ROSE COTTAGE

HYDROGEOLOGICAL & WATER NEUTRALITY ASSESSMENT

AUGUST 2025

PROJECT NO. 25260458

B. A. Hydro Solutions Limited

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HYDROGEOLOGICAL & WATER NEUTRALITY ASSESSMENT

Rose Cottage
Bakers Lane
Shipley
Horsham
West Sussex
RH13 8GF

Report researched and produced by B. A. Hydro Solutions Limited (BAHS Ltd) on the instruction of Jennifer Winter.

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UKAS PERSONNEL CERTIFICATION

ISO/IEC 17024

CHAS® Accredited Contractor

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GLOSSARY OF TERMS

BAHS		B. A. Hydro Solutions Limited
µg/kg		Micrograms per kilogram
µg/l		Micrograms per litre
bgl		Below ground level
BGS		British Geological Survey
BH		Borehole
CA		Coal Authority
CAMS		Catchment Abstraction Management Strategy
DWI		Drinking Water Inspectorate
DWS		Drinking Water Standard
EA		Environment Agency
EHO		Environmental Health Officer
GP3		Groundwater Protection Policy
GSH/C		Ground Source Heating/Cooling
ha		Hectare
HSE		Health and Safety Executive
HGA		Hydrogeological Assessment
HTGA		Hydro-Thermogeological Assessment
LA		Local Authority
m		Metres
m2/day		Square metres per day
m3/day		Cubic metres per day
maOD		metres above Ordnance datum
mg/kg		Milligrams per kilogram
mg/l		Milligrams per litre
NE		Natural England
NGR		National Grid Reference
NRW		Natural Resources Wales
PWL		Pumped Water Level
RWL		Rest Water Level
s		Drawdown in metres
SEPA		Scottish Environment Protection Agency
SPZ		Source Protection Zone
SSSI		Site of Special Scientific Interest
SVC		Volumetric Heat Capacity
T		Transmissivity
TGA		Thermogeological Assessment
UKAS		United Kingdom Accreditation Service
UXO		Unexploded Ordnance
λ		Thermal Conductivity

1 Introduction

B. A. Hydro Solutions Ltd. (BAHS) has been commissioned to complete a Hydrogeological Assessment of conditions present at the following site with a view to developing a new groundwater abstraction of up to 20 m^3/day. Information collected, interpreted and analysed within this Assessment provides a feasibility guide, and shall assist in the design and location of the prospective borehole(s). If more than 20 m^3/day is sought, the outline borehole design provided in this Assessment may not be sustainable. Due to the location within the Sussex North Water Resource Zone, there is a need to assess the water neutrality status of the proposal as only water neutral projects are acceptable to Natural England who are responsible for conservations site assessed to be at risk within the Zone.

The site location is illustrated in the following figure; for the purpose of considering geological strata and depths to each stratum, a mean site elevation has been adopted throughout this report, as listed below:

Site Address:	Rose Cottage	
	Bakers Lane	
	Shipley	
Postcode:	RH13 8GF	
Drill position NGR:	TQ 13890 23584	
Elevation adopted:	23	maOD

Table 1: Site details

2 Objectives

This Assessment seeks to fulfil the following objectives:

- Confirm the geological sequence.
- Define the hydrogeological setting.
- Consider where groundwater is present.
- The quantity and seasonality of groundwater present.
- Identify the preferred target horizon for abstraction.
- Consider the likely quality of water present.
- Report the regulatory conditions applicable.
- Develop an outline borehole design.

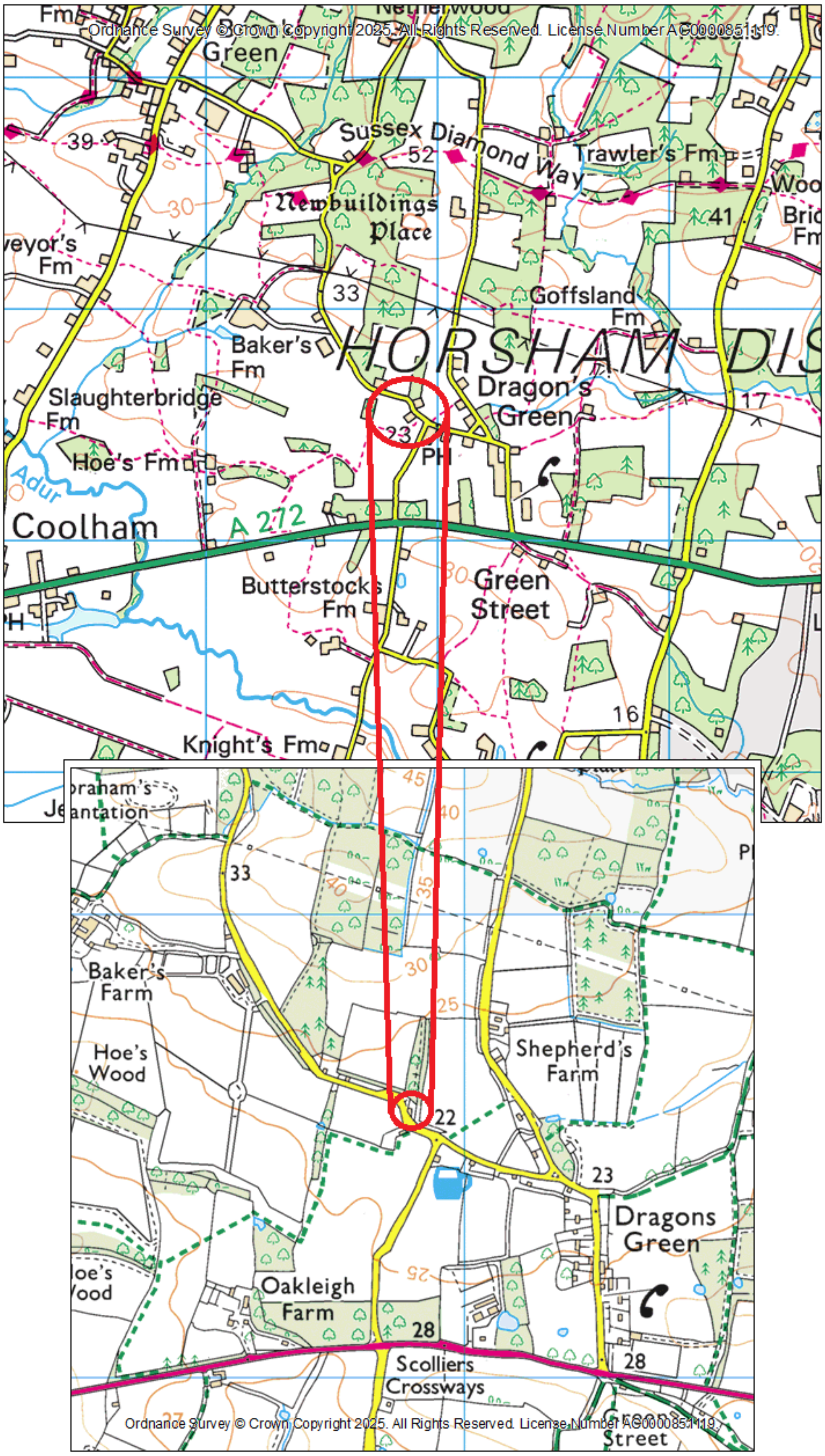

Figure 1: Location Map

3 Geological Setting

3.1 Geology

The following discussion of the geology beneath the site is based on a site-specific literature review and historical borehole records that have been obtained for the purpose of predicting the geological unit thickness, nature and depths. As geological units are not laterally continuous, vary in thickness and are not homogeneous, the predicted thickness and depths may differ slightly if or when proved by drilling.

It is recommended that during drilling B. A. Hydro Solutions Limited are consulted in order to compare the confirmed geology with that anticipated in order to refine the borehole design. The geology and thicknesses reported are based on the assumption that the borehole is drilled at the National Grid Reference (NGR) listed in Table 1 from the elevation stated. If the drill position changes the findings of the Assessment will need to be updated.

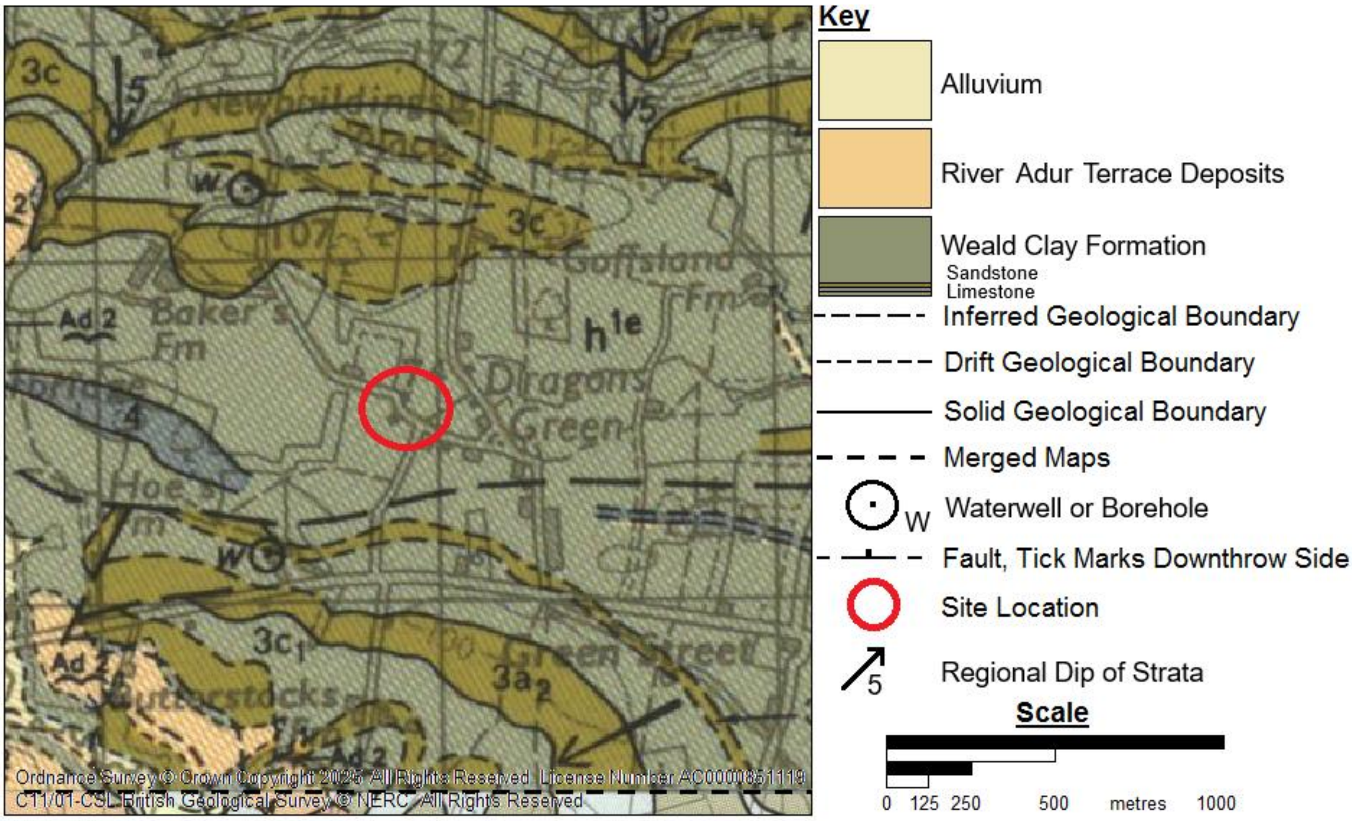

Figure 2: Geological Map

The geology mapped at ground level across the local area is illustrated in Figure 2; the location of the site is circled in red, the following table summarises the strata present, their names, lithological nature and the anticipated thicknesses of each unit.

Geological Group	Geological Formation	Lithological Nature	Anticipated Thickness (metres)
-	-	Soil and/or Worked Ground and/or Made Ground	<2
Wealden Group	Weald Clay Formation	Mudstones with limestones, siltstones and ironstones	>100

Table 2: Summary of Geological Sequence

3.2 Structure

The main geological structures present and affecting the ground beneath the site are listed below. The tectonic events and the sequences leading to the resulting structures are not considered by this Assessment as such detail does not affect the conclusions drawn by this study.

- Faults in the local area are anticipated to affect the geological sequence or the presence/abundance of groundwater beneath the site
- The strata considered by this Assessment have experienced minor tectonic deformation since their deposition, they have been gently folded/tilted and faulted.
- The strata dip at 3 to 6 degrees to the south.

4 Lithological Characterisation

4.1 Soil & Drift

4.1.1 Soil

All sites are underlain by some form of soil, worked ground, made ground or a combination of the above. This Assessment does not seek to characterise the nature of this layer as it is normally relatively thin and does not have any hydrogeological bearing on the presence, abundance or nature of the groundwater present. Where sites are underlain by known or possible contamination, appropriate professional advice should be sought. In most cases it would not be appropriate to construct a borehole for groundwater abstraction where it would/may pass through such ground.

As a precautionary approach, it should be assumed when designing a new abstraction borehole, that the soil could be liable to collapse, and that temporary casing would be needed through the soil and drift deposits present beneath. Soils and the first 1 to 3 metres below ground level [depending on ground conditions and the target horizon for abstraction] should be cased and sealed out of new boreholes on completion in order to form a reliable sanitary seal.

4.1.2 Drift

There are no mapped or reported Drift deposits present beneath the proposed drill position.

4.2 Weald Clay Formation

The rock head beneath this site is formed by the Weald Clay Formation which is likely to be weathered to a depth of 5 to 10 metres below rock head. Weathering, erosion and exposure will have reduced the strength of the ground resulting in it becoming weaker, less able to stand without temporary support and liable to collapse when drilled.

The Weald Clay Formation is the top most unit of the Wealden Group and is typically formed of mudstones and shales with subordinate layers of siltstone, occasional layers of fine to medium grained sandstones, some of which are calcareous in nature. The mudstones, shales and siltstones form a series of thinly bedded sediments which tend to be a dark grey colour. A number of thicker sandstone and limestone horizons have been found to extend over some distance, whilst most are lensoidal with only limited lateral extents.

The Horsham Stone Member and the Paludina Limestones are examples of more traceable horizons within the Weald, which have more of a regional presence. Most of the more arenaceous deposits and limestones have such limited thicknesses and lateral extents that they have no hydraulic connection to ground level and thus contain finite pockets of water.

The Weald Clay sequence has a maximum thickness of up to 457 metres in this area although erosion may have thinned the sequence present. The boundary between the mudstone and shale sequence of the Weald Clay and the Tunbridge Wells Sand Formation beneath is often poorly defined.

When drilling through the Weald Clay Formation, which has a minimum thickness of 100 metres below a weathered upper surface, one can expect increasing hardness and competence as drilling progresses. The ground typically stands without support once drilled, although temporary casing may be necessary if drilling operations extend over a longer period. It is important to note that there are no water-bearing strata within an economically viable drill depth below this unit, making it the final geological horizon of consideration in this Assessment. During drilling through this unit, some drilling flush may be lost due to the presence of layers of sandstone, ironstone, and limestone that have become jointed and fractured in the Weald Clay at this location.

5 Hydrology and Hydrogeology

5.1 Hydrology

A new borehole drilled to target the horizon identified in Section 5.2 would have no direct or indirect effect on surface water features. During drilling there is a low risk of drilling fluids migrating through the shallower ground and emerging in any watercourses, springs or boreholes/wells very close to the drill position. On completion any such hydraulic link would be closed by the lining and grouting of the borehole.

The Environment Agency's flood designation for the site is summarised below, this Assessment is not, and cannot be used as part of, a flood risk assessment.

Flood risk from River or Sea:	Very Low Risk
Description of Risk:	Very low risk means that this area has a chance of flooding of less than 0.1% each year. This takes into account the effect of any flood defences in the area. These defences reduce, but do not completely stop, the chance of flooding as they can be overtopped, or fail.
Flood risk from Surface Water:	High Risk
Description of Risk:	High risk means that this area has a chance of flooding of greater than 3.3% each year. Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding.
Flood risk from Reservoirs:	Extremely Unlikely (Very Low)
Description of Risk:	Flooding from reservoirs is extremely unlikely. An area is considered at risk if peoples' lives could be threatened in the event of a dam or reservoir failure.
Flood risk from Groundwater:	Extremely Unlikely (Very Low)
Description of Risk:	Flooding from groundwater is extremely unlikely in this area as the hydrogeological setting means there is either no groundwater shallow enough to cause problems or the site rests on impermeable ground.

Table 3: Flood Designation

Based on the flood risk status above, the site this Assessment provides the following guidance:

The overall flood risk for this site is assessed as being HIGH; boreholes should be completed with headworks above ground level, within a structure to protect the borehole from flood waters and any chance of being damaged by flood debris. The power supply should be completed within a waterproof housing and/or elevated above highest anticipated flood water levels. The borehole should be sealed to prevent any ingress of flood water. Any dip points, cable entry points, breather pipes, etc should be sealed into the head plate and it should be possible to seal/isolate these in the event of a flood. Any breather pipe allowing air into the borehole must extend to a sufficient height to always be above flood water. The breather pipe should have a filter and a mechanism to allow it to be isolated.

5.2 Hydrogeology

In this section the ground beneath the site is divided into hydrogeological units which are in turn considered in terms of the presence, abundance, movement and potential to sustain a new groundwater abstraction. Each unit is considered as it is reached with depth below the site. The preferred hydrogeological unit for a potential new groundwater abstraction is identified. The necessary drill depth, anticipated rest water level, along with the potential yield and necessary drawdown in water levels needed to sustain the predicted yield are set out in Table 4.

The study has considered the different strata present beneath the site in terms of their hydrogeological conditions to assess whether there may be a prospect of finding water. Where there are no boreholes or abstractions locally which can be used directly to judge the potential of the ground, BAHS Ltd use information derived from representative abstractions completed into comparable hydrogeological settings.

Hydrogeological Unit(s):	Soil & shallow weathered Weald Clay
Hydrogeological Description:	N/A
RWL:	Dry
T range:	N/A

Comments:
The hydrogeological characteristics of the soil and shallow weathered Weald Clay indicate that the shallow ground is typically dry, with minimal water content except after periods of rainfall. Water naturally moves downward to the permanent water table. As a result of the predominantly dry conditions, the shallow ground is unable to support significant groundwater abstraction through a modern conventional borehole.

Hydrogeological Unit(s): Weald Clay Formation (up to 50m deep)
Hydrogeological Description: Unproductive
RWL: 10 to 15 maOD
T range: 1.5 to 5 m^2/day
Comments:
The Weald Clay Formation (within a depth of up to 50 metres) is considered an unproductive horizon, nonetheless groundwater is present and primarily located in joints and fractures within the rock and hard layers, along with limited amounts in pore spaces. The density and connectivity of these joints and fractures decrease with depth, the unit is partially saturation with water levels fluctuating during wet and winter periods. There is a risk of water loss if a borehole is drilled deeper than intended, and advice should be sought if insufficient water is encountered. This hydrogeological unit shows potential for sustaining a small groundwater abstraction, with water likely to be drawn from the first 50 metres due to fewer and poorly connected water-bearing layers at greater depths receiving minimal recharge.

Hydrogeological Unit(s): Weald Clay Formation (>50m deep)
Hydrogeological Description: Unproductive
RWL: 10 to15 maOD
T range: 1.5 to 5 m^2/day
Comments:
The Weald Clay Formation (greater than 50 metres depth) has an estimated water level <10 above ordnance datum. Groundwater within this Formation is primarily found in joints and fractures within the rocks, with limited amounts in pore spaces. The density and connectivity of these joints and fractures decrease with depth. This unit remains consistently saturated under natural conditions, but drilling boreholes deeper than designed may lead to water loss as deeper water levels often have a lower piezometric head. Seeking advice before drilling deeper is recommended if insufficient water is encountered. The deeper Weald Clay Formation contains minimal water, making it unsuitable for sustaining groundwater abstraction. Completing a sump in a new borehole within this horizon may help maximise yields from shallower horizons. Deeper layers of the Weald Clay Formation contain sandstone and limestone but lack significant jointing and fractures and receive no direct rainfall recharge. Water in these layers represents a finite resource, with some layers being less saturated, leading to potential water loss from shallower ground into deeper layers if boreholes are drilled too deep.

This Assessment recommends targeting the Weald Clay Formation if a new groundwater abstraction is developed at this site as this horizon represents the most favourable conditions present. Based on water level and abstraction records from local boreholes passing through comparable ground; this

Assessment estimates a Transmissivity (T) range in the local area of 1.5 to 5 m^2/day.

Using a conservative T value, a 10 metre drawdown in water levels below a rest water level of 10 to 15 maOD; a yield of between 0.4 and 1.3 cubic metres per hour should be sustainable. The following table summarises the above values and the predicted yield:

Rest Water Level	8 to 13 mbgl	Or	10 to 15 maOD
Drawdown in water levels (m)	10		
Transmissivity Range (m^2/day)	1.5	To	5
Potential yield range (m^3/hour)	0.4	To	1.3
Drill depth range (m):	65	To	75

Table 4: Hydrogeological Properties

6 Water Quality

The quality of groundwater present beneath the site cannot be accurately predicted before a borehole is drilled and tested. Sampling and analysis of a water sample from a local borehole drawing from the same geological horizon could provide a good indication of the likely quality of water that may be drawn from a new borehole.

BAHS sample, and test, water quality from boreholes and wells across the United Kingdom and have built up an extensive database of results. Test results from the closest comparable boreholes, wells and springs to the site assessed are provided in the table below. These results can only be used as an indication of the possible quality of water present beneath the site. UK values are the Drinking Water Standards defined by relevant regulations and standards.

Parameters	Concentrations Measured Locally					UK Limit	Unit	Over Limit
	Min		Max	Average	Median			
Alkalinity	119	to	297	214	225	-	mg/l	
Aluminium		<20		-	-	200	µg/l	
Calcium	8	to	73	30	8	-	mg/l	
Chloride	56	to	111	86	81	250	mg/l	
Chromium		<30		-	-	50	µg/l	
Copper		<100		-	-	2000	µg/l	
Cyanide		<10		-	-	50	µg/l	
Fluoride		<450		-	-	1500	ug/l	
Total Iron (FeII+FeIII)	110	to	2400	987	450	200	µg/l	*
Lead		<1		-	-	10	µg/l	
Magnesium	3	to	44	17	5	-	mg/l	
Manganese	14	to	400	153	44	50	µg/l	*
Nitrate		<5		-	-	50	mg/l	
Nitrite	15	to	78	37	18	500	µg/l	
Phosphate		<0.05		-	-	-	mg/l	
Potassium	2	to	7	4	2	-	mg/l	
Sodium	160	to	209	193	209	200	mg/l	*
Sulphate		<150		-	-	250	mg/l	
Sulphide		<0.1		-	-	-	mg/l	
Zinc		<0.2		-	-	-	mg/l	
Electrical Conductivity	635	to	635	635	635	2500	µS/cm	
Hardness, Total, as CaCO3	20	to	183	127	179	-	mg/l	
pH	7.7	to	8.4	8.1	8.1	6.5-9.5	pH units	
Total Dissolved Solids	317	to	742	466	414	-	mg/l	

Table 5: Indicative water quality

The above provide an indication of the likely water quality, only once a borehole has been drilled and a representative water sample collected can the final water treatment be designed. Water treatment is likely to be necessary to reduce the concentrations of Iron, Manganese, and Sodium as seen in the water samples collected from boreholes, wells, and springs originating from the same geological horizon, as these parameters have been measured locally to be close to or above drinking water limits. BAHS recommend discussing water treatment needs with the drilling contractor/water treatment specialist once the hole has been drilled and the analysis has been completed.

B. A. Hydro Solutions Ltd recommends for potable supplies, that as a minimum a particle filter and ultraviolet light treatment system is installed to deal with microbiological risks.

7 Water Neutrality

7.1 Background & Definition

There are documented concerns that a number of conservation areas are at risk of deteriorating as a result of changes to the hydrogeological and hydrological environment. There is reason to believe the abstraction of water by the local water undertaker is having an adverse effect on the conservation areas. At present it cannot be demonstrated beyond doubt that the existing abstractions are having an effect, consequently Natural England advise that developments within this effected zone must not add to this impact.

Natural England conclude there can be no adverse effect on the integrity of;

- Arun Valley Special Area Conservation (SAC)
- Arun Valley Special Protection Area (SPA)
- Arun Valley Ramsar Site.

For a new development to not have an adverse effect it must be water neutral [quality and quantity]. The definition of water neutrality is the use of water in the supply area before the development is the same or lower after the development is in place (*Natural England's Position Statement for Applications within the Sussex North Water Supply Zone, September 2021 – Interim Approach*).

7.2 The Sussex North Water Resource Zone

The area of primary concern to Natural England is an area known as the Sussex North Water Resource Zone. The following figure illustrates the zone:

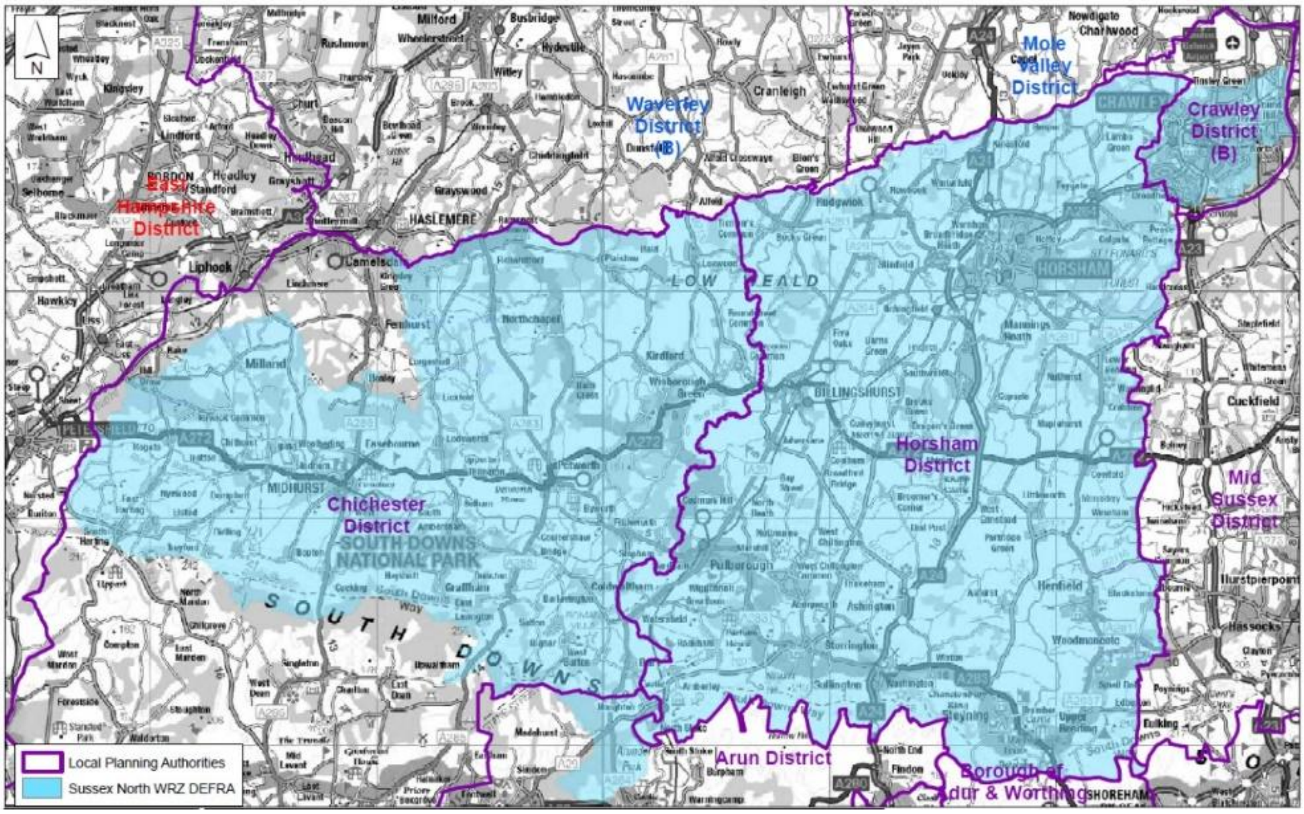

Figure 3: Sussex North Water Resource Zone

7.3 Source(s) of Water

In order for the abstraction of groundwater not to affect the water balance within the Sussex North Water Resource Zone (Zone) the water abstracted must not have otherwise ended up within the Zone being protected. In this part of the Assessment BAHS considers the groundwater body that it is drawn from and whether it is in hydraulic continuity with surface water or groundwater within the Zone.

This section also considers whether the abstraction of groundwater from the source horizon would adversely or positively affect the quality of groundwater present, and whether there may have any effect on the protected Zone.

The Assessment has completed a review of the hydrogeological setting of this site in order to identify all surface water and groundwater links between the site and the three sites identified by Natural England. The following considers the groundwater abstraction in terms of direct potential impact of watercourses the conservation sites are dependent on, and indirect impact by way of reduced groundwater baseflow to watercourses.

The proposed abstraction would be taken from the Weald Clay Formation, a predominantly mudstone unit, containing thin limestone, sandstone and ironstone bands. The borehole design specifies that this shallow ground would be cased out of a new borehole to avoid it indirectly drawing water from surface water features and to prevent the ingress of poor-quality shallow groundwater and surface waters.

Deeper sandstone, limestone and ironstone bands within the Weald Clay Formation have become jointed and fractured, allowing the movement and accumulation of water in thin layers. These thin beds regionally dip towards the south, groundwater flow within these layers is very slow moving or stationary, flow is in the same direction as the strata dip and moving further below ground level and increasingly becoming more and more isolated from the surface water regime being protected by the Water Neutrality Zone.

Groundwater abstracted from these layers would therefore be reducing groundwater movement towards the south, and from beneath, surface water catchments covered by the Adur. Casing out the uppermost horizons will prevent any link and impact on surface water.

There is no identifiable pathway for an impact from the abstraction on the River Arun catchment, which the Neutrality Zone was set up to protect. The property's domestic users currently use mains water, and as they are within the Sussex North Water Supply Zone, this would be coming from public water supply abstractions affecting the River Arun. Supplying the user(s) from a borehole will decrease the impact on the River Arun and contribute to meeting the objectives of the Neutrality Zone.

7.4 Groundwater Recharge

Natural England will consider developments in terms of whether it is/might have, an effect on the recharge to groundwater and groundwater fed environments. For example, might the borehole block pathways for groundwater recharge, change groundwater flow patterns, runoff and infiltration rates.

This section of the Assessment considers whether the borehole would change groundwater recharge potentials across the site and whether use of soakaways and associated drainage systems could help to increase the water balance contribution. Finally, the effect of any changes to natural groundwater recharge and any induced recharge is considered in terms of water quality.

7.4.1 Natural Groundwater Recharge

The abstraction draws from water bearing layers within the Weald Clay Formation which are recharged naturally where they outcrop to the north. Due to the very low transmissivity of the permeable layers, recharge to these beds is very slow and small, hence the relatively low yield from the abstraction borehole. While the yield would be low it would be sufficient and sources from the Weald are found to be sustainable over the long term once they have reached an equilibrium.

When considered in terms of the recharge over a line outcrop, the recharge rates would be very low. Recharge would also be primarily in winter when the soil moisture levels are highest allowing surplus rainfall to penetrate deeper into/through the soil into the deeper solid geology.

The low transmissivity of the ground, mainly winter recharge and slow recharge rate means the new abstraction effectively can only abstract what it receives and cannot draw or induce a more rapid movement of groundwater. The influence of the abstraction would therefore not be seen at ground level and could not change the rate of groundwater recharge.

7.4.2 Induced Recharge

As discussed in Section 7.4.1, a new groundwater abstraction can only take groundwater naturally replacing that abstracted but couldn't 'suck' through any additional water. This means the abstraction couldn't induce an artificially high(er) rate of groundwater recharge. Consequently, as the rate of recharge would not be affected by the abstraction, there would be no change to the volumes of rainfall entering/recharging the ground.

Given the thickness of clay overlying the deeper limestone, sandstone and ironstone bands that the abstraction would draw from, and the limited permeability and extent of these horizons, it is extremely unlikely that any recharge from the River Adur or tributaries would be induced. Even if this was to occur, it would be an immeasurably small impact on a river system with artificially raised flows. There is effectively no possibility of this abstraction inducing recharge.

7.4.3 Water Quality Impact

Again, as the groundwater abstraction cannot affect water levels at ground level, or the rate of groundwater recharge, the abstraction has no effect on surface waters or their quality.

The small amounts of groundwater abstracted cannot influence the quality of groundwater present as the rate of groundwater movement is determined by the ground's low transmissivity and not the rate of abstraction. The speed of movement would not be changed by the abstraction and thus the residence time and chemistry of groundwater would remain the same.

As already documented, there is no link between groundwater in the Weald Clay Formation and surface water features, there would be no change in surface water quality as a result of abstraction, even if it did affect the quality of groundwater, which it is not expected to do.

7.5 Water Neutrality Conclusion

The abstraction draws from the Weald Clay Formation and has no direct or indirect link or influence on groundwater of surface water that sustains the River Arun catchment, the reason for the Neutrality Zone being designated. By replacing mains water use, the abstraction is likely to have a small positive effect on the water balance within the River Arun catchment. This abstraction is therefore a water neutral abstraction.

8 Regulatory Considerations

8.1 Licensing

In England the Environment Agency (EA), and Natural Resources Wales (NRW) in Wales, have assessed the available surface water and groundwater resources within each river and groundwater management unit (catchments). The status of each unit or catchment is documented in a corresponding Catchment Abstraction Management Strategy (CAMS). Some of the units have been assessed as having water available, which means that the EA or NRW will consider an application for a licence to abstract surface or groundwater, on a case-by-case basis, dependent on the effects of the new abstraction on other existing abstractors and the environment, in the vicinity.

Other units may be deemed as either over abstracted or over licensed, and there is an over-arching stance in these areas that applications for consumptive groundwater abstraction licences would be refused under these CAMS policies. There are, however, some circumstances where licences may be granted for abstraction at certain times of the year, dependent on hydrological conditions, and possible restrictions imposed on the licences. Applications for licences for open loop ground source heating systems may be considered in all surface water and groundwater units providing the water will be returned to the source and there would be no detrimental effects arising from the proposal.

There is a different system in Scotland operated by the Scottish Environment Protection Agency (SEPA). The following forms a guide taken directly from SEPA publications, with interpretation by B. A. Hydro Solutions Ltd. Boreholes and wells come under the Controlled Activity Regulations (CAR) and their further amendments. It is up to the client or their approved representatives to seek authorisation from SEPA and must prove that any abstraction is sustainable and is not detrimental to the local environment.

Boreholes abstracting less than 10 cubic metres per day will fall under the General Binding Rules and are considered low risk to the environment and do not require registration.

A borehole drawing between 10 and 50 cubic metres per day requires registration, which will require an application to SEPA and incur a fee. A borehole abstracting between 50 and 2000 metres cubed per day would require a simple licence and an abstraction of over 2000 metres cubed per day would require a complex licence. A licence depends on the identification of a responsible person, who must ensure compliance with the conditions of the licence. An application charge will apply, and the activity may also be subject to an annual subsistence charge.

As this Assessment is for an abstraction not exceeding 20 cubic metres a day, the relevant CAMS and resource status for this site has not been determined (10 cubic metres a day in Scotland). An abstraction of up to 20 m^3/day in England and Wales does not require a licence, the limit being 10 m^3/day in Scotland; this allows a cumulative abstraction up to the relevant volume per day from any combination of springs, surface water, boreholes, well, etc., per relevant property deed.

8.2 Permitting

The EA are moving most regulated activities to a permit-based system which will include abstraction licenses. At present permits are needed for certain activities in close proximity to watercourses and/or where there is a release to the environment. This can include soakaways, direct and indirect discharges to groundwater, open loop ground source heating/cooling systems and drainage activities. It may be possible to avoid a formal permit by ensuring compliance with general binding rules, please refer to the EA, NRW or SEPA websites.

Ground source heating and cooling systems shall be covered by a permitting system with exemptions where compliance with general binding rules can be achieved. At the time of reporting the general binding rules had not been confirmed, BAHS recommends seeking clarification prior to commencing projects that may be affected.

8.3 Source Protection Zone(s)

Source Protection Zones (SPZs) indicate the presence of sensitive licensed groundwater abstractions from the underlying aquifer(s), often those used for public/private potable supply. The EA and NRW use these zones in conjunction with their Groundwater Protection Policy (GP3) to set up pollution prevention measures in areas which are at high risk, and to monitor the activities of potential polluters nearby that may result in contamination of these sources.

Is site within a SPZ:	No
SPZ number:	N/A

Table 6: Source Protection Zones

Based on the SPZ status beneath the site, this Assessment provides the following guidance:

Although this site is not within a Source Protection Zone, a new borehole should be correctly grouted, headworks sealed and any activities that could pose a risk of contamination must be excluded from around the borehole. For example no soakaways, chemical stores, heating oil storage, septic tanks, etc., within 50 metres of the borehole, and no livestock kept within 20 metres of the borehole.

8.4 Mining Remediation Authority Reporting & Permitting

Where a site is underlain by coal bearing strata and strata termed Coal Measures, a Coal Authority Report is recommended to determine whether there are any known mine workings or shafts on or beneath the property. This report will also inform whether a permit to drill is needed to complete the planned drilling work.

This site is not within a Coal Mining Reporting Area. There is therefore no reason to contact the Mining Remediation Authority (MRA), formerly known as the Coal Authority (CA) and a permit to drill from the MRA is not needed.

8.5 Bylaws

There are some local bylaws which prohibit or limit drilling within certain areas. This Assessment cannot provide a definitive list of bylaws, if any may exist that could affect activities on the site, the LA should be consulted in advance of drilling works.

BAHS are not aware of any bylaws that apply to groundwater abstractions/drilling in this area. When consulting with local drilling contractors BAHS recommend raising this with them and/or checking with your Local Authority or planning department.

8.6 Private Water Supply Regulations

A private water supply feeding one household alone (with no associated commercial activities) does not need to be registered with the Local Authority's Environmental Health Department. Nonetheless it is still recommended to register a borehole so that Environmental Health may consider the supply when they are consulted/involved with other activities, planning applications, development, pollution incidents, etc., in the vicinity.

The Local Authority are responsible for administering and enforcing the Private Water Supplies (England) Regulations 2016, Private Water Supplies (England)(Amendment) Regulations 2018 and The Private Water Supplies (Wales) Regulations 2017. It is normally the Environmental Health Department and their officers who undertake the inspections and enforcement works.

The Local Authority are responsible for completing a risk assessment on the private water supply once every 5 years to identify any defects, issues in the immediate vicinity or risks posed from further away that may compromise the quality of water being supplied. Based on the risk assessment the Local Authority will define a list of water quality parameters and the frequency they must be tested to confirm parameters are present at concentrations below the UK Drinking Water Limits.

If there are defects or improvement works the Local Authority deem to be necessary, they will work with the water undertaker to agree a plan to resolve/upgrade/make corrections within an appropriate timeframe. If the works are not completed the Local Authority can issue enforcement notices and/or prevent the water supply being used.

8.7 Borehole Registration

There is a requirement under the Water Resources Act 1991 (as amended by the Water Act 2003) that boreholes are registered with the British Geological Survey and the Environment Agency. Please find a registration form at the end of this report for use once your borehole has been completed, alternatively registering the borehole(s) can be delegated to your drilling contractor.

8.8 Site Specific Regulations

There are documented concerns that a number of conservation areas are at risk of deteriorating as a result of changes to the hydrogeological and hydrological environment. There is reason to believe the abstraction of water by the local water undertaker is having an adverse effect on the conservation areas. At present it cannot be demonstrated beyond doubt that the existing abstractions are having an effect, consequently Natural England advise that developments within this affected zone must not add to this impact.

For a new development to not have an adverse effect it must be water neutral [quality and quantity]. The definition of water neutrality is the use of water in the supply area before the development is the same or lower after the development is in place (Natural England's Position Statement for Applications within the Sussex North Water Supply Zone, September 2021 – Interim Approach).

9 Geological & Drilling Hazards

The following table summarises the primary geological and drilling hazards this Assessment has identified in the research and production of this document. While every effort has been made to capture all possible risks, drilling boreholes is always challenging and thus it is impossible to foresee and avoid all risks. There can be no guarantee that drilling will be successful, although preparation and careful design should reduce the risk significantly and/or allow an informed decision to drill. See notes in Additional Information 1 at the end of the report.

Geological Unit: / Drilling Issues:	Shallow Soil & Weathered Weald Clay Formation	Weald Clay Formation (<50m)	Weald Clay Formation (>50m)
Risk of needing shallow temporary casing	M	L	L
Risk of needing deep(er) temporary casing	L	L	L
Risk of unstable ground too deep to case	L	L	L
Risk of running sand present	L	L	L
Likelihood of artesian groundwater conditions	L	L	L
Likelihood of swelling clays being present	H	H	M
Risk of near vertical joints and fractures	L	L	L
Likelihood of groundwater presence and flow beneath the site	L	M	L
Risk of encountering cavities, voids, caves, etc.	L	L	L
Risk of solution features being present or developing	L	L	L
Likelihood of encountering hard layers/bands which may slow drilling	L	M	M
Risk of subsidence due to drilling	L	L	L
Likelihood of losing flush during drilling	M	M	L
Risk of encountering natural gas (poisonous, explosive, compressed, etc.): Assessed due to the organic content of the Weald	L	M	L
Risk of the ground being affected by landfills (and associated leachate & gases)	L	L	N/A
Likelihood the site rests on strata that may have been mined	L	L	L
Risk of contaminated land being present	L	L	N/A
Risk of encountering buried structures, tunnels or other infrastructure	L	L	N/A
Possibility of unexploded ordnance (this is not a UXO risk assessment)	L	L	N/A

High	Medium to High Likelihood	Medium	Low to Medium Likelihood	Low	Low Likelihood

Table 7: Geological & Drilling Hazards

10 Assessment Summary

B. A. Hydro Solutions Ltd. has been commissioned to complete a Hydrogeological Assessment to investigate the potential of developing a new groundwater abstraction for a private water supply. This study has collected and assessed all available information at the time of production. The prospect of successfully drilling a borehole to abstract the required volume of groundwater to support this proposal is based on a hydrogeological interpretation of the geology, and the conditions anticipated being present.

Please refer to:
- Section 3 for geological & structural summary,
- Section 4 for discussion on the lithology beneath the site,
- Section 5 for discussion on the hydrological and hydrogeological setting,
- Section 6 for discussion on the anticipated water quality,
- Section 7 for relevant regulatory information, and
- Section 8 for geological and drilling hazards.

The findings from this study and recommended design for a new abstraction borehole at the property are listed below:

Strata	Thickness (m)	Max Depth (m)
Weald Clay Formation	>100	>100
Target horizon for borehole:	Weald Clay Formation	
Shallowest anticipated drill depth:	65	metres
Maximum anticipated drill depth:	75	metres
Recommended primary casing depth:	5	metres
Recommended screen depth:	To Base	metres
Gravel or Formation pack:	Graded Gravel Pack	
Anticipated rest water level:	10 to 15	maOD
Anticipated transmissivity range:	1.5 to 5	m^2/day
Anticipated yield range:	0.4 to 1.3	m^3 per hour
Water Quality Summary:	Fair to Poor	
Problematic water quality parameters:	Iron, Manganese and Sodium	
Direction of Groundwater Flow:	South	

Table 8: Summary table

A borehole drilled at this location should be plain cased to around 5 metres below ground level and grouted to provide a reliable sanitary seal. The hole should then be screened to its base to pick up all inflow horizons with depth. Seasonally water levels are expected to fluctuate as springs effectively drain the aquifer in summer, dry and drought periods. The design provided in this

Assessment is an 'outline', see Figure 4, as the final design should evolve as the hole is drilled to reflect minor changes in the geology as proven by drilling.

Flooding from groundwater is extremely unlikely in this area as the hydrogeological setting means there is either no groundwater shallow enough to cause problems or the site rests on impermeable ground.

The overall flood risk for this site is assessed as being HIGH; boreholes should be completed with headworks above ground level, within a structure to protect the borehole from flood waters and any chance of being damaged by flood debris. The power supply should be completed within a waterproof housing and/or elevated above highest anticipated flood water levels. The borehole should be sealed to prevent any ingress of flood water. Any dip points, cable entry points, breather pipes, etc should be sealed into the head plate and it should be possible to seal/isolate these in the event of a flood. Any breather pipe allowing air into the borehole must extend to a sufficient height to always be above flood water. The breather pipe should have a filter and a mechanism to allow it to be isolated.

Although this site is not within a Source Protection Zone, a new borehole should be correctly grouted, headworks sealed and any activities that could pose a risk of contamination must be excluded from around the borehole. For example no soakaways, chemical stores, heating oil storage, septic tanks, etc., within 50 metres of the borehole, and no livestock kept within 20 metres of the borehole.

A private water supply feeding one household alone (with no associated commercial activities) does not need to be registered with the Local Authority's Environmental Health Department. Nonetheless it is still recommended to register a borehole so that Environmental Health may consider the supply when they are consulted/involved with other activities, planning applications, development, pollution incidents, etc., in the vicinity.

BAHS are not aware of any bylaws that apply to groundwater abstractions/drilling in this area. When consulting with local drilling contractors BAHS recommend raising this with them and/or checking with your Local Authority or planning department.

This site is not within a Coal Mining Reporting Area. There is therefore no reason to contact the Mining Remediation Authority (MRA), formerly known as the Coal Authority (CA) and a permit to drill from the MRA is not needed.

There are documented concerns that a number of conservation areas are at risk of deteriorating as a result of changes to the hydrogeological and hydrological environment. There is reason to believe the abstraction of water by the local water undertaker is having an adverse effect on the conservation areas. At present it cannot be demonstrated beyond doubt that the existing abstractions are having an effect, consequently Natural England advise that developments within this affected zone must not add to this impact.

For a new development to not have an adverse effect it must be water neutral [quality and quantity]. The definition of water neutrality is the use of water in the supply area before the development is the same or lower after the development is in place (Natural England's Position Statement for Applications within the Sussex North Water Supply Zone, September 2021 – Interim Approach).

The abstraction draws from the Weald Clay Formation and has no direct or indirect link or influence on groundwater of surface water that sustains the River Arun catchment, the reason for the Neutrality Zone being designated. By replacing mains water use, the abstraction is likely to have a small positive effect on the water balance within the River Arun catchment. This abstraction is therefore a water neutral abstraction.

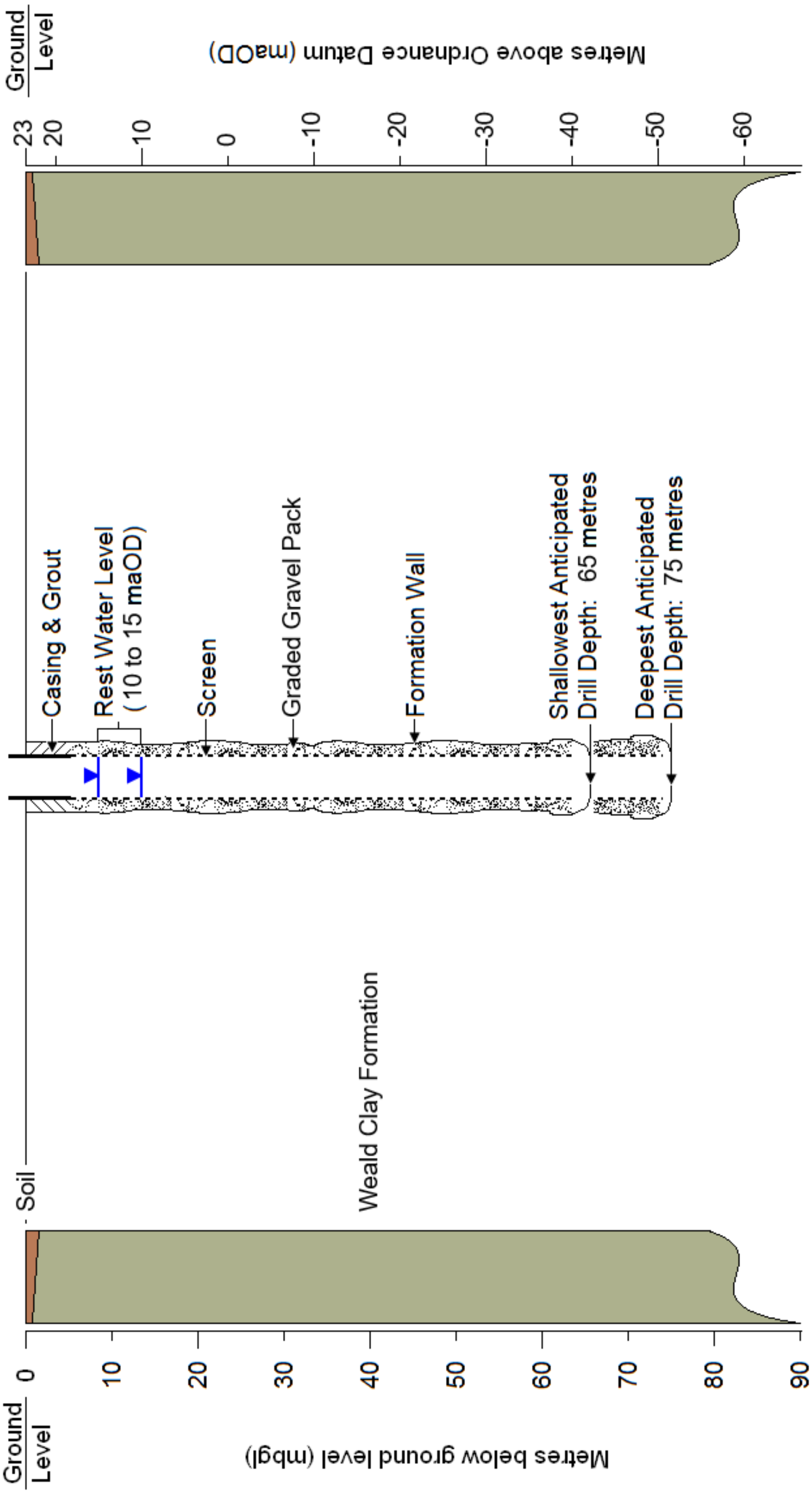

Figure 4: Outline borehole design

Disclaimer – Rose Cottage, Bakers Lane, Shipley, Horsham, West Sussex, RH13 8GF

The information and analyses provided in this report are based on data and information made available to B. A. Hydro Solutions Ltd. and represent the professional opinions and interpretations of B. A. Hydro Solutions Ltd. This report is prepared with the utmost care based on the current state of knowledge and technology and the data provided by the client along with data specifically collected for this assessment.

B. A. Hydro Solutions Ltd. makes no warranties, expressed or implied, regarding the accuracy, completeness, or utility of the information contained in this report. While we strive to provide accurate and up-to-date information, the conditions of the subsurface environment are inherently variable and complex. As such, B. A. Hydro Solutions Ltd. cannot guarantee that the conditions described in this report will be representative of all areas of the site or that they will remain unchanged over time.

Clients considering the implementation of projects based on findings within this report should be aware that natural conditions, including but not limited to groundwater presence, quantity, and quality, as well as thermogeological and soakaway performance, may not meet expectations. These conditions can vary due to factors beyond our control, including seasonal variations and other external influences not accounted for in this study.

Decisions and actions taken based on this report are the sole responsibility of the client. B. A. Hydro Solutions Ltd. shall not be liable for any direct, indirect, incidental, or consequential damages resulting from the use of this information. Clients are encouraged to engage in further consultation and to conduct additional studies where necessary. This disclaimer applies to this report and any other related documentation provided by B. A. Hydro Solutions Ltd. Use of this report constitutes acceptance of these terms.

AUGUST 2025

Guide to Drilling & Managing Your Borehole

Complete a Hydrogeological Assessment - HGA (feasibility study), a borehole specification may be sought at the same time

Engage drilling contractor, confirm drill position is viable in terms of access and space to drill, amend borehole design if the drill position changes

Borehole is drilled; geological boundaries, water levels, etc confirmed by drilling may be checked with the author of the HGA in case the design needs to be amended

Install borehole screen, liner, gravel pack, grout, etc, as designed (updated as needed)

Develop borehole by clearance pumping, airlifting, surging, pressurising, acidizing, etc.

Sample the water for lab testing once pumped long enough to get a representative sample (consistently clear, can take from hours up to days to achieve)

Design, instal and commission water treatment as needed. Register with the Local Authority (LA) for routine testing and risk assessment sign off

Service water treatment and pumping systems in line with the manufacturer's recommended frequency. Complete routine sampling and analysis of the water in line with the LA defined frequency and parameter list, or ask your driller, installer or BAHS for advice.

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Additional Information 1 – Geological and Drilling Hazards Explanatory Notes

The following discusses the primary geological and drilling hazards that could be encountered. While every effort is made to capture all possible risks, drilling boreholes is always challenging and thus it is impossible to foresee and avoid all risks. There can be no guarantee that drilling will be successful, although preparation and careful design should reduce the risk significantly and/or allow an informed decision to drill. This Assessment has identified, in the research and production of this document, the risks that can be anticipated. See the earlier Geological and Drilling Hazards Table.

Temporary casing is essential to stabilize the ground and prevent collapse, thereby allowing the borehole to reach the required depth. Typically, most boreholes necessitate at least a short section of temporary casing. However, as the depth increases, the casing not only becomes heavier but also more challenging to install and subsequently remove. The removal difficulty arises as the surrounding earth may exert a 'gripping' effect on the casing, necessitating drilling rigs with increasingly robust pull-back capabilities. Installation of temporary casing is therefore a time-consuming process.

The availability of appropriate casing is another consideration; not all contractors possess the necessary casing on hand, and even when they do, the available lengths and diameters may not meet specific project requirements. Drillers must be prepared in advance to ensure preparedness, although unforeseen circumstances may still necessitate additional casing that could not be initially anticipated.

Running sand, a phenomenon where sand and water cascade into a borehole, can occur naturally or be induced by drilling activities. Running sand does not occur in all geologies, it is more common where the ground is formed of sands and weakly cemented sandstones. This issue typically arises due to a flow of water or a disparity in hydrostatic head between the interior and exterior of the borehole, leading to the accumulation of sand within the hole. The situation is analogous to attempting to dig a deep hole on a sandy beach, where the sand and water continually collapse into the hole.

To manage this challenge, methods such as casing or the use of specific drilling fluids are employed. The latter involves adjusting the density and viscosity of the fluids to support the sand-rich walls of the borehole, thereby preventing the ingress and collapse of sand and water. Additionally, a horizon that appears stable can collapse due to running sand if the hydrostatic head inside the borehole drops below that of the surrounding aquifer. Consequently, running sand issues may not be immediately apparent and can emerge as a significant problem during the drilling process. Furthermore, if the sand horizon is not adequately sealed during drilling, running sand can continue to plague the borehole, resulting in the hole filling, sandy ingress to the pump, turbidity, wear on the pump, etc.

Artesian groundwater conditions occur when water within a discrete horizon is under pressure, causing it to rise up a borehole and settle above the ground level from which drilling commences. For groundwater to be classified as artesian, it must be confined beneath a layer of lower permeability or within discrete fracture networks. The recharge area, where rainfall replenishes the groundwater, must be at a higher elevation than the point of drilling. Artesian conditions vary in intensity: weak conditions are characterised by a water level less than one metre above ground and/or a slow flow from the borehole; mild conditions have a water level between one and ten metres above ground and/or a low to moderate flow; strong conditions feature a water level more than ten metres above ground and/or a strong flow.

Managing artesian flow requires designing boreholes with sufficient steel casing in the upper sections to withstand the pressure, capped with a sealing plate. Uncontrolled artesian boreholes, often termed 'wild,' pose significant risks as they waste water, deplete source aquifers, and can harm the surrounding environment. Consequently, allowing an artesian borehole to flow uncontrolled is illegal due to its adverse environmental impacts and resource depletion.

Swelling clays, which are geological layers composed of clay-rich soil that remains plastic due to incomplete hydration, pose significant challenges during drilling operations. As these clays absorb water introduced into the environment through drilling, they expand, encroaching into the borehole space. This expansion is further exacerbated by the unloading of pressure during drilling and the creation of a void, leading to a reduction in the diameter of the drilled hole.

In some instances, this can cause the borehole to contract to the extent that casings and liners may collapse. To manage this issue, it may be necessary to ream the holes to accommodate the installation of casings, ground loops, and other structures. Additionally, swelling clays can cause temporary casings to become stuck, complicating drilling operations. While it is challenging to completely prevent the effects of swelling clays, mitigative strategies such as drilling with a larger initial diameter can be employed to account for potential shrinkage.

Nearly vertical joints and fractures can lead to deviations in drilling trajectories from the intended vertical path. Larger fractures may also lead to partial or complete loss of drilling fluids, which can halt the progression of the borehole. Highly fractured zones are prone to creating unstable borehole walls, potentially leading to collapses or the falling of large blocks of ground into the borehole. Additionally, subsurface voids, caves, and historical workings complicate drilling operations.

These features not only pose stability issues but also complicate the lining and finishing of boreholes. They disrupt the flushing process necessary for clearing drill cuttings, as these cuttings tend to accumulate in the voids rather than returning to the surface. Although sometimes predictable, voids are often encountered unexpectedly, necessitating immediate operational adjustments which can have cost implications, including potential redesigns while the drilling rig and crew incur downtime.

Understanding the presence and flow of groundwater is crucial in the planning and design of new boreholes. Groundwater at shallow depths can complicate drilling operations, particularly when using compressed air techniques. Such conditions often lead to the emergence of large volumes of water that necessitate diversion and management strategies to prevent interference with the drilling apparatus and to maintain safe, manageable working conditions.

The presence of groundwater can significantly affect the dynamics of water flush drilling, potentially leading to the unintended intake or loss of water through permeable strata. This interaction necessitates careful management of drilling fluids to maintain the efficiency and safety of the operation. Moreover, when drilling in aquifers, it is vital to consider the potential impacts on the aquifer to prevent any temporary or permanent reduction in yield or degradation of water quality that could affect local water users.

Solution features pose similar challenges to those discussed around voids, caves, and historical workings; and are associated with zones of high groundwater movement, including the occasional presence of underground rivers. These geological structures can form rapidly in geologies where the host rock is weak, soluble, or susceptible to erosion. Historical solution features pose a risk of inducing sinkholes during drilling activities.

The process of drilling or subsequent groundwater abstraction can lead to ground removal, potentially resulting in void collapses, which may occur sometime after the drilling and not necessarily immediately around or below the borehole. Although rare, there are documented instances globally where a direct link to drilling activities has been established, with many more cases where the link is inferred. Solution features often complicate the completion of boreholes as initially planned. However, if encountered below the water table, they can sometimes yield large quantities of water, thus boreholes should not be immediately abandoned. Proper decommissioning of boreholes is crucial if they are to be abandoned, to prevent further geological hazards.

The loss of drilling fluid, commonly referred to as "losing flush," presents significant challenges. This impedes the return of drilling fluids and cuttings to the surface, which can disrupt the drilling process. The inability to efficiently remove cuttings from the borehole can lead to several complications: the drilling pace slows, the drill head may become clogged, and the drill bit is prone to overheating. The cuttings effectively levitate or float within the rising drilling fluid, they can collapse back into the bottom of the hole once the drilling rods are withdrawn or drilling is paused.

This collapse often fills in the previously drilled depth, preventing the hole from reaching its intended depth. Additionally, the stability of the borehole can be compromised by cuttings that adhere to the hole's walls or lodge within wall pockets. These materials can subsequently collapse into the borehole during drilling or while installing, leading to further difficulties. Such problems require careful management of drilling fluids and strategies to mitigate the risks.

During drilling operations, there is sometimes a risk of encountering natural gas, particularly in areas with historical mining activities, such as coal mining regions. Natural gas accumulations can also originate from organic-rich layers of clay, silt, and mud, or from hydrocarbon-rich strata. The release ore mobilisation of gases can be triggered by drilling, chemical processes, increased temperatures or decreased pressure. Oxidation of organic matter in the subsurface can generate gases, along with other less common sources of gases of various types.

Gases pose significant hazards due to their potentially poisonous, explosive, or suffocating nature, and the pressure at which they are found can lead to dangerous blowouts. The hazards are posed not only to the drilling crew but also to nearby humans, animals, and the environment, during and after completion of works.

In regions known for such geological conditions, it is imperative to implement safety measures including gas monitoring and venting, and to avoid the use of compressed air in drilling operations to prevent the migration of gases to adjacent areas. In coal mining areas, obtaining a drilling permit is legally required, which helps manage risks by ensuring appropriate drilling methods are employed. Even in areas where permits are not required, adopting a similar risk assessment approach and developing a suitable drilling methodology is strongly advised where there is any possible risk. Despite thorough risk management, unforeseen gas encounters still occur, necessitating immediate cessation of drilling activities and professional assessment and management of the situation.

Drilling a borehole into or near a landfill site presents significant risks primarily due to the potential release of landfill gas and leachate. Landfill gas, predominantly composed of methane and carbon dioxide, is generated through the anaerobic decomposition of organic waste. If disturbed by drilling, these gases can escape into the atmosphere or accumulate in enclosed spaces, posing serious fire, explosion, and health hazards.

Leachate, a contaminated liquid that percolates through/from waste material, can also be mobilised by drilling activities. This leachate often contains a variety of harmful chemicals and biological agents, which, if released, can contaminate local soil and water bodies, leading to significant environmental and health risks. Therefore, careful risk assessment, monitoring, and management strategies must be implemented when drilling near or into landfill sites to mitigate these hazards effectively, especially historic landfills which may not have been engineer or managed appropriately.

Drilling a borehole in areas that have been previously mined for minerals, salt, coal, or other resources presents significant hazards. Such regions often exhibit increased subsurface instability due to voids and weakened structural integrity resulting from the extraction processes. This can lead to a higher risk of subsidence, where the ground above the voids collapses, potentially causing damage to infrastructure and posing safety risks.

The presence of abandoned mine workings can complicate drilling operations, as encountering unexpected voids or old mine infrastructure can lead to equipment failure or loss, drilling delays, and increased costs. Furthermore, these areas may also be associated with the accumulation of hazardous gases or contaminated groundwater, which can pose environmental and health risks during and after drilling activities. Therefore, thorough assessments and the use of appropriate drilling technologies are crucial to mitigate these risks as well as compliance with permit requirements.

Drilling a borehole in potentially contaminated ground poses significant risks, both environmental and health-related. The primary concern is the mobilisation of contaminants, which can occur when the drilling process disturbs the subsurface environment. This disturbance can lead to the spread of contaminants into previously uncontaminated soil layers or groundwater systems, exacerbating the existing pollution and potentially leading to broader environmental degradation.

There are direct health risks to workers involved in the drilling process, as they may be exposed to hazardous substances released during drilling. Such exposure can lead to acute or chronic health issues depending on the nature and concentration of the contaminants. Furthermore, the introduction of drilling equipment into contaminated zones can lead to cross-contamination, where contaminants adhere to the equipment and are transported to other, previously uncontaminated sites. Therefore, careful assessment and management strategies must be implemented before initiating drilling activities in contaminated areas to mitigate these risks.

Drilling boreholes presents several risks, particularly when encountering below-ground abandoned structures, tunnels, and utilities. These encounters can lead to a range of issues and operational challenges. Drilling into unknown or unmapped structures such as foundations, walls, drains, etc can prevent the progression of boreholes necessitating a move in drill positions and/or damage to drill bits and equipment.

Hitting existing utilities, such as gas lines, water pipes, or electrical cables, can result in utility outages, costly damages, and pose serious safety risks including explosions or electrocutions. Such encounters can lead to significant project delays, increased costs, and legal complications if prior surveys and utility surveys are not conducted thoroughly. Therefore, trial pits should be dug prior to drilling and where appropriate utility mapping is recommended before commencement to mitigate these risks.

Drilling in areas where there could be unexploded ordnance (UXO) presents significant risks, including the potential detonation of explosives, which can lead to severe injury or death of personnel and extensive damage to equipment. To mitigate these risks, comprehensive precautions must be implemented where there is a risk of encountering UXO. Prior to drilling, desk studies should be completed leading on to geophysical surveys to detect the presence of UXO.

Surveys typically involve the use of magnetometers or ground-penetrating radar to identify metallic objects or anomalies beneath the surface. Only trained explosive ordnance disposal (EOD) professionals should safely remove or neutralise UXO. Where the risk remains despite desk studies and surveys, holes should be progressed by specialist contractors who can use downhole geophysics to check ahead of the drill bit for possible UXO. All drilling personnel should receive specific training on the risks associated with UXO and the protocols for emergency response.

Additional Information 2 – Licensing Restriction

BAHS Ltd. have been instructed to complete a Hydrogeological Assessment for use in the development of a proposed new groundwater borehole. A borehole for abstraction purposes requires an abstraction licence if quantities exceed 20 m^3/day.

Licences are awarded by the Environment Agency (EA) following a detailed review of the availability of the resource in the specific area. The country is divided into river catchments that are individually assessed to determine the total surface and groundwater resource that can be theoretically abstracted while maintaining sufficient levels or flows to protect or enhance the environment. Resources are then licensed up to the limit deemed sustainable by the Environment Agency.

Additional Information 3 – Hydrogeological Terms

The hydrogeological properties of strata and the ground as a whole is a function of its permeability and the ease at which water is able to move through the various strata. The ground can broadly be divided into three hydrogeological rock types, the aquifers which contain water, aquitards which can contain water but restrict the movement of water and aquicludes which do not contain water and act as a barrier to groundwater movement.

Groundwater moves through the ground via either pore spaces in the rocks, fractures and joints which dissect the strata or sometimes through solution features such as caves. The interconnectivity of the pores, joints, fractures and solutions features determines the amount of water which can accumulate and the ability of the ground to transmit.

The storage potential of the ground is described by its *storativity* [S] which is a dimensionless value ranging from zero up to one. The larger the number the greater the proportion of the saturated ground, in terms of total volume, which can be drained by lowering the water table. If the storativity was one it would be space entirely filled with water and no rock.

When the storativity is very low or zero there is no space in which water can accumulate or none of the water in the ground can be abstracted by lowering the water table. Due to the number of observations needed to quantify the storativity of the ground it is uncommon to be able to derive such values from historical data.

The grounds ability to transmit water is measured by its *transmissivity* [T], the larger the number the easier the water is able to move through the rocks. Theoretically there is no maximum T value, practically it is limited by the aquifer thickness, the volume of water in the aquifer and the capacity of the borehole and pump used to test the ground conditions.

The productivity of boreholes is simplistically measured by its *specific yield* [Sy] which is a measure of the sustainable yield a borehole can deliver per day per metre the water table is lowered. This can easily be derived from measurements recorded during pump tests or reported steady state yield and drawdown values.

Additional Information 4 – Borehole Registration Document WR38

WR38: Borehole record form

Borehole record form

Water Resources Act 1991 (as amended by the Water Act 2003)

A Site details

Borehole drilled for ______

Location ______

NGR (ten digits) ______ Please attach site plan

Ground level (if known) ______ metres Above Ordnance Datum

Drilling company ______

Date drilling commenced ______ (DD/MM/YYYY) Completed ______ (DD/MM/YYYY)

B Construction details

Borehole datum (if not ground level) ______ metres (m). Please tick if this is above ☐ or below ☐ ground level.
(point from which all measurements of depth are taken, for example, flange, edge of chamber)

Borehole drilled diameter ______ mm from ______ to ______ m/depth
______ mm from ______ to ______ m/depth
______ mm from ______ to ______ m/depth
______ mm from ______ to ______ m/depth

Casing material ______ diameter ______ mm from ______ to ______ m/depth
and type (for example, if plain steel, plastic slotted). Please record permanent casing details, not temporary casing.

Casing material ______ diameter ______ mm from ______ to ______ m/depth

Casing material ______ diameter ______ mm from ______ to ______ m/depth

Casing material ______ diameter ______ mm from ______ to ______ m/depth

Grouting details ______

Water struck at 1. ______ m (depth below datum – mbd) 2. ______ m (mbd)
3. ______ m (mbd) 4. ______ m (mbd)

C Test pumping summary (Please supply full details on form WR39)

Test pumping datum ______ m. Please tick if this is above ☐ or below ☐ ground level.
(if different from borehole datum)

Pump suction depth ______ mbd

Water level (start of test) ______ mbd

Water level (end of test) ______ mbd

Type of test (for example, bailer, step, constant rate)

______

Pumping rate ______ m^3/hour ☐ or litres/second ☐. Please tick as appropriate.
for ______ days, ______ hours, ______ mins

Recovery to ______ mbd in ______ days, ______ hours, ______ mins
(from end of pumping)

Date(s) of measurements Pump started ______ (DD/MM/YYYY)
Pump stopped ______ (DD/MM/YYYY)

Please supply chemical analysis if available. If you have included this please tick this box ☐

WR38: Borehole record form

D Strata log

Geological classification (BGS only)	Description of strata	Thickness m	Depth (to base of strata) m
	(continue on separate page if necessary)		
	Other comments (for example, gas encountered, saline water intercepted)		

E Completing this form

How long did it take you to fill in this form?

For Official use only

Date received (DD/MM/YYYY)	File	Consent number	BGS reference number
Accession number	Wellmaster number	SOBI number	NGR
LIC NO	Purpose		EA reference number
Copy number	Entered by		

F The Data Protection Act 1998

The Environment Agency will process the information you provide so that we can:

- deal with your application;
- make sure you keep to the conditions of any consent; and
- process renewals.

The Environment Agency will pass the information provided on this form to the British Geological Survey, in accordance with Section 198 of the Water Resources Act 1991, which states that any person drilling a well or borehole more than fifty feet below the surface, shall notify the British Geological Survey of this and provide them with the information as requested on this form.

We may also process or release the information to:

- offer you documents or services relating to environmental matters;
- consult the public, public organisations and other organisations (for example, the Health and Safety Executive, local authorities, the emergency services, the Department for Environment, Food and Rural Affairs) on environmental issues;
- carry out research and development work on environmental issues;
- prevent anyone from breaking environmental law, investigate cases where environmental law may have been broken, and take any action that is needed;
- assess whether customers are satisfied with our service, and to improve our service; and
- respond to requests for information under the Freedom of Information Act 2000 and the Environmental Information Regulations 2004 (if the Data Protection Act allows).

We may pass the information on to our agents or representatives to do these things for us.

The British Geological Survey will use the information you provide to assist in its geological mapping programme and other research activities.

The British Geological Survey will process, or release, the information to:

- offer you documents or services relating to environmental matters;
- consult the public, public organisations and other organisations (for example, the Health and Safety Executive, local authorities, the emergency services, the Department for Environment, Food and Rural Affairs) on environmental issues;
- carry out research and development work on environmental issues;
- assess whether customers are satisfied with our service, and to improve our service; and
- respond to requests for information under the Freedom of Information Act 2000 and the Environmental Information Regulations 2004 (if the Data Protection Act allows).

We may pass the information on to our agents or representatives to do these things for us.

- We will also publish the information on our website; and
- provide the technical details of the borehole (for example, the depth, geology and water levels) to others. This will not include information about ownership of the borehole.