

**HYDROLOGICAL RISK ASSESSMENT, PROPOSED
NORTH SHAFT INVESTIGATION BOREHOLE,
DOVE'S NEST, NORTH YORKSHIRE**



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HYDROLOGICAL RISK ASSESSMENT, PROPOSED NORTH SHAFT INVESTIGATION BOREHOLE, DOVE'S NEST, NORTH YORKSHIRE

1 INTRODUCTION

The purpose of this hydrological risk assessment is to provide the UK regulator for Controlled Waters in England, the Environment Agency, with sufficient information to support a planning application to construct an investigation borehole for a proposed mine shaft. Following advice received from the Environment Agency (Ref. 1), Form WR-9, the Oil and Gas UK Guidelines for the Suspension and Abandonment of Wells (Ref. 2) and other relevant Environment Agency guidance (Ref. 3) have been used in the preparation of this document.

Basic information on the geological units and hydrogeology of the Cleveland Basin has been summarised in Ref. 4 for use in this document.

2 BASIC DETAILS

2.1 GRID REFERENCE

The National Grid Reference (NGR) for the proposed borehole is **489297 505434**. The general location of the proposed borehole drilling site is shown in Figure 1 at 1:2,500 scale which includes an insert at 1:25,000 scale.

2.2 INDICATED DEPTH

The indicated maximum depth for the proposed borehole (terminating within the Eskdale Group), based on the borehole prognosis (Table 1), is approximately **1,200 metres**.

2.3 MINE WORKINGS

There are no former or current mine workings (coal, jet, ironstone etc.) anticipated at this location.

2.4 GROUNDWATER ABSTRACTIONS

There are no domestic drinking water groundwater abstractions within 250 m of the proposed drilling site. Environment Agency records indicate the nearest registered groundwater abstraction is approximately 4 km northwest of the site, to the southeast of Ruswarp. Local Authority records indicate the nearest recorded utilised private water supply is located at the Moorside Supply South (serving Moorside Farm, Moorside House and Thornhill) at NGR 488753, 505094, approximately 620 m WSW of the proposed site and at approximately 190 m AOD. These records also indicate that the Low Moor caravan site at NGR 489460 503944 has a water supply borehole based on EA and field observations as being located at NGR 489570, 503620, approximately 1.48 km S of the proposed borehole site, and that Newton House has a private water supply at NGR 488880 504006, approximately 1.50 km SW of the proposed borehole site.

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2.5 ANTICIPATED GEOLOGICAL SEQUENCE

The anticipated geological sequence to be encountered by the proposed borehole, based on available geological information, is given in the borehole prognosis in Table 1.

2.5.1 Near-Surface Geology

The 1:10560 and 1:1:50,000 scale geological maps (Figures 2 and 3) indicate the near-surface geology on site comprises the Moor Grit Sandstone, underlain by the Scarborough Formation, both of which are part of the Ravenscar Group (Table 1).

There are no geological borehole logs in close proximity to the site available from the BGS GeoIndex database. FWS Consultants Ltd have undertaken a number of preliminary site investigations of the Doves Nest site. Trial pit logs confirm the presence of 0.25 m of topsoil across the site, underlain generally by between 2.4 and 3.95m of clay, thinner to the east and thicker to the west. Bedrock has been identified as sandstone, forming a roughly horizontal rockhead surface at depths ranging from 2.65 to 4.20 m bgl.

2.5.2 Geological Borehole Data

Available geological borehole logs from the BGS GeoIndex database, proximal to the proposed borehole location, are as follows:-

BOREHOLE NAME	REF NO.	DEPTH (m)	EASTING	NORTHING
Sneaton Low Moor Caravan site	NZ80SE6	73.2	489570	503620
RTZ 3	NZ90NW4	1269.8	491805	506684
YP5	NZ80NE9	1285.95	489566	506853

The nearest available Water Well data from the BGS GeoIndex archive are:-

BOREHOLE NAME	REF NO.	DEPTH (m)	EASTING	NORTHING
Sneaton Low Moor caravan site	NZ80/7	73.2	489570	503620

The borehole log for NZ80/7, which is located approximately 1,480 m south from the proposed site, includes hydrogeological and pumping test data from the Scarborough Formation (Secondary A aquifer unit in this area). Water was struck at 68.6 m bgl, towards the base of a 6.7 m thick grey soft sandstone unit which is most likely part of the Scarborough Formation, and rose to a rest water level of 56.1 m bgl. During pumping, at a rate of 720 gallons per hour, the groundwater level fell to 59.7 m bgl, and recovered, on completion of pumping tests, to the original rest water level within two minutes. A record of the groundwater quality is also given, indicating a pH of 6.8, low levels of trace metals, 0.1 mg/l iron, 0.1 mg/l manganese, 30 mg/l chloride, 206 mg/l

CaCO₃ alkalinity, 0.04 mg/l free ammonia and <1 coliform bacteria per 100 mls.

In addition, York Potash Ltd have borehole records for their SM3/3A exploration borehole which was located approximately 1 km southeast of the proposed borehole site (Ref. 10).

2.6 ANTICIPATED AQUIFER UNITS

An assessment of the anticipated aquifer units to be intercepted by the proposed borehole, within the geological profile summarised in Table 1, is based on Ref. 4.

2.6.1 Principal/Major Aquifers

There are two Principal/Major aquifers, as identified by the Environment Agency, that will be intercepted by the proposed borehole at depths below 780 m (Table 1). These are as follows:-

- Sherwood Sandstone Group;
- Brotherton Formation (Upper Magnesian Limestone).

2.6.2 Secondary A/Minor Aquifers

There are a number of Secondary A aquifers anticipated to be intercepted within the upper 250 m (Table 1) by the proposed borehole as follows:-

- Moor Grit Member;
- Scarborough Formation;
- Cloughton Formation;
- Eller Beck Formation;
- Saltwick Formation (may/may not be present at this location);
- Dogger Formation;
- Blea Wyke Sandstone Formation (if present);
- Cleveland Ironstone Formation;
- Staithes Sandstone Formation.

2.6.3 Secondary B/Non-Aquifers

There are a number of Secondary B aquifers anticipated to be intercepted by the proposed borehole as follows:-

- Redcar Mudstone Formation;
- Penarth Group;
- Mercia Mudstone Group;
- Roxby Formation;
- Sherburn Anhydrite Formation;
- Billingham Anhydrite;
- Fordon Evaporites.

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2.6.4 Unproductive Strata/Non-Aquifers

- Whitby Mudstone Formation.

2.7 GROUNDWATER VULNERABILITY

The Groundwater Vulnerability status of the proposed borehole drilling site, based on the Environment Agency Groundwater Vulnerability Map for the area (Figure 5) is:-

Low: This status relates to the combined presence of a near-surface Secondary A aquifer and a low vulnerability soil: Low vulnerability soils are soils in which the pollutants are unlikely to penetrate the soil layer because either water movement is largely horizontal, or they have the ability to attenuate diffuse pollutants. Lateral flow from these soils may contribute to groundwater recharge elsewhere in the catchment. They generally have a high clay content and are represented by soils of the Denchworth, Salop and Brickfield Associations (Ref. 8). The presence of a 2.4 – 3.95 m low permeability clay beneath the site has been confirmed by trial pitting. The low vulnerability status has been confirmed by reference to the current EA online groundwater vulnerability maps located within the general web address:-

<http://maps.environment-agency.gov.uk/wiyby>

2.8 SURFACE WATERS

Based on the results of a site visit, and the Ordnance Survey map (1:25,000 scale), the nearest surface waters to the proposed borehole drilling site are:-

SURFACE WATER	DISTANCE (m)	AZIMUTH
Surface water drain leading from the spring discharge water storage tank to north of Doves' Nest Farm discharging to surface water drain 380 m SE of proposed site (see below).	340	SE
Surface water drain to East of Doves' Nest Farm leading to Sneaton Thorpe Beck.	380	SE

A field drain previously in close proximity to the proposed drilling site has been removed as part of the development of the Doves Nest site. The nearest surface water to the proposed site is therefore 340 m to the SE.

2.9 HYDROLOGICAL FEATURES

The nearest relevant hydrological features (such as springs, wetlands, bogs etc.) are:-

HYDROLOGICAL FEATURE	DISTANCE (m)	AZIMUTH
Spring, North of Doves' Nest Farm	320	SE
Spring, East of Doves' Nest Farm	380	SE
Probable Spring, Moor House Farm	620	SW
Spring at Windmill Hill Plantation	580	N
Covered Reservoir	480	NW

2.10 FLOOD RISK

The Environment Agency online Floodrisk map shows the site is outside any area at risk of flooding from rivers and sea.

2.11 DRILLING METHOD STATEMENT

A detailed drilling method statement is being prepared by the York Potash Drilling Supervisor. The following constitutes a general summary of the drilling method statement as it relates to the proposed boring, and ultimately the safe completion/abandonment of the investigation borehole, to prevent pollution of controlled waters.

We understand drilling is likely to be undertaken using a lorry mounted drilling platform and drawworks, together with a power generator and mud pumps. Topsoils and subsoils will be stripped to a depth of around 1 m and stockpiled as part of the site development. The drill rig will be established on a level drilling platform comprising approximately 0.25 m of suitable, compacted, imported, crushed, inert stone if earthworks are required at this site in order to achieve a level drilling platform.

It is planned to drill the investigation borehole using a one casing system. The borehole will be cased from surface to the Whitby Mudstone Formation. The proposed casing depth, based on the borehole prognosis, is given in Figure 5.

A concrete-lined pressure vessel sump will be established from ground level to approximately 2 m bgl. This will prevent interaction between any return drilling fluids and the superficial deposits/rockhead. A conductor pipe will be installed within the concrete cellar, and sealed into the cellar to prevent any discharge of fluids from the conductor pipe or cellar. Following drilling of the cased section, a fibreglass casing will be advanced from surface to the casing point. The external annulus of the casing will be cemented in place at the proposed casing depth identified in Figure 5, and pressure tested, before commencement of the next stage of drilling. Permanent casings are cemented to prevent interaction between the drilling muds and groundwater in the intercepted shallow aquifer units of the Ravenscar Group, and/or pollution/interaction of groundwaters from different depths.

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Our current proposal is as follows:-

Drill from surface down to the Whitby Mudstone Formation (WMF) – install a permanent casing and cement this section. This is identical to our current ‘three casing’ methodology as described in the Hydrological Risk Assessments for all previous York Potash exploration boreholes. This will mean all the shallow Secondary A aquifers (principally in the Ravenscar Group) locally utilised for water supplies, or providing baseflow to rivers etc., will be protected in exactly the same way as with all previous boreholes.

Drilling will continue beyond the casing point to the base of the Eskdale Group at around a depth of 1200 m bgl (Figure 5). This section will be completed by either open hole drilling, with subsequent wireline logging, or by coring. No second casing will be required as the borehole will be completed at around 1200 m bgl (the depth at which the second casing would normally be installed) and subsequently cemented back to surface level, thus no aquifers below this depth will be intersected.

The borehole will intercept the Cleveland Ironstone Formation (CIF), the Staithes Sandstone Formation (SSF) and the Sherwood Sandstone Formation. The detailed geological log for the nearest York Potash exploration borehole (SM3) indicates the following geological deposits and thicknesses are likely to be present at the Doves Nest site based on geological cuttings:-

FORMATION	GEOLOGY	FROM (m bgl)	TO (m bgl)	THICKNESS (m)
Cleveland Ironstone Formation	Mudstone, siltstone and silty sandstone bands, mid to light grey, occasionally pyritic.	177.2	199.2	22.0
Staithes Sandstone Formation	Silty sandstone, argillaceous with beds of “cleaner” sandstone, occasionally carbonaceous and pyritic.	199.2	245.7	46.5

The BGS/EA report (“The physical properties of minor aquifers in England and Wales” (EA R&D Publication 68) also notes the CIF comprises a succession of around 20 m of mudstones, siltstones and ironstones. The formation is essentially an argillaceous non-aquifer with a potential to impact on groundwater flow in areas where it has been mined. Current information indicates no mining of the CIF in the York Potash area of interest.

The SSF in the EA R&D Publication 68, is described as a less significant aquifer than the Ravenscar Group and thinning to the south of Staithes (within the York Potash area of interest) with the development of shales and mudstones. Primary utilisation of this aquifer is to the south and west of the York Potash exploration area, around Thirsk and Northallerton.

The geological evidence from boreholes SM3 and SM11 suggests that only the “cleaner” beds of sandstone could act as aquifer units. Whilst the thicknesses of these individual units are not known, they are not considered to make up a substantial part of the Staithes Sandstone Formation.

Thus within the area of the Doves Nest site, the CIF and SSF may be regarded as equivalent to Secondary B/non-aquifers. The Redcar Mudstone and Penarth Group (Rhaetic), which lie between the Whitby Mudstone Formation (WMF) and the Mercia Mudstone Group (MMG), are both Secondary B/non-aquifers, and thus will not be affected. So the section beneath the Whitby Mudstone Formation, down to the borehole Total Depth (TD) at 1,200 m bgl is effectively a non-aquifer. The only aquifer present below the WMG that will be intercepted before completion of the hole in the Eskdale Group will be the Sherwood Sandstone Formation (which is typically saline).

It is proposed to drill the borehole from surface to the Whitby Mudstone Formation using overpressured drilling muds containing only non-hazardous materials, namely water, bentonite and pH adjusters such as a small amount of caustic soda. Thus there will be no anticipated groundwater inflow into the borehole during drilling, and no potential for contamination of near-surface groundwaters. Any substantial aquifer units encountered from surface to the Whitby Mudstone Formation during drilling will be sealed off, as necessary, using a cement grout. Once the casing is installed and cemented in position, any aquifer units will effectively be isolated from the borehole and from each other. The shallow Secondary A aquifers down to the Whitby Mudstone Formation will be isolated from the drilling fluids to be used in the next stage of drilling from the Whitby Mudstone Formation down to the base of the Eskdale Group at 1,200 m bgl, and from interaction with any ingress of saline groundwater from the Sherwood Sandstone Formation aquifer.

The drilling platform will be located a minimum of 10 m from a water course, >50 m from any spring or well, or from any borehole not used to supply water for domestic or food production purposes; and >250 m from any well, spring or from any borehole used to supply water for domestic or food production purposes in order to be compliant with Environment Agency Standard rules for environmental permits.

2.12 BOREHOLE COMPLETION STATEMENT

The borehole completion objectives are to:-

- remove the hazard of a deep, open hole;
- prevent the borehole from acting as a conduit for contamination to enter groundwater;
- prevent the mixing of saline and potentially potable groundwaters from different aquifer units;
- prevent the flow of groundwater from one geological horizon to another, and;
- prevent access of water to the salt formations where uncontrolled dissolution could occur, and a hazard presented to future mineworkings.

On completion of drilling to the required depth within the Eskdale Group, the borehole will be logged by standard wireline geophysical methods that involve the lowering of a sonde with a radiation source to the full depth of the borehole. Best efforts will be made to recover any radiation sources from the well. Where radiation sources cannot be successfully recovered, these will be notified to the Environment Agency, as appropriate.

On completion of drilling, primary and secondary permanent barriers will be installed in the cased borehole based on current guidelines (Ref. 2). There is no anticipated requirement for a through-tubing abandonment. The internal annulus of each borehole will be infilled with a suitable cement grout from the base upwards, up to the base of the pressure vessel sump at 2 m bgl.

3 RISK ASSESSMENT

A summary of the risks associated with various relevant criteria covered in this document is tabulated in Table 2.

Groundwater Source Protection Zone

The site is not within an Environment Agency Zone I/II/Total Catchment Groundwater Source Protection Zone. There are no utilised potable drinking water spring discharges located within 250 m from the identified proposed drillsite boundary. The nearest licensed/known groundwater abstraction borehole (at Moorside Supply South) is approximately 620 m south-west of the site. Therefore there is a **LOW** risk to potable drinking water/Groundwater Source Protection Zones.

Groundwater Vulnerability

The groundwater vulnerability of the proposed site is **LOW**. The site is designated as a Low Soil Class vulnerability and overlies a Secondary A aquifer (the Moor Grit). The depth of the water table in this aquifer is not known, but is potentially < 10 m bgl. The proposed site is underlain by topsoil and a low permeability boulder clay to a proven depths of between 2.65 and 4.20 m bgl. The groundwater vulnerability risk is **LOW**.

Groundwater Contamination

The shallowest bedrock (Secondary A) aquifer is the Moor Grit. A further three aquifer units containing groundwater potentially suitable for utilisation, discharge to springs, or to provide baseflow to surface waters within the Ravenscar Group are thought to be present beneath this unit. A number of groundwater issues/springs occur in the area, but most are more than 500 m from the proposed site and are therefore at **LOW** risk. The nearest spring discharges to the proposed site associated with Doves Nest Farm 320 m southeast of the site. This is a former water supply spring to the property but now discharges into a surface water drain together with a septic tank discharge.

The bedrock secondary A aquifer is located between 2.65 and 3.20 m below the proposed site and the groundwater level in this aquifer is unknown. Springs emerging to the W and E of the site coincide approximately with the interface between the Moor Grit and the underlying Scarborough Formation, and probably represent discharge of shallow groundwaters infiltrating the superficial deposits and moving down into the largely

unsaturated Moor Grit before being discharged at the Moor Grit/Scarborough Formation contact. There is a **MEDIUM** risk of groundwater contamination from drilling muds on this shallow groundwater aquifer. However, as the spring at Doves Nest Farm provides baseflow to Sneaton Thorpe Beck there is also a **MEDIUM** risk to surface waters.

The Environment Agency's What's in your backyard (WIYBY) website page indicates that the Environment Agency **DO NOT** restrict activities that may pollute water supplies in the area identified for the proposed drilling platform.

Prior to drilling, a cellar and conductor pipe will be installed and adequately sealed and tested to ensure no drilling fluids can migrate out of the conductor pipe/cellar into the surrounding bedrock. This should provide protection against contamination of shallow groundwater in the Moor Grit (and ultimately into Sneaton Thorpe Beck) from drilling fluids. The borehole will be drilled with drilling muds containing no hazardous substances, and will be permanently cased, from surface to the Whitby Mudstone Formation, thus mitigating the risk of any hazardous substances within the drilling mud or surface contamination entering the Secondary A aquifers via the borehole once the casing is installed. During drilling, any significant drilling fluid losses, once identified, are sealed using a cement grout to prevent loss of drilling fluids to formation. The permanent casing will also mitigate the risk of any contamination of these shallow aquifer units from interaction with the drilling muds whilst drilling through the underlying Lias Group and into the Mercia Mudstone Group, Sherwood Sandstone Group and the Eskdale Group. On completion, the borehole will be filled with cement grout to within approximately 2 m of ground level thus removing any potential preferential pathway to/from surface. All nearby surface springs associated with Moorhouse Farm, Moorside House and Soulsgrave Farm are currently being monitored for potential impact as part of the current Doves Nest site development, and drilling of SM11 (Doves Nest South). No impacts have been identified during drilling of SM11 and thus no impacts are anticipated during drilling of the North Shaft investigation borehole.

The implementation of the identified mitigation procedures above leaves a residual **LOW** risk of contamination.

Nearest Surface Water/Other Hydrological Features

Current EA regulations specify a minimum distance for any potentially polluting activity of 10 m from any water course, 50 metres from any spring or well, or from any borehole not used to supply water for domestic or food production purposes; and 250 metres from any well, spring or from any borehole used to supply water for domestic or food production purposes. During site preparation and removal of surface soils on the Doves Nest site, a field drain previously within 10m of the proposed drilling site was removed. There are no surface waters within 10m of the drill site. Any risk to surface waters during drilling are **LOW**.

Flood Risk

The site is not at risk from flooding.

4 CONCLUSION

Based on the information above for the proposed borehole drilling site at Doves Nest site, we consider the highest level of risk to Controlled Waters (surface water and groundwater) to be **MEDIUM**. Mitigation measures, including the use of conductor pipes/cellars, permanent casing of the well and utilising non-hazardous drilling mud in geological formations above the Whitby Mudstone have been identified that will reduce the overall risk to **LOW**.

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PRINCIPAL CONSULTANT

DR F W SMITH
DIRECTOR

K WELLS
GEOLOGIST

30 January 2013



5 REFERENCES

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- 4 FWSC, 2011. A Review of the Hydrogeology of the Cleveland Basin, North Yorkshire. Report 1433, March 2011.
- 5 BGS, 1879. Geological Map of the June 1879 Area of Fylingdales Moor. 1:10560 Scale. June 1879.
- 6 BGS, 1998. Whitby and Scalby. England and Wales Sheet 35 and 44. Solid and Drift Geology. 1:50,000 Provisional Series.
- 7 Environment Agency, 1994. Sheet 9, Northeast Yorkshire. Groundwater Vulnerability 1:100,000 Map Series.
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TABLE 1 BOREHOLE PROGNOSIS - North Shaft

Based on intersections encountered at SM11 to date (22/1/13), SM2, SM3 and SM7 and surface ground level of 202.2m AOD

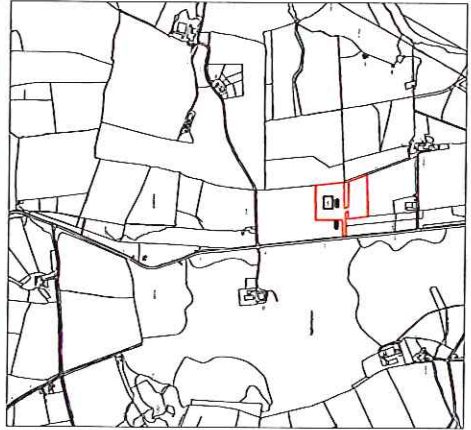
STRATIGRAPHIC UNIT		FROM	TO	THICKNESS
		(m bgl)	(m bgl)	(m)
Quaternary	Devensian glacial drift	0.00	3.40	3.40
Middle Jurassic	Ravenscar Group and Dogger Formation	3.40	109.21	105.81
Lower Jurassic	<u>Lias Group</u>			
	- Whitby Mudstone Formation	109.21	179.21	70.00
	- Cleveland Ironstone Formation	179.21	206.21	27.00
	- Staithes Sandstone Formation	206.21	255.41	49.20
	- Redcar Mudstone Formation			
	Ironstone Shales, Banded Shales and Pyritous Shales	255.41	348.21	92.80
	Siliceous Shales	348.21	394.21	46.00
	Calcareous Shales	394.21	491.21	97.00
Triassic	<u>Penarth Group (Rhaetic)</u>	491.21	513.41	22.20
	<u>Mercia Mudstone Group</u>			
	- Upper Triton Formation	513.41	522.21	8.80
	- Keuper Anhydrite Member	522.21	562.21	40.00
	- Lower Triton Formation	562.21	642.01	79.80
	- Upper Dowsing Formation	642.01	748.21	106.20
	- Röt Salt	748.21	793.21	45.00
	- Upper Bunter Shale	793.21	801.21	8.00
	<u>Sherwood Sandstone Group</u>			
	- Upper Bunter Sandstone	801.30	896.21	94.91
	- Middle Shale Unit (Red Marl)	896.21	937.71	41.50
	- Middle Bunter Sandstone	937.71	1032.21	94.50
	Permian	<u>Eskdale Group</u>		
- Roxby Formation				
Transition Beds		1032.21	1136.81	104.60
Lower Bunter Shales		1136.81	1203.21	66.40
Brockelschiefer Member		1203.21	1228.26	25.05
- Littlebeck (Top) Anhydrite		1228.26	1229.14	0.88
- Sleights Siltstone		1229.14	1231.58	2.44
<u>Staintondale Group</u>				
- Sneaton Halite (Unit E)		1231.58	1235.16	3.57
- Sneaton Halite (Unit D)		1235.16	1252.40	17.24
- Sneaton Potash (Unit C)		1252.40	1256.39	3.98
- Sneaton Halite (Unit B)		1256.39	1264.32	7.93
- Sneaton Halite (Unit A)		1264.32	1274.21	9.89
- Sherburn Anhydrite		1274.21	1282.52	8.30
- Carnallitic Marl		1282.52	1301.19	18.68
<u>Teesside Group</u>				
- Boulby Halite (Unit D)		1301.19	1303.34	2.14
- Boulby Potash (Unit C)		1303.34	1306.70	3.37
- Boulby Halite (Unit B)		1306.70	1338.87	32.17
- Boulby Halite (Unit A)		1338.87	1349.74	10.88
- Billingham Anhydrite		1349.74	1365.25	15.50
- Brotherton Formation		1365.25	1412.62	47.37
- Grauer Salztou		1412.62	1413.62	1.00
<u>Aislaby Group</u>				
- Fordon Evaporite Formation		1413.62	1413.62	
Halite and anhydrite		1413.62	1445.02	31.40
Upper Anhydrite		1445.02	1478.47	33.45
Upper Polyhalite Deposit		1478.47	1520.65	42.19
Halite with minor polyhalite and anhydrite (Sulphatic Halite)		1520.65	1576.92	56.27
Lower Polyhalite Deposit (May be present. If not, then expect sulphatic halite)		1576.92	1616.92	40.00
Halite & Anhydrite	1616.92		20.00	
- Kirkham Abbey Formation				

TABLE 2: NORTH SHAFT INVESTIGATION BOREHOLE – HYDROLOGICAL RISK ASSESSMENT SUMMARY SHEET

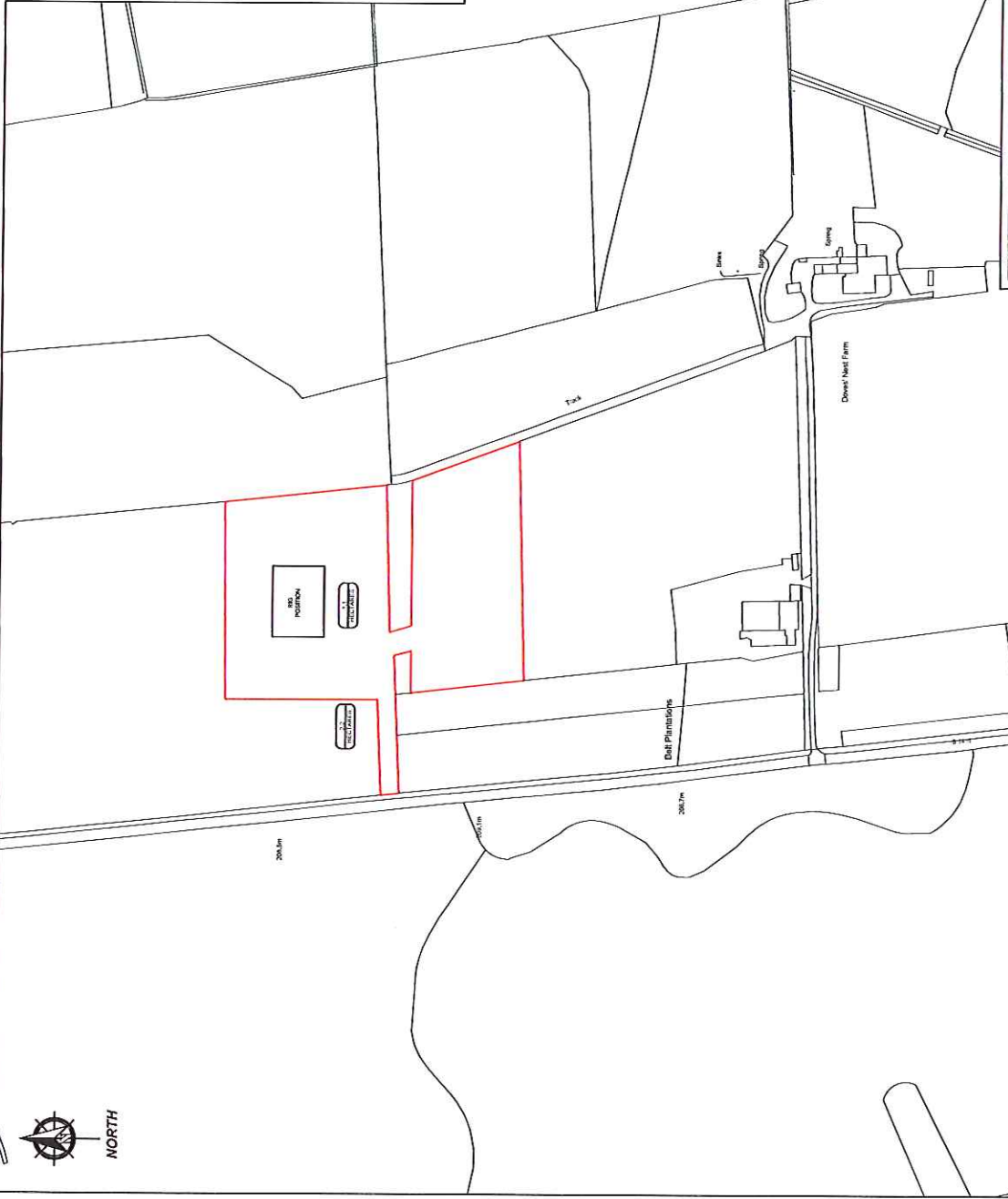
CRITERIA	RESULT	EVIDENCE	RISK TO CONTROLLED WATER	RESULTANT RISK AFTER MITIGATION
Protection of major groundwater abstractions	Outside groundwater source protection zone and no drinking water spring discharge or groundwater borehole within 250 m of the proposed drilling site.	EA Groundwater source protection zone map, response from Local Authority and discussions with site owner	LOW	LOW
Groundwater vulnerability	Low vulnerability status	EA Groundwater vulnerability map	LOW	LOW
	No superficial deposit aquifer	Online Superficial deposit aquifer designation map.		
Groundwater contamination	Superficial deposits: Between 1.9 and 3m of stiff to very stiff boulder clay over sandstone rockhead. One occurrence of running sand in trial pits.	Site investigation trial pits	MEDIUM	LOW
	Secondary A bedrock aquifers potentially providing baseflow to surface waters	Online Bedrock aquifer designation map and Ref. 4.		
	Shallowest aquifer: Moor Grit/Scarborough Formation estimated at < 10m bgl.	BGS Geology Map and Ref. 4		
Nearest surface waters	No reported utilisation of groundwater spring discharge – Doves Nest Farm reported by owner to be on Mains water supply. Spring discharge runs to surface drain	Site observations, discussions with land owner, Local Authority and Environment Agency records	LOW	LOW
	There are no surface waters within 10 m of the drill site.	Site observations - During site preparation and removal of surface soils on the Doves Nest site, a field drain previously within 10m of the proposed drilling site was removed.		
Other hydrological features (e.g. springs, wetlands, bogs etc)	Multiple spring discharges providing baseflow to surface waters. Nearest spring providing baseflow to surface waters is approximately 320 m from proposed drillsite.	Site observations and OS map	MEDIUM	LOW
	Flood risk	None – outside EA flood zone	LOW	LOW

11 MAR 2013

NY/ANPA
11 MAR 2013



SCALE: 1:25000



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1 of 1

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1 of 1

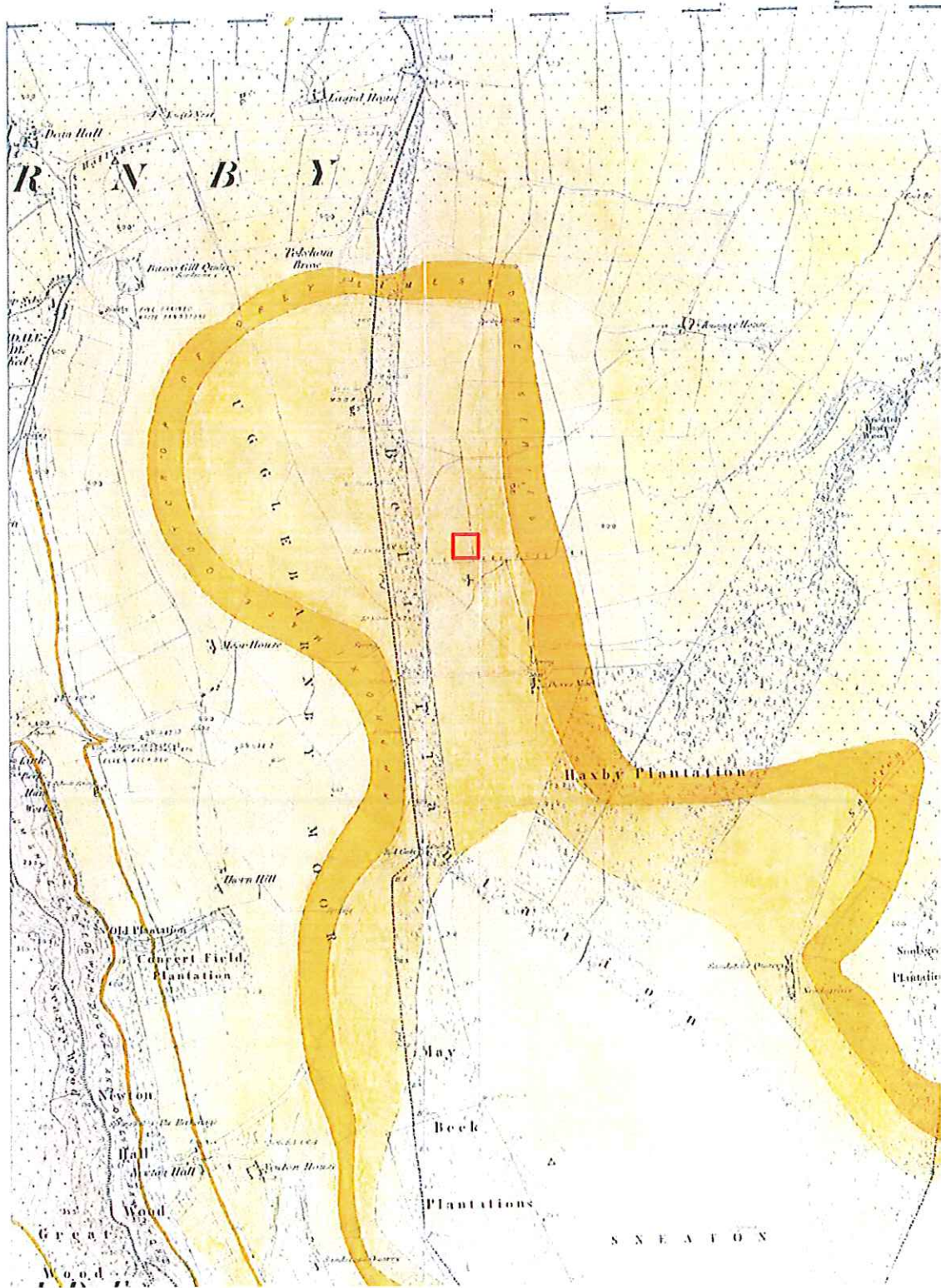
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1 of 1

SCALE: 1:2500

REV	DESCRIPTION	DATE	APPROVED
A	ISSUED FOR INFORMATION	17.01.2013	
B	FOR PERMITS		
C	FOR PERMITS		
D	FOR PERMITS		
E	FOR PERMITS		
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T	FOR PERMITS		
U	FOR PERMITS		
V	FOR PERMITS		
W	FOR PERMITS		
X	FOR PERMITS		
Y	FOR PERMITS		
Z	FOR PERMITS		

Key

Approximate location of North Shaft Investigation Borehole -



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JOB TITLE

Project 40

DRAWING TITLE

Extract from 1:10,560 scale geological map (Ref. 5)

CLIENT

York Potash

DRAWING NUMBER

Figure 2

STATUS

DATE

January 2013

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NYMNPA

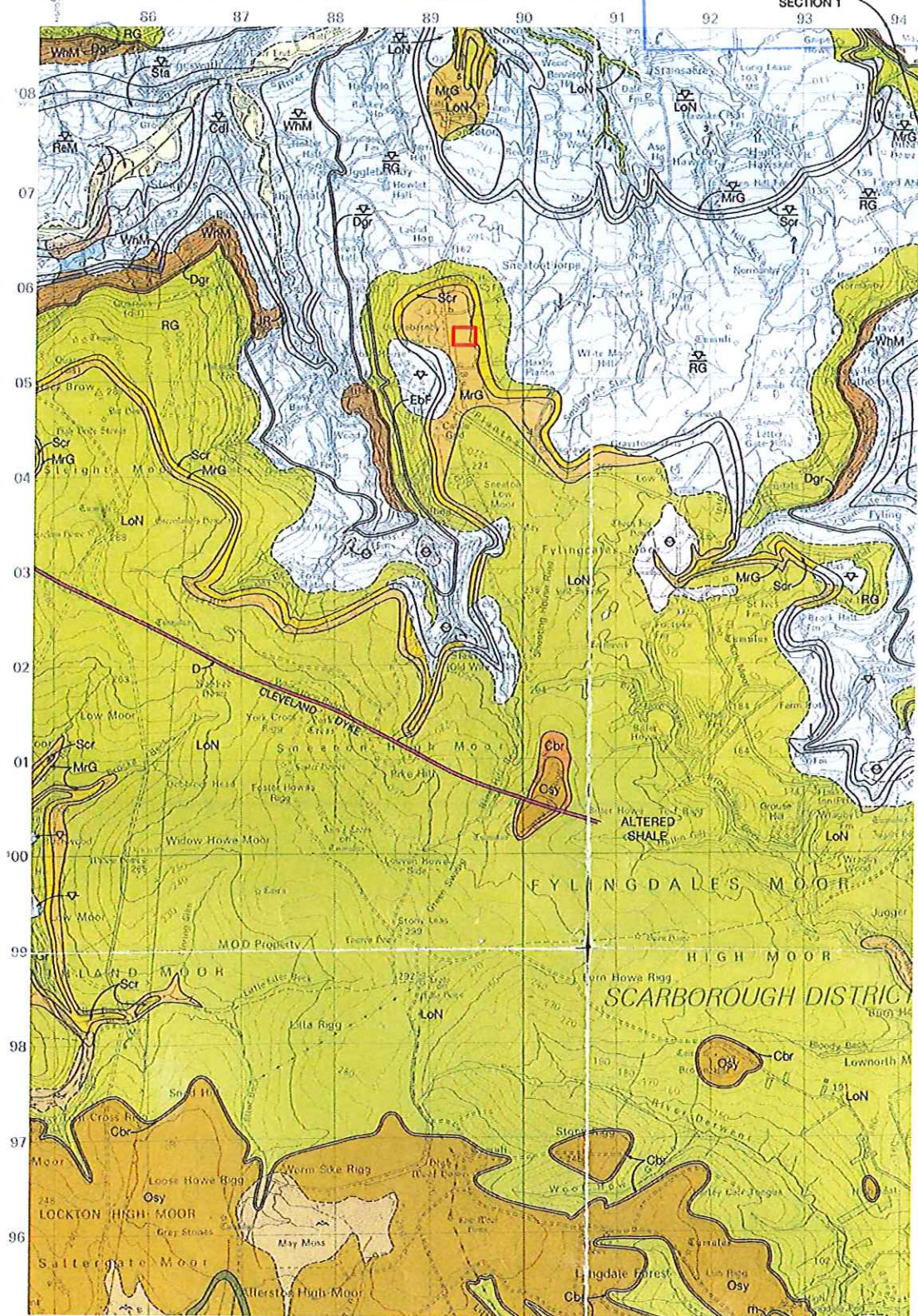
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LINE OF SECTION 1

93

Key

Approximate location of North Shaft Investigation Borehole -



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DRAWING TITLE

Extract of 1:50,000 scale geological map (Ref. 6)

CLIENT

York Potash

DRAWING NUMBER

Figure 3

DATE


January 2013

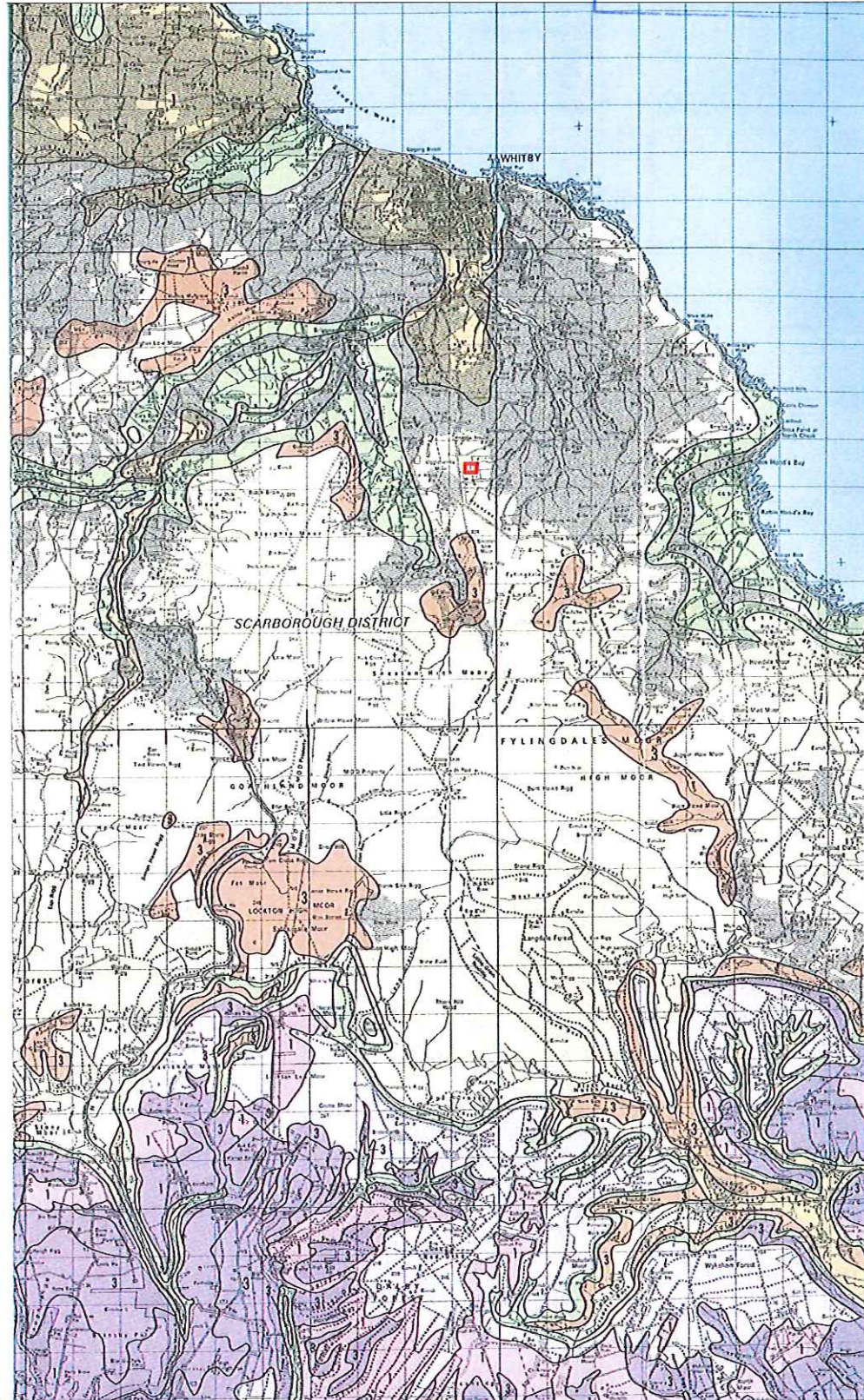
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Key
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JOB TITLE

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CLIENT

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DATE

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DRAWING TITLE

Extract of groundwater vulnerability map (Ref. 8).

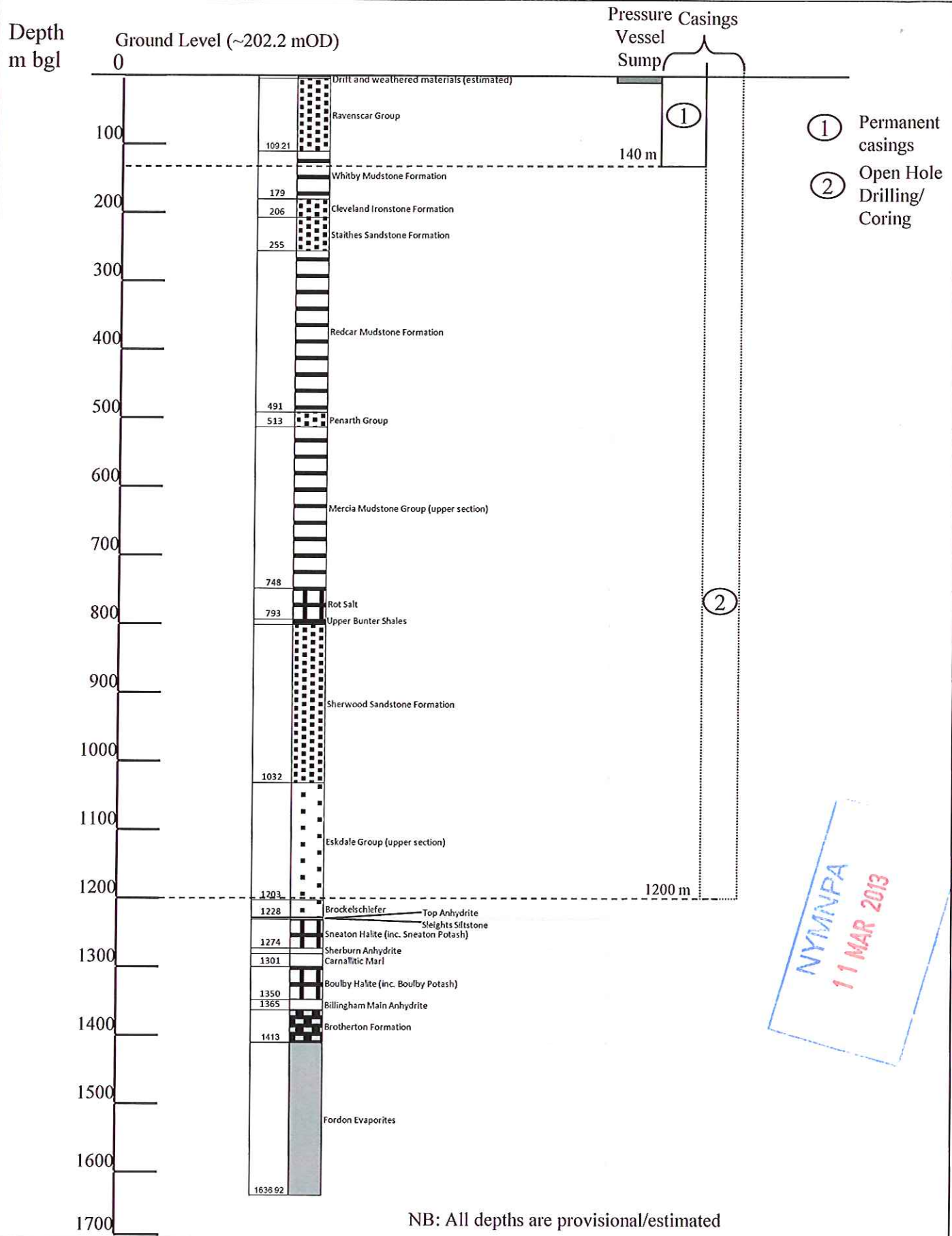
DRAWING NUMBER

Figure 4

STATUS

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NB: All depths are provisional/estimated

FWS CONSULTANTS LTD Environmental and Geological Consultants Merrington House, Merrington Lane Industrial Estate, Spennymoor, Co Durham. DL16 7UT Tel: 01388 420633 Fax: 01388 819705 www.fwsconsultants.com	JOB TITLE Project 40	CLIENT York Potash	DATE JAN 2013
	DRAWING TITLE Provisional Proposed Borehole Casing Depths	DRAWING NUMBER Figure 5	STATUS
			SCALE NTS

NYMNP
11 MAR 2013

APPENDIX 1
NOTES ON LIMITATIONS

NOTES ON LIMITATIONS

1 FWS Consultants Ltd (FWSC) has prepared this report solely for the use of the Client and/or his agent on the basis of exchange(s) of proposals and instructions, and FWSC accepts no responsibility or liability:-

- a) for use of this report by any party other than the person for whom it was commissioned, or;
- b) for the consequences of the report being used for any purpose other than that for which it was commissioned.

Should any third party wish to use or rely upon the contents of the report, written approval from FWSC must be sought. Furthermore, it is strongly recommended that independent advice is sought by that third party with respect to its specific proposals or requirements.

- 2 The conclusions and recommendations in this report represent our professional opinions, derived from currently accepted industry practices, exercising all reasonable skill and care to be expected of a professional environmental consultancy of similar size and experience. The assessments and judgments given in this report are directed by both the finite data on which they are based and the proposed works to which they are addressed, taking account of the resources devoted to it by agreement with the client and/or his agent (whether in writing, or subsequent verbal instructions).
- 3 Environmental desk studies/audits comprise a study of readily available information obtained from various identified sources, authorities and parties. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. Cost benefit analyses and estimations of income potentially available from sustainable resource systems are undertaken using current utility prices that may be subject to change. Any identified risks in desk study/audit reports are perceived risks based on the information available at the time. Actual risks can only be assessed after carrying out a physical investigation of the site.
- 4 Data acquisition during site investigations is subject to the limitations of the methods of investigation used and access constraints. Exploratory holes undertaken during fieldwork, particularly boreholes, investigate a small volume of ground in relation to the size of the site and thus can only provide an indication of site conditions. There may be some conditions relating to the site and the proposed development, such as localized "hotspots" of contamination that have not been disclosed by the investigation. The nature and extent of variations between these explorations may not become evident until further investigation. If variation or other latent conditions then appear evident, it will be necessary to re-evaluate the recommendations of this report.
- 5 The findings and opinions are relevant to the dates of the site works and should not be relied upon to represent conditions at substantially later dates. Site conditions will change over time due to natural variations and human activities. Groundwater, surface water and soil gas conditions should be anticipated to change with diurnal, seasonal and meteorological variations. Variation in the types and concentrations of contaminants and variations in their flow paths may occur due to seasonal water table fluctuations, past disposal practices, the passage of time, or subsequent developments or activities on the site or adjacent area.
- 6 The opinions expressed in this report regarding any contamination are based on simple statistical analysis and comparison with available guidance values. No liability can be accepted for the retrospective effects of any changes or amendments to these values.