WOODHOUSE FARM

RETROSPECTIVE HYDROGEOLOGICAL & WATER NEUTRALITY ASSESSMENT

OCTOBER 2024

PROJECT NO. 24250518

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RETROSPECTIVE HYDROGEOLOGICAL & WATER NEUTRALITY ASSESSMENT

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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 Retrospective Hydrogeological and Water Neutrality Assessment of conditions present at the following site following the successful completion of a new groundwater abstraction of up to 20 m^3/day. Information collected, interpreted and analysed within this Assessment documents the hydrogeological conditions present and demonstrates the abstraction is water neutral, thus having no effect on conservation sites within the Sussex Water Neutrality 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:	Woodhouse Farm	
	Wheatsheaf Road	
	Henfield	
Postcode:	BN5 9BA	
Drill position NGR:	TQ 22875 16548	
Elevation adopted:	18	maOD

Table 1: Site details

2 Objectives

This Assessment seeks to fulfil the following objectives:

- Confirm the geological sequence.
- Define the hydrogeological setting.
- Document where groundwater is present.
- Document the yield and seasonality of a new abstraction.
- Document the quality of water present.
- Report the regulatory conditions applicable.
- Document why the abstraction is water neutral.
- Report the borehole design as constructed.

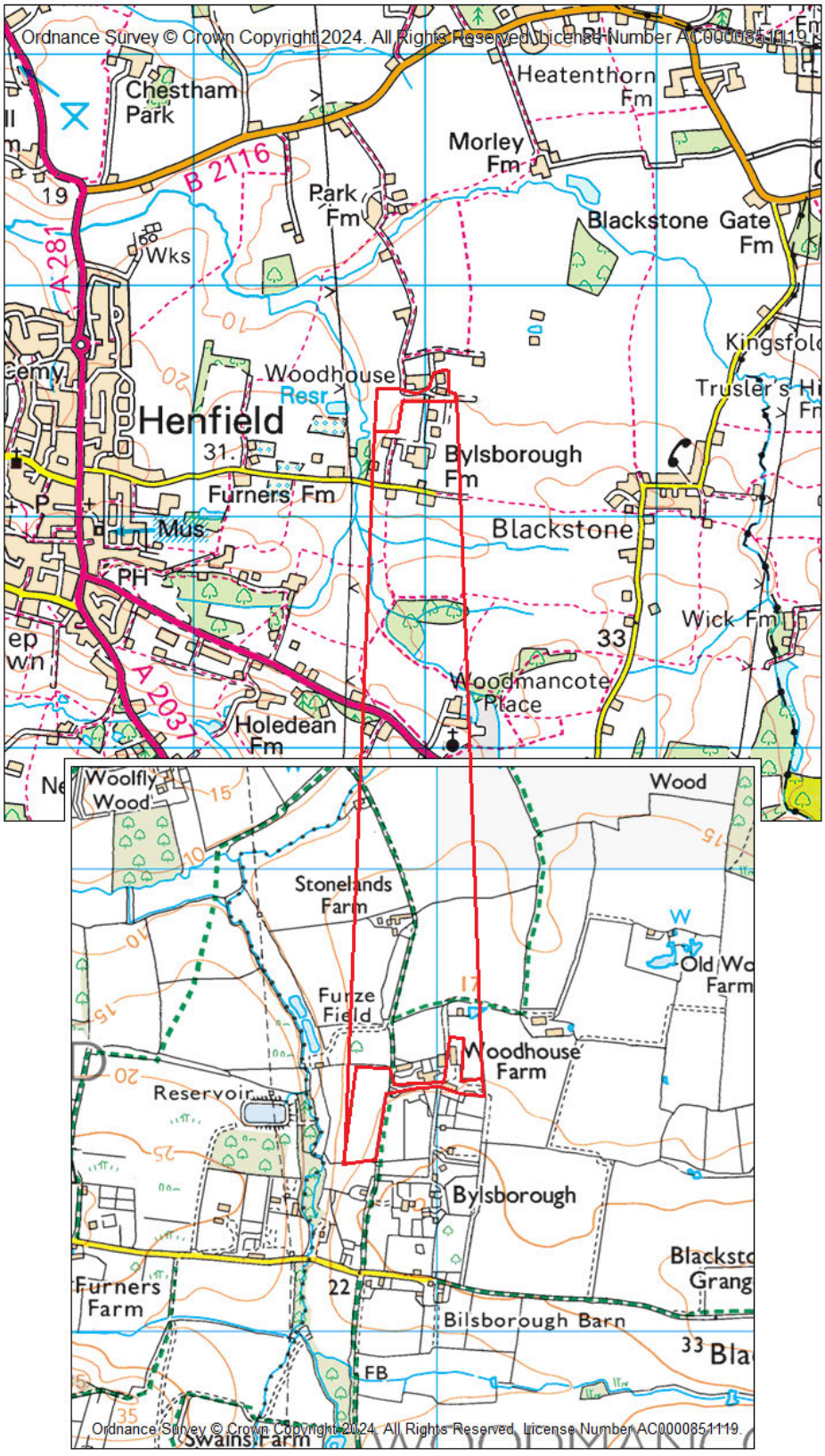

Figure 1: Location Map

3 Geological Setting

3.1 Geology

The following discussion of the geology beneath the site is based on a site-specific literature review, drilling logs from the borehole constructed and historical borehole records that have been obtained for the purpose of characterising the geological unit thickness, nature and depths. As geological units are not laterally continuous, vary in thickness and are not homogeneous, the thickness and depths will differ slightly from location to location.

The geology and thicknesses reported are based on the reported geology at the borehole drill position, see National Grid Reference (NGR) listed in Table 1, from the elevation stated.

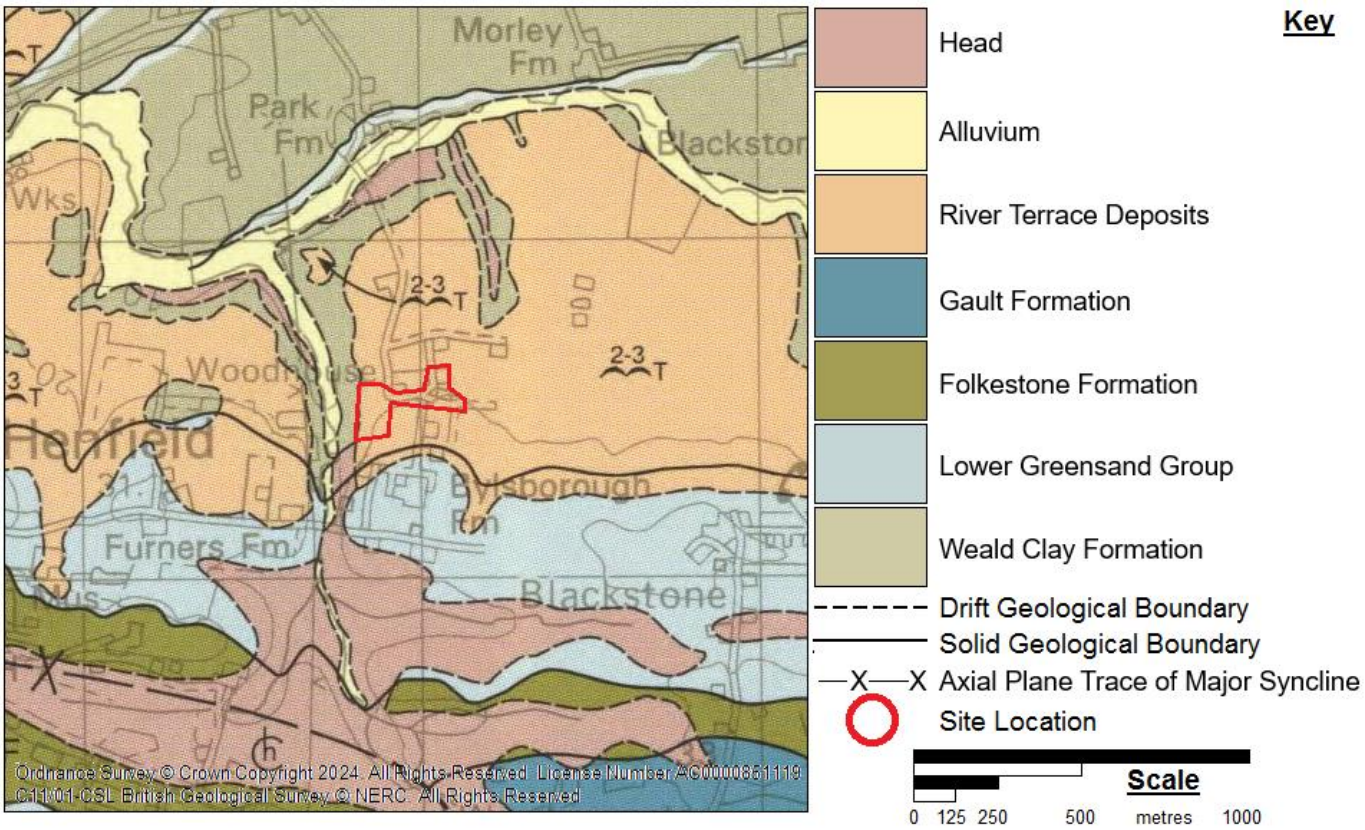

Figure 2: Geological Map

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

Geological Group	Geological Formation	Lithological Nature	Anticipated Thickness (metres)
-	-	Soil and/or Worked Ground and/or Made Ground	<2
-	River Terrace Deposits	Sands and gravels mixed with clays	11 to 13
Lias Group	Weald Clay Formation	Mudstones with limestones, siltstones and ironstones	160 to 210

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.

- Local faulting has resulted in the displacement of ground laterally and/or vertically, nonetheless this is not anticipated to affect the presence or abundance of groundwater beneath the site.
- The strata considered by this Assessment have experienced moderate tectonic deformation since their deposition, they have been folded/tilted and faulted.
- The strata dip at up to 40 degrees to the south to south-east.
- The site sits on the northern limb of the north-west to south-east trending Henfield Syncline

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

Local geological maps show the site to be located on an outcrop of River Terrace Deposits. The deposits are described as silty loams with local occurrences of pebbly sands. The deposits are limited in extent and are 2 to 3 metres in thickness, however this is mixed with the weathered upper surface of the Weald Clay, which combined, extends to 12 to 13 metres below ground level and is reported as one unit in the drillers logs for the borehole completed on site (see Appendix 1).

4.2 Weald Clay Formation

The rock head beneath this site is formed by the Weald Clay Formation which is weathered to a depth of around 10 metres below rock head. Weathering, erosion and exposure has 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

and 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 210 metres in this area although erosion has thinned the sequence present. The walls of the borehole can swell inwards and/or collapse during drilling, especially if the process is prolonged or if there are delays, such as over a weekend. Drilling of the new borehole did not suffer from this due to the drilling method and approach adopted.

This geological unit is the final one considered in this Assessment, as it is the deepest economically viable water-bearing horizon. The borehole did not need to extend deeper as a sufficient yield was proven from a borehole drilled to 71 metres. The drilling log is presented in Appendix 1, this documents the strata encountered, water levels and yield.

5 Hydrology and Hydrogeology

5.1 Hydrology

The new borehole drilled to target the horizon identified in Section 5.2 had no direct or indirect effect on surface water features. During drilling there was only 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 has been 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:	Low Risk
Description of Risk:	Low risk means that this area has a chance of flooding of between 0.1% and 1% 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:	Unlikely (Low)
Description of Risk:	Flooding from reservoirs is unlikely in this area. 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:	Unlikely (Low)
Description of Risk:	Flooding from groundwater is unlikely in this area as the hydrogeological setting means under normal conditions groundwater is not shallow enough to cause problems. Water levels could only rise to problematic levels following prolonged, and extreme wet conditions.

Table 3: Flood Designation

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 ability to sustain a new groundwater abstraction. Each unit is considered as it is reached with depth below the site. The drill depth, rest water level, along with the confirmed yield and necessary drawdown in water levels needed to sustain the yield are set out in Table 5.

Hydrogeological Unit(s): Soil & River Terrace Deposits - seasonally dry
Hydrogeological Description: N/A
RWL: N/A
T range: N/A
Comments:
The hydrogeological characteristics of the Soil & River Terrace Deposits indicate that this unit is predominantly unsaturated or only seasonally wet. The shallow ground conditions are primarily dry, with moisture presence limited to certain seasonal periods. Consequently, these deposits are unable to support any significant scale of groundwater abstraction using modern conventional boreholes.

Hydrogeological Unit(s): Weald Clay Formation - weathered
Hydrogeological Description: N/A
RWL: N/A
T range: N/A
Comments:
The shallow Weald Clay Formation is predominantly dry, or only seasonally wet. This part of the Formation's limited capacity for water retention is due to water penetrating deeper to the permanent water table.

Hydrogeological Unit(s): Weald Clay Formation (deeper)
Hydrogeological Description: Secondary (undifferentiated) Aquifer
RWL: 0 to 2 maOD
T range: 5 to 10 m^2/day
Comments:
The Weald Clay Formation, classified as a Secondary (undifferentiated) Aquifer, has water levels ranging from 0 to 2 metres above ordnance datum. Groundwater within this Formation is predominantly located in pore spaces, with additional presence in the limited joints and fractures that traverse the unit. Notably, both porosity and the extent of jointing and fracturing, diminish with increasing depth. The unit remains fully saturated below 16 to 18 metres below

ground level, there is no risk of water loss when drilling boreholes deeper than initially designed. This Formation has potential for sustaining new, reliable groundwater abstraction as confirmed by the borehole completed.

This Assessment confirms the target horizon for a new borehole would be the Weald Clay Formation, as installed. Based on water level and abstraction records from the newly drilled borehole, along with records from local boreholes passing through comparable ground; this Assessment estimates a Transmissivity (T) range in the local area of 5 to 10 m^2/day.

Using a conservative T value, up to 15 metre drawdown in water levels below a rest water level of 0 to 2 maOD; a yield of between 1.3 and 2.6 cubic metres per hour has been confirmed as sustainable. The following table summarises the above values and the yield:

Rest Water Level	16 to 18 mbgl	Or	0 to 2 maOD
Drawdown in water levels (m)	15		
Transmissivity Range (m^2/day)	5	To	10
Potential yield range (m^3/hour)	1.3	To	2.6
Drill depth (m):	71		

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. On completion of the new borehole and following two rounds of water sampling and analysis actual results are available which have been combined with records from local boreholes drawing from the same geological horizon to understand the quality present.

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. UK values are the Drinking Water Standards defined by relevant regulations and standards.

Parameters	From Borehole			Concentrations Measured Locally				UK Limit	Unit
	Min		Max	Min	Max	Average	Median		
Alkalinity	-	to	-	77	327	228	231	-	mg/l
Aluminium	213	to	6148.9*	45	213	56	20	200	µg/l
Calcium	-	to	-	4	129	53	26	-	mg/l
Chloride	-	to	-	15	263	136	122	250	mg/l
Chromium	-	to	-	<30		-	-	50	µg/l
Copper	-	to	-	<100		-	-	2000	µg/l
Cyanide	-	to	-	<10		-	-	50	µg/l
Fluoride	-	to	-	100	3197	1381	847	1500	ug/l
Total Iron (FeII+FeIII)	621.6	to	14725.2	308	14725	3524	1431	200	µg/l
Lead	-	to	-	<2		-	-	10	µg/l
Magnesium	-	to	-	0.2	34	11.6	10.0	-	mg/l
Manganese	16.3	to	221.6	16	488	214	190	50	µg/l
Nitrate	<0.9	to	<0.9	<22		-	-	50	mg/l
Nitrite	<0.004	to	0.195	<50		-	-	500	µg/l
Phosphate	-	to	-	0.05	1	0.75	0.88	-	mg/l
Potassium	-	to	-	<8		-	-	-	mg/l
Sodium	-	to	-	10	360	144	103	200	mg/l
Sulphate	-	to	-	<40	174	105	107	250	mg/l
Sulphide	-	to	-	<0.1		-	-	-	mg/l
Zinc	-	to	-	0.1	2	1.1	1.1	-	mg/l
Electrical Conductivity	1538	to	1607	246	1818	1205	1444	2500	µS/cm
Hardness, Total, as CaCO3	12.9	to	-	11	461	152	70	-	mg/l
pH	8.2	to	8.4	7	8.40	7.73	7.72	6.5-9.5	pH units
Total Dissolved Solids	-	to	-	117	1293	658	663	-	mg/l

*** Results not included in local maximum values as may be a drilling residue rather than being naturally present**

Table 5: Measured water quality in borehole & locally

Based on the concentrations measured in samples collected from the new, and compared with sample analysis from other boreholes, wells, and springs originating from the same geological horizon, water treatment is necessary to address elevated levels of iron and manganese, locally treatment is often needed for raised levels of chloride, fluoride, iron, manganese, and sodium.

Chloride concentrations range locally from 14.6 to 263 mg/l, exceeding the UK limit of 250 mg/l; fluoride levels range from 100 to 3197 µg/l, with an average of 1381.33 µg/l, surpassing the limit of 1500 µg/l; iron concentrations are significantly high, ranging from 308 to 14725 µg/l, far above the 200 µg/l limit; manganese levels range from 16.3 to 488 µg/l, exceeding the 50 µg/l limit; and sodium concentrations range from 10 to 360 mg/l, with an average of 143.75 mg/l, approaching the 200 mg/l limit.

This borehole specifically needs treatment for iron and manganese based on test results (see Appendix 2). With treatment, the water from this borehole represents a wholesome supply, the yield of which has already been confirmed to be more than adequate.

7 Regulatory Considerations

7.1 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.

7.2 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.

7.3 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.

7.4 Coal 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 Coal Authority (CA) and a permit to drill from the CA is not needed.

7.5 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.

7.6 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.

7.7 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.

7.8 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 affect, 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).

8 Water Neutrality

8.1 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*).

8.2 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:

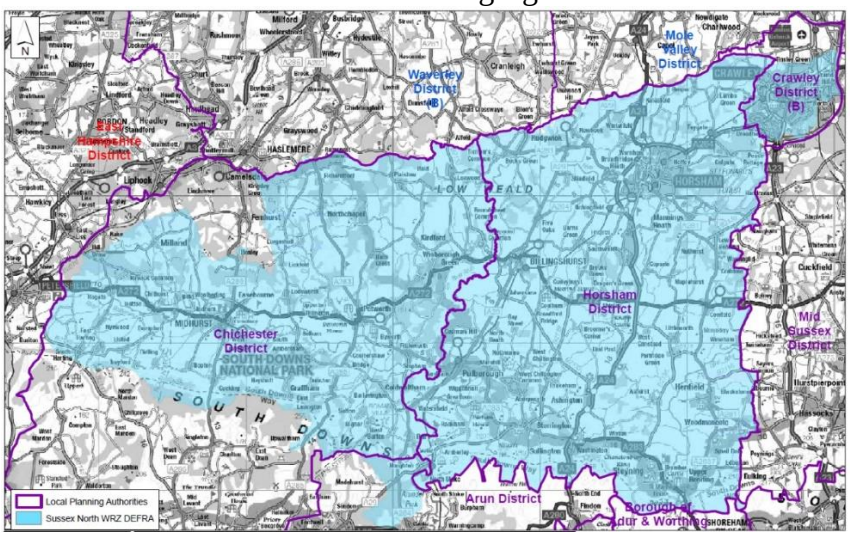

Figure 3: Sussex North Water Resource Zone

8.3 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 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 abstraction draws water from the thin limestone, sandstone and ironstone bands within the Weald Clay Formation which have become jointed and fractured allowing the movement and accumulation of water in thin layers. These thin beds regionally dip towards the south and south-east so away from, and outside of, the Sussex North Water Resource Zone. Groundwater flow within these layers is very slow or stationary, where there is flow it is in the same direction as the strata dip.

Groundwater abstracted from these layers would therefore be reducing groundwater movement towards the south to south-east, and from beneath, surface water catchments not covered by the Sussex North Water Resource Zone. While very unlikely to induce any loss of baseflow or leakage from surface water downwards, due to the layers of clay separating the horizons from surface water: any impact that may arise from the proposed groundwater abstraction would not be on or within the Sussex North Water Resource Zone.

The abstraction would therefore have no effect on groundwater or surface water, under or within the Sussex North Water Resource Zone.

8.4 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.

8.4.1 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 abstraction rate over a 24 hour period would be more than sufficient to meet the needs of the property, the volumes are small. 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.

8.4.2 Induced Recharge

As discussed in Section 8.4.1, 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.

8.4.3 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.

8.4.4 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 could affect the Neutrality Zone. This abstraction is therefore a water neutral abstraction.

9 Assessment Summary

B. A. Hydro Solutions Ltd. has been commissioned to complete a Retrospective Hydrogeological and Water Neutrality Assessment to document the borehole drilled, the sustainable yield and the water neutrality of the abstraction, relative to the Sussex Water Neutrality Zone. This study has collected and assessed all available information at the time of production.

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 water quality,
- Section 7 for relevant regulatory information, and
- Section 8 for Water Neutrality.

The findings from this study are listed below:

Strata	Thickness (m)	Max Depth (m)
River Terrace Deposits	11 to 13	13
Weald Clay Formation	160 to 210	223
Target horizon for borehole:	Weald Clay Formation	
Drill depth:	71	metres
Recommended primary casing depth:	21	metre
Screen depth:	To Base	metres
Gravel or Formation pack:	Filter Pack	
Rest water level:	0 to 2	maOD
Transmissivity range:	5 to 10	m^2/day
Confirmed yield:	2.4	m^3 per hour
Water Quality Summary:	Fair to Poor – Without Treatment	
Problematic water quality parameters:	Iron and Manganese - Treatable	
Direction of Groundwater Flow:	South-East	

Table 7: Summary table

The borehole drilled at this location was plain cased with steel to 6 metres, it was then continued to 71 metres depth and installed with screen and casing. The hole was plain cased with PVC to 21 metres below ground level then screened to its base to pick up all inflow horizons with depth. On completion the rest water level was 16 metres below ground level and able to sustain a yield of 2.4 cubic metres an hour with only a small drawdown in water levels.

Initially the water quality was very poor with very high levels of aluminium and iron being the main problematic parameters. After an extended period of pumping the quality was found to be much better (See Appendix 2). The borehole design, as installed is set out in Figure 4 and documented in Appendix 1.

Flooding from groundwater is unlikely in this area as the hydrogeological setting means under normal conditions groundwater is not shallow enough to cause problems. Water levels could only rise to problematic levels following prolonged, and extreme wet conditions. The overall flood risk for this site is assessed as being LOW.

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

The abstraction draws from the Weald Clay Formation and has no direct or indirect hydraulic link or influence on groundwater of surface water that could affect the Neutrality Zone. **This abstraction would therefore have no connection or influence on the Sussex Water Neutrality Zone and would thus be a water neutral abstraction.**

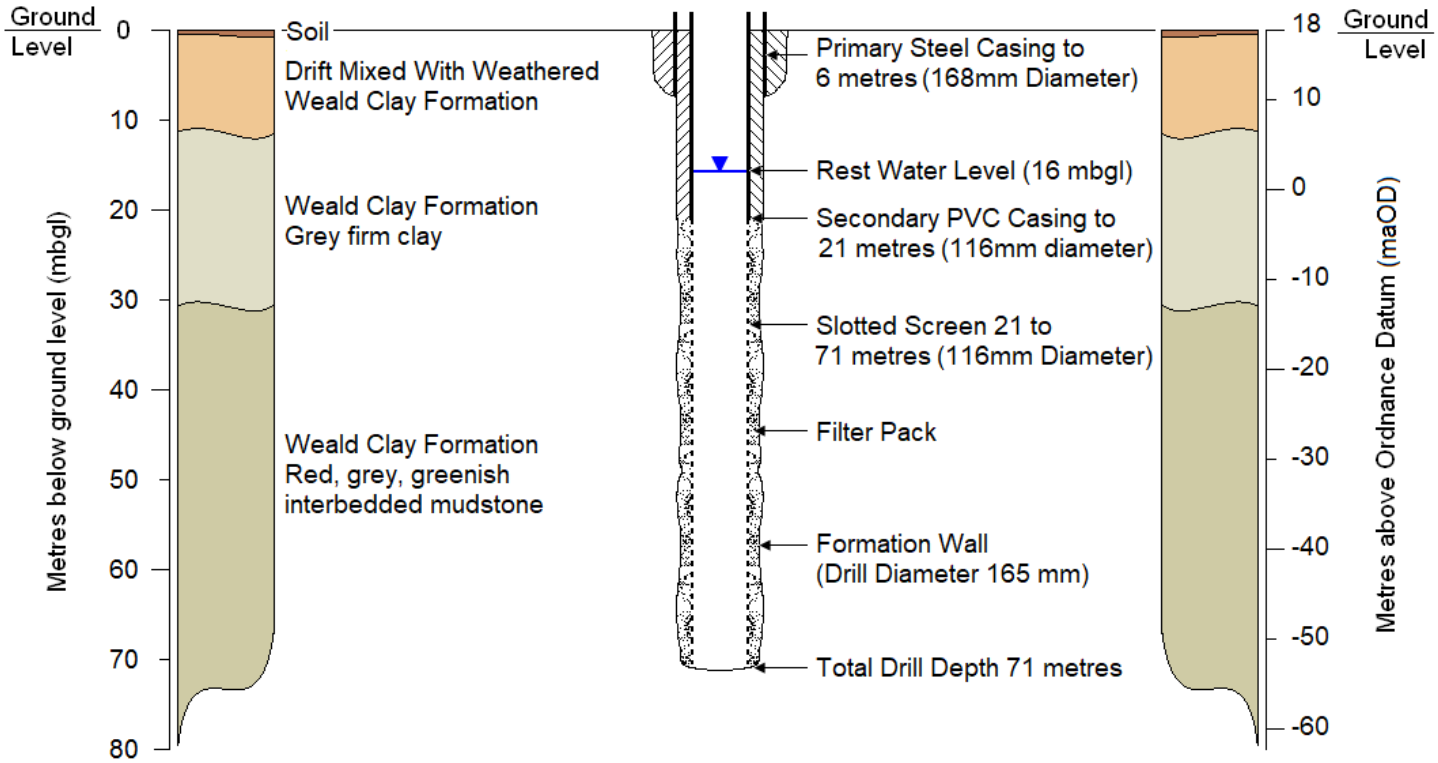

Figure 4: Borehole design as constructed

Disclaimer – Woodhouse Farm, Wheatsheaf Road, Henfield, , BN5 9BA

Information within this Hydrogeological Report has been gathered from all sources available to B. A. Hydro Solutions Ltd. Discussion and interpretation is the professional opinion of B. A. Hydro Solutions Ltd. based on information and data provided by the client plus the best available information collected specifically for this study.

If the client wishes to drill a borehole based on the information contained within this report B. A. Hydro Solutions Ltd. must stress no guarantee can ever be given that groundwater will be present, or that the quantity or quality of groundwater required will be available for abstraction. B. A. Hydro Solutions Ltd. cannot guarantee the ground conditions discussed/used (as drawn from research undertaken) are directly comparable to the ground beneath the site. Groundwater quantities/qualities, ground properties including thermal potentials can vary seasonally and as a result of external factors beyond our control and not foreseen by this study.

OCTOBER 2024

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Additional Information 1 – 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 2 – 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.

Appendix 1 - Borehole Design

WR38: Borehole record form

Borehole record form

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Environment Agency

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

A Site details

Borehole drilled for: Mr C Broucke

Location: Woodhouse Farm Wheatsheaf Road Woodmancote Henfield BN5 9BA

NGR (ten digits): 52180 11784 Please attach site plan

Ground level (if known): metres Above Ordnance Datum

Drilling company: Borehole Service Utilities ltd

Date drilling commenced: 07/05/2024 (DD/MM/YYYY) Completed: 13/05/2024 (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:

220	mm from	0	to	6 m/depth
165	mm from	6	to	71 m/depth
	mm from		to	m/depth
	mm from		to	m/depth

Casing material: Steel diameter: 163.8 mm from: 0 to: 6 m/depth
and type (for example, if plain steel, plastic slotted). Please record permanent casing details, not temporary casing.

Casing material: PVC	diameter: 113	mm from: 0	to: 21	m/depth
Casing material: PVC	diameter: 113	mm from: 21	to: 71	m/depth
Casing material:	diameter:	mm from:	to:	m/depth

Grouting details: Bentonite Grout to 6m

Water struck at 1. 41 m (depth below datum – mbd) 2. 58 m (mbd)
3. m (mbd) 4. m (mbd)

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

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

Pump suction depth: 65 mbd

Water level (start of test): 16 mbd

Water level (end of test): 16 mbd

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

Pumping rate: 2.4 m³/hour ☑ or litres/second ☐. Please tick as appropriate.

for: 2 days, hours, mins

Recovery to: 16 mbd in: 0 days, 0 hours, 1 mins
(from end of pumping)

Date(s) of measurements: Pump started: 14/05/024 (DD/MM/YYYY)
Pump stopped: 15/05/2024 (DD/MM/YYYY)

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

WR38 Version 2, February 2011 page 1 of 3

WR38: Borehole record form

D Strata log

Geological classification (BGS only)	Description of strata	Thickness m	Depth (to base of strata) m
	Topsoil	0	1
	Yellow Clay with Sand	1	12
	Grey firm Clay	12	30.5
	Red/Grey/ Greenish interbedded Mudstone	30.5	71
	(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? 25 minutes

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		

WR38: Borehole record form

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.

WR38 Version 2, February 2011 page 3 of 3

Appendix 2 – Water Quality Analysis

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Hampshire, GU14 0NZ
E-Mail: sales@southeastwater.co.uk
Website: www.southeastwater.co.uk

south east water
scientific services

ANALYTICAL REPORT

Borehole Service Utilities Ltd
Merlins
Farnham Lane
Haslemere
Surrey
GU27 1EU

Certificate Number: 1259639-1 Final

Order Number: WOODHOUSE 1

Collected From: WOODHOUSE FARM

Date Received: 05/06/2024

Date Reported: 11/06/2024

Lab Ref.	Sample Details	Method	Test	Result	Units	Limit	Flag
4780H06	Desc: BOREHOLE GROUND WATER Collect From: WOODHOUSE FARM Order No: WOODHOUSE 1 Received Date: 05/06/2024 Tested Date: 05/06/2024 Sampling Date: 05/06/2024 10:00 Sample Type: GW : Ground Water Product: SS-PWS	660	Colour	<2	mg/l Pt/Co	<20	
		660	Conductivity	1607	uS/cm		
		660	Hydrogen Ion (pH)	8.4	pH_unit	6.5 to 9.5	
		660	Turbidity	248.000	NTU	<4.000	
		230	Odour - Quantitative	0			
		400	E coli	0	mpn/100ml	0	
		400	Total Coliforms	10	mpn/100ml	0	
		430	Colony Count 3 Days at 22°C	>300	cfu/ml		
		730	Aluminium	6148.9	µg / l	<200.0	
		730	Iron	14725.2	µg / l	<200.0	
		730	Manganese	221.6	µg / l	<50.0	
		360	Clostridium perfringens (including spore	0	cfu/100ml	0	
		390	Enterococci	0	cfu/100ml	0	
		255	Ammonium (Ammonia and Ammonium Ions)	0.787	mg/l	<0.500	
		245	Nitrate	<0.9	mg/l	<50.0	
		225	Nitrite	<0.004	mg/l	<0.500	
		calc	Nitrite/Nitrate	0.000	mg/l	<1.000	*

[redacted]
Richard Brown
Laboratory Manager

Disclaimers:

Unless otherwise stated, all results apply to the sample as received. Information provided by the customer (includes Date, Time, Sample Matrix & Sample Description) can affect the validity of the result.
Opinions and interpretations expressed in this report are outside the scope of UKAS accreditation.
Details of Uncertainty of Measurement and Analytical Quality Control are available on request.
Where a statement of conformity to a Regulatory Standard or customer limit is provided, the uncertainty of measurement is not taken into account unless shown on the certificate.
*** - denotes non UKAS accredited test**
A result of 0 cfu denotes none found in volume analysed

UKAS TESTING
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Hampshire, GU14 0NZ
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Website: www.southeastwater.co.uk

south east water
scientific services

ANALYTICAL REPORT

Borehole Service Utilities Ltd
Merlins
Farnham Lane
Haslemere
Surrey
GU27 1EU

Collected From: WOODHOUSE FARM
Date Received: 16/07/2024

Certificate Number: 1278667-1 Final
Order Number: POST PUMPING TEST 1
Date Reported: 22/07/2024

Lab Ref.	Sample Details	Method	Test	Result	Units	Limit	Flag
4809351	Desc: BOREHOLE GROUND WATER Collect From: WOODHOUSE FARM Order No: POST PUMPING TEST 1 Received Date: 16/07/2024 Tested Date: 16/07/2024 Sampling Date: 16/07/2024 09:30 Sample Type: DW : Drinking Water Product: SS-PWS	660	Colour	<2	mg/l Pt/Co	<20	
		660	Conductivity	1538	uS/cm		
		660	Hydrogen Ion (pH)	8.2	pH_unit	6.5 to 9.5	
		660	Turbidity	5.400	NTU	<4.000	
		230	Odour - Quantitative	0			
		230	Taste - Quantitative	0			
		400	E coli	0	mpn/100ml	0	
		400	Total Coliforms	1	mpn/100ml	0	
		430	Colony Count 3 Days at 22°C	>300	cfu/ml		
		730	Aluminium	213.7	µg / l	<200.0	
		730	Iron	621.6	µg / l	<200.0	
		730	Manganese	16.3	µg / l	<50.0	
		255	Ammonium (Ammonia and Ammonium Ions)	0.724	mg/l	<0.500	
		245	Nitrate	<0.9	mg/l	<50.0	
		225	Nitrite	0.195	mg/l	<0.500	
		calc	Nitrite/Nitrate	0.065	mg/l	<1.000	*
		205	Total Hardness	12.9	mg/l		
		360	Clostridium perfringens (including spore	0	cfu/100ml	0	
		390	Enterococci	0	cfu/100ml	0	

Disclaimers:

Unless otherwise stated, all results apply to the sample as received. Information provided by the customer (includes Date, Time, Sample Matrix & Sample Description) can affect the validity of the result.
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*** - denotes non UKAS accredited test**
A result of 0 cfu denotes none found in volume analysed

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