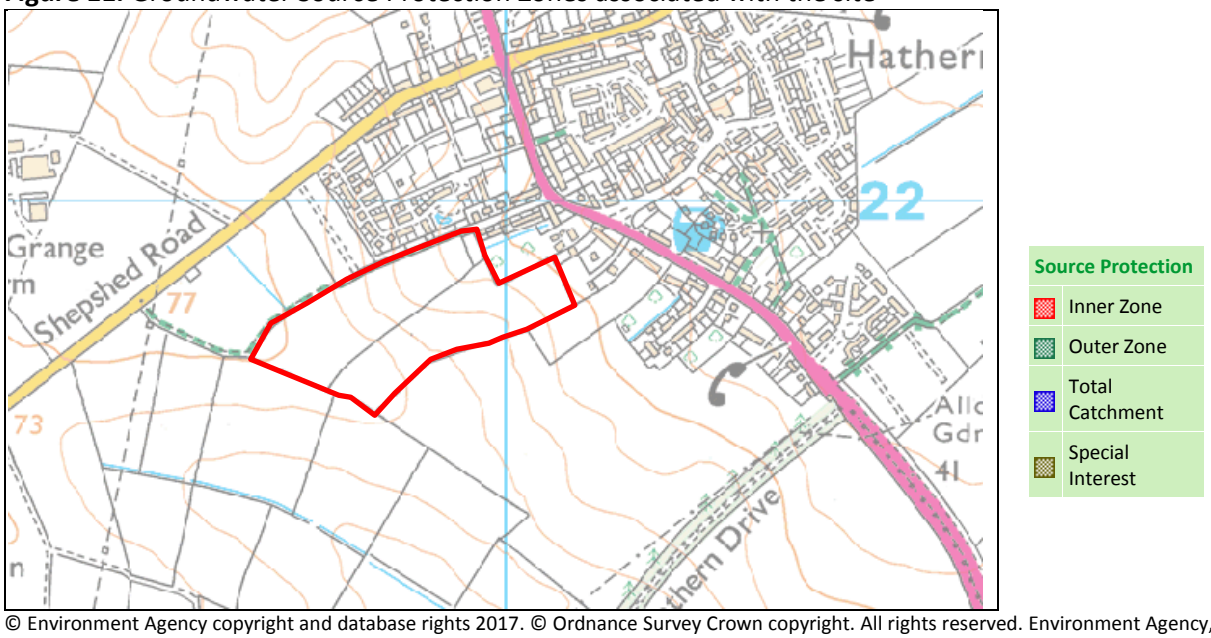
4.5.1 Groundwater vulnerability

This section reviews all components of hydrology, geology and top soil surface water drainage to assess risk notably to groundwater.

4.5.2 Source Protection Zones

The position of the site relative to current ground water protection zones is shown in Figure 11.

Figure 11. Groundwater Source Protection Zones associated with the site



Source Protection Zones (SPZs) provide an indication of the risk to groundwater supplies that may result from potentially polluting activities and accidental releases of pollutants. Generally the closer the activity or release is to a groundwater source the greater the risk. Three zones (an inner, outer and total catchment) are usually defined although a fourth zone (zone of special interest) is occasionally defined.

The Agency has subdivided groundwater source catchments into four zones. Two of these are determined by the travel time of potential pollutants, the third by the source catchment area itself and the fourth is a "Zone of Special Interest". This fourth zone highlights areas where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

- *Zone I (Inner Protection Zone)* - This zone is defined by a travel time of 50-days or less from any point within the zone at, or below, the water table. Additionally, the zone has, as a minimum, a 50-meter radius. It is based principally on biological decay criteria and is designed to protect against the transmission of toxic chemicals and water-borne disease.
- *Zone II (Outer Protection Zone)* - This zone is defined by the 400-day travel time, or 25% of the source catchment area, whichever is larger. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants.
- *Zone III (Total catchment)* - This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source.
- *Zone of Special Interest* - For some groundwater sources an additional Zone of Special Interest may be defined.
  These zones highlight areas (mainly on non-aquifers) where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

The proposed development site lies outside any Groundwater Source Protection Zone.

4.5.3 Aquifer vulnerability

The Groundwater Vulnerability maps are produced at 1:100,000 scale. They show, by means of colour coding, those areas of the country where water-bearing rocks (aquifers) are present. They also show the vulnerability of groundwater to pollution. The aquifers are classified into major, minor and non-aquifers according to their physical properties and their consequent value as a resource.

The classification of the land surface reflects the ability of contaminants to leach through the covering soils and pose a potential risk to groundwater at depth. The maps also indicate areas where the presence of low permeability drift may provide additional groundwater protection.

These maps can therefore be used for an initial screening assessment of the vulnerability of groundwater to contaminants applied to the surface of the ground. They do not provide all information relevant to the determination of vulnerability, such as the depth to water table or nature of the drift deposits. Site-specific information would always be needed for a detailed assessment of vulnerability at a given location. The original groundwater vulnerability maps were produced some time ago.

Groundwater Vulnerability Maps provide information on how significant the ground waters are likely to be and if they are vulnerable to pollution occurring at the land surface. The maps have descriptions on them to explain the different aquifer and soil types.

Areas shown as "major aquifers" have strategic significance for water resource; they often support large abstractions for the public water supply.

Minor aquifers have a more localised significance to domestic, agricultural and industrial users (although they may still be used for drinking water). Non-aquifers do not store significant amounts of groundwater. However, in some areas they can support local supplies: e.g. small springs feeding individual properties.

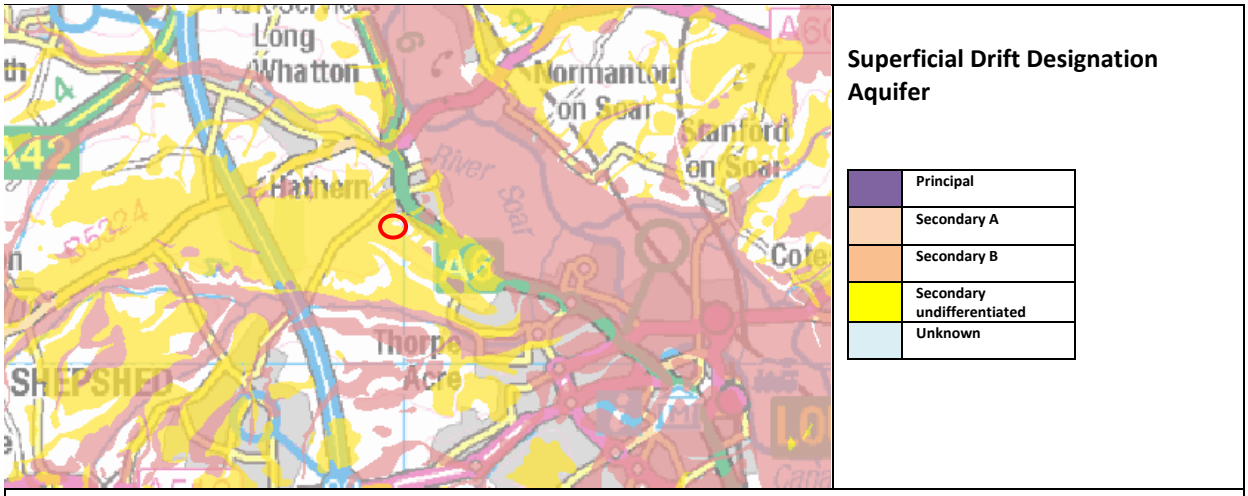


Figure 12. Superficial drift aquifer designation

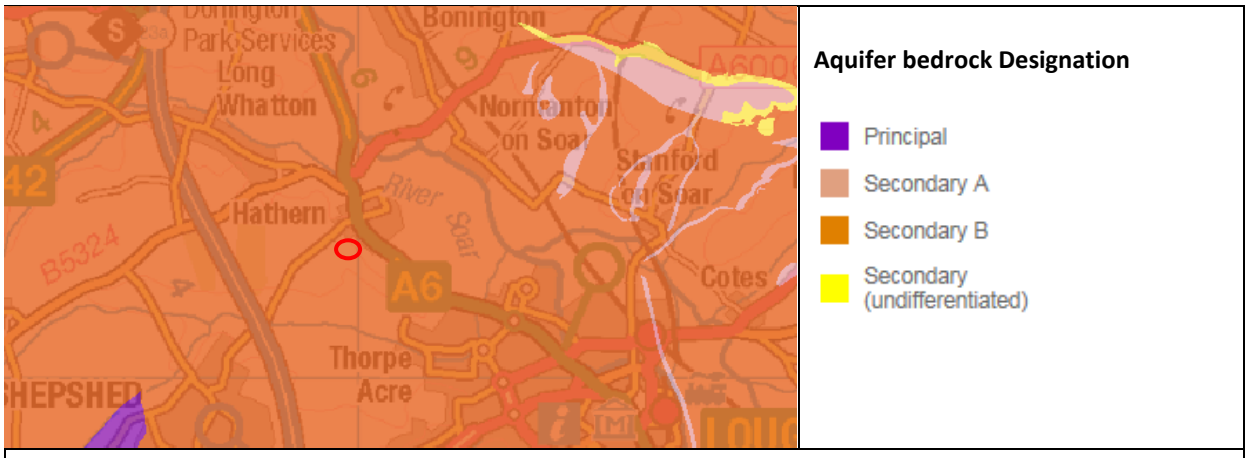


Figure 13. Bedrock aquifer designation

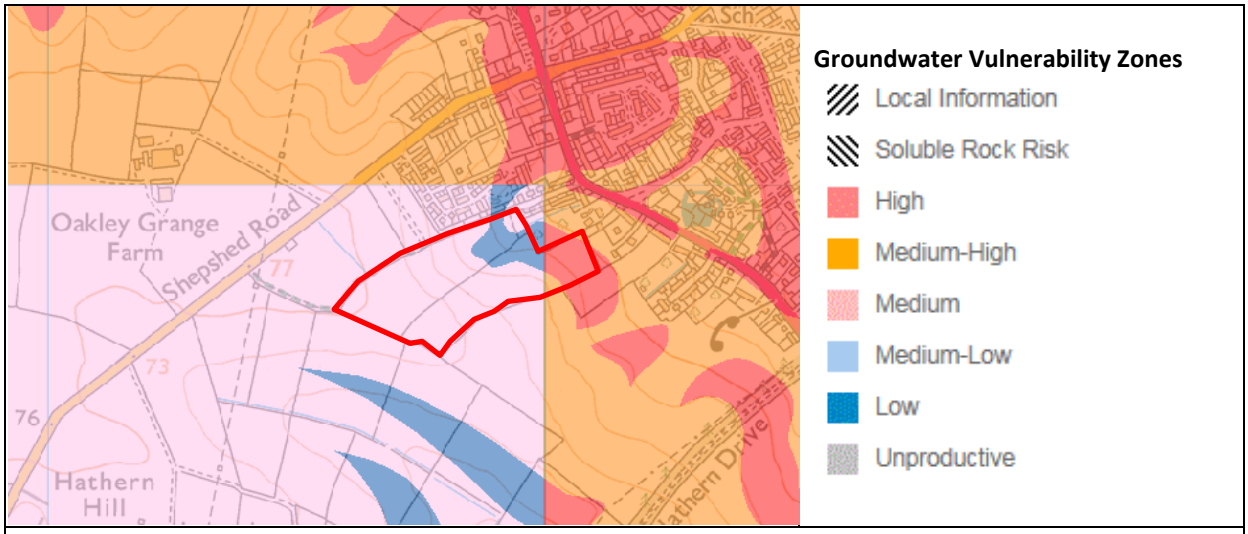


Figure 14. Groundwater vulnerability

Groundwater Vulnerability Maps provide information on how significant the ground waters are likely to be and if they are vulnerable to pollution occurring at the land surface. The maps have descriptions on them to explain the different aquifer and soil types. Areas shown as "major aquifers" have strategic significance for water resources, they often support large abstractions for the public water supply. Minor aquifers have a more localised significance to domestic, agricultural and industrial users (although they may still be used for drinking water). Non-aquifers do not store significant amounts of groundwater. However, in some areas they can support local supplies: e.g. small springs feeding individual properties.

Major and minor aquifers may be important in contributing to the base-flow of streams and rivers. The maps show where groundwater is protected from above by rocks with a low permeability, such as glacial clay. They also show the characteristics of the soil above.

Superficial drift deposits which overlay the solid geological strata can sometimes be substantial in thickness. They are often variable in composition changing from highly permeable outwash gravels to low permeability clays over short distances both laterally and vertically. The presence of permeable drift deposits is recognised as Minor Aquifers except where these overlie a Major Aquifer and they then assume the status of a Major Aquifer.

The site is over a Secondary undifferentiated Aquifer associated with the superficial deposits and a Secondary B Aquifer associated with the bedrock. The site is classed as having a range of vulnerabilities from high to medium with most of the site either medium – high or medium vulnerability in respect to groundwater pollution. The site is not within a drinking water safeguard zone but is within a Surface Water Nitrate Vulnerable Zone.

4.5.4 Flood risk

The site is within Flood Zone 1 land which is very low risk – less than 1 in 1000 in any given year (Figure 15). The site is not covered by flood warnings issued by the Environment Agency.

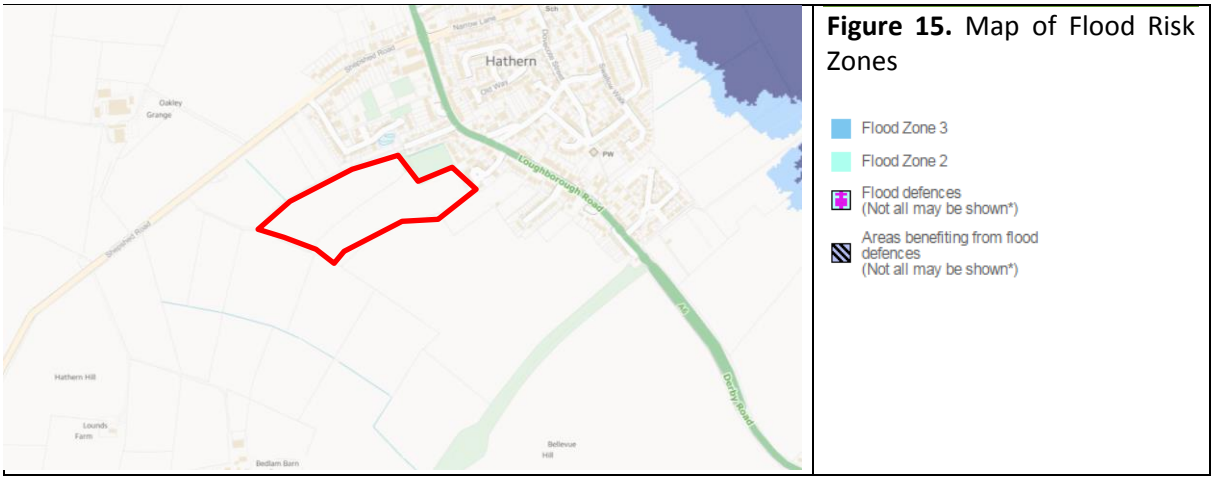


Figure 15. Map of Flood Risk Zones

If areas of impermeable surfaces such as buildings, roads etc. are constructed on a greenfield site, a surface water management system designed in accordance with the principles of Sustainable Urban Drainage Schemes (SUDS) will be required.

4.5.5 Wells in the vicinity of the site

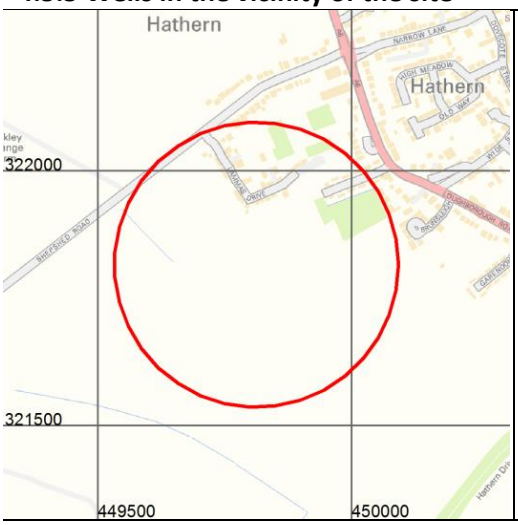


Figure 16. Well records
Number of records within a 300 m radius of the centre of the site: 0

Search area indicated in red

4.5.6 Boreholes in the vicinity of the site

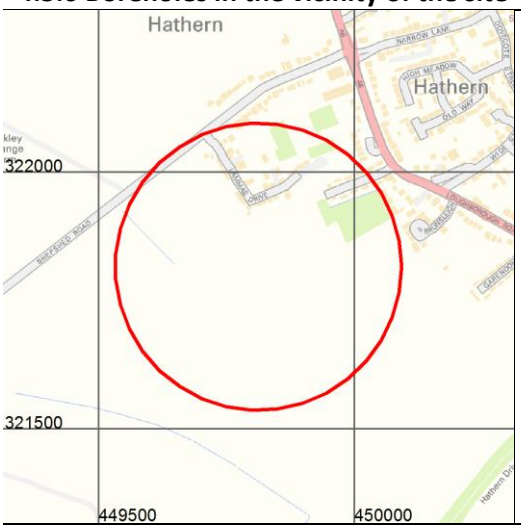


Figure 17. Borehole records
Number of records within a 300 m radius of the centre of the site:

Search area indicated in red

4.6 Meteorological data

The agro climatic index number for this site is 22E with a mean annual rainfall of 627 mm, the Standard Average Annual Rainfall (SAAR) for the site itself is 631 mm.

4.7 Surface water issues

The site has a very low risk (less than 0.1% chance) of surface water flooding occurring in any year. Occasionally poor surface water drainage associated with these soils may lead to wet conditions under foot when there is prolonged rainfall, however this is likely to be limited in extent and most problematic along the downslope edge of the site. Any works which might increase the risk of flooding on or off site need to be identified and the risks assessed and mitigated using a suitable SUDS compliant approach.

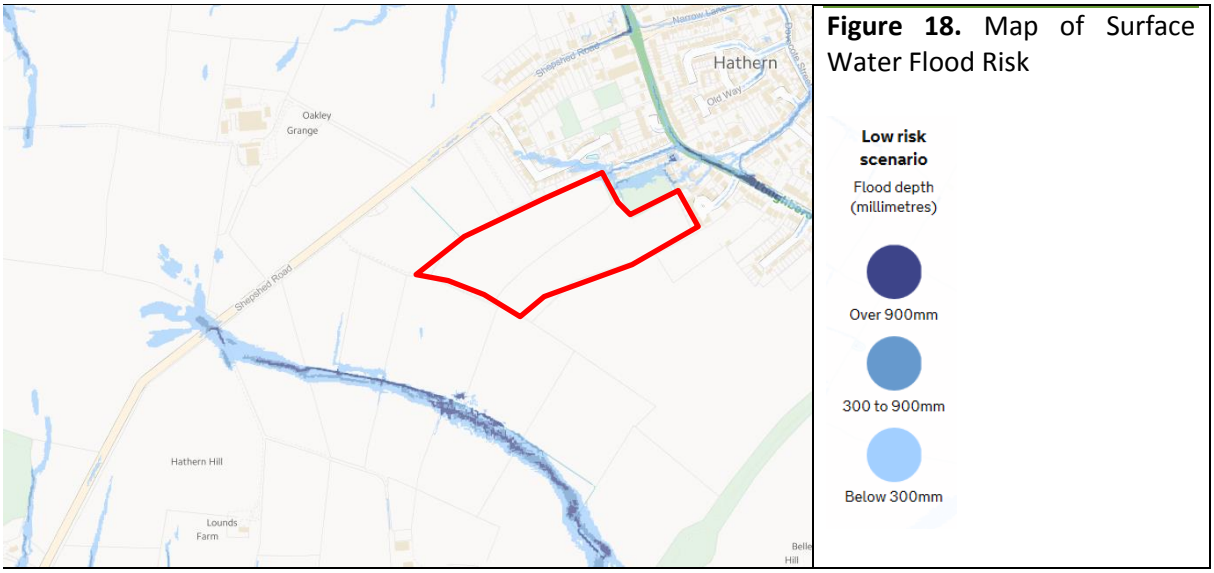


Figure 18. Map of Surface Water Flood Risk

5.0 Pollutant risk

Due to the approximately 60 per annum number of full burials at the site, the cumulative ammoniacal nitrogen concentrations are likely to be high with similar levels of total organic compounds (TOC).

Pathogens

There has been some evidence from recent studies of the occurrence of Enterococci and Clostridium bacteria found in drainage water of cemeteries. Enterococci are bacteria that are commonly found in the bowel of normal healthy individuals. They can cause a range of illnesses including urinary tract infections, bacteraemia (blood stream infections) and wound infections.

The two most common species of Enterococci are E. faecalis and E. faecium. During the mid-1980s, enterococci with resistance to glycopeptide antibiotics such as vancomycin and teicoplanin emerged, termed glycopeptide-resistant enterococci (GRE). Most GRE are E. faecium.

Due to the nature of the soil and geomorphology, there is unlikely to be much movement of pathogenic organisms, notably Pseudomonas aeruginosa and Faecal streptococci, other than where burials coincide with any sand lenses that connect to the adjacent watercourses and given the presence only of a shallow field ditch and the highly localised nature of any sand lenses, this is considered unlikely. However pathogens tend to be short lived away from the host and if there is no immediate ground water risk or potable well supply, the risk may therefore be considered acceptably low. This site is underlain by a Secondary Undifferentiated Aquifer in relation to the superficials and a Secondary B Aquifer associated with the bedrock. Pollutants entering groundwater within the superficial deposits may be in hydraulic continuity with the water providing base flow to the adjacent streams but again, due to the highly localised nature of any sand lenses and the general lack of perched water this is considered unlikely. The Secondary B Aquifer associated with the bedrock is reasonably well protected by both the depth of superficials and the relatively low permeability of the superficial deposits.

Post-burial accumulation of water around a coffin is unlikely to be an issue in these soils but to minimise this and the risks thereafter faced on re-opening a grave it is suggested that backfill over a new burial be compacted well to minimise infiltration through to the burial itself.

6.0 Depth of burial

Based on data from the British Geological Survey and from the trial digs, the site is overlain by soils derived from silt and some clay but which also contains locally variable sand lenses. Typically such soils are moderately to poorly drained and prone to structural damage if worked when wet. Digging is unlikely to be impacted by the presence of hard rock but running sands may prevent burials if perched water is encountered in any sandy lenses which occur within burial depth.

7.0 Archaeology

It is recommended that consultation with the county archaeological team be undertaken to ascertain any archaeological interest in the area.

8.0 Risk evaluation

Assessment of general hazards

The potential of a number of pollutant pathways and the degree of associated risk assessed numerically on a 0-10 score with 10 being the highest risk is shown in Table 4. From the resultant data, the final values are assessed against burial number and a determinant of risk calculated from EA flow charts and nomographs.

Table 4. Summary of pollution risk associated with the site

Risk	Assessment High, moderate, Low	Comment	Score
Burials per annum	Moderate	Expected to be around 60 per annum	
Drift / superficial data	Low	Clay, silt and sand dominated glacial till	4-3
Drift thickness	Low	Varies between 15m and 1m but the majority of the site between 3 and 5 m	4-3
Proximity to water course	High	Wet ditches flow along the western boundary – probably surface water fed, not groundwater.	8-7
Proximity to land drains	High	Shallow land drains present in field (0.5m)	8-7
Depth to Water Table	Low	Occasional water strikes within superficials but volumes low and extent variable. No recorded groundwater struck within 16m of the surface.	4-3
Proximity to Wells or potable water source	Very Low	No wells within 500 m radius	2-1
Flow mechanism	Low	Generally Intergranular flow through clay, silt and sand, though flow rates may be locally fast.	4-3
Aquifers	Low	Secondary undifferentiated aquifer over a Secondary B / non aquifer with low vulnerability	4-3
SPZ	Very Low	The site for development lies outside any SPZ	2-1
Met data	Moderate	Annual rainfall moderate	N/A
Proximity to housing	Low	Residential housing in close proximity of the site	N/A
SSSI	Low		N/A
Archaeology	Low	None observed but will require County Archaeologist assessment	N/A
		Total	**40-31**

Table 4 is assessed using the groundwater vulnerability-ranking criteria in Table 5. The total score comes to 40 - 31 and is considered as a low to moderate risk. These data are then assessed against the burial rate of 60 per annum on the groundwater risk nomograph p.37 of PP223. The final assessment of risk for this site according to the nomograph (Figure 19), would class it as being **High**.

Table 5. Groundwater ranking

Ranking	Very Low 2-1	Low 4-3	Moderate 6-5	High 8-7	Very High 10-9
Drift Type	Clay	Silt	Silty sand	Sand/gravel	Absent
Drift Thickness	>5 m	>3-5 m	3 m	0-3 m	Absent
Depth to water Table	>25 m	11 – 25 m	10 m	5 – 9 m	<5m
Flow mechanism	Intergranular				Fissured
Proximity to wells					Within 250 m from private potable supply
Aquifer type	Non Aquifer		Minor aquifer		Major aquifer
Abstractions and SPZs	Outside Zone 3	Within Zone 3	Close to boundary of Zone 2	Within Zone 2	Within Zone 1
Water courses and springs		>100 m	>50 <70 m	>30 <50 m	<30 m
Drains	>100 m	>40 <100 m	30 – 40 m	>10 <30 m	<10 m

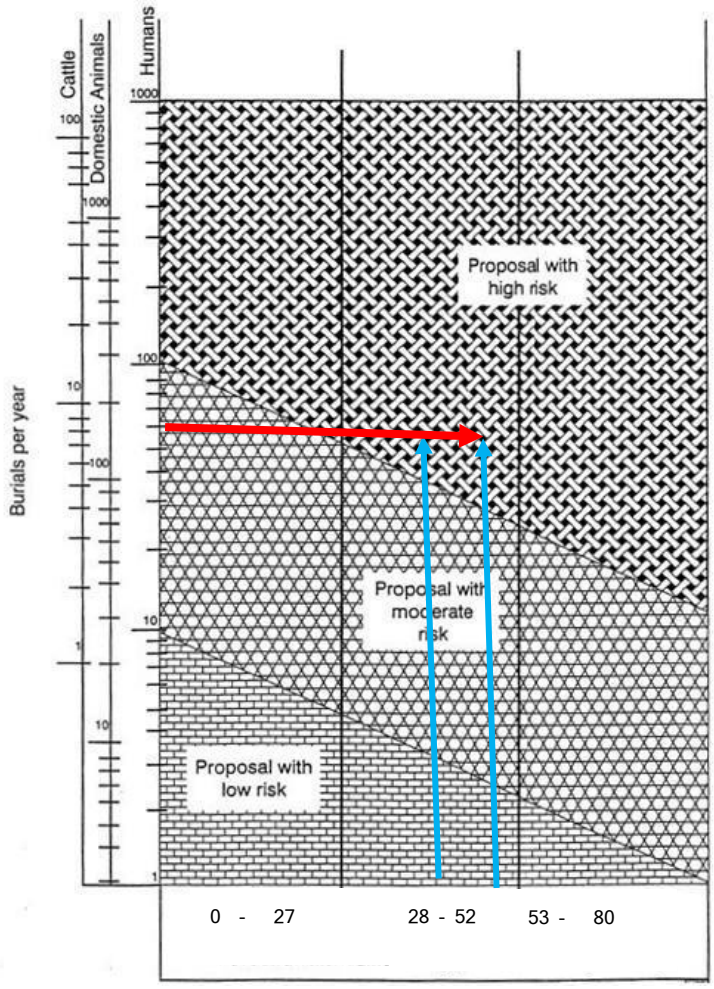


Figure 19. Groundwater risk nomograph

9.0 Conclusion

The site is considered to be **High risk** with the risk mainly attributed to the predicted burial numbers.

Given that burials are likely to be into the silt and clay-dominated superficial deposits and that no groundwater was struck within 3.5m of the surface (1.7m of the base of a double burial) the risk to groundwater is somewhat mitigated as the silty clay is slowly permeable and will increase pollutant retention time and will also remove some ammonium through cation exchange. Though the source of pollutants is present in the form of burials and the receptor is present in the form of the groundwater and any surface water which it might feed, the pathway is likely to be slow and tortuous due to the presence of the silty clay. To ascertain the nature and extent of any risk more precisely, flux modelling of the major pollutants ammonium and nitrate will be required.

Some low volume perched water was struck towards the top of the hill which may make burials in this area practically difficult. In addition, the presence of an infilled pit at the top of the site further reduces the utility of this area for burials though this area could be used for a car park or similar infrastructure. This is because the nature of the infill is uncertain and it may contain perched water within it making burials difficult.

Where burials take place only in the silty clay dominated soils, water may gather around burials making re-opening potentially difficult. This can be mitigated by compacting backfill over recent burials firmly to reduce the risk of infiltration through the disturbed back-fill material.

By way of grave-specific mitigation if needed, the addition of Zeolitic compounds could be added to the base of graves. Zeolites such as Clinoptilolite have CEC values exceeding 150 meq/l and when placed in the base of the grave will absorb significant amounts of Ammonium via cation exchange processes in addition to the existing capacity of the clay soil (Rozic et al 2009).

Calculations would suggest that at least 90% of the human nitrogen (1.8 kg) release could be absorbed by 150 kg of Clinoptilolite or a high CEC clay material such as Bentonite.

The site has complex micro-topography which would require extensive groundworks to create a surface which works efficiently as a cemetery. This will add cost and complexity to the project.

10.0 Reporting details

Report Author:	Mr Alex Vickers
Verification:	Mr Justin Smith
Date:	28.1.18

Cemetery Development Services - Terms and Conditions

Cemetery Development Services (CDS)
Terms and Conditions for the Supply of Services

Interpretation

In these Conditions
AGREED FEE means the charges agreed between CDS and the Client in relation to the Specified Service
CLIENT means the person named on the Specification Sheet for whom CDS has agreed to provide the Specified Service in accordance with these Conditions
CONTRACT means the contract for the provision of the Specified Service
DOCUMENT includes, in addition to a document in writing, any map, plan, graph, drawing or photograph, any film, negative, tape or other device embodying visual images and any disc, tape or other device embodying any other data
INPUT MATERIAL means any Documents or other materials, and any data or other information provided by the Client relating to the Specified Service
OUTPUT MATERIAL means any Documents or other materials, and any data or other information provided by CDS relating to the Specified Service
SPECIFICATION SHEET means the sheet to which these Conditions are appended
SPECIFIED SERVICE means the service relating to geophysical surveys of land to be provided by CDS for the Client and referred to in the Specification Sheet
CDS means CDS (registered in England under number 05089827) or its subsidiary as stated on the Specification Sheet
The headings in these Conditions are for convenience only and shall not affect their interpretation.

Supply of the Specified Service

CDS shall provide the Specified Service to the Client subject to these Conditions. Any changes or additions to the Specified Service or these Conditions must be agreed in writing by CDS and the Client.
The Client shall allow CDS adequate access to its property at reasonable times and for so long as is necessary to enable CDS to provide the Specified Service in accordance with the Contract.
The Client shall at its own expense supply CDS with all necessary Documents or other materials, and all necessary data or other information relating to the Specified Service, within sufficient time to enable CDS to provide the Specified Service in accordance with the Contract. The Client shall ensure the accuracy of all Input Material.
CDS shall have no liability for any loss or damage, however caused, to the Input Material. All Output Material shall be at the sole risk of the Client from the time of delivery to or to the order of the Client.
The Specified Service shall be provided in accordance with the Specification Sheet subject to these Conditions.
Further details about the Specified Service, and advice or recommendations about its provision or utilisation, which are not given in CDS's brochure or other promotional literature, may be made available on written request.
CDS may correct any typographical or other errors or omissions in any brochure, promotional literature, quotation or other document relating to the provision of the Specified Service without any liability to the Client.
CDS may at any time without notifying the Client make any changes to the Specified Service which are necessary to comply with any applicable safety or other statutory requirements, or which do not materially affect the nature or quality of the Specified Service.

Charges

Subject to any special terms agreed, the Client shall pay the Agreed Fee and any additional sums which are agreed between CDS and the Client for the provision of the Specified Service or which, in CDS's sole discretion, are reasonably incurred as a result of the Client's instructions or lack of instructions, the inaccuracy of any Input Material or any other cause attributable to the Client.
All charges quoted to the Client for the provision of the Specified Service are exclusive of any Value Added Tax, for which the Client shall be additionally liable at the applicable rate from time to time.
CDS shall be entitled to invoice the Client on completion of the Specified Service.
The Agreed Fee and any additional sums payable shall be paid by the Client (together with any applicable Value Added Tax, and without any set-off or other deduction) within 30 days of the date of CDS's invoice.
If payment is not made on the due date, CDS shall be entitled, without limiting any other rights it may have, to charge interest on the outstanding amount (both before and after any judgment) at the rate of 4 % above the base rate from time to time of Barclays Bank plc from the due date until the outstanding amount is paid in full.

Rights in Input Material and Output Material

The property and any copyright or other intellectual property rights in:
any Input Material shall belong to the Client
any Output Material and any amendments or variations to the Input Material made by CDS shall, unless otherwise agreed in writing between the Client and CDS, belong to CDS, subject only to the right of the Client to use the Output Material for the purposes of utilising the Specified Service.
Any Input Material or other information provided by the Client which is so designated by the Client and any Output Material shall be kept confidential by CDS, and all Output Material or other information provided by CDS which is so designated by CDS shall be kept confidential by the Client; but the foregoing shall not apply to any Documents or other materials, data or other information which are public knowledge at the time when they are so provided by either party, and shall cease to apply if at any future time they become public knowledge through no fault of the other party.
The Client warrants that any Input Material and its use by CDS for the purpose of providing the Specified Service will not infringe the copyright or other rights of any third party, and the Client shall indemnify CDS against any loss, damages, costs, expenses or other claims arising from any such infringement.

Warranties and Liability

CDS warrants to the Client that the Specified Service will be provided using reasonable care and skill and, as far as reasonably possible, in accordance with the Specification and at the intervals and within the times referred to in the Specification Sheet. Where CDS supplies in connection with the provision of the Specified Service any goods (including Output Material) supplied by a third party, CDS does not give any warranty, guarantee or other term as to their quality, fitness for purpose or otherwise, but shall, where possible, assign to the Client the benefit of any warranty, guarantee or indemnity given by the person supplying the goods to CDS.
CDS shall have no liability to the Client for any loss, damage, costs, expenses or other claims for compensation arising from any Input Material or instructions supplied by the Client which are incomplete, incorrect, inaccurate, illegible, out of sequence or in the wrong form, or arising from their late arrival or non-arrival, or any other fault of the Client.
Except in respect of death or personal injury caused by CDS's negligence, or as expressly provided in these Conditions, CDS shall not be liable to the Client by reason of any representation (unless fraudulent), or any implied warranty, condition or other term, or any duty at common law, or under the express terms of the Contract, for any loss of profit or any indirect, special or consequential loss, damage, costs, expenses or other claims (whether caused by the negligence of CDS, its servants or agents or otherwise) which arise out of or in connection with the provision of the Specified Service or their use by the Client, and the entire liability of CDS under or in connection with the Contract shall not exceed the amount of CDS's charges for the provision of the Specified Service, except as expressly provided in these Conditions.
CDS shall not be liable to the Client or be deemed to be in breach of the Contract by reason of any delay in performing, or any failure to perform, any of CDS's obligations in relation to the Specified Service, if the delay or failure was due to any cause beyond CDS's reasonable control.

Termination

Either party may (without limiting any other remedy) at any time terminate the Contract by giving written notice to the other if the other commits any breach of these Conditions and (if capable of remedy) fails to remedy the breach within 30 days after being required by written notice to do so.

Insolvency of Client

This clause applies if:
the Client makes any voluntary arrangement with its creditors or (being an individual or firm) becomes bankrupt or (being a company) becomes subject to an administration order or goes into liquidation (otherwise than for the purposes of amalgamation or reconstruction); or
an encumbrancer takes possession, or a receiver is appointed, of any of the property or assets of the Client; or
the Client ceases, or threatens to cease, to carry on business; or
CDS reasonably apprehends that any of the events mentioned above is about to occur in relation to the Client and notifies the Client accordingly.
If this clause applies then, without prejudice to any other right or remedy available to CDS, CDS shall be entitled to cancel the Contract or suspend any further provision of services under the Contract without any liability to the Client, and if the Services have been provided but not paid for the price shall become immediately due and payable notwithstanding any previous agreement or arrangement to the contrary.

General

These Conditions (together with the terms, if any, set out in the Specification Sheet) constitute the entire agreement between the parties, supersede any previous agreement or understanding and may not be varied except in writing between the parties. All other terms and conditions, express or implied by statute or otherwise, are excluded to the fullest extent permitted by law.
Any notice required or permitted to be given by either party to the other under these Conditions shall be in writing addressed to the other party at its registered office or principal place of business or such other address as may at the relevant time have been notified pursuant to this provision to the party giving the notice.
No failure or delay by either party in exercising any of its rights under the Contract shall be deemed to be a waiver of that right, and no waiver by either party of any breach of the Contract by the other shall be considered as a waiver of any subsequent breach of the same or any other provision.
If any provision of these Conditions is held by any competent authority to be invalid or unenforceable in whole or in part, the validity of the other provisions of these Conditions and the remainder of the provision in question shall not be affected.
Any dispute arising under or in connection with these Conditions or the provision of the Specified Service shall be referred to arbitration by a single arbitrator appointed by agreement or (in default) nominated on the application of either party by the President for the time being of Institute of Arbitrators.
English law shall apply to the Contract, and the parties agree to submit to the non-exclusive jurisdiction of the English courts.