Cemetery Development Services

Poringland Parish Council
Ground Water Audit
Poringland Cemetery Extension

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Poringland Parish Council

An Environment Agency T2 Assessment for the current cemetery off Rectory Road, Poringland, NR14 7SL. Grid Ref: 627262; 302123

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1.0 Executive summary

The site is considered to be **moderate risk** with the risk mainly attributed to the presence of shallow groundwater, the proximity to surface waters and the permeable nature of the superficial deposits. This is mitigated somewhat by low predicted burial numbers. **Most significantly, the groundwater is within 1m of the base of a normal grave over much of the site. This contravenes EA standing advice for cemeteries which requires at least 1m of dry ground beneath the base of a grave.** Furthermore, the presence of perched water within layers of sands and gravels further up the soil profile gave rise to running sand conditions in two of the pits excavated making it practically very difficult, if not impossible, to dig stable graves in such conditions. Though the occurrence of such layers will vary over the site, and may improve in summer, it adds complexity to managing this site efficiently.

A source of pollutants is present in the form of burials with the nearest receptor in the form of groundwater within as little as 0.6m under a normal double grave or 1m under a single grave. This groundwater will feed the nearby stream and given the free-draining nature of the subsoil materials the rate of transfer of pollutants from the cemetery to the stream could be fast. This stream is the most sensitive receptor as there are no wells recorded in the vicinity of the site and the groundwater in question is associated with local superficial deposits rather than strategically important groundwater supplies. That said, ammonium is a major pollutant of surface waters and thus surface waters fed by this aquifer may be at increased risk due to burials in this cemetery. The risk can be more accurately defined by undertaking flux modelling for ammonium and nitrate at this site.

The overall risk posed by the site is mitigated somewhat by the low burials numbers, thus total loading each year is also likely to be low and the EA may deem this to be acceptable. It is important to discuss the finding of this assessment with the EA at the earliest opportunity in order to be develop a mitigation strategy that protects sensitive receptors. Such mitigation may be in the form of deep drainage to de-water the soil to a depth of at least 1m below a normal double grave, and in so doing also reduce the risk of running conditions occurring at burial depth by removing perched water. The problem with this approach on this site is a lack of space to move the machinery around the site as needed, a lack of access and a lack of space to treat any such water effectively ahead of discharge.

By way of grave-specific mitigation, 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.

Based on the above it is recommended that contact be made with the local Groundwater Protection Team as soon as possible in order to get more advice from the EA and determine the best way to manage this site. There is a risk that the EA may deem the site too risky to allow burials to continue and that if no suitable remediation options are found, the cemetery may need to be closed.

2.0 Introduction

Cemetery Development Services Ltd. has been asked to carry out a Tier 2 assessment for the current Poringland Cemetery and the planned extension area. 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 may need mitigation works to avoid groundwater pollution associated with burials. In the worst case, where mitigation is unlikely to work or cannot be accomplished, burials may need to cease and cemeteries close.

The site has been assessed on a 1 km area of influence: grid reference 627262; 302123, nearest postcode: NR14 7SL. The site is calculated as being approximately 0.5 hectares (1.2 acres).

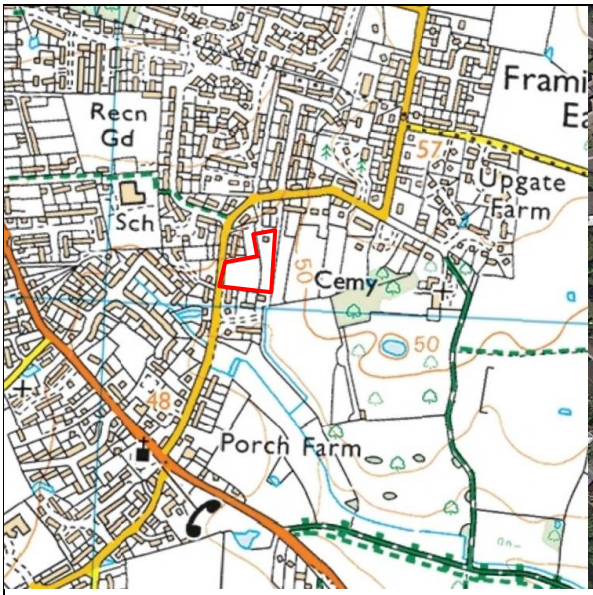


Figure 1a. Map of the site

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

This report will review the site 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 12-15 per year.

3.0 Background

This section sets out the relevant legal and policy advice relevant to the grant of planning permission for new and also the operation of existing cemeteries. 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.

The most up-to-date guidance issued by the Environment Agency is provided in:

- 'The Environment Agency's approach to groundwater protection' (February 2018 Version 1.2), which updated 'Groundwater protection: Principles and practice (GP3) (2013)'; and
- 'Cemeteries and burials: prevent groundwater pollution' which was published in March 2017 and updated in February 2018. The purpose of the guidance is to help those operating cemeteries to understand how to manage cemeteries and burial of human and animal remains, to prevent or limit groundwater pollution.

Failure to manage and reduce any environmental risk to a minimum may result in action being taken under the Environmental Permitting (England and Wales) Regulations 2016, the Water Resources Act 1991 and the Anti-pollution Works Notice Regulations 1999.

3.1 Groundwater protection policy

Initial risk screening starts with the tools contained in the 'The Environment Agency's approach to groundwater protection' (previously Principles and Practice for the groundwater protection), Section L: Cemetery developments GP3 .

Tools include Groundwater Vulnerability and Source Protection Zone (SPZs) 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

In its Position Statement L1 (p109 of 'The Environment Agency's approach to groundwater protection') the Agency advises that it will object to the grant of planning permission for any new cemetery, or the extension of an existing cemetery, within Zone 1 of an SPZ or 250 metres from a well, borehole or spring used to supply water that is used for human consumption, whichever is the greater distance.

Position Statement L3 advises on the protection of groundwater in highly sensitive locations. The Agency advises that it will apply a risk-based approach to assessing the suitability of sites outside of

the zones noted in position statements L1 and L2 (concerning mass casualty emergencies). It will place a high priority on protecting groundwater within principal aquifers and groundwater catchments for drinking water supply; and seek to avoid new cemetery developments for greater than 100 graves in these high vulnerability areas except where the thickness and nature of the unsaturated zone, or the impermeable formations beneath the site protect groundwater, or the long-term risk is mitigated by appropriate engineering methods. It advises that all cemetery developments and burials must maintain an unsaturated zone below the level of the base of the grave(s) and that the Agency will work with the local authorities to identify alternative options where necessary.

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
- SPZs
- 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**.**

<u>Tier 1</u>

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 minimise 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 require specified steps to be taken to prevent or remedy pollution of controlled waters.

3.4 Environmental Permitting (England & Wales) Regulations 2016

Burial of human corpses can result in discharge of hazardous substances and non-hazardous pollutants to groundwater. They are, therefore, covered by the requirements of the EU Groundwater Daughter Directive, issued under the Water Framework Directive 2006 and now transposed in England and Wales by the Environmental Permitting (England & Wales) Regulations 2016 (EPR 2016). It is an offence to cause or knowingly permit pollution of controlled waters other than under and in accordance with an environmental permit.

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 an existing cemetery with the main site almost full and an extension area adjacent to the main cemetery about to be commissioned fully (it currently holds one burial). The site has residential houses and gardens to the west, north and east and the existing cemetery to the south. The nearest watercourse is a small unnamed, culverted stream running east some 15m from the site boundary. In addition to this, there are a series of small ponds to the south west, south and south east of the site varying between 77m, 135m and 315m from the site respectively. A small stream also occurs on the OS map to the south of the site approximately 130m from the southern boundary with a wet ditch also shown on the OS map some 57m to the south east of the site.

The site falls from around 52.5 m AOD along the northern boundary of the site to around 51m AOD along the boundary between the existing cemetery and the extension area at an average grade of around 2.3%. The main fall is to the south / south east but with a slight cross fall from west to east.

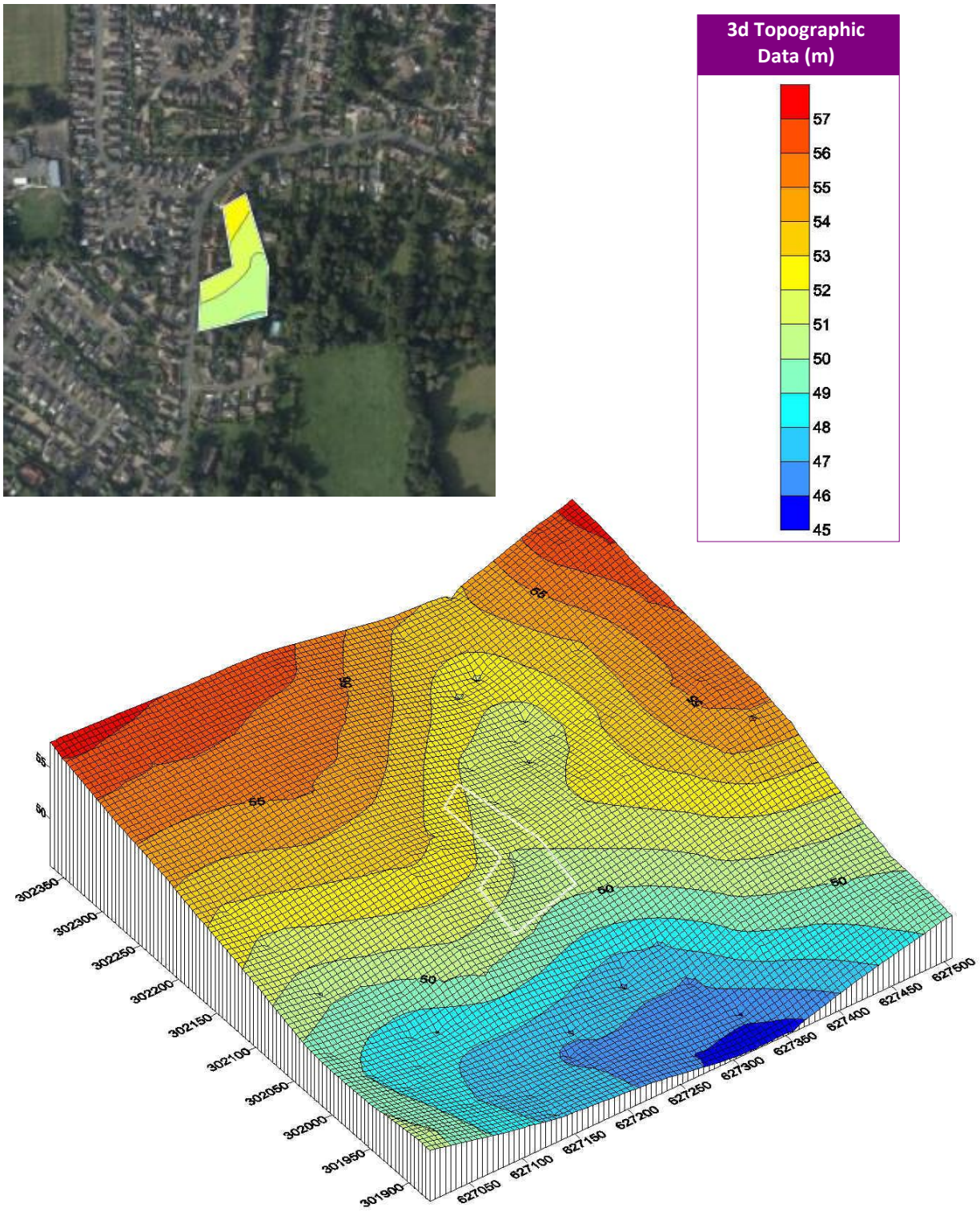


Figure 2. Topography of the site.

4.2 Soil type

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

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

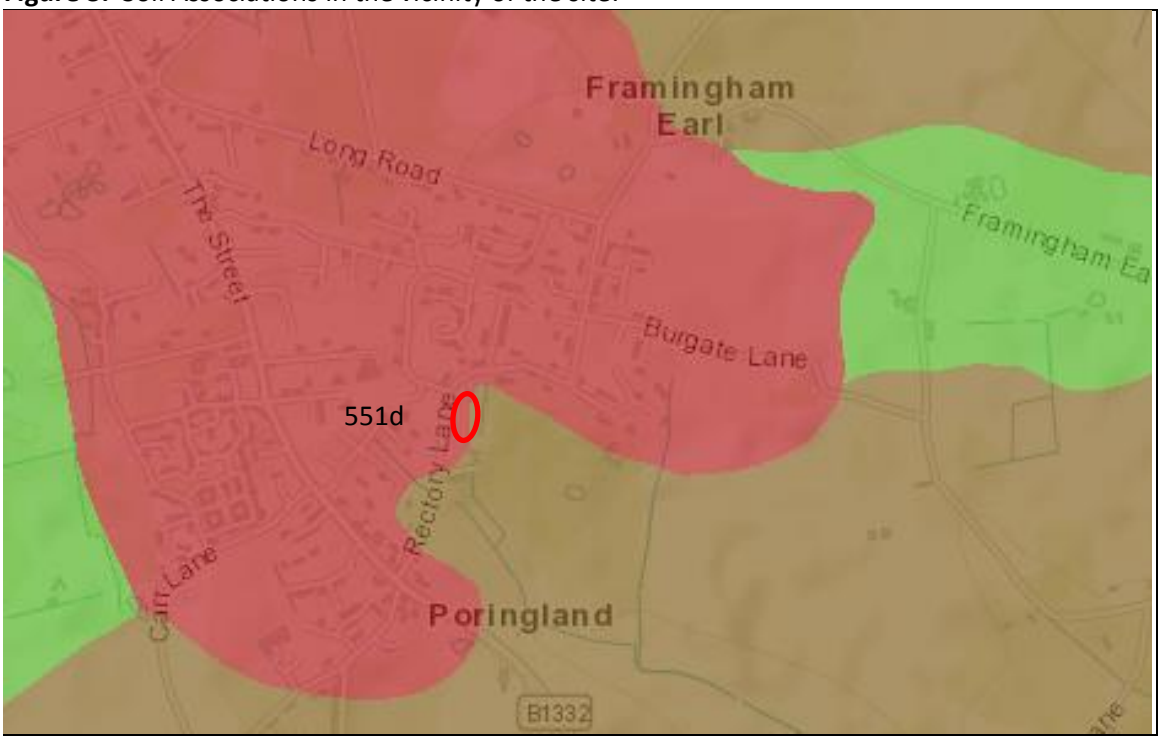


Table 1. Soil Associations in the vicinity of the site.

Soil Association	Sub Groups	Description
511d Newport 1	Wick Blackwood Rudge	Deep, well-drained sandy and coarse loamy soils. Some sandy soils affected by groundwater.

These soils are generally well drained and easy to work. Where the glacio-fluvial deposits occur over impermeable subsoils or bedrock material perched water or groundwater can occur and should this be shallow enough to occur within 1m of the base of a grave the site would not comply with EA standing advice on burials (no burials permitted where groundwater occurs within 1m of the base of a grave).

4.2.1 Trial pits

Site investigations were undertaken on 11th May 2018 with 3 trial pits dug to between 1.4 metres and 2.1 m (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.

Figure 5. Trial pit locations.

The trial pits revealed a complex soil pattern over the area tested. All pits had a sandy topsoil (LOAMY SAND to SANDY LOAM texture) which varied between a shallowest of 0.42 m deep in Pit 1 and a deepest of 0.85 m in Pit 2. The soil was dark brown black in colour, loose and friable. It is likely that the soils have formed in the glacio-fluvial superficial deposits that begin to tail-off over the site, thinning towards the east. This is reflected in the subsoil variability.

In Pit 1 the topsoil is underlain by a distinct orange coloured mottled layer of SANDY GRAVEL with some stones. The mottling present is indicative of a layer in the soil which is periodically waterlogged. When waterlogged parts of the soil become anaerobic and this produces reducing conditions in the soil. When the iron in the soil is reduced from Ferric to Ferrous iron it changes colour from orange to greenish grey, hence creating the mottled pattern visible in this soil. This layer extended to a depth of 0.77 m and became wetter with depth, less mottled and greyer in colour.

Between 0.77m and 1.3m was a layer of grey, saturated clay-bound SANDY GRAVEL which began to flow at a moderate rate into the pit. The sides were unstable and began to collapse into the pit within minutes of opening it. Between 1.3 and 1.48 m was a drier layer of SANDY CLAY however it was not possible to excavate below this due to repeated collapse of the pit sides and running conditions in parts of the soil above. It is likely the water in the saturated layer between 0.7m and 1.3m is perched within the sandy gravel over a the less permeable sandy clay at 1.3m. This perched water is unlikely to be in hydraulic connection with local surface water but may be connected to the underlying true groundwater in places. This layer coincides with burial depth and in this location would make excavating a stable grave almost impossible as the soils were flowing and would run under shuttering and side supports. In addition, if a burial was possible, the water would gather around the grave meaning that the site would not comply with EA standing advice of not burying into standing water. It would also make digging adjacent graves difficult without a significant gap between graves as adjacent graves would be likely to collapse into new graves when dug in such conditions.

In Pit 2 (downslope from Pit 1), the topsoil was very deep, loose and friable and overlaid a thinner layer of orangey grey, mottled SANDY GRAVEL which occurred between 0.85m and 1.17m. Though wet, this layer was not saturated in this location and remained stable with no side wall collapse. This suggests that water held in this layer is localised and not general under the site as a whole. Though an issue in Pit 1, the perched water was not encountered in Pit 2 though it was excavated within 40 m of Pit 1. This makes planning the use of the cemetery extension area difficult as some areas may be possible to use whereas others within even a few meters may be impossible to dig a stable grave in.

Between 1.17m and 1.84m there was a layer of SANDY CLAY with gravel which became wetter with depth. At 1.84m was a layer of saturated, plastic clay which gave way to a saturated fine sand at 2.04m. Water began to flow into the base of the pit immediately and rose quickly to a depth of 10 cm within 15 minutes. Some side wall collapse was observed from the saturated clay layer but was not extensive.

The water encountered in Pit 2 is likely to be the true groundwater associated with the glacio-fluvial deposits rather than a layer of perched water such as that found in Pit 1. It is likely this groundwater would also have been struck in Pit 1 if it was possible to dig the pit deeper in that location. The presence of groundwater at this depth indicates that the site would fail to meet the EA standing advice requiring there to be no water table within 1m of the base of a grave. With groundwater present at 2.04 m this makes even single burials non-compliant with EA advice.

Pit 3 was excavated in the existing cemetery area at the base of the slope and some 10m from the nearest burial. The topsoil again a dark brownish black LOAMY SAND / SANDY LOAM extending to a depth of 0.56m This was underlain by an orange brown, mottled layer of clay-bound SANDY GRAVEL with some stones. This layer became wetter with depth to 1.1m. Between 1.1m and 1.6m was a grey clay-bound SANDY GRAVEL which was saturated and quickly began to flow into the excavated pit. Between 1.6m and 1.8m there was a drier though plastic layer of SANDY CLAY, over which the water in the layer above was perched. The pit was dug to a depth of 2.1m where saturated fine sand was stuck and groundwater began to flow into the pit base. The pit could not be extended further and began to fill rapidly with running sand from higher in the profile and significant side-wall collapse. The pit was filled to avoid further side wall collapse.

Pit 3 was effectively a combination of the conditions encountered in Pits 1 and 2, with a perched water layer between 1.1m and 1.6m and then true groundwater struck between 1.8 and 2.1m. In this location not only would it be very difficult to practically dig a grave deeper than 1.1m due to running conditions, side wall collapse and water gathering around a burial, but there is also groundwater within 1m of the base of a grave, even a single grave.

In summary a combination of shallow, localised perched water in the upper subsoil makes the practical excavation of a grave difficult in parts of the site, with some areas being stable and some areas being unstable but there being no way of knowing which areas will be suitable or not until a grave is attempted. This may improve over summer as the perched water layer begins to dry but this cannot be guaranteed. From a groundwater pollution perspective, there is groundwater within 1m of the base of a grave over the site generally and with a permeable layer of sand, gravel and clayey sand between the base of a grave and this groundwater the risk of pollutants released from burials entering the groundwater is high. Though unlikely to be used for potable purposes, the groundwater is likely to supply the local streams and rivers via base flow and as such any pollutants within the groundwater are likely to impact the surface waters.

The risk from the site is reduced significantly by the low burial rate of between 12 and 15 per year and the EA may take a view on this in respect to overall risk from the site. More detailed flux modelling of the site is recommended ahead of speaking with the EA to provide a better assessment of the risks posed. It should be noted that even if the risk to ground and surface water from the site is deemed to be acceptable, the practical issues of digging graves in ground that is saturated in places will remain. In addition, if burials into saturated ground are made, then re-opening such graves will be difficult and any water removed from the grave as

part of that process much be treated as polluted and taken off site in a tanker for disposal at a licensed water treatment plan.

The only way to mitigate both the perched water and to reduce the groundwater level to a depth more than 1m below the base of a grave would be to install deep drains to depths between 2.8 – 3.0m. This requires larger machinery which given the access issues to the site may not be possible to bring in. In addition, all water flowing from the drains would need to be treated ahead of discharge assuming a suitable discharge point can be found. The simplest way to do this would be to pump water from the drains into the nearest foul water sewer but there may not be capacity in the sewage system to deal with the additional flow. Otherwise an on-site treatment system such as a small package treatment system would be needed and a suitable surface water outfall found for the cleaned water. The cost is likely to be very high, the practical issues associated with digging and installing such a system are hard to overcome and the impact on available remaining burial space is also likely to be significant within such a small site. Given all these issues, the council may be better advised to look for a new site for a cemetery, restrict burials to single depth in areas where digging graves is practical (assuming the EA allow it) or using this site for ashes interment only in future.

4.3 Geology

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

4.3.1 Artificial ground

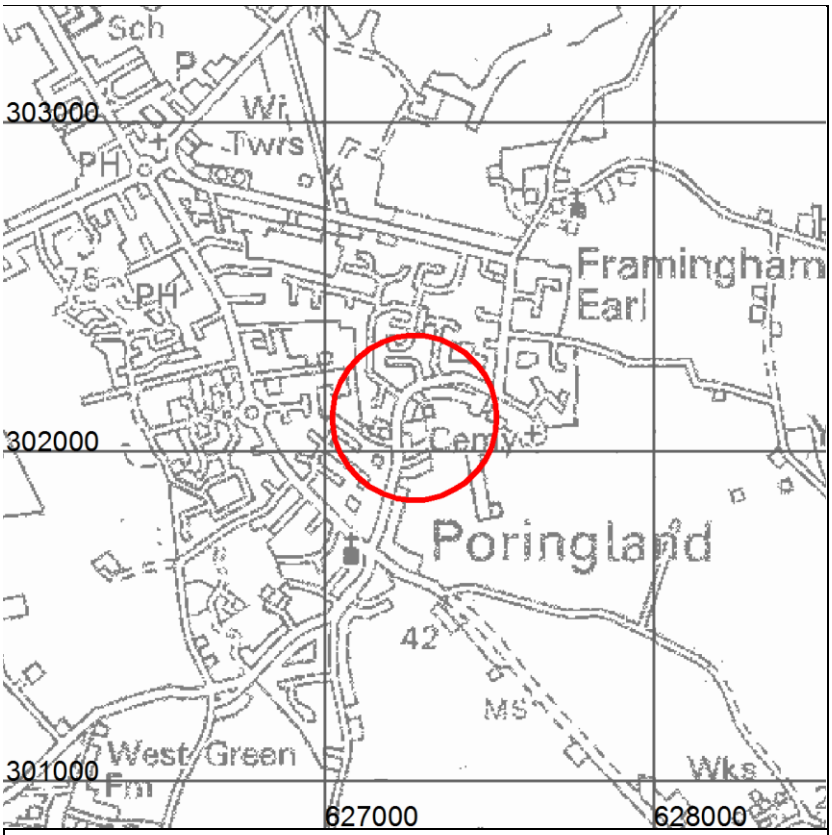


Figure 6. Artificial ground in the vicinity of the site.
Search area indicated in red

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

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 publication in 1975 and the site is not located in a built-up area. There is a borehole within the search area but not within the site that has indicated the presence of artificial ground to 2 m depth located within a nearby housing development.

Modern and historic Ordnance Survey maps from 1887, 1908, 1929, and 1951 to the present day show that the site has not had any previous development apart from some small buildings close to the road. Artificial Ground might be present, such as landscaping, and should be considered.

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 superficial deposits on site are variable, complex and the thickness is not well constrained as there are no boreholes on site.

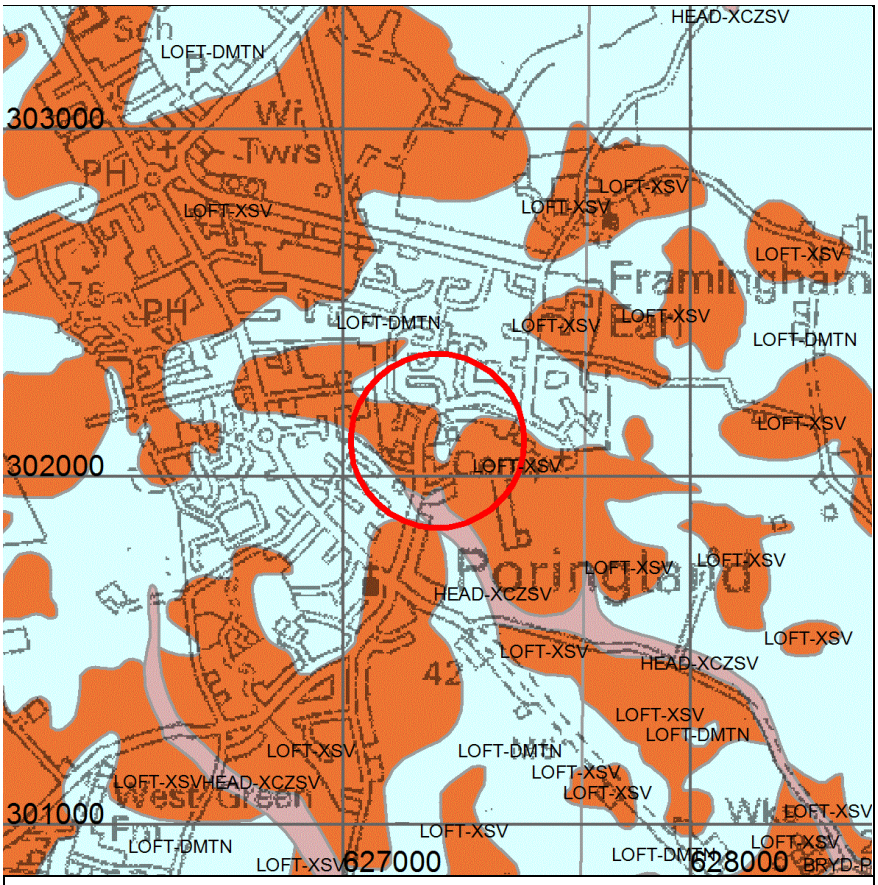


Figure 7. Superficial deposits in the vicinity of the site.

Search area indicated in red

Key to Superficial deposits:

Map colour	Computer Code	Name of geological unit	Composition
	BRYD-P	BREYDON FORMATION	PEAT
	LOFT-DMTN	LOWESTOFT FORMATION	DIAMICTON
	LOFT-XSV	LOWESTOFT FORMATION	SAND AND GRAVEL
	HEAD-XCZSV	HEAD	CLAY, SILT, SAND AND GRAVEL

Head deposits– Clay, Silt, Sand and Gravel
Head deposits are mapped in the south of the site. They are probably composed of gravelly sandy clay but can be of variable lithology. They are formed from downslope mass-movement (solifluction) of up-slope materials under past conditions of cold climate. They are thickest on the lower slope and valley bottoms. Head deposits may be more extensive than shown on the geological map, but discontinuous and up to 3 m thick.

Lowestoft Glacigenic Formation
The whole site is on the Lowestoft Glacigenic Formation with the eastern 10 metres mapped as on the Lowestoft Till Member and the rest of the site on sand and gravel. The Lowestoft Glacigenic Formation was deposited between about 420 000 and 480 000 year BP, during the Anglian glacial period. It is composed of beds of glacial till, sand and gravel (glaciofluvial), and silt and clay (glaciolacustrine). In this area the Lowestoft Glacigenic Formation is composed of an upper layer of sand and gravel and lower gravelly sandy clay of the Lowestoft Till Member.

Lowestoft Glacigenic Formation – upper Sand and Gravel
This unit comprises sandy gravel and gravelly sand with a few cobbles. It is clayey in part; the clay is brown, sometimes grey and slightly sandy. The gravel is composed of flint with minor quantities of quartz, quartzite and chalk. This unit, where present, might be up to 8 m thick based on local borehole records.

Lowestoft Till Member - Lowestoft Formation – Glacial Till
The Lowestoft Till Member is composed of calcareous, gravelly, sandy clay with a low cobble count (glacial till). The gravel is composed mostly of chalk and flint and the coarser gravel and cobbles are of flint. Chalk content might increase with depth. There is a moderate potential for a shrink-swell hazard associated with the Lowestoft Till Member. Drilling records in the area indicate that this deposit could be between 10 and 20 m thick.

Beneath the Lowestoft Till Member there might be a few metres of sand and gravel and/or brown sandy clay with occasional flint gravel of the Happisburgh Glacigenic Formation. If present it is probably 3 to 5 m thick. Alternatively, if there is only a sand and gravel it is probably the Crag Group.

4.3.3 Rockhead depth

The depth to rockhead (bedrock) is not known with any degree of certainty, but it is estimated to be around 17 to 33 metres. However, the Crag Group (geological bedrock) can be difficult to distinguish from overlying superficial deposits.

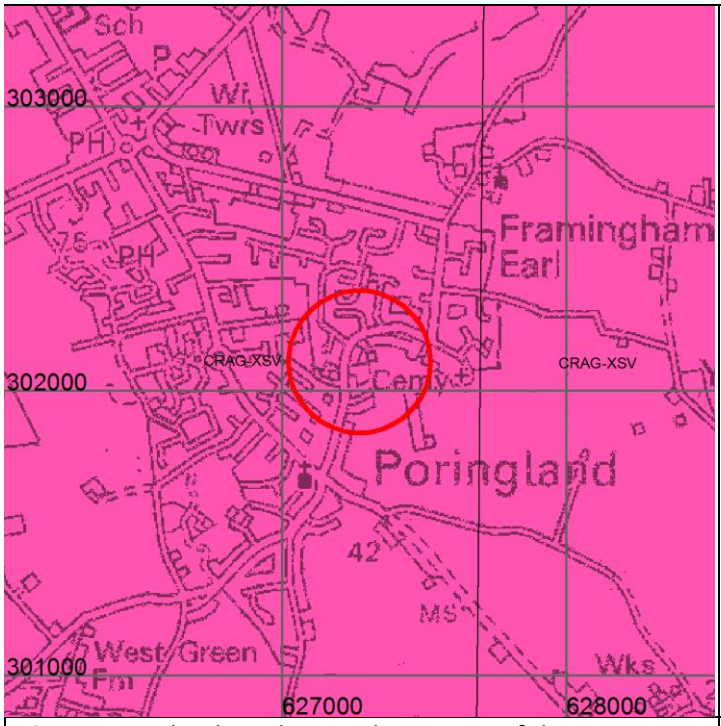
4.3.4 Bedrock geology

Crag Group
The Superficial Deposits are underlain by the Crag Group, which is almost entirely of Pleistocene age. The Crag Group consists of an upper part of sand and gravel ('Wroxham Crag') becoming mainly glauconitic (green mineral), locally shelly, fine-to medium-grained sand with increasing depth. Also,

with increasing depth, thin beds and lenses of grey clay occur sporadically. The lower part of the Crag Group commonly contains thick beds of grey clay. The Crag sand is typically greenish-grey when unweathered but weathers to yellowish brown. Beneath this site the Crag Group is probably at least 10 m thick. The Crag Group can be difficult to distinguish from overlying superficial deposits.

White Chalk Subgroup

Below the Crag Group is the White Chalk Subgroup, Late Cretaceous, which consists of white, fine-grained limestone (chalk) consisting principally of the silt-sized, calcareous remains of planktonic algae with beds of flint, gravel to cobble-sized, sometimes small boulder-size, flint, stronger chalk (hardgrounds) and marl seams, which are common at many levels in the succession. It is probably over 300 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
	CRAG-XSV	CRAG GROUP	SAND AND GRAVEL

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	
West 627110, 302090	East 627440, 302120

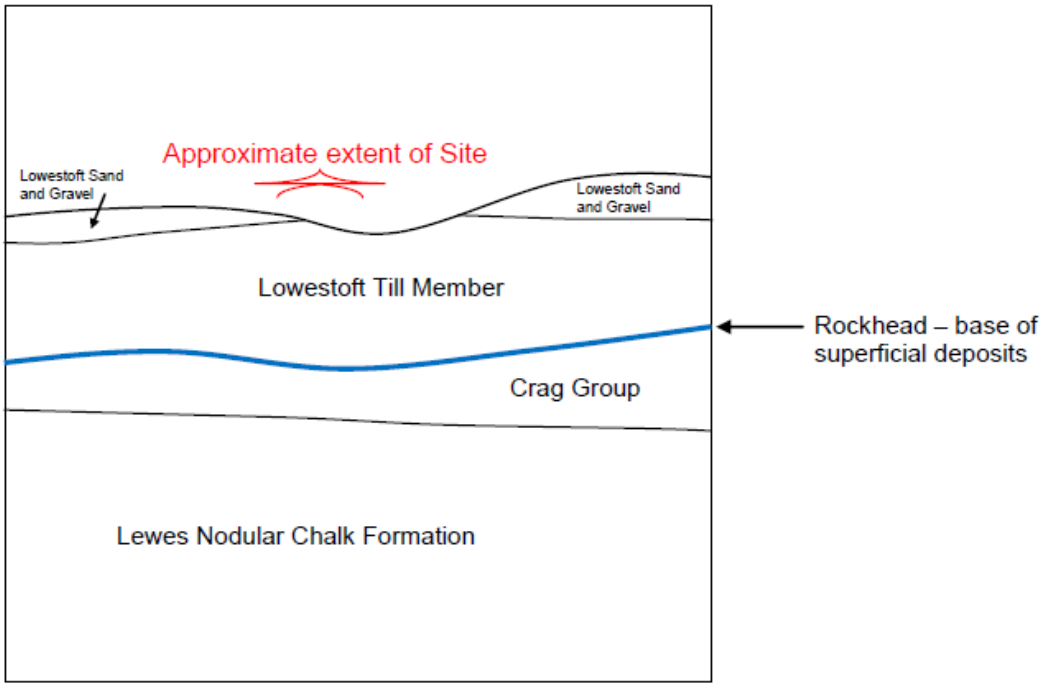
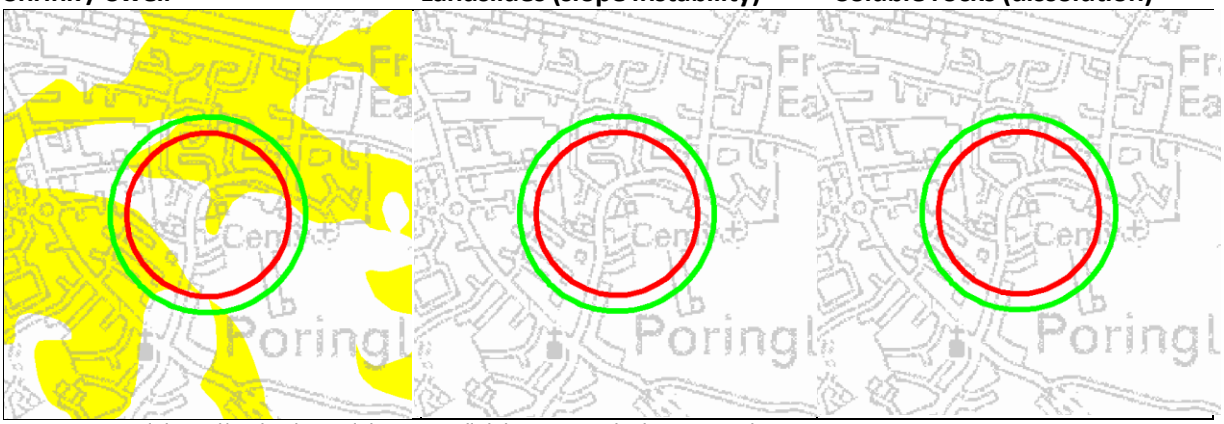


Figure 9. A schematic representation of the underlying geology of the site.

4.4 Additional geological considerations

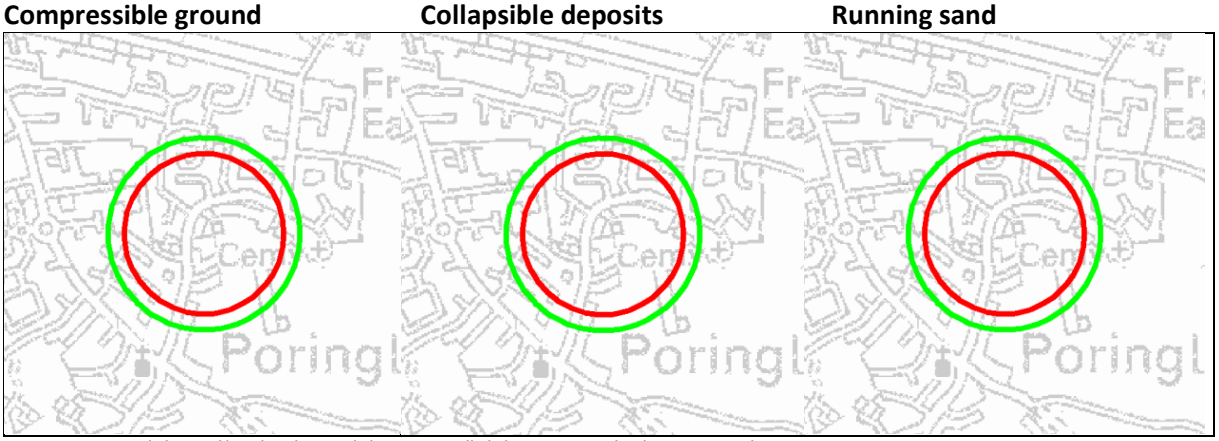
Figure 10. A summary of the geological hazards associated with the site.

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 (Yes/No)?	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. There is potential for a moderate shrink-swell hazard associated with Lowestoft Till Member (Lowestoft Glacigenic Formation). The clay is slightly susceptible to shrink-swell behaviour in response to changes in water content.
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 B = Potential for hazard is not significant and is at a level such as to cause problems only in exceptional circumstances.
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. However, if the Lowestoft Glacigenic Formation sand and gravel contains beds of water bearing sand, such as above the Lowestoft Till Member, or sand within the Crag Group might be prone to run if intersected by pit or borehole. This appears to be the case on this site where water is present and perched within the sands and gravels overlying either the Lowestoft Till Member or a clayey phase of the Lowestoft Glacigenic Formation.
Other Potential Hazards		
Mining	No	
Flooding	No	Limited potential for groundwater flooding to occur below ground level.
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.

Evidence from shallow boreholes in the superficial deposits in the area (within half a kilometre of the site) indicate that water is likely to be struck at shallow depths, if permeable deposits are encountered. Where permeable deposits underlie low permeability deposits the water level may rise above the level at which it is first struck. None of the borehole records describe overflowing water levels, but most of them were located at slightly higher ground elevations (about 55 m above OD) than the site.

The Crag and Chalk aquifers can be in hydraulic continuity, depending on whether clay layers are present in the Crag Group. The site lies close to a Chalk groundwater divide, so there is some uncertainty over the direction of groundwater flow in the Chalk aquifer at depth, it could be westwards towards the River Tas, but may be north or 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
Head deposits (if present).	Typically low permeability, but may be permeable in part.	No data.	No data.	Not classified.
Lowestoft Formation, upper sand and gravel.	Highly permeable, intergranular flow.	Shallow groundwater may be encountered within 2m of the surface.	No data but likely to be hard and contain some iron.	Secondary aquifer with high vulnerability.
Lowestoft Formation, Lowestoft Till Member.	Generally low permeability but may contain some water if contains any coarser – grained, more permeable horizons.	Shallow groundwater may be encountered within 2m of the ground surface.	Hard and often iron rich.	Secondary aquifer.
Happisburgh Glacigenic Formation (if present).	Highly permeable, intergranular flow.	Will be saturated. Water may rise above the level where first struck.	Hard and typically iron rich.	Secondary aquifer.
Crag Group	Highly permeable, intergranular flow.	Will be saturated. Water may rise above the level where first struck.	Hard and typically iron rich.	Principal aquifer with low vulnerability.
Lewes Nodular Chalk Formation (White Chalk subgroup).	Important regional aquifer, fracture flow.	Rest water level about 10 – 15m above OD, i.e. water may rise above where first struck (depending on depth to rockhead).	Hard with chloride ion concentration less than 50 mg/l, and in places iron rich	Principal aquifer.

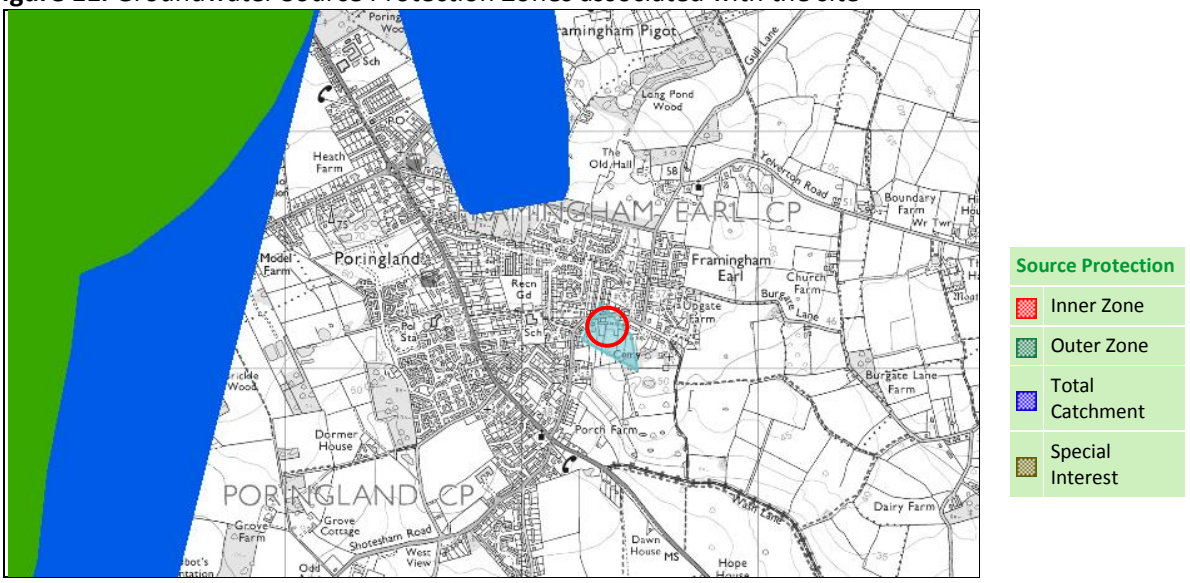
4.5.1 Groundwater vulnerability

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 of any source protection zones and though SPZ's do occur to the north and west, they are over 250 m from the site.

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.

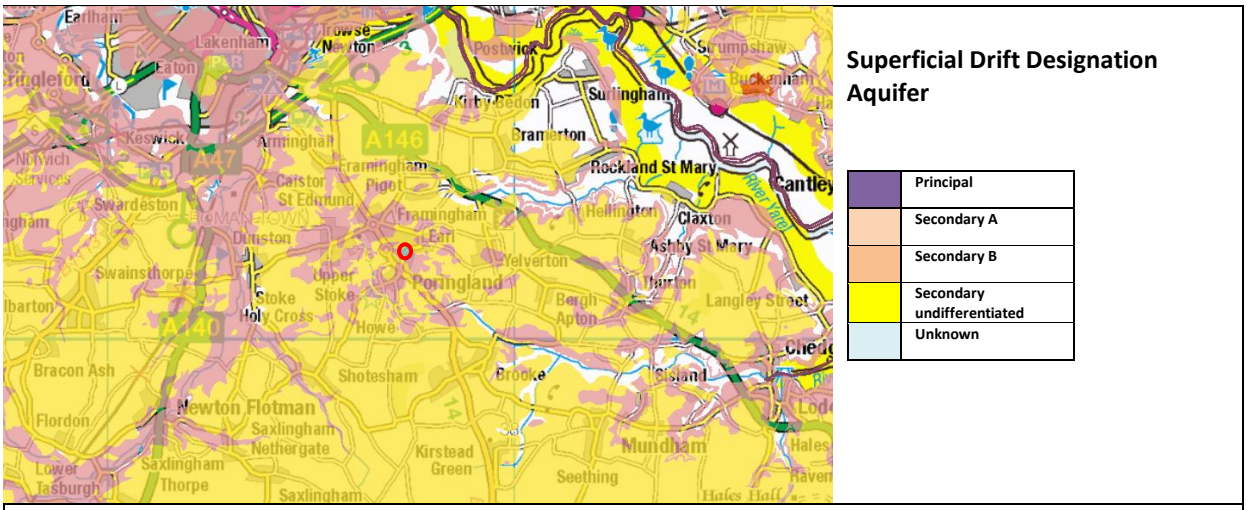


Figure 12. Superficial drift aquifer designation associated with the site

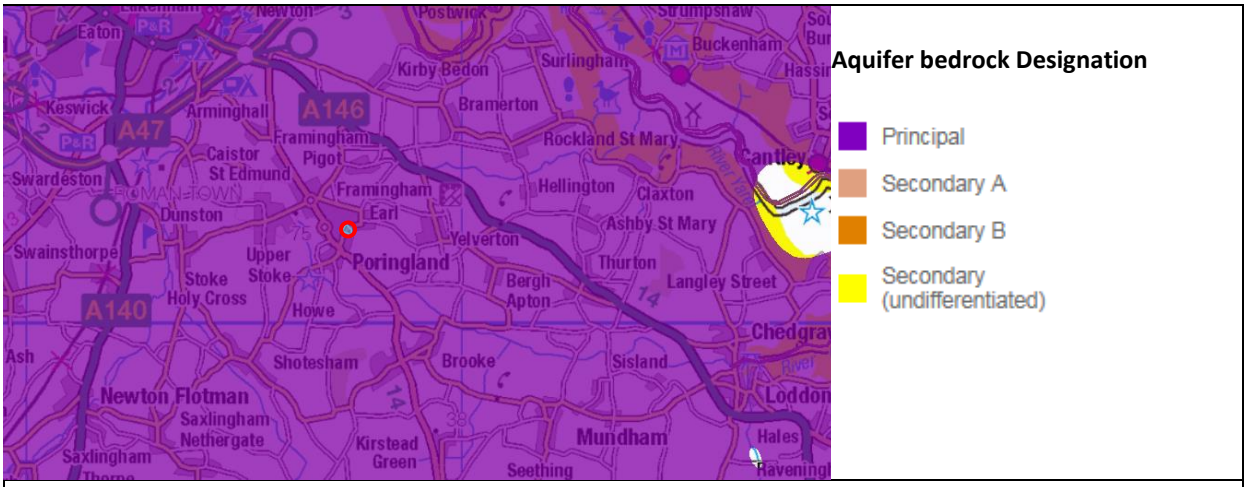


Figure 13. Bedrock aquifer designation

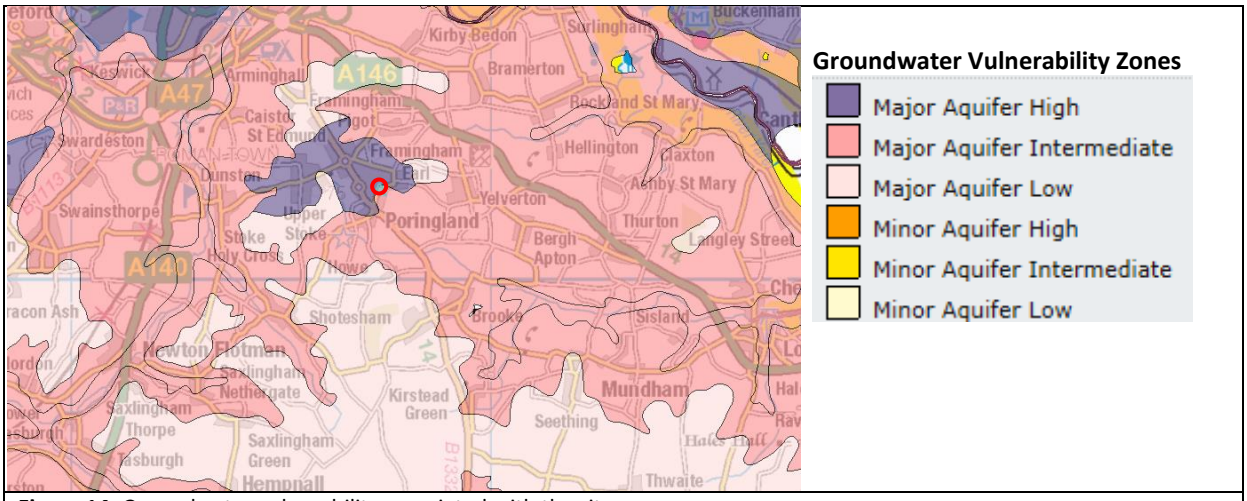


Figure 14. Groundwater vulnerability associated with the site

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 partially over a Secondary A Aquifer and a Secondary Undifferentiated Aquifer associated with the superficial deposits and over a Principal Aquifer in respect to the bedrock. The groundwater

vulnerability associated with this site is considered to be intermediate with reference to the Principal Aquifer. The site is not within a drinking water safeguard zone nor is it within a water Nitrate Vulnerable Zone associated with either surface or groundwater.

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.

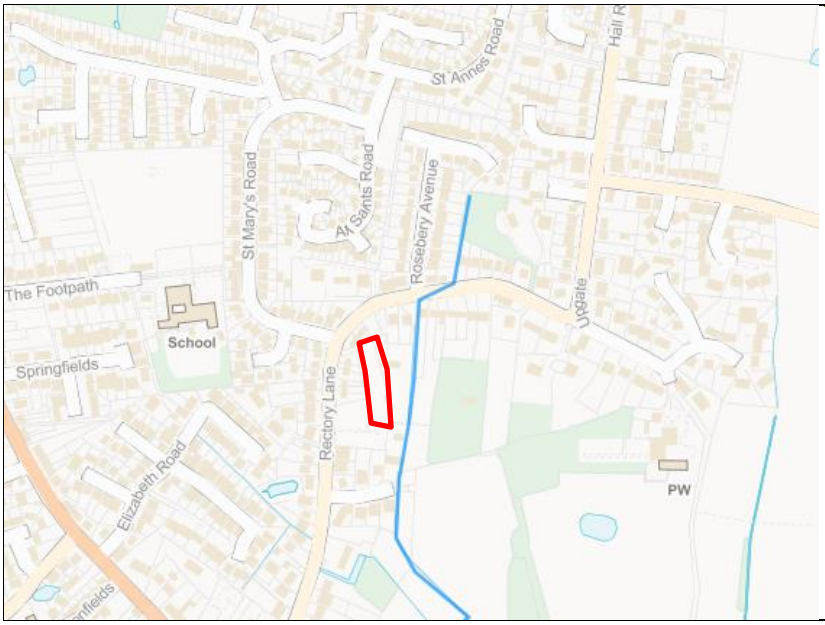


Figure 15. Map of Flood Risk Zones

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

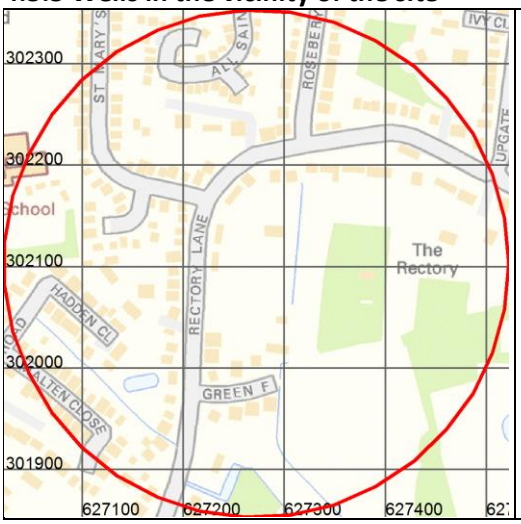


Figure 16. Well records
Number of records within a 300 m radius of the centre of the site: 0

Search area indicated in red

4.5.6 Boreholes in the vicinity of the site

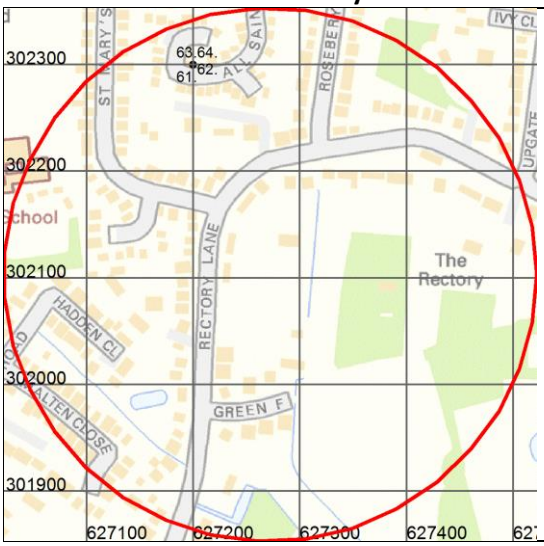


Figure 17. Borehole records
Number of records within a 300 m radius of the centre of the site: 4

TG20SE61
TG20SE62
TG20SE63
TG20SE64

Search area indicated in red

4.6 Meteorological data

The agro climatic index number for this site is 24 with a mean annual rainfall of 623 mm, the Standard Average Annual Rainfall (SAAR) for the site itself is 600 mm.

4.7 Surface water issues

The site generally has a very low risk of surface water flooding within it (less than 0.1% chance of surface water flooding occurring in any year) however a strip running through the centre of the site has a low risk of surface water flooding (less than 1% chance in any year). 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.

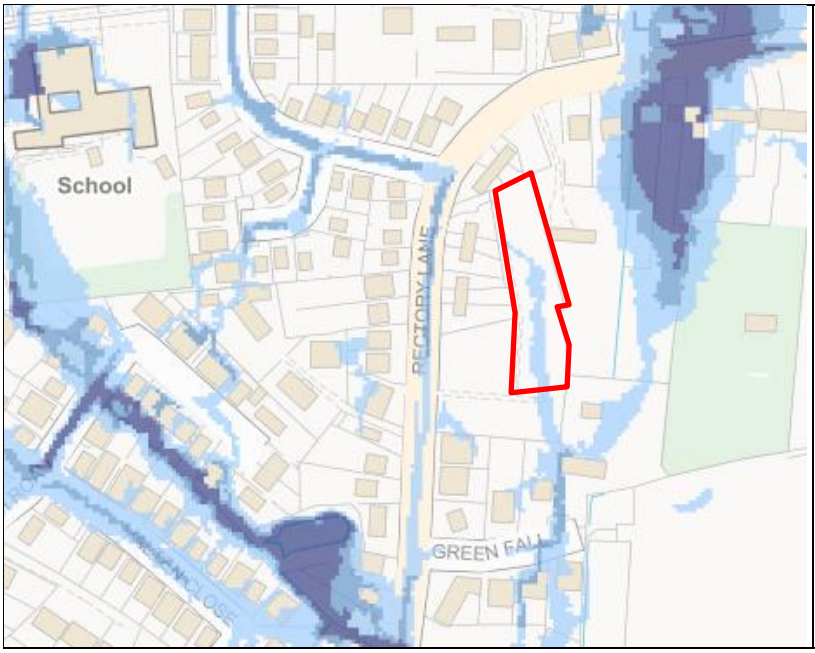


Figure 18. Map of Surface Water Flood Risk

5.0 Pollutant risk

Due to the approximately 12 - 15 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, even given the free draining nature of the sands and gravels. 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 acceptably low. In this case however, perched water and shallow groundwater is at or close to burial depth and as a result, any water which gathers around a burial is highly likely to become contaminated with pathogenic micro-organisms, though the risk will decline over time. Thus, the greatest risk would be present if re-opening a grave when the burial was less than 1 – 2 years old. Any water encountered should be pumped to a tanker and disposed of at a suitably licensed waste facility. It should not be discharged over the surface. All gravediggers should also wear suitable PPE. Given the shallow depth of water on this site, EA standing advice on burials has not been met and thus without mitigation the EA may determine the risk to groundwater is too significant for burials to continue at this site. Even if suitable mitigation can be carried out, the EA may deem the residual risk too high to allow burials, though the low number of annual burials may reduce overall risk sufficiently to continue to use the site where ground conditions allow.

6.0 Depth of burial

The key practical limitation to burial depth is the incidence of running sands at or close to burial depth. Where running sands occur within grave depth then even shuttering and supports are unlikely to prevent sidewall collapse, making burials impossible. Running conditions within the extension area were variable, so some places may be suitable for burials but the location of such areas cannot be predicted and may vary according to the time of year. As noted above, the site does not meet EA standing advice on burials in respect to depth to groundwater and as a result Agency advice should be sought in relation to using the site in the future for burials and whether the site, following mitigation works (if any are possible), may be suitable for use.

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	Low	Expected to be around 12-15 per annum	
Drift / superficial data	High	Present as sands and gravels	8-7
Drift thickness	Moderate	Around 3-5m	6-5
Proximity to water course	Very High	The nearest water course is 15 m away	10-9
Proximity to land drains	Very low	The land is unlikely to be drained	2-1
Depth to Water Table	Very high	Water table encountered within 2.5m of the surface	10-9
Proximity to Wells or potable water source	Very Low	No wells within 500 m radius	2-1
Flow mechanism	High	Intergranular flow sands and gravels	8-7
Aquifers	Moderate	Secondary A aquifer	6-5
SPZ	Very Low	Outside Zone 3	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	**54-45**

Table 4 is assessed using the groundwater vulnerability-ranking criteria in Table 5. The total score comes to **54-45** and is considered as 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 **Moderate**.

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

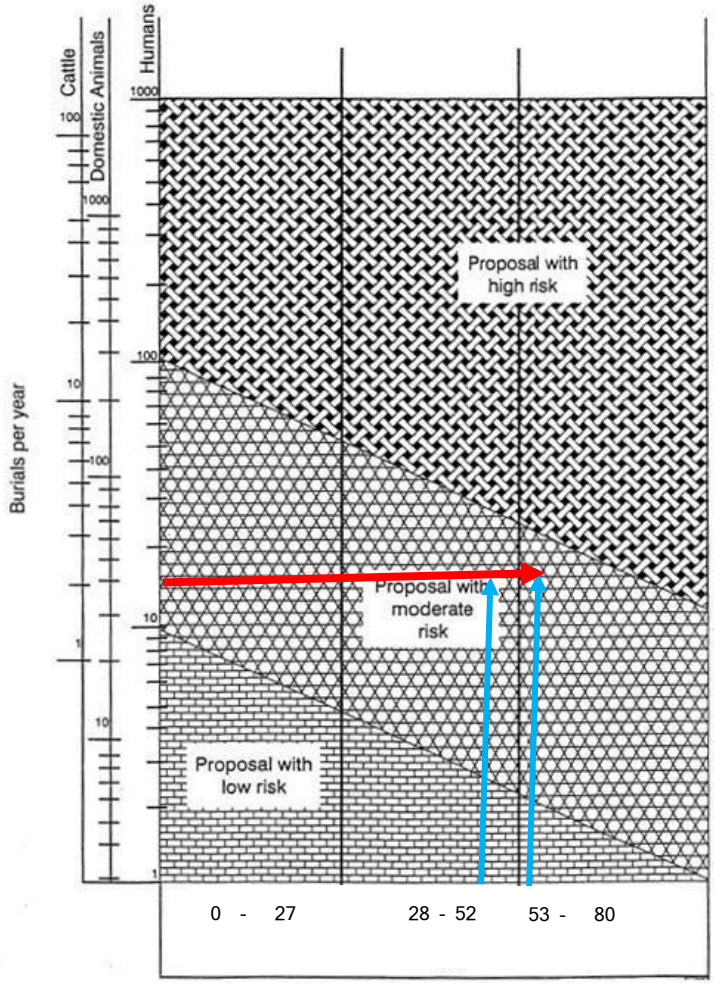


Figure 19. Groundwater risk nomograph

9.0 Conclusion

The site is considered to be **moderate risk** with the risk mainly attributed to the presence of shallow groundwater, the proximity to surface waters and the permeable nature of the superficial deposits. This is mitigated somewhat by low predicted burial numbers. Most significantly, the groundwater is within 1m of the base of a normal grave over much of the site. This contravenes EA standing advice for cemeteries which requires at least 1m of dry ground beneath the base of a grave. Furthermore, the presence of perched water within layers of sands and gravels further up the soil profile gave rise to running sand conditions in two of the pits excavated making it practically very difficult, if not impossible, to dig stable graves in such conditions. Though the occurrence of such layers will vary over the site, and may improve in summer, it adds complexity to managing this site efficiently.

A source of pollutants is present in the form of burials with the nearest receptor in the form of groundwater within as little as 0.6m under a normal double grave or 1m under a single grave. This groundwater will feed the nearby stream and given the free-draining nature of the subsoil materials the rate of transfer of pollutants from the cemetery to the stream could be fast. This stream is the most sensitive receptor as there are no wells recorded near to the site and the groundwater in question is associated with local superficial deposits rather than strategically important groundwater supplies. That said, ammonium is a major pollutant of surface waters and thus surface waters fed by this aquifer may be at increased risk due to burials in this cemetery. The risk can be more accurately defined by undertaking flux modelling for ammonium and nitrate at this site.

The overall risk posed by the site is mitigated somewhat by the low burials numbers, thus total loading each year is also likely to be low and the EA may deem this to be acceptable. It is important to discuss the finding of this assessment with the EA at the earliest opportunity in order to be develop a mitigation strategy that protects sensitive receptors. Such mitigation may be in the form of deep drainage to de-water the soil to a depth of at least 1m below a normal double grave, and in so doing also reduce the risk of running conditions occurring at burial depth by removing perched water. The problem with this approach on this site is a lack of space to move the machinery around the site as needed, a lack of access and a lack of space to treat any such water effectively ahead of discharge.

By way of grave-specific mitigation, 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.

Based on the above it is recommended that contact be made with the local Groundwater Protection Team as soon as possible in order to get more advice from the EA and determine the best way to manage this site. There is a risk that the EA may deem the site too risky to allow burials to continue and that if no suitable remediation options are found, the cemetery may need to be closed.

10.0 Reporting details

Report Author:	Mr Alex Vickers
Verification:	Miss Lucy Pedder
Date:	04.06.18

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.