Site Condition Report

Environmental Permit Variation

West Newton A Wellsite

East Riding of Yorkshire

PEDL 183

December 2018

www.rathlin-energy.co.uk

APPROVAL LIST

	Title	Name	Signature
Prepared By	HSE & Permit Advisor	Sean Smart	
Reviewed By	HSE and Planning Manager	Jonathan Foster	
Approved By	Country Manager	Tom Selkirk	

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1. INTRODUCTION

Rathlin Energy (UK) Limited (Rathlin) is a private company with its head office in Beverley, East Riding of Yorkshire. Rathlin is a petroleum exploration, development and production company with operations in the United Kingdom. Rathlin is the operator of PEDL183.

This Site Condition Report has been provided as a record of the site condition prior to the commencement of the WNA-2 drilling operations. It will continue to be updated as the operations progress and will be used to identify any changes to the environment as a result of the permitted operation when surrendering the environmental permit. For clarity, the West Newton A wellsite was previously referred to as the West Newton Wellsite.

2. SCOPE

This Site Condition Report is applicable to the West Newton A wellsite in accordance with the environmental permits and planning consent.

It is applicable to Rathlin, its contractors and subcontractors and can be used in support of an application to the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016 (EPR2016), where there is a requirement to provide a Site Condition Report. This Site Condition Report has been produced in accordance with the Environment Agency's H5 guidance.

This Site Condition Report has been prepared as part of an application to vary the existing West Newton A environmental permit (EPR/BB3001FT) and supersedes all previous versions of the Site Condition Report.

3. DEFINITIONS

EPR2016:	Environmental Permitting (England and Wales) Regulations 2016
HRA:	Hydrogeological Risk Assessment
Km:	Kilometre
m:	Metres
MD KB:	Measured Depth below Kelly Bushing
mm:	Millimetres
MAGIC:	Multi-Agency Geographic Information for the Countryside
PEDL:	Petroleum Exploration and Development Licence
TVD SS:	True Vertical Depth Subsea
UK:	United Kingdom
WNA-1:	West Newton A 1 Well
WNA-2:	West Newton A 2 Well

4. WELLSITE DETAILS

The proposed West Newton A exploratory operations are being undertaken at the following location:

West Newton A Wellsite
Rathlin Energy (UK) Limited
Fosham Road
Marton
Hull
HU11 5DA

National Grid Ref: TA 19268 39131

Site Area: 0.975 hectares

A Site Location Plan has been provided within Site Plans Document (RE-EPRA-WN-SP-004) and Appendix 1 of this Site Condition Report.

Figure 4.1: West Newton A Wellsite Location (Source: Google Earth October 2018)

5. SITE CONDITION PRIOR TO PERMIT ISSUE

The following section provides a detailed report on the current site condition of the West Newton A wellsite location at the point of application submission.

5.1 Source of Information

This Site Condition Report has been compiled using a range of information sources, including:

- Landmark, Envirocheck Report;
- MAGIC;
- The Environment Agency;
- LandIS Soilscapes website; and
- British Geological Survey.

5.2 Environmental Setting

The West Newton A wellsite is located to the north of West Newton and east of Marton. It is located within the parish of Aldbrough, in the East Riding of Yorkshire.

The surrounding landscape consists of flat open fields that are interspersed with patches of woodland and divided by hedgerows and ditches. An area of semi-improved grassland lies adjacent to the western boundary and extends 10m into the field. There are a number of mature hedgerows that border the field.

The nearest conurbations are West Newton, circa 1,130m to the south and Marton, circa 800m to the west.

A desktop study was undertaken to identify any designated sites which may be affected by the proposals. The results of the desktop survey using the Multi-Agency Geographic Information for the Countryside (MAGIC) interactive mapping tool concluded that no RAMSAR or Special Areas of Conservation are within 10km of the wellsite. Two Special Protection Areas, Hornsea Mere and Greater Wash, were identified within 10km of the wellsite. Additionally, Scheduled Ancient Monuments, National Nature Reserves or Local Nature Reserves were not identified within a 2km boundary of the proposed wellsite. A Sites of Special Scientific Interest, Lambwath Meadows, was identified approximately 1km from the wellsite.

Five Local Wildlife Sites have been identified within 2km of the proposed wellsite. The closest, 821m southwest, is The Moors, Burton Constable. The area is predominantly arable fields with interspersed woodland and hedgerows.

It is noted that a number of water courses, typically field drains, are present, the closest being circa 9m from the western boundary.

5.2.1 Flood Risk

Using the Environment Agency's Flood Mapping tool, it is evident that West Newton A wellsite is located within flood zone 1, an area with a low probability of flooding. Appendix 2 provides the result of flood risk mapping which indicates that a flood risk assessment is not required as part of the permit application.

5.2.2 Geological Setting

The near surface geology across the West Newton A wellsite is Devensian Period Boulder Clay, which is a thick drift deposit.

Below the Devensian Age Boulder Clay is located the Cretaceous Age Chalk, which is designated by the Environment Agency as a principal aquifer of regional importance. The Chalk in the region is subdivided into the following sub-units (in increasing age and depth) Rowe, Flamborough, Burnham, Welton and Ferriby Chalks.

This Chalk formation forms the Yorkshire Wolds, which starts immediately north of Bridlington and runs southwards. The structural dip of the Chalk is to the east north-east with an angle of about 1.4° (1 in 40). To the east of the Yorkshire Wolds, a buried cliff line, which runs north-south through Beverley, indicates the transition into the lower lying Holderness coastal plain in which thick drift deposits overly the Chalk strata.

A summary of the geology is provided in Figure 5.1 and is derived from a true representation of the subsurface geology encountered during the WNA-1 drilling operation.

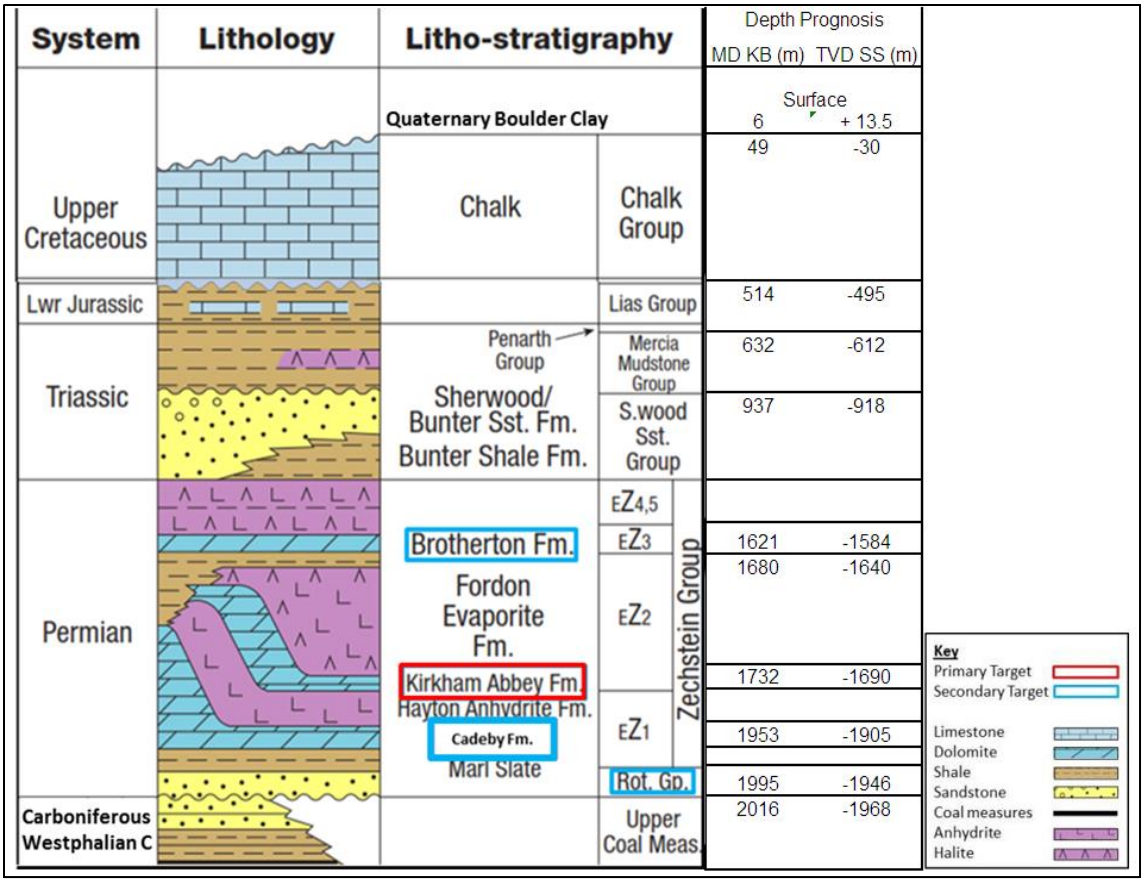

Figure 5.1: Encountered Geology at West Newton A wellsite

5.2.3 Hydrogeological Setting

The West Newton A wellsite is situated on Boulder Clay, which overlays the Chalk formations beneath it. The Boulder Clay is generally considered a low permeability aquitard and is classified by the Environment Agency as unproductive strata within the area of the site. Due to the thickness of the Boulder Clay, it is highly unlikely that there is any hydraulic connection with the chalk. Any aquifers contained within the Boulder Clay are small and are likely to be isolated.

The Chalk formation is designated a principal aquifer by the Environment Agency. The groundwater quality within the Chalk aquifer is understood to be naturally saline (mineralised formation water rather than saline intrusion). Under the Water Framework Directive classification, the aquifer has been designated by the Environment Agency as poor quality.

Deeper strata beneath the Chalk, such as the Jurassic, Triassic and Permian formations may retain localised permeability despite their depth, however, these strata are not considered to be economically usable due to their great depth and are likely to possess saline or mineralised (poor) groundwater quality.

The original Hydrogeological Risk Assessment (HRA) for the West Newton A well test has been reviewed by Rathlin and is considered suitable and relevant for the WNA-2 well testing programme. For clarity, no Groundwater activities will be taking place during the proposed well testing operations. An acid wash and squeeze may be undertaken, however due to the concentration and quantity of the acid it is considered de-minimis. A copy of the HRA has been provided within Appendix 3.

5.3 Pollution History

5.3.1 Pollution Incidents Affecting the Land

The development has been specifically and carefully designed to ensure that all processes with the potential to lead to contamination are contained within areas which are separated from the underlying strata, ground and surface waters. All site operations which have the potential to lead to contamination of the surrounding environment will take place within the compound and the plant which have been designed and installed to minimise the risk of contamination.

Site activities will be regulated by an environmental permit issued by the Environment Agency. The permit will formalise operations at the site to ensure that they are undertaken with a view to minimising the risk of potential contamination.

5.3.2 Historical Land Use and Associated Contamination

Prior to the West Newton A wellsite being constructed, the land formed part of an arable field. Below is a summary of previous land use and changes in the local area following a review of maps obtained from Envirocheck. These maps do not identify any significant land use changes or evidence of historic landfills or pits.

- 1855 - 1892: Site located within agricultural land with vegetated hedgerows. Lambwath Stream runs 400m to the north and comprises a network of drains. The Lambwath Stream valley is labelled as liable to be flooded. Course of drain running northwards towards Lambwath Stream identified adjacent to site. Wooded area of West Newton Belts 800m to the southwest. Moat identified around Murton Chapel, 600m to the southwest.
- 1910 - 1911, 1928 -1929: Same land use, Lambwath Stream labelled as Keyingham Level Drainage and liable to flooding.

- 1951 - 1952, 1956 -1957: Same land use but Lambwath Stream valley no longer labelled as liable to flooding.
- 1980 - 1983: Same land use, Barns 650m to the east labelled as High Fosham. Pond labelled as lagoon identified 700m to the northwest immediately north of Lambwath Stream.
- 2006: Same land use, small ponds located 350m to west and 900m to east. Drainage network clearly visible by colouring.
- 2010: Same land use to 2006 apart from pocket of wooded land 300m to the northwest.

5.3.3 Visual and Olfactory Evidence of Existing or Historic Contamination

There is no visual or olfactory evidence to suggest existing or historic contamination at the wellsite location.

5.3.4 Evidence of Damage to Pollution Prevention Measures

No evidence of damage to any pollution prevention measures have been identified at the time of this report being produced.

Rathlin have previously identified a puncture to its High Density Polyethylene (HDPE) liner within the upper part of its containment ditch during a period of inactivity at the wellsite. It is believed that this was caused by vandalism.

The Environment Agency were informed immediately following the incident and the liner was repaired immediately. No pollution occurred as a result of the puncture as the rainwater levels were significantly below the location of the puncture. Pollution Prevention measures will be checked prior to the undertaking of future permitted activities.

6. WELLSITE CONSTRUCTION

The West Newton A wellsite was constructed in the 2nd quarter of 2013, to enable the drilling and testing of up to two exploratory boreholes.

The topsoil was stripped from the site area and placed in a storage bund along the eastern boundary of the wellsite. Subsoil was removed to create a level surface and stored in a separate bund along the southern boundary. A ditch was excavated along the perimeter of the wellsite to provide environmental containment.

Once the surface of the site was level and the perimeter ditch excavated, an impermeable membrane, constructed from 1mm fully welded HDPE, was installed across the entire site area and perimeter ditch. The impermeable membrane is protected above and below from a layer of nonwoven needle punched geotextile, which protects the impermeable membrane from being damaged by subsequent operations. Inspections and testing of the impermeable membrane were performed during installation to confirm its integrity.

Geogrid was then laid across the site area and overlaid by 300mm thick layer of MOT Type 1 stone to provide a suitable working surface. Figure 6.1 details a cross section of the wellsite surface construction.

Three sides of the containment ditch were backfilled using 300mm twin walled perforated plastic pipe and backfilled using clean stone. The purpose of backfilling the perimeter ditches was to provide additional working area.

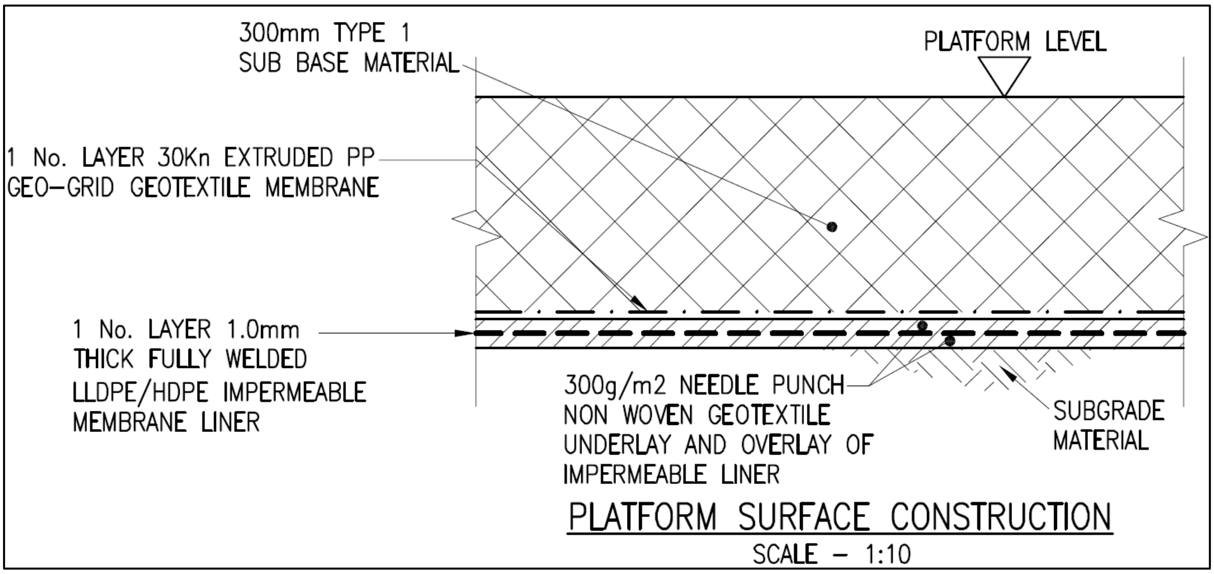

Figure 6.1: Wellsite Construction Cross Section

Within the centre of the site a concrete cellar was constructed, formed from pre-cast concrete rings. The impermeable membrane has been integrated into the cellar walls using foam back metal batons to ensure that the integrity of the site is maintained. The cellar rings were sealed together using a tokstick sealant and a 200mm concrete jacket surround cast. The cellar provides an additional containment and houses the wellhead. An integrity test was carried out following construction to confirm environmental integrity. Integrity tests proved that the cellar had environmental integrity.

Following the construction of the West Newton A wellsite in 2013 additional construction works have been carried out, these include:

- Replacement of perimeter stock fencing with a 1.8m high paladin fencing;
- Installation of two (2) groundwater monitoring boreholes;
- Installation of a Class 1 Oil-Water Separator; and
- Segregating part of the wellsite to create a car parking area at the northern boundary (non-active area).

A second well cellar will also be built for the drilling of the second borehole, known as the West Newton A-2 well (WNA-2). For clarity, Rathlin currently holds the necessary environmental permits to drill the second well.

7. WELL CONSTRUCTION

7.1 West Newton A – 1 Well

Drilling of WNA-1 commenced in early 3rd quarter 2013 and was completed by the end of 3rd quarter 2013.

Construction of the borehole began with the mobilisation of a small waterwell rig, which drilled a 32" hole through the boulder clay and into the top section of the chalk to a depth of approximately 69m Below Ground Level. Once the borehole was drilled, steel casing was run and cemented back to surface. This rig was then removed from site.

A larger oilfield drilling rig was then mobilised to site to drill the remaining hole sections to the target depth. The operations involved drilling a number of hole sections, which reduced in size to and through the target formations. As each hole size was drilled, steel casing was run and cemented in place. Once each casing string was run, it was pressure tested to confirm its integrity.

With the casing strings run and cemented in position, it is considered that there is sufficient protection and isolation between the different formations to prevent fluids from other formations contaminating any aquifers.

7.2 West Newton A – 2 Well

This Site Condition Report will be revised following the completion of the WNA-2 well to ensure that information relating to the condition of the wellsite remains current.

8. Development Activities

8.1 Permitted Activities

The West Newton A wellsite currently holds the following environmental permits:

- Mining Waste Permit (EPR/BB3001FT) incorporating both a Mining Waste Operation and an Installation activity for the incineration of hazardous waste above 10 Tonnes per day. It also includes a Water Discharge Activity for the discharge of clean surface run-off water from the wellsite; and
- SR 2014 No4 Permit (EPR/PB3030DJ) for the Accumulation and Disposal of radioactive waste from the NORM Industrial Activity of the production of oil and gas.

8.2 Additional Activities

Additional activities proposed to be undertaken at the West Newton A wellsite which do not fall within the regulatory regime of EPR2016 will include:

- Car parking for staff vehicles;
- Provision of welfare facilities for site staff;
- Well maintenance; and
- Storage and disposal of non-hazardous and hazardous waste not directly associated with the permitted activities.

8.3 Environmental Risk Assessment

An Environmental Risk Assessment (RE-EPRA-WN-ERA-007) has been submitted to the Environment Agency as part of an application for a variation to the existing West Newton A environmental permit (EPR/BB3001FT).

9. ENVIRONMENTAL MONITORING

To ensure that operations conducted at the West Newton A wellsite do not cause an adverse impact on the environment Rathlin has undertaken a suite of environmental monitoring. Environmental monitoring is undertaken in accordance with the methodologies presented to the Local Planning Authority, East Riding of Yorkshire Council and the Environment Agency. This Section provides details of the environmental monitoring, which for clarity consists of sampling and analysis of a number of environmental parameters including:

- Air;
- Groundwater;
- Surface Water; and
- Soils.

The results of environmental monitoring have been issued to the Environment Agency in accordance with the existing environmental permit.

9.1 Air Quality Monitoring

Four ambient air quality monitoring locations were identified and agreed with the Environment Agency and have been the subject of monitoring during periods of operation at the West Newton A wellsite. Additional spot sampling for Methane was also undertaken as Methane could not be analysed via the diffusion tube methodology. As such a grab sample bag was used. The parameters being monitored for included:

- Methane;
- Benzene;
- Toluene;
- Ethylbenzene;
- m,p-Xylene;
- o-Xylene;
- Volatile Organic Compounds;
- Nitrogen Dioxide;
- Nitric Oxide; and
- Sulphur Dioxide.

9.2 Groundwater Monitoring

Two groundwater monitoring boreholes were installed at the West Newton A wellsite in 2014. The wellsite has been the subject of groundwater monitoring since the 26 June 2014. The parameters being monitored for include:

- Depth to Groundwater;
- Groundwater Elevation;
- Mercury – Total Hg;
- Cadmium – Total Cd;
- pH;
- BOD;
- Turbidity;
- Total Suspended Solids;
- Alkalinity;
- Hardness;
- Sulphate;
- Chloride;
- Nitrate;
- Calcium;
- Magnesium;
- Potassium;
- MTBE;
- Benzene;
- Toluene;
- Ethylbenzene;
- P/m-Xylene;
- 0-Xylene;
- SR Toluene;
- SR 4-BFB;
- TPH (C5-35);and
- Methane.

Groundwater samples are collected on a 3 monthly basis during periods of inactivity at the West Newton A wellsite, with the results being formally submitted to the Environment Agency for review in line with the conditions set by the environmental permit.

During periods of well testing activities, as stated within the environmental permit, the frequency in which samples will be taken will increase to a monthly basis to ensure that the operations being undertaken do not have an impact on groundwater quality.

Groundwater Monitoring will continue to be undertaken through the lifetime of the West Newton A wellsite.

9.3 Surface Water Monitoring

The surface water collected within the West Newton A wellsite perimeter containment ditch is the subject of 3 monthly sampling and analysis with the results being submitted to the Environment Agency. The parameters being monitored for included:

- pH;
- Electrical Conductivity;
- Total Suspended Solids;
- Biochemical Oxygen Demand ;
- Turbidity;
- Alkalinity (Total, Bicarbonate);
- Hardness;
- Mercury (Total Hg);
- Cadmium (Total Cd);
- Sulphate;
- Sulphur;
- Chloride;
- Sodium;
- Nitrate;
- Calcium;
- Magnesium;
- Potassium;
- Aluminium;
- Iron;
- Manganese;
- Zinc;
- Benzene;
- Toluene;
- Ethel Benzene;
- p/m-Xylene;
- o-Xylene;
- MTBE; and
- Total Petroleum Hydrocarbons.

The purpose of the surface water monitoring is to ensure that any surface water discharged from the wellsite is clean. For clarity, water discharges will only take place when the wellsite is inactive.

9.4 Soil Analysis

A series of shallow geotechnical boreholes were drilled prior to the site being constructed. These boreholes confirmed that the average topsoil depth across the site was 0.20m. The subsoil consists of soft clay with occasional sand lenses. There was no indication of groundwater within these shallow boreholes.

In summary, the soil analysis provides a record for future restoration of the site. The results show that there is no specific contamination on the wellsite and it is considered inert.

The soils which were excavated as part of the construction phase have been stored in a temporary bund along the perimeter of the wellsite.

APPENDIX 1 – SITE LOCATION PLAN

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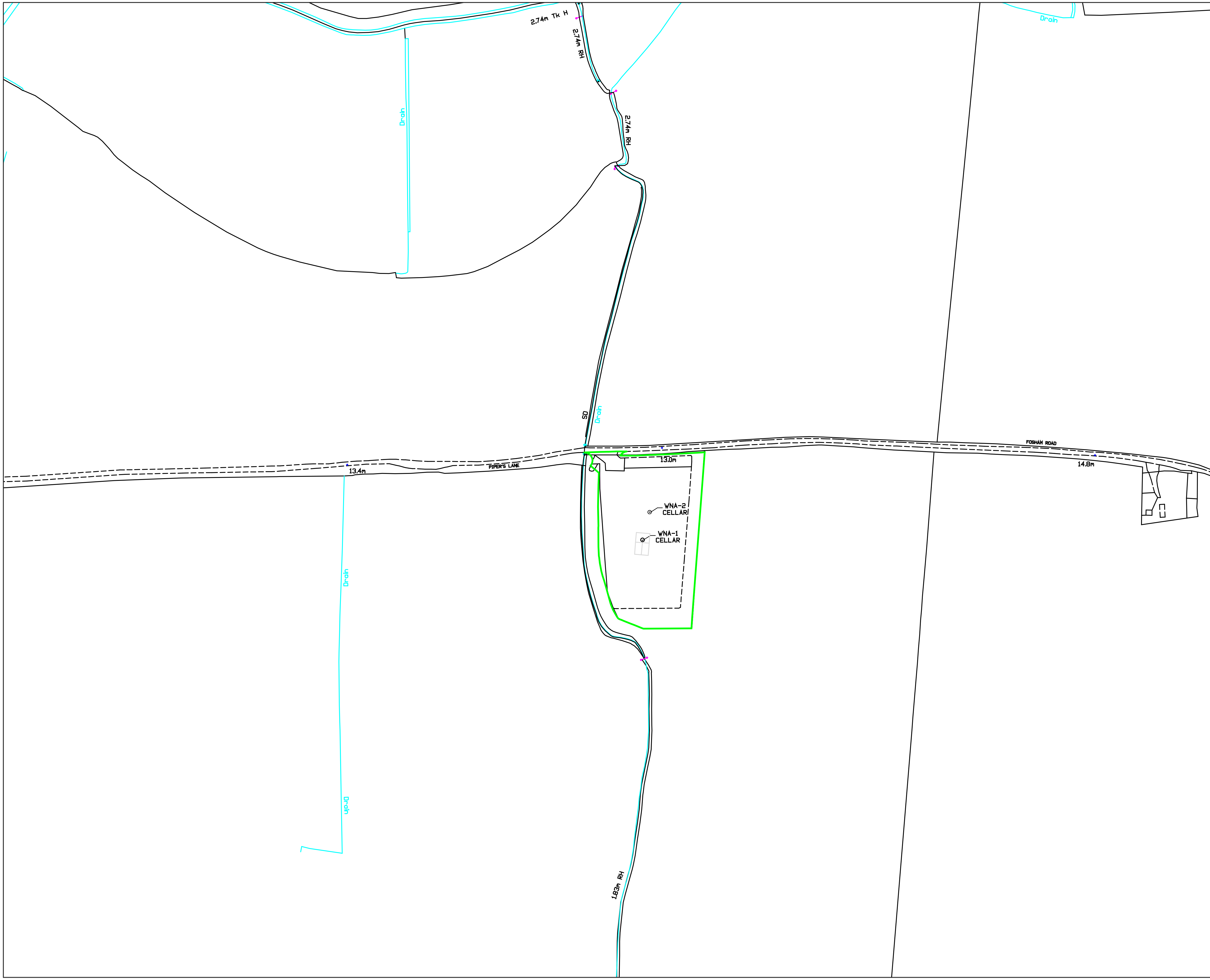

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KEY:

SITE BOUNDARY

REV	DATE	BY	DETAILS	APR
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
0	DEC18	JF	ORIGINAL ISSUE	JF

Rathlin Energy

Rathlin Energy (UK) LIMITED

SITE	WEST NEWTON A WELLSITE
PROJECT	WEST NEWTON A-2 APPRAISAL WELL
TITLE	LOCATION PLAN

SCALE	1:2,500	DWG NO.
SIZE	A3	RE-EPR-WNA-SP-004-1
SHEET	1 OF 1	

APPENDIX 2 – FLOOD RISK MAPPING RESULTS

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Environment Agency

Flood map for planning

Your reference	Location (easting/northing)	Created
West Newton A	**519269/439143**	**11 Oct 2018 3:05**

Your selected location is in flood zone 1, an area with a low probability of flooding.

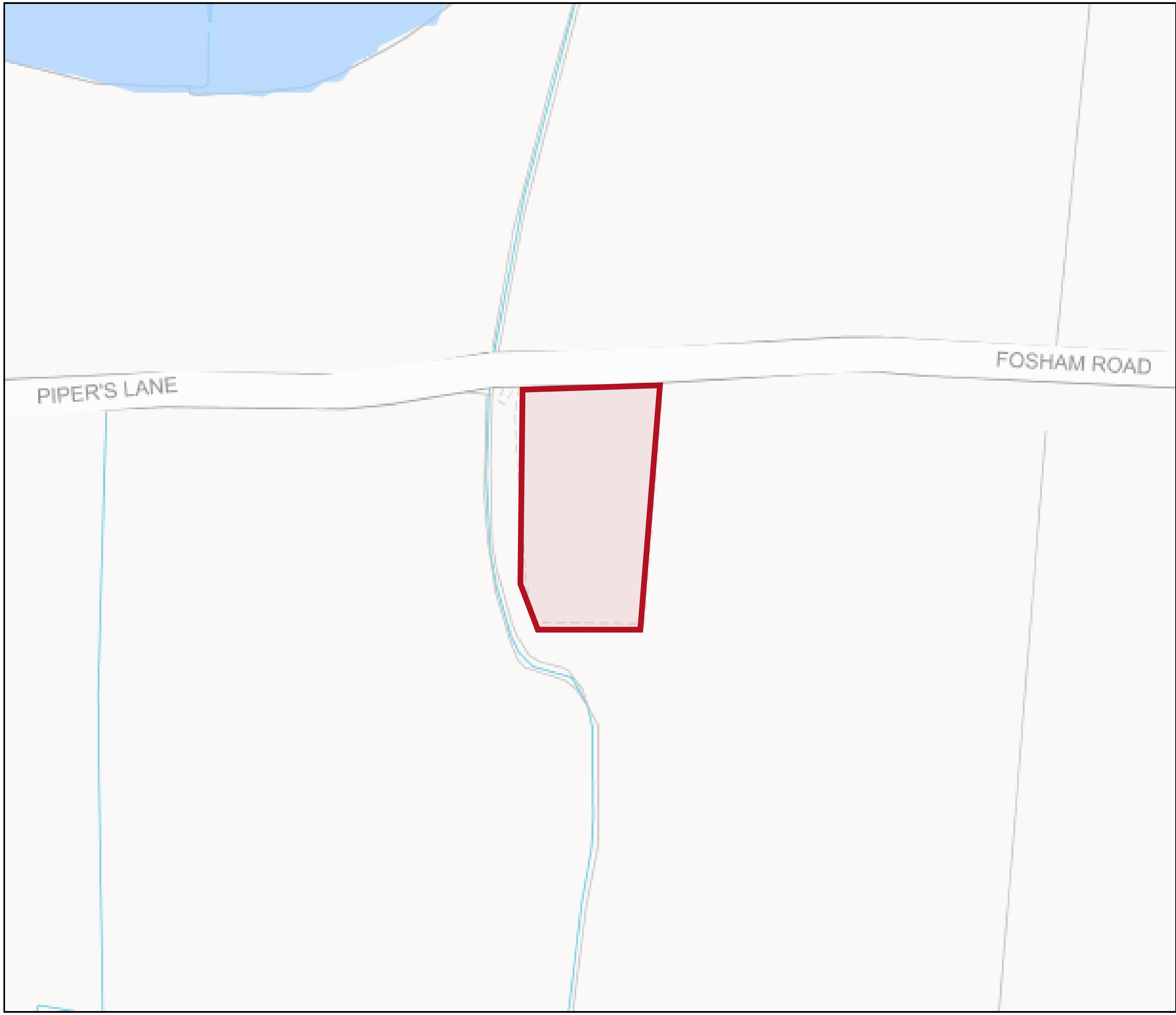
This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn’t include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.



Environment Agency

Flood map for planning

Your reference
West Newton A

Location (easting/northing)
519269/439143

Scale
1:2500

Created
11 Oct 2018 3:05

Selected area
Flood zone 3
Flood zone 3: areas benefitting from flood defences
Flood zone 2
Flood zone 1
Flood defence
Main river
Flood storage area

0 20 40 60m

APPENDIX 3 – HYDROGEOLOGICAL RISK ASSESSMENT

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Hydrogeological Risk Assessment
West Newton Wellsite, East Riding of Yorkshire

Final Report
July 2012

47063550 / HRA-WN-MARP0001

Prepared for

Revision Schedule

Hydrogeological Risk Assessment
July 2012

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	20 July 2012	Draft	**James North** Graduate Hydrogeologist	**Sean Needham** Principal Hydrogeologist	**Sean Needham** Principal Hydrogeologist
02	25 July 2012	Final Draft	**Sean Needham** Principal Hydrogeologist	**Sean Needham** Principal Hydrogeologist	**Sean Needham** Principal Hydrogeologist
03	26 July 2012	Final	**Sean Needham** Principal Hydrogeologist	**Sean Needham** Principal Hydrogeologist	**Sean Needham** Principal Hydrogeologist

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Limitations

URS Infrastructure & Environment UK Ltd ("URS") has prepared this Report for the sole use of Moorhouse Drilling and Completions ("Client") and Rathlin Energy (UK) Limited in accordance with the Agreement under which our services were performed as set out in proposal reference 018062012-SNN issued via e-mail by Dr. Sean Needham (URS) to Mr Philip Silk of Moorhouse Drilling & Completions on 18 June 2012. Authorisation to proceed was received from Andrew Smith of Moorhouse Petroleum Limited on 20 June 2012 (via e-mail) and the works were undertaken under Moorhouse Drilling & Completions Purchase Order MDC/Rathlin/-WN/URS/0001, dated 18 June 2012. No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by URS. This Report is confidential and may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of URS.

The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by URS has not been independently verified by URS, unless otherwise stated in the Report.

The methodology adopted and the sources of information used by URS in providing its services are outlined in this Report. The work described in this Report was undertaken in July 2012 and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

URS disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report, which may come or be brought to URS' attention after the date of the Report.

Certain statements made in the Report that are not historical facts may constitute estimates, projections or other forward-looking statements and even though they are based on reasonable assumptions as of the date of the Report, such forward-looking statements by their nature involve risks and uncertainties that could cause actual results to differ materially from the results predicted. URS specifically does not guarantee or warrant any estimate or projections contained in this Report.

Unless otherwise stated in this Report, the assessments made assume that the sites and facilities will continue to be used for their current purpose without significant changes.

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1 Introduction

1.1 Background

This report has been prepared on behalf of Rathlin Energy (UK) Limited in accordance with URS proposed scope of works reference 018062012-SNN issued via e-mail by Dr. Sean Needham (URS) to Mr Philip Silk of Moorhouse Drilling & Completions on 18 June 2012. Authorisation to proceed was received from Andrew Smith of Moorhouse Petroleum Limited on 20 June 2012 (via e-mail) and the works were undertaken under Moorhouse Drilling & Completions Purchase Order MDC/Rathlin/-WN/URS/0001, dated 18 June 2012.

The current report provides a hydrogeological risk assessment (HRA) for the proposed drilling of up to two exploration wells at West Newton, East Riding of Yorkshire. The site covers 0.9 ha and is located approximately 14km to the east of Beverley, near Kingston Upon Hull, Yorkshire at national grid reference 519300, 439170 (refer to Figure 1).

It is understood that Rathlin Energy (UK) Limited will soon be applying for planning permission for the construction of a temporary drilling site with associated access, to drill up to two exploration boreholes for the purpose of mineral exploration (oil and natural gas). Following site construction it is proposed to drill up to two exploration wells to a depth of approximately 3,214m below ground level (approx. 3,201m below sea level). Various tests to evaluate the underground formations and reservoir characteristics are proposed. If no commercial quantities of petroleum hydrocarbons (oil & natural gas) are found then the site will be restored. However, if economic quantities of petroleum hydrocarbons are found a planning application will be made for extraction (production).

As yet no comments have been received from pre-application consultees such as the Environment Agency or Yorkshire Water Services Ltd.

2 Assessment Method

The assessment has been undertaken using the Source-Pathway-Receptor model, which is in line with the EA Horizontal Guidance Note H1 – Annex (j) (EA 2010). This model identifies the potential sources or 'causes' of effect as well as the receptors (water resources) that could potentially be affected. However, the presence of a potential effect source and a potential receptor does not always infer an effect, there needs to be a clear mechanism or 'pathway' via which the source can have an effect on the receptor.

The first stage in utilising the Source-Pathway-Receptor model is to identify the causes or 'sources' of potential impact. The sources have been identified through a review of the details of the proposed development, including the size and nature of the development, potential construction methodologies and timescales. This has been undertaken in the context of local conditions relative to water resources near the site, such as topography, geology, climatic conditions and potential sources of contamination.

The next stage is to undertake a review of the potential receptors, that is, the water resources themselves that have the potential to be affected. The identification of potential water resource receptors has been undertaken through a review of baseline data.

The last stage is to determine if there is an exposure pathway or a 'mechanism' allowing an effect to potentially occur between source and receptor.

Once potential effects on water resources are identified, it is necessary to determine how significant the effects are likely to be, to enable the identification of potential mitigation measures that can counteract negative effects. The effect on the receptors depends largely on the sensitivity of the receptor and the magnitude of effect experienced.

An assessment of the significance of each effect has been undertaken based on the methodology provided in the Web-based Transport Analysis Guidance; specifically the Water Environment Sub-Objective WebTAG Unit 3.3.11 (Department of Transport 2003). This provides an appraisal framework for taking the outputs of the Environmental Impact Assessment process and analysing the key information of relevance to the water environment. The guidance is based on guidance prepared by the Environment Agency and builds on the water assessment methodology in Design Manual for Roads and Bridges (DMRB) 11:3:10 (Highways Agency 2008). Although this method was designed primarily for transport projects it is applicable to and widely used for other development types.

Receptor Sensitivity

The sensitivity or importance of each water resource (the receptor) is based on its considered value, for example its value as an ecological habitat, as a source of drinking water or as a recreational resource (see Table 1).

Table 1 Importance of Water Resource

Importance	Criteria	Examples
Very high	Water resource with an importance and rarity at an international level with limited potential for substitution.	- A water resource making up a vital component of a protected Special Area of Conservation (SAC) or Special Protection Area (SPA) under the EC Habitats Directive - A water body achieving a status of 'High status or potential' under the WFD - Principal aquifer providing potable water to a large population - EC designated Salmonid fishery
High	Water resource with a high quality and rarity at a national or regional level and limited potential for substitution.	- A water resource designated or directly linked to a Site of Special Scientific Interest (SSSI). - Principal aquifer providing potable water to a small population - A river designated as being of 'Good status' or with a target of Good status or potential under the WFD - A water body used for national sporting events such as regattas or sailing events - EC designated Cyprinid fishery
Medium	Water resource with a high quality and rarity at a local scale; or Water resource with a medium quality and rarity at a regional or national scale.	- Secondary aquifer providing potable water to a small population - An aquifer providing abstraction water for agricultural and industrial use
Low	Water resource with a low quality and rarity at a local scale.	- A non 'main' river or stream or other water body without significant ecological habitat

Magnitude of Impact

The magnitude of a potential impact is then established based on the likely degree of impact relative to the nature and extent of the proposed development (see Table 2). It is important to consider at this stage that potential impacts can be beneficial as well as adverse which would be highlighted within an Environmental Impact Assessment (EIA)[1] were this to be required as part of the planning application. The derivation of magnitude is carried out independently of the importance of the water resource.

[1] Not all planning applications require an EIA to be undertaken.

Table 2 Magnitude of Impact

Magnitude of Impact	Criteria	Examples
High	Impact results in a shift in a water bodies potential attributes.	- Loss of EU designated Salmonid fishery - Change in WFD classification of a water body. - Compromise employment source - Loss of flood storage/increased flood risk - Pollution of potable source of abstraction
Medium	Results in impact on integrity of attribute or loss of part of attribute.	- Loss / gain in productivity of a fishery. - Contribution / reduction of a significant proportion of the effluent in a receiving river, but insufficient to change its WFD classification - Reduction / increase in the economic value of the feature.
Low	Results in minor impact on water bodies attribute.	- Measurable changes in attribute, but of limited size and / or proportion.
Very Low	Results in an impact on attribute but of insignificant magnitude to affect the use / integrity.	- Physical impact to a water resource, but no significant reduction / increase in quality, productivity or biodiversity. - No significant impact on the economic value of the feature. - No increase in flood risk

Significance of Effect

Once the magnitude of an impact is derived, the significance of the potential effect can then be derived by combining the assessments of both the importance of the water resource and the magnitude of the impact in a simple matrix (see Table 3 below).

Effects which are assessed to be major or moderate are considered to be significant; those that are minor and negligible are not considered to be significant.

Table 3 Significance of Effect

Sensitivity of Receptor	Magnitude of Impact			
	High	**Medium**	**Low**	**Very Low**
Very High	Major	Major / Moderate	Moderate	Moderate / Minor
High	Major / Moderate	Moderate	Moderate / Minor	Minor
Medium	Moderate	Moderate / Minor	Minor	Negligible
Low	Moderate / Minor	Minor	Negligible	Negligible

3 Baseline Conditions

3.1 Site Description

The planning application is for a site of 0.9 ha located in the civil parish of Aldbrough in the East Riding of Yorkshire, National Grid reference (NGR) 519300E, 439170N. The location of the site and extent of the study area is shown in Figure 2. The study area of this report is the site together with the territory up to 2 km radius from the site boundary.

The site is located 1.5km north of the hamlet of West Newton in an area of low lying land known as Holderness, set between the Yorkshire Wolds Chalk uplands and the coastline of the North Sea (as identified in Figure 3). Holderness is a rich area of agricultural lowland, which was drained in the middle ages for cultivation. In the vicinity of the site the land is flat with the land elevation predominantly between 10 and 20m Above Ordnance Datum (AOD), which generally declines gradually to the west towards the valley of the River Hull where ground elevations are below 5mAOD.

The site is located at an elevation of approximately 13m AOD and is bound to the west by a small stream which flows northwards towards the Lambwath Stream, located approximately 400m from the site. The Lambwath Stream flows from east to west and forms a local valley that receives surface water from a network of locally north to south trending streams and drains. The Lambwath Stream valley bottom ranges in width between 200m and 700m in the vicinity of the site at an elevation of between 5 and 10m, gently sloping to the west.

The mean annual rainfall is estimated at between 600 and 660mm/a based on the regional term average (1971 to 2000) annual rainfall map for East England (refer to http://www.metoffice.gov.uk/climate/uk/averages/regmapavge.html#neengland) and the long term 1971-2000 annual rainfall of 565.4mm recorded at Cleethorpes (7m Above Mean Sea Level (AMSL)) located approximately 45km to the southeast of the West Newton well site.

3.2 Surface Water and Drainage

Lambwath Stream is the closest main watercourse to the site, located approximately 400m to the north and flows in a westerly direction through the village of Skirlaugh until it reaches Monkbridge Stream (drain) at NGR 511410E 437300N, which then flows in a southerly direction into Holderness drain towards Kingston Upon Hull until reaching the tidal river Humber. Notable surface water features local to the site are highlighted on Figure 2.

The proposed wellsite is located adjacent to an unnamed surface water field drain which flows along the western edge of the site northwards, meeting Lambwath Stream at 519200E 439550N. Surface elevation contours suggest that the catchment to the unnamed stream adjacent to the site is relatively small and is likely to consist of several arable fields. The site is surrounded by several other unnamed surface water field drains, which generally flow northwards towards Lambwath Stream.

The only other named surface watercourses in the vicinity of the site is named L Dike, located 1,800m to the east flowing northwards towards Lambwath Stream, and Norward Drain, located 2,100m to the southwest which flows to the south. Numerous small unnamed ponds have been identified from OS maps, of which the closest is located 240m to the northwest of the site. No other surface water features of note have been identified.

The Holderness catchment is not considered in the Hull and East Riding Catchment Abstraction Management Strategy (Environment Agency, 2006). However, it is noted that there are very few surface water abstraction licenses to the east of Hull. Many of the drains are noted as being level controlled by pumping managed by Internal Drainage Boards, with water levels influenced by the tide.

Data obtained from the EA (2012) indicates that no surface water data is available within a 2km radius of site. The closest surface water level and surface water quality records are available for Lambwath Bridge (located 3km to the northwest of the site) where water depths varied between 0.17m and 0.54m between November 2011 and April 2012. No further information was made available to URS.

3.3 Geology

The regional superficial and bedrock geology in the Yorkshire Wolds and Holderness area is illustrated in Figure 3. Site specific geological maps are included in Figures 5 and 6.

The Yorkshire Wolds form the western edge of a broad synclinal basin of Cretaceous Age rocks starting in the north at Bridlington, with an axis that runs approximately along the North Sea coast. The structural dip of the Chalk is to the ENE with an angle of about 1.4° (1 in 40).

To the east of the Yorkshire Wolds, a buried cliff line which runs north-south through Beverley indicates the transition into the lower lying Holderness coastal plain in which thick drift deposits overly the Chalk strata (Allen et al, 1997).

A geological cross section, constructed in a position north of the proposed drilling site is shown in Figure 4. The section is annotated with the approximate equivalent position of the current site and presents the general easterly dip of the strata.

The site is located on Devensian Period, drift deposits called Boulder Clay (Till), overlying the boundary between the Rowe and Flamborough Chalk formations. Boulder Clay is a superficial deposit that predominantly comprises a clay grade matrix within which, a complex mixture of sediment grades may be present (eg silts, sands, gravels boulders etc) formed during the various Glaciation periods over the last 2 million years. The mixture of sediment grades being derived from materials scoured by glaciers, depositing moraines of clay dominated Till and generally more localised outwash sand and gravel from periods of seasonal and post glacial meltwaters. The drift extensively covers the coastal plain reaching a thickness of up to 45m (Allen et al, 1997). Indeed a historical borehole record for an assumed disused borehole (TA23NW15) located 1.8km to the southeast, indicated up to 45.4m of Boulder Clay (BGS Geoindex, 2012).

Within the Boulder Clay are localised areas of shallow Devensian Age Sand and Gravel (glaciofluvial deposits), identified in nearby disused boreholes (TA13NE27), thought to be no more than 3m in thickness (BGS Geoindex, 2012). The low lying valley of Lambwath Stream, close to the site, is underlain with Flandrian Age Alluvium comprising clays, silts, sand and gravel. Sand, Gravel and Alluvium have been identified at thicknesses of about 3m in nearby disused boreholes (TA13NE31, TA13NE26, TA13NE27, TA13NE28) which are within 2km of the site (BGS Geoindex, 2012).

At depth beneath the Devensian Age Boulder Clay is located the Cretaceous Age Chalk, which is designated by the EA as a principal aquifer of regional importance. The Chalk in the region is sub-divided into the following sub-units (in increasing age & depth) Rowe, Flamborough, Burnham, Welton and Ferriby Chalks, which dip to the east. The junction between the Boulder Clay and the Chalk represents an unconformity, with the top of the Chalk representing an ancient erosional surface. The base of the Chalk is estimated at -400mAOD, based on contours of the base of chalk (Foster and Milton, in Allen et al, 1997).

Beneath the Chalk lie the Lower Cretaceous, Jurassic and Triassic formations.

A summary of the geological formations is provided in Table 4. The deeper geological formations have been derived from unpublished data supplied by Rathlin Energy (UK) Limited (July 2012).

Table 4 Indicative Geological Succession at Site

Period	Geological Formation	Approximate Thickness [1] [2] (m)
Devensian	Boulder clay	40 - 45
Upper Cretaceous	Rowe Chalk	355
	Flanborough Chalk	
	Burnham chalk	
	Welton Chalk	
	Ferriby Chalk	
Jurassic	Lias	180
Triassic	Penarth Group	500
	Mercia Mudstone	
	Sherwood Sandstone	
	Bunter Shale	
Permian	Brotherton	1000
	Fordon Evaporite	
	Kirkham Abbey	
	Hayton Anhydrite	
	Cadeby	
	Marl Slate	
Carboniferous Westphalian	Upper coal Measures	150
	Middle Coal Measures	300
	Lower Coal Measures	150
Carboniferous Namurian	Millstone Grit	400
	Bowland Shales	
Carboniferous Dinantian	Carboniferous Limestone	350
Devonian	Old Red Sandstone Group	-

Sources [1]: BGS Geoindex (2012), Allen et al (1997), NERC (1980), Smedley (2004).

Source [2] Interpreted from Unpublished data from Rathlin Energy (UK) Limited (July 2012).

3.4 Hydrogeology

3.4.1 Hydrogeological Units

Boulder Clay

The Boulder Clay is generally considered a low permeability aquitard and is classified by the Environment Agency (EA) as unproductive strata in the area of the site (refer to Figure 7). Given the extensive thickness of the Boulder Clay (40-45m), it is considered highly unlikely that a hydraulic connection is present between the underlying Chalk aquifer and local surface water features in the vicinity of the site.

Sand, Gravel, and Alluvium.

The superficial Sand, Gravel and Alluvium deposits in the vicinity of the site are unconfined and are classified by the EA as Secondary A aquifers (refer to Figure 7). The aquifers are unlikely to be greater than 3m in thickness, as identified by the thickness of these sediments logged in nearby disused boreholes.

The unnamed ditch adjacent to the site is likely to be in continuity with the alluvium underlying the Lambwath Stream to the north of the site. However, there is no likely hydraulic continuity between the superficial A aquifer and the underlying deeper Principal Chalk, aquifer due to the thickness of the Boulder Clay deposits.

Cretaceous Chalk

Located at depth beneath the site is the Chalk, which is designated as a Principal Aquifer by the EA. The outcrop area for the Chalk is presented as Figure 8, while the aquifer classification is presented as Figure 9.

It is noted that there are no licensed groundwater abstractions from the Chalk within a 2km radius of the site (Environment Agency 2012 and Envirocheck Survey data 2012). A request for information from East Riding of Yorkshire Council, confirmed that there are no known unlicensed (or private) abstractions in the immediate area. In addition, the Hull and East Riding CAMS (Environment Agency, 2006) report notes; "there are no large abstractions in the Holderness catchment, those that do exist are small and are mainly used for agriculture and none of which affect river flows". The lack of abstraction wells is corroborated by the fact that no groundwater Source Protection Zones are defined on the EA website for the Holderness area.

The thickness of the Chalk aquifer in the vicinity of the site is estimated at approximately 355m. The base of the Chalk aquifer rests unconformably on Jurassic Age Lias Group strata, which comprise of approximately 180m of Clays and Mudstones that form a major low permeability aquitard to the base of the Chalk.

The groundwater quality within the Chalk aquifer is understood to be naturally saline (mineralised formation water rather than saline intrusion) and under the WFD classification, the aquifer has been designated by the EA as poor quality (refer to Section 3.4.5).

Deeper Strata

Deeper strata beneath the Chalk such as the Jurassic, Triassic and Permian formations may retain localised permeability despite their depth. However, these strata are not considered to be economically usable due to their great depth and are likely to possess saline or mineralised (poor) groundwater quality.

3.4.2 Aquifer Properties

Cretaceous Chalk

The aquifer properties of the Yorkshire Chalk are summarised in Allen *et al* 1997. The transmissivity values range from less than 1 m^2/d to over 10,000 m^2/d, as obtained from 87 pumping tests at 68 sites. The geometric mean is 1258 m^2/d. Storage coefficients have a geometric mean of $7.2x10^{-3}$.

The hydraulic properties of the Chalk are predominantly controlled by the distribution and degree of fracturing and fissuring, which increase at the near surface due to weathering and groundwater table fluctuations. The predominance of such features declines with depth especially below the top 25 to 50m of the Chalk. Also, declines in the degree of fracturing can be noted in areas where the Chalk has a high Clay or Marl content. Beneath the low permeability Boulder Clay at the site, the confined Chalk aquifer is indicated as having good permeability as presented in Figure 10. This figure presents the regional distributions of aquifer transmissivity (a measure of permeability) prepared from groundwater models as reported in Allen et al (1997), for which a transmissivity of 800m2/d has been inferred for the Chalk at depth beneath the site.

A hydrogeological cross-section by Fraser and Milton (1976, in Allen et al, 1997), suggests groundwater in the Chalk beneath the site is likely to comprise saline poor quality formation water.

Sand and Gravel and Alluvium.

The Secondary (minor) aquifer within the sand and gravel and alluvium deposits, is encountered up to 3m in depth in close vicinity of the site. The properties of these secondary aquifers are likely to be locally variable dependant on the predominance of interbedded lower permeability (silt or clay) layers.

3.4.3 Groundwater Level Elevation, Fluctuations and Flow

The Chalk aquifer located at depth beneath the site is saturated and confined. Therefore, groundwater is likely to be pressurised, and groundwater levels are unlikely to exhibit large seasonal fluctuations.

Groundwater elevation data received from the EA (2012) for well reference TA23WNF0CC, located in West Newton approximately 1.8km to the southeast of site (at NGR 520475E 437860N). The location of this well is noted on Figure 12. Measured groundwater levels between the period of February 1997 and June 2012, varied between 0.62 and 2.52mAOD and exhibited a small annual seasonal variation of approximately 0.5m. This borehole was identified by the EA as being within the Chalk. It should be noted, however, that this well is located in close proximity (+/- 100m) to a licensed groundwater abstraction (reference 2/26/32/177, NGR 520600E, 437700N) presented on Figure 12. This abstraction is identified in both the Envirocheck and EA data (2012) as abstracting groundwater from within the superficial deposits at The Old Farm in West Newton and is likely to be shallow. Despite the close proximity and potential uncertainty, URS believe that these are two separate wells and are not hydraulically connected due to the boulder clay. No other groundwater wells were identified by the EA within 5km of the site and no groundwater quality data was provided.

Inferred regional groundwater level contours in the confined Chalk for 1976 are presented as Figure 11 (NERC, 1980), which indicates elevations of between -20 and -30m below sea level in the area of the site. Regional groundwater flow is inferred to be south/southeasterly with shallow hydraulic gradients. However, as noted above the EA groundwater level data (if truly from the Chalk aquifer) would indicate an approximate 20m rise in groundwater levels within the confined Chalk beneath the site. No further information is available to URS to confirm this potential rise over the last 35 years. Although the information presented on Figure 11 is relatively old, the inferred regional groundwater flow directions are still considered valid even where groundwater elevations may have regionally changed.

Groundwater within the superficial Sand, Gravel and Alluvium is likely to be shallow and potentially in continuity with surface watercourses. Therefore, groundwater levels are likely to respond to seasonal fluctuations. The flow direction in the superficial deposits in the Lambwath Stream valley is likely to be topographically controlled (downstream to the west) and towards the watercourse.

Surface water in the ditch adjacent to the site will flow to the north into Lambwath Stream and will likely be in continuity with the Secondary A aquifer.

3.4.4 Groundwater Abstractions

From the information made available for the current study, licensed and private groundwater and surface water abstractions located within a 2km radius of the site are listed in Table 5. Their locations in relation the site are presented on Figure 12.

Table 5 Licensed and Un-licensed Water Abstractions in the Vicinity of the Site (July 2012)

Figure Reference	Number	Designation	Use	Source	Name	Distance From Site	Down Hydraulic Gradient of Site
1	2/26/32/176	Licensed	Private - Agriculture - Spray irrigation	Surface Water	Lambwath Stream	1360m E	**No**
2	2/26/32/177	Licensed	Private - Agriculture - Spray irrigation	Groundwater	Superficial drift	1874m SE	**No**

The licensed groundwater abstraction relates to a water well sunk into the superficial drift deposits and the licensed surface water abstraction obtains water from the Lambwath Stream.

The closest pubic water supply operated by Yorkshire Water Services Limited, is located approximately 13km to the west-south-west close to Kingston Upon Hull (no further details on this source were available at the time of this study).

Discussions between Moorhouse Petroleum and East Riding of Yorkshire Council during July 2012 have confirmed that no private unlicensed abstractions within 5km of the site are known to the Council. Such abstractions can be common in rural areas, as they are often used for domestic water supply. Any abstraction of less than 20m3/d is not required to be licensed. These unlicensed sources are normally registered with the local authority, however, they often can remain unregistered.

For the current study, none of the identified abstractions are located in areas potentially down hydraulic gradient from the site.

3.4.5 Water Framework Directive Status

Groundwater

The Water Framework Directive (WFD) sets a target of achieving overall 'Good status' in all water bodies (including rivers, streams, lakes, transitional and coastal water bodies, and groundwater) by 2027. For groundwaters, Good status has a quantitative and a chemical component; status is measured on the scale High, Good, Moderate, Poor and Bad.

The WFD status of groundwater bodies of interest to the current study is provided in Table 6 (EA website accessed July 2012).

Table 6 WFD assessment of Groundwater bodies in proximity to the site

Waterbody Name / ID	Current Quantitative Quality	Current Chemical Quality	2015 Predictive Quantitative Quality	2015 Predicted Chemical Quality
Hull and East Riding Chalk GB40401G700700	Poor	Poor	Poor	Poor

Under the WFD classification the Chalk aquifer has been designated as poor quality. Although not noted on the EA website, the poor designation for quantity is likely to reflect the natural saline/mineralised formation water.

The Chalk aquifer has been assigned an "At Risk" designation (EA website, accessed July 2012).

Surface Water

The WFD status of surface water bodies of interest to the current study is provided in Table 7 and Figure 13 (EA website accessed July 2012).

Table 7 WFD assessment of Surface Water bodies in proximity to the site

Waterbody Name / ID	Current Ecological Quality	Current Chemical Quality	2015 Predictive Ecological Quality	2015 Predicted Chemical Quality
Lambwath Stream from Source to Foredyke Stream GB104026066860	Moderate	Does not require assessment	Moderate	Does not require assessment

The reasons why the watercourse has been considered to have moderate ecological quality is not stated on the EA website, however, URS consider that this may be due to the combination of the maintained nature of the watercourses by discharges from sewage treatment plants (refer to Section 3.5.3) and potential eutrophication effects resulting from low summer flows and agricultural pollution such as nitrates (refer to Section 3.5.2) which potentially affects biodiversity.

The watercourse has been assigned an "At Risk" designation by the EA (EA website July 2012)

3.5 Land Designations

3.5.1 Source Protection Zones and Aquifer Vulnerability

Source Protection Zones (SPZ) are areas that have been designated by the EA. There are three zones; an inner or zone 1, outer or zone 2 and total catchment or zone 3. The zones have been determined to represent a 50 day travel time, a 400 day travel time, and the whole groundwater catchment for public water supply groundwater sources, respectively. These zones highlight the increasing vulnerability of the groundwater abstractions to contaminant inputs. The closer the polluting activity to the groundwater source, then the greater the potential risk will be.

The SPZ map for the catchment in which the proposed drilling site lies is presented as Figure 14, which indicates that the site is not currently located within a designated SPZ catchment.. The closest SPZ is located 9.5km to the west/southwest of the site defined for a series of abstractions in the Chalk aquifer on the outskirts of Kingston Upon Hull. (Please note that the actual locations of the public water sources are not shown on the maps and their location cannot be given in documents that may be in the public domain.)

Aquifer Vulnerability: The designated vulnerability of shallow Boulder Clay and Alluvial deposits in the vicinity of the site is presented as Figure 15. In the immediate area of the site the Boulder Clay has been designated as Non Aquifer with negligible permeability. The minor aquifers associated with the sand and gravel and alluvium superficial deposits to the north of the site are characterised as high in vulnerability due to the presence of high leachable soil (high permeability).

The vulnerability for the deeper Chalk aquifer has not been designated because of the extensive and thick Boulder Clay cover (defined as negligible permeability), which offers substantial protection to the underlying Chalk.

3.5.2 Nitrate Vulnerable Zones

The site is located within an extensive Nitrate Vulnerable Zone (NVZ) designated for the surface waters in the region (refer to Figure 16). The designation is an indirect indicator for the vulnerability of surface waters to leachable agricultural pollutants.

3.5.3 Historic Land Use and Pollution Incidents

A review of historic 1:2,200 and 1:10,000 scale Ordnance Survey Maps supplied by Landmark Information Group (3 July 2012) for land use changes and evidence of mining or quarrying (quarries & pits often used in past as landfills) indicated the following:

- 1855, 1892: site located within agricultural land with vegetated hedgerows. Lambwath Stream runs 400m to the north and comprises a network of drains. The Lambwath Stream valley is labelled as liable to be flooded. Course of drain running northwards towards Lambwath Stream identified adjacent to site. Wooded area of West Newton Belts 800m to the southwest. Moat identified around Murton Chapel, 600m to the southwest.
- 1910-1911, 1928-1929: Same land use, Lambwath Stream labelled as Keyingham Level Drainage and liable to flooding.
- 1951-1952, 1956-1957: Same land use but Lambwath Stream valley no longer labelled as liable to flooding.

- 1980-1983: Same land use, Barns 650m to the east labelled as High Fosham. Pond labelled as lagoon identified 700m to the northwest immediately north of Lambwath Stream.
- 2006: Same land use, small ponds located 350m to west and 900m to east. Drainage network clearly visible by colouring.
- 2010: Same land use to 2006 apart from pocket of wooded land 300m to the northwest

According to the EA website (July 2012) no historic or active waste tips or landfills are noted within a 2km radius of the site. A historic landfill named Engine Lane is located in Burton Constable, 2.7km to the south of the site.

According to environmental database information (Envirocheck) supplied by Landmark Information Group (3 July 2012) the following activities are noted within a 1km radius of the site (please note that provided locations are to within 100m and are presented on Figure 17):

1. Discharge Consent (NGR 519990 439720) approximately 770m northeast from site: Sewage discharge of final/treated effluent into Lambwath Stream operated by Yorkshire Water Services Ltd at Withernwick Waste Water Treatment Works, Consent authorised by the Environment Agency – current status active.
2. Discharge Consent (NGR 518500 439200) approximately 950m west from site: Sewage discharge of final/treated effluent (not water company) to land/soakaway at Wood End House, Consent authorised by the Environment Agency – current status active.
3. Discharge Consent (NGR 518463 439194) approximately 980m west from site: Sewage discharge of final/treated effluent (not water company) to tributary of Lambwath Stream at Hawleys Cottage, Consent authorised by the Environment Agency – current status active.
4. Pollution Incidents to Controlled Waters (NGR 519800 440100) approximately 990m north from site: Crude sewage discharged to freshwater stream/river from foul sewer at Lambwath Stream Road Bridge in December 1990. The incident was recorded as Category 2 – Significant Incident.

3.5.4 Protected Areas

The closest Site of Special Scientific Interest (SSSI) is located 830m to the northeast of site at Lambwath Meadows. The SSSI is identified in Figure 18. The site lies within an area of adopted green belt.

4 Hydrogeological Risk Assessment

4.1 Review of Activities Proposed and the Potential Impacts

4.1.1 Site Operations

The identification of the potential sources of impact to groundwater and surface waters in the vicinity of the site has been undertaken by a review of the details of the scheme as provided by Rathlin Energy (UK) Limited. This information included the size, nature, time scale, construction methods and post extraction land use.

The proposal comprises four phases, the details of the activities that are pertinent to the HRA in each phase are;

1. **Site Construction.** The construction of a temporary access track and exploration site. The works are estimated to take about five weeks and comprise removal of topsoil & vegetation, levelling, formation of earth bund screens, a perimeter drainage system and the creation of a high density polyethylene (HDPE) impermeable membrane over the entire area of the site (approx. 80 x 120m). A 10m buffer zone will also be present between the site and the undammed ditch to the west. The impermeable membrane will also underlie the perimeter drains. The membrane will be sandwiched between two layers of 300g/m^2 needle punch non woven geotextile to provide protection to underlying shallow sediments. The HDPE impermeable membrane will be covered with MOT Type 1 hardcore to create the site working surface. Two cellars will be constructed roughly in the centre of the site. The cellars comprise 2.4m diameter concrete rings which are integrated into the impermeable membrane. The integrity of the cellars is to be tested to ensure that they are sealed.

2. **Drilling.** The drilling of up to two exploration wells each to a total depth of approximately 3,214m below ground level (approx. 3,201m below sea level). The drilling will be undertaken by two different rigs. The top section though the Boulder Clay and 35m into the top of the Cretaceous Chalk to an anticipated depth of approximately 75m below ground level would be undertaken by a 'Waterwell Rig' while the rest of the depth would be undertaken with an oilfield drilling rig. Based on standard hydrogeological characteristics of the Chalk, the more permeable zone of the Chalk is typically encountered within the top 35m of the Chalk (often termed "the effective aquifer thickness"). The aim of the drilling methodology is to isolate this zone from the second drilling phase. The deeper zones of the Chalk are likely to be of much lower permeability and less fractured compared to what might be present near the contact with the Boulder Clay. In addition, groundwater salinity may also increase with depth. The duration of the drilling activities are estimated at six to twelve weeks per well with additional two weeks mobilisation and one week of demobilisation. The proposed well design is shown in Figure 19. With regards the first drilling run to seal the Boulder Clay and top 35m of the Chalk (to an approximate depth of 75m below ground level) the diameter of the casing will be $13^3/_8$" (340mm). The drilling method for the waterwell rig will use water based bentonite drilling fluids. Once the first casing run has been installed and the upper more productive zone of the Chalk aquifer isolated from the borehole, the oilfield drilling rig used to continue the borehole to depth will deploy a range of water based fluids in the remaining $12^1/_4$" (311mm), $9^1/_2$" (241mm), $7^7/_8$" (200 mm) and 6" (152mm) holes to depth. These deeper drilling fluids are isolated from the Cretaceous Chalk principal aquifer by steel casing and cement grouting which will completely seal the external annulus of the $9^5/_8$", $8^6/_8$" 7" and 5" casings. A deeper cement seal will be placed in the annulus for the final 7" casing. The proposed method for

cementing of casing below the first two strings, will ensure any cement goes 100ft above any permeable or hydrocarbon bearing zones. This is the standard used by Oil and Gas UK for the abandonment of wells; however, this is incorporated into the design of the well in order to minimise potential environmental issues and also to make it easier for well abandonments at a later date.

3. **Testing**. It is planned to undertake evaluative drill stem tests and extended well tests. The extended well test could be for a period of up to 90 days when the petroleum reservoirs are evaluated. During this period the wells are pumped and are anticipated to produce a mixture of gas, oil and water. The gas will be flared or cold vented via temporary pipework and the oil and water separated and collected in tanks before removal from site for disposal or further processing. The water will be saline and must be disposed of at a specialist facility. Whilst on site the water and oil pose a potential source of contamination and are held in tanks in bunded areas.

4. **Restoration**. Site restoration and aftercare or further planning application. If the prospect is not commercial the site will be restored over a five week period to its initial condition. The decision to abandon and plug the well(s) may be made by the applicant at any phase of the development. Another planning application would be made to the Mineral Planning Authority should the applicant wish to develop the site into a production gas well. The site restoration would in such an instance be delayed pending the subsequent planning application. The well if abandoned will be sealed with mechanical and cement plugs within the steel casing. The casing strings will be cut off 1.5m below ground level and finished with a welded steel plate. Restoration will remove all materials brought to make the site work area, replace the soil stored in the perimeter bunds. Five years of aftercare will ensure that the land is restored to its previous condition.

4.1.2 Potential sources of impact on groundwater

The potential sources of impact on the water environment for evaluation may include:

1. Incidents that result in the spillage of pollutants to the ground prior to the creation of an effectively sealed site surface;
2. Loss of foul or contaminated drainage from the site into surface water feature adjacent to the western site boundary or due to permeable shallow soils and hence groundwater seepage within soils to the adjacent surface water feature;
3. Leakage from the perimeter drainage system due to faults with its construction, particularly if the drains contain pollutants;
4. Loss of chemicals or fuel stored on site to the perimeter drainage or elsewhere that exceeds the storage capacity in the drains;
5. Loss of drilling fluids and associated cuttings into fractures within the underground strata during the construction of wells though the Chalk aquifer;
6. Loss of cement and other grouting materials into fractures within the underground Chalk strata during the grouting procedures of the 13 $^{3}/_{8}$" and 9 $^{5}/_{8}$" casing;
7. Loss of drilling fluids while constructing the wells below the first (top) casing run within the Cretaceous Chalk by leakage through or around the casing and grout seal.

8. Loss of drilling fluids or produced water (brine) that may collect in the wellhead cellars into the ground through failure in the wellhead cellar construction;
9. Incidents that result in loss of contaminants to ground or surface water from vehicles transporting construction materials or product or waste materials to and from the site;
10. Flushing of contaminated surface retained pollutants into the ground during the site decommissioning process;

The list of potential sources of impact includes those that the proposed activities include embedded mitigation measures within the design.

4.1.3 Risks to Water Quality

The risk to surface and groundwater quality can arise from the introduction of pollutants to the ground or by the mobilisation of existing contamination (current conditions). At the site and study area there is neither evidence nor expectation of groundwater contamination given its agricultural usage. This risk factor is, therefore, not carried forward into the risk assessment matrix. The more significant risk to groundwater arises from the introduction of pollutants from the surface or at depth from the construction of the site facility, storage of chemicals on the new site and the drilling of the appraisal wells. The potential losses from the site of polluting chemicals could potentially result in an impact upon surface water features adjacent to the site and during drilling potentially deeper groundwater that underlies the site beneath the Boulder Clay cover. The extent of any pollution plume that is created under the site will depend upon the quantity lost and its properties (attenuation rates, density etc). The presence of the extensive (40-45m thick) Boulder Clay cover along with a good cement grout seal on the well casings will prevent any connection or pathway between the surface and the deeper Chalk aquifer. Any surface loss of chemicals or contaminated water that could not be controlled by the surface drainage system or leak through a fault in the impermeable liner would migrate via a combination of overland flow or seepage through shallow saturated soils towards the surface water feature that is located along the western boundary of the site.

4.2 Receptor Importance

The assessment of Baseline Conditions, as identified in Section 3, has identified the following key groundwater and surface water receptors:

Surface Water Features: These are considered to be the most significant and sensitive long term receptors for the current HRA. Loss of foul or contaminated drainage from the site is likely due to topographic gradient towards the unnamed drain/stream running adjacent to the western site boundary. This water feature is understood to flow in a northerly direction where it joins the Lambwath Stream and also the associated underlying superficial aquifer located 400m to the north of the site. The importance of these receptors is assessed as being **very high** as the surface water in the Lambwath Stream and shallow groundwater in the superficial deposits is known to be used (via licensed abstractions) for local farming and spray irrigation. These surface waters are known to already be ecologically stressed.

Chalk Aquifer: Again is considered to be a significant and sensitive receptor primarily during the early phases of drilling. The Chalk strata underlies the site beneath a significant covering of low permeability Boulder Clay deposits to a depth of about 400m. The importance of the receptor is assessed as being **high**. The reasons for the classification of the receptor are in accordance with the factors set out in the method in Table 1, namely that the Chalk is a regionally important principal aquifer which supports public water supply abstraction for Kingston Upon Hull and the surrounding areas to the west of the site. This classification remains despite;

- the Chalk being confined at depth and not being open to supply baseflow to surface water features,
- the likely presence of naturally occurring saline/mineralised groundwater within the Chalk beneath the site that limits its use for potable supply.
- and the major groundwater abstractions being located up hydraulic gradient of the site. Based on available information, regional groundwater beneath the site is likely to be encountered at elevations of between -20 and -25m below seal level with hydraulic gradient towards the south/southeast rather than west.

The much deeper aquifers within the Jurassic, Triassic and Permian formations are not considered to be important receptors due to their depth and likely high salinity or mineralised groundwater quality. At shallow depths these aquifers are highly productive aquifers of national importance, however, at the great depths beneath the current site they are likely not to be exploited for water supply or provide base flow to surface water features. As such these aquifers are not considered to represent viable sensitive receptors for pollution from the proposed drilling operations and are not considered further.

4.3 Identification of Pathways

The pathway provides a route or a method by which potential source or sources of contamination could impact on receptors.

The assessment of baseline conditions described in Section 3 indicates that the surface water feature located adjacent to the western site boundary will represent both the long term primary receptor but also a pathway for potential foul or contaminated drainage to migrate from the site into the Lambwath Stream and the underlying superficial aquifer to the north of the site. The deeper confined Chalk strata which could be affected for a limited period during early drilling phases could be fractured, however zones of major permeability are unlikely as the aquifer is saturated and confined.

The pathways that are considered in this HRA are;

1. Horizontal pathway from direct runoff from site to surface watercourse,
2. Overtopping of perimeter drains and into surface watercourses
3. Failures in the impermeable membrane into shallow saturated soils and migration to surface watercourse.
4. A vertical pathway through the drift deposits could be created in the annulus of the well between the borehole wall and the $13^3/_8$” (340mm) conductor pipe. This void is planned be completely filled with grout to the surface.
5. Through faults in the well cellars as a result of unidentified construction issues that provide a route through the cellar wall or around the junction between the cellar floor and the 13 $^3/_8$” (340mm) conductor pipe into the underlying Chalk via a fault in the annulus cement seal.

6. Movement from the borehole during the drilling through the Chalk. Fractures that intercept the borehole walls could provide a pathway for the short period when the drilling operations through the Chalk take place.

7. Movement from depth below the casing shoe of the $13^{3}/_{8}$" (340mm) conductor pipe when drilling the second stage of the borehole (12¼" (311mm) hole). This would only provide a pathway if the base of the cementation job were to be unsatisfactory or that the casing shoe were to be set at too shallow a depth and within strata that are highly permeable. The casing depth is proposed to be at 75 mbgl, which is anticipated to be approximately 30 to 35m below the base of the Boulder Clay.

4.4 Appraisal of Magnitude of Impact on Receptors

The proposed development has the potential to impact water resource features within the area. The significance of any effect will depend on the sensitivity of the water resource and the current conditions of the resources, the magnitude of any impact and the implementation of any mitigation measures during construction and operation.

The magnitude of the potential impact on the receptor has also qualitatively assessed the anticipated likelihood of the risk elements. Those events that are considered very unlikely are given a lower magnitude than those that are more likely to occur. The likelihood of the particular event that could present a risk to the receptors has also been assessed with the embedded mitigation within the proposed planning application.

4.5 Assessment of Significance of Effects

As described in Section 2.1, the significance of effects is a product of the magnitude of the impact and the importance of the receptor. The estimated significance of the potential impacts on the identified receptors are presented in Table 9. The significance of the effect is assessed shown with the embedded mitigation measures, which are stated, and with the additional mitigation measures recommended. Where it is considered that the embedded and or the additional mitigation are likely to completely remove the risk then the magnitude of potential impact is marked as 'Scoped Out' and the significance marked as 'No Impact'

Table 8 Hydrogeological Risk Assessment Summary

Activity or Phase	Potential Source of Impact	Pathway	Receptor Name	Receptor Importance/ Sensitivity	Likelihood	Magnitude of Potential Impact	Significance of effect with embedded mitigation	Embedded Mitigation within proposed application	Additional Mitigation	Magnitude of potential impact with additional mitigation	Significance after additional mitigation
Site Construction	Existing contamination under site	Mobilisation to surface water	Surface Watercourses (including Lambwath Stream)	Very High	Very Unlikely	Moderate	Moderate/Minor	A 10m buffer zone will be present between the site and the undammed ditch to the west.	Geotechnical boreholes to establish baseline conditions	Scoped Out	No Impact
All Construction Phases	Fuel Oil spillage on ground and leakage of drilling fluid	Overland flow and leakage	Surface Watercourses (including Lambwath Stream)	Very High	Likely	Medium	Moderate/Minor	Use of double walled fuel tanks and bunded areas and site impermeable membrane, site perimeter drain, and 10m buffer zone between the site and the undammed ditch to the west.		Scoped Out	No Impact
			Saturated Chalk	High	Very Unlikely	Medium	Major/Moderate	Use of site impermeable membrane and wellhead protection during drilling		Scoped Out	No Impact
Construction of Wells	Water based Drilling Fluids - Bentonite, Caustic Soda, Sodium Carbonate during 1st two drilling runs	From borehole walls into fractures	Saturated Chalk	High	Likely	Medium	Major/Moderate	Use of drilling fluid loss materials to plug the fractures	a. Clean drilling equipment prior to use at the site. b. Water well drilling techniques - Reverse circulation and use of potable water as the drilling fluid	Scoped Out	No Impact
	Contaminants inadvertently introduced as a result of failures of drilling equipment		Saturated Chalk	High	Very Unlikely	Very Low	Moderate/Minor	Standard good practice for rig & equipment maintence		Very Low	Moderate/ Minor Likely to be Minor due to low likelihood of occurrence
	Cement Grout during sealing of the top $13^{3}/_{8}$" (340mm) conductor pipe casing and the second $9^{5}/_{8}$" (245mm) casing	Directly via fractures & fissures intercepted by the borehole	Saturated Chalk	High	Likely	Low	Minor	Continuous monitoring of cementation process to identify excessive losses		Low	Minor
	Water based drilling fluids while drilling of the deeper hole second section from 75m to 1575m below seal level	In annulus behind the shallow conductor casing if the cement grout is incomplete	Shallow 35m zone of Saturated Chalk	High	Very Unlikely	Very Low	Moderate/Minor	a. Pressure testing of casing following cementation b. Monitoring drilling fluid losses		Scoped Out	No Impact
Well Construction & Testing	Site Chemical and drilling fluids lost at surface	Spillage onto site surface, to site drainage then via leaks in impermeable membrane or overtopping drainage system capacity	Surface Watercourses (including Lambwath Stream)	Very High	Unlikely	Medium	Moderate/Minor	a. Bunding of chemicals stored on site b. Heat sealing of impermeable membrane c. Drain capacity to be sufficient to retain storm event site runoff d. Site runoff to be tankered offsite for appropriate disposal	a. Regular visual inspection of perimeter drain b. Monitor daily the water level in perimeter drain c. Contingency plan to empty drain and repair should leakage be suspected	Scoped Out	No Impact

Activity or Phase	Potential Source of Impact	Pathway	Receptor Name	Receptor Importance/ Sensitivity	Likelihood	Magnitude of Potential Impact	Significance of effect with embedded mitigation	Embedded Mitigation within proposed application	Additional Mitigation	Magnitude of potential impact with additional mitigation	Significance after additional mitigation
Testing	Produced water (brine) that is lost from the well head and collects in the wellhead cellar	Leakage from the wellhead cellar through faults in the impermeable seal or via faults in the wellhead and casing	Saturated Chalk	High	Very Unlikely	Medium	Moderate/Minor	a. well cellar sealed with impermeable membrane b. annulus of top $13^{3}/_{8}$" (340mm) conductor pipe casing grouted to surface with cement c. integrity of cement seals demonstrated with leak off tests	a. routine regular inspection of cellars b. pump out and dispose using a licensed waste carrier of fluids collected in the cellar.	Scoped Out	No Impact
	Produced water (brine) that is lost from subsurface	Leakage through unidentified faults in the well casing	Saturated Chalk	High	Very Unlikely	Very Low	Moderate	a. Well integrity testing b. Detail monitoring of pressures during production testing. Should these indicate loss of fluids underground then remedial action will be taken		Very Low	Moderate/ Minor Likely to be Minor due to low likelihood of occurrence
Site Restoration	Contaminants within site surface hardcore accumulated during drilling and testing phases	Leached from hardcore onto areas of site following removal of impermeable membrane, thence lateral seepage directly into the surface watercourse	Surface Watercourses (including Lambwath Stream)	Very High	Very Unlikely	Low	Minor	Removal of all potentially contaminated material from site prior to removal of the impermeable membrane		Scoped Out	No Impact
Construction & Testing	Loss of pollutants during road transportation as a result of accident or misadventure. Produced hydrocarbons, brines, drilling arisings, drilling fluids	Various	Various	Un assessed	Unlikely	Very Low	Un assessed	Selection of contractors with experience in petroleum products and high level of HSE		On-site Risks Scoped out Off-site Risks Un assessed	On-site No Impact Off-site Risks Un assessed

5 Conclusions

A hydrogeological risk assessment (HRA) has been undertaken for the proposed drilling of a petroleum exploration borehole drilling at West Newton site to identify whether the development is likely to have significant residual effects upon water features.

The water features that could be potentially adversely impacted by a development are the unmanned surface water feature adjacent to the western site perimeter (plus its connection to the Lambwath Stream and the associated underlying superficial aquifer) and the deeper confined Chalk aquifer.

Based upon the information supplied to URS for this assessment, the following conclusions are drawn:

- The potential risks to the adjacent unnamed surface water course that borders the site and flows north to the Lambwath Sream and the underlying superficial aquifer, posed by above ground activities is considered to be low, provided the following are implemented and maintained:
  - the perimeter drains and associated storm water collection systems are maintained and regularly tested for leaks during the life-span of the site. Site regrading during construction should remove any topographic decline towards the stream in order to limit surface run-off in this direction. Drain and storm water collection systems should be located away from the area of the stream, although such systems often rely on gravity feed and tend to exploit natural topographic declines.
  - the integrity of the impermeable membrane is maintained throughout the lifespan of the site operations, Where new services or structures are planned then trenching or foundation excavations should be prohibited unless suitable mitigation measures and appropriate below ground trench/foundation designs to achieve fluid containment are adopted.
  - continual integrity testing of wells, wellhead chambers and above ground pipes, tanks/bunded areas etc
  - continual operation throughout the lifespan of the site in line with the most up to date management, health & safety and environmental standards in operation at the time.
- It is considered that the greatest potential impact to the Chalk aquifer posed by the proposed exploration site is likely to result from drilling activities, namely the release of turbid waters and/or associated contaminants to groundwater. Although due to the proposed drilling methods the likelihood of impact is considered low, it is greatest during the first stage of drilling through the Chalk aquifer. The proposed drilling method is designed to completely isolate the Chalk aquifer from the deeper drilling activities by the sealing of the first (outer) casing run. In addition, the use of water based drilling muds during all drilling phases will act to seal the borehole wall and limit any loss of fluid to the wider Chalk aquifer.
- Following completion of the full borehole, the Chalk aquifer is considered to be protected from very deep fluids by the presence of three separate well casings, all of which cover the full length of the Chalk aquifer. In addition, the annuluses for the two outer casings are to be fully cemented, with further cemented sections within the

deeper sections of the borehole. It should be noted, however, that this protection is reliant on adequate cement grout seals to fill the small voids between individual well casings and also the borehole wall. These seals are due to be pressure tested as part of the installation works.

Mitigation measures, most of which are embedded into the design of the development, have significantly reduced the risk of contamination associated with the construction and operation of the site for petroleum exploration via the drilling and testing of a ca. 3000m deep borehole from entering the aquifer in either the unsaturated or saturated zones. The significance of the effect of this risk is assessed to be no impact or negligible for most categories assessed, including the completed borehole. However, during the drilling phase of works, minor to moderate potential risks are indicated for the loss of cement grout to the aquifer (as the first well casing is sealed) and also for the unlikely event that a drill rig breakdown results in the loss of fluids to the aquifer. Although categorised as “Moderate” at worse, under the adopted risk assessment methodology, this is only one graduation above the lowest possible effect that can be assessed for activities on the Chalk aquifer which is “Moderate/Minor”. Given the low likelihood of such events occurring, the moderate designation is not considered to be significant.

Based upon the available information supplied to URS, the proposed drilling method, along with continued operation of the site and associated maintenance to ‘up to date’ regulatory standards, we consider that site represents a minor risk to surface water features adjacent to the site and a low risk to the Chalk aquifer, primarily due to the mitigation measures implemented by the site. However, such mitigation measures should be continually reviewed and revised, especially where site conditions vary from currently expected. It should also be noted that although likely risks are deemed at this stage to be ‘low to minor’, these could potentially increase to ‘moderate’ as a result of unforeseen situations or where failures of the mitigation measures arise.

6 References

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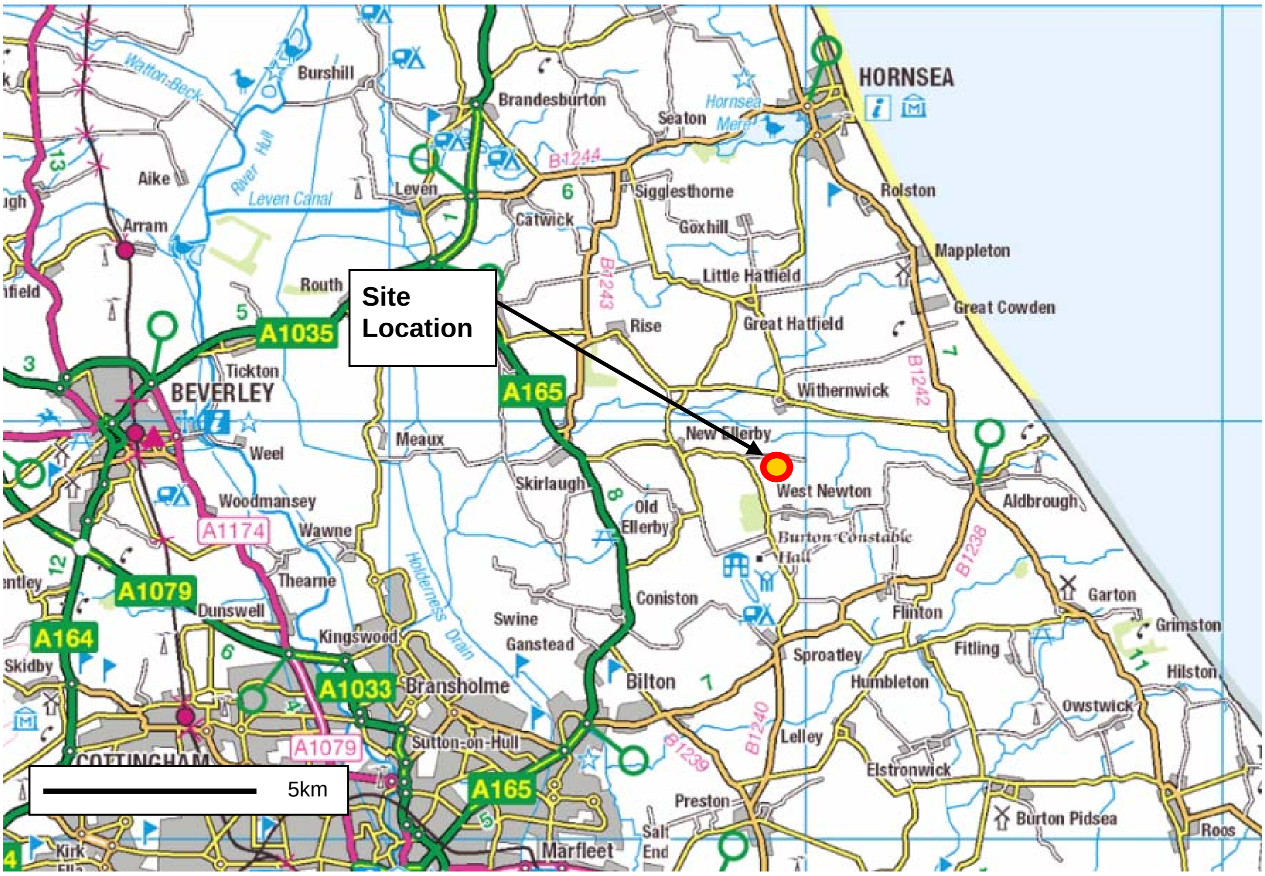


Figure 1: General Location Map (1:250,000 Scale Ordnance Survey)

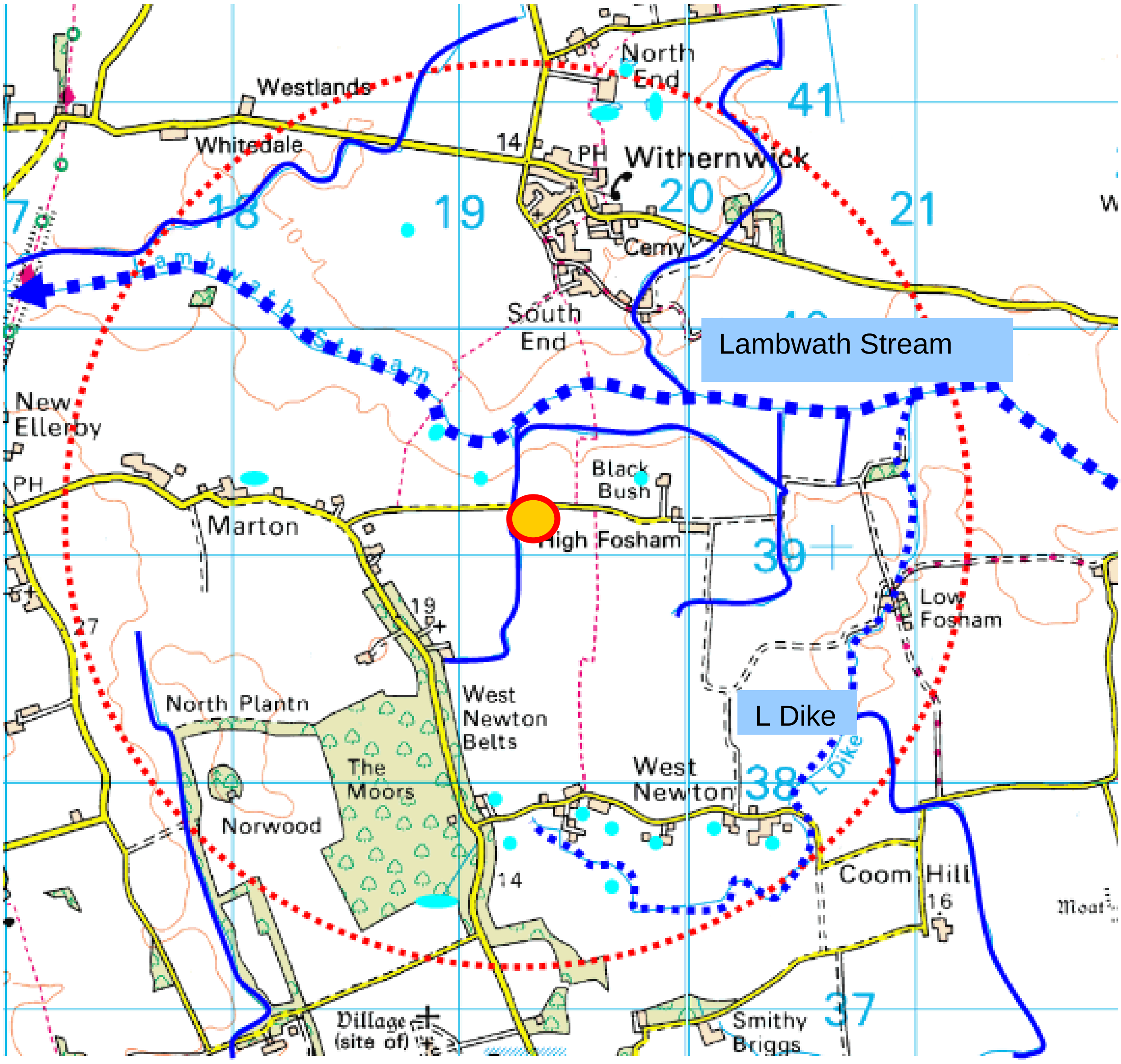


Figure 2: Detailed Site Location Map Highlighting Key Surface Water Features

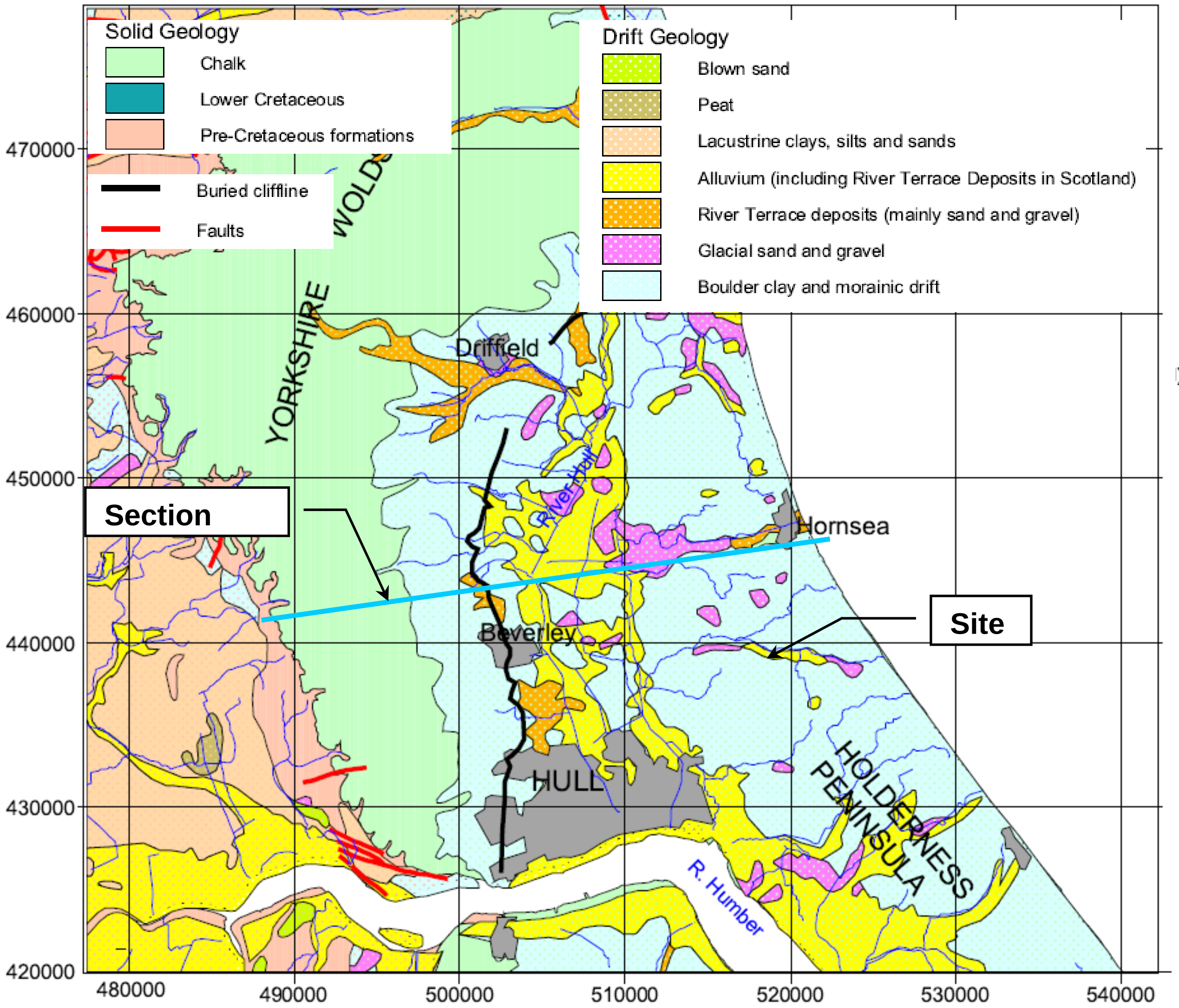


Figure 3: Regional Geology Map (after Smedley 2004)

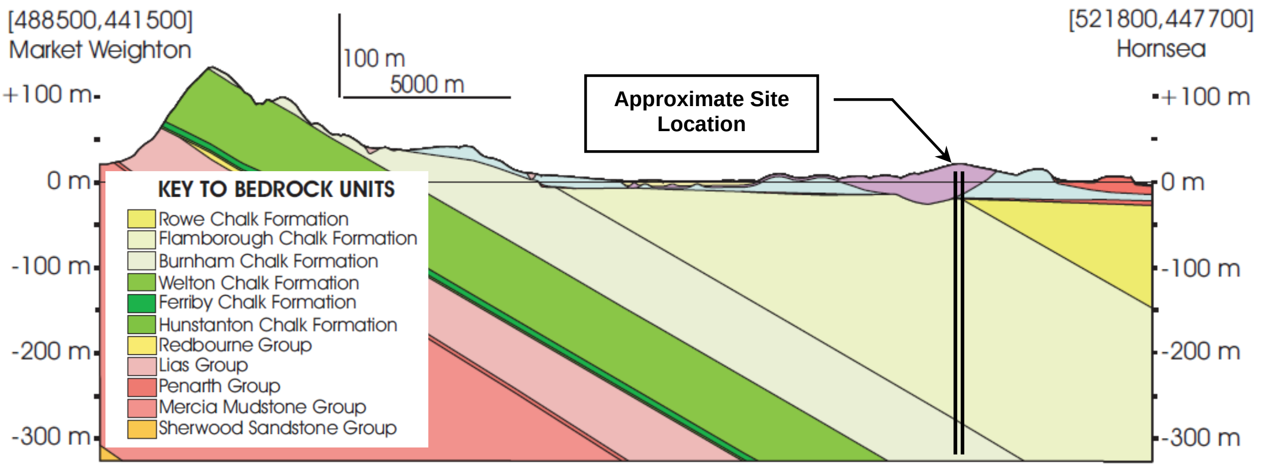


Figure 4: Regional Geological Cross-Section (after Smedley 2004)

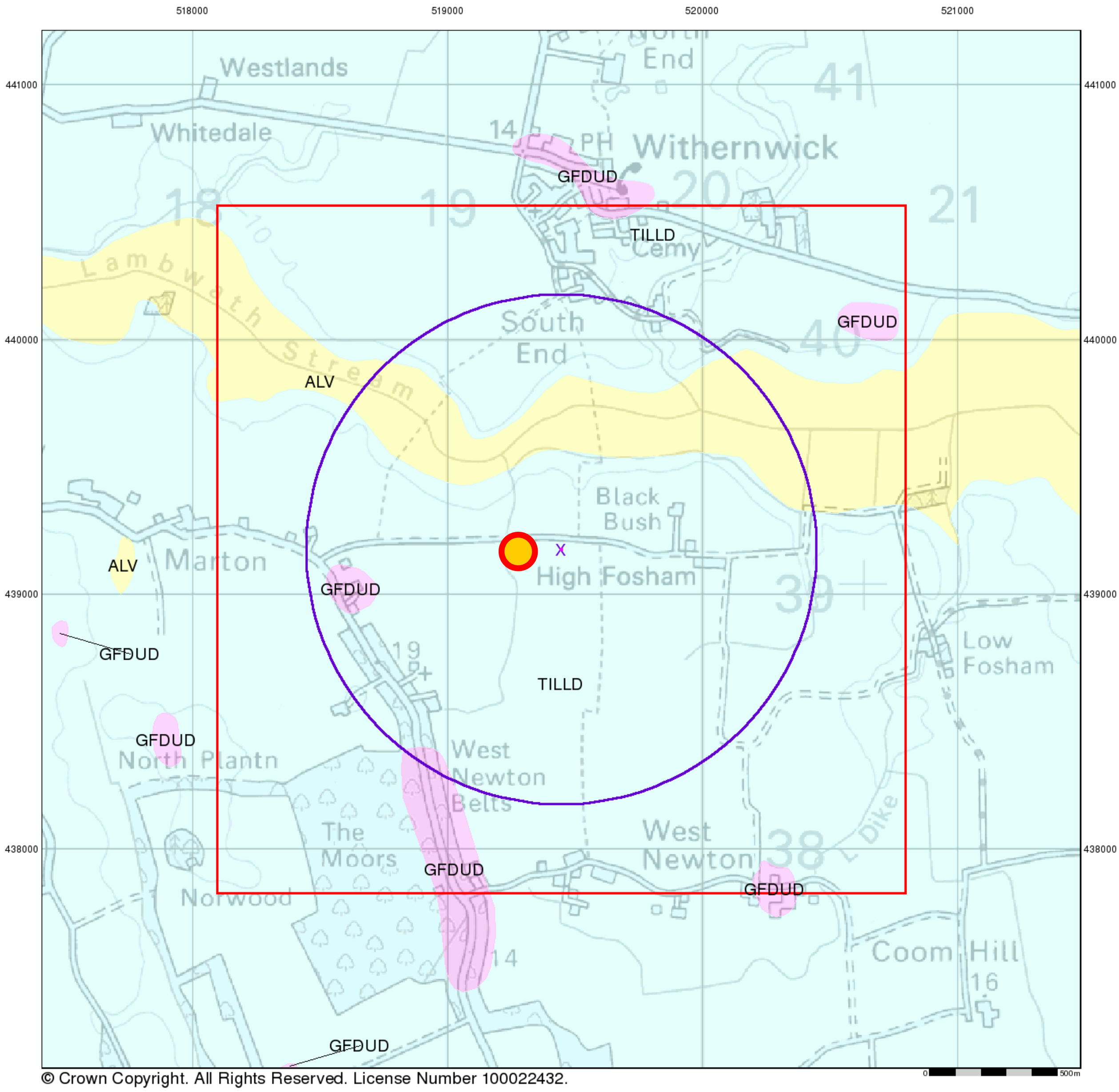


Image provided by Envirocheck report Ref: 40018694_1_1, dated 3 July 2012

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Flandrian - Flandrian
	TILLD	Till, Devensian	Diamicton	Devensian - Devensian
	GFDUD	Glaciofluvial Deposits, Devensian	Sand and Gravel	Devensian - Devensian

Figure 5: Detailed Superficial Geology Map for the Immediate Area of the Site (Adapted from Landmark Survey Report, July 2012)

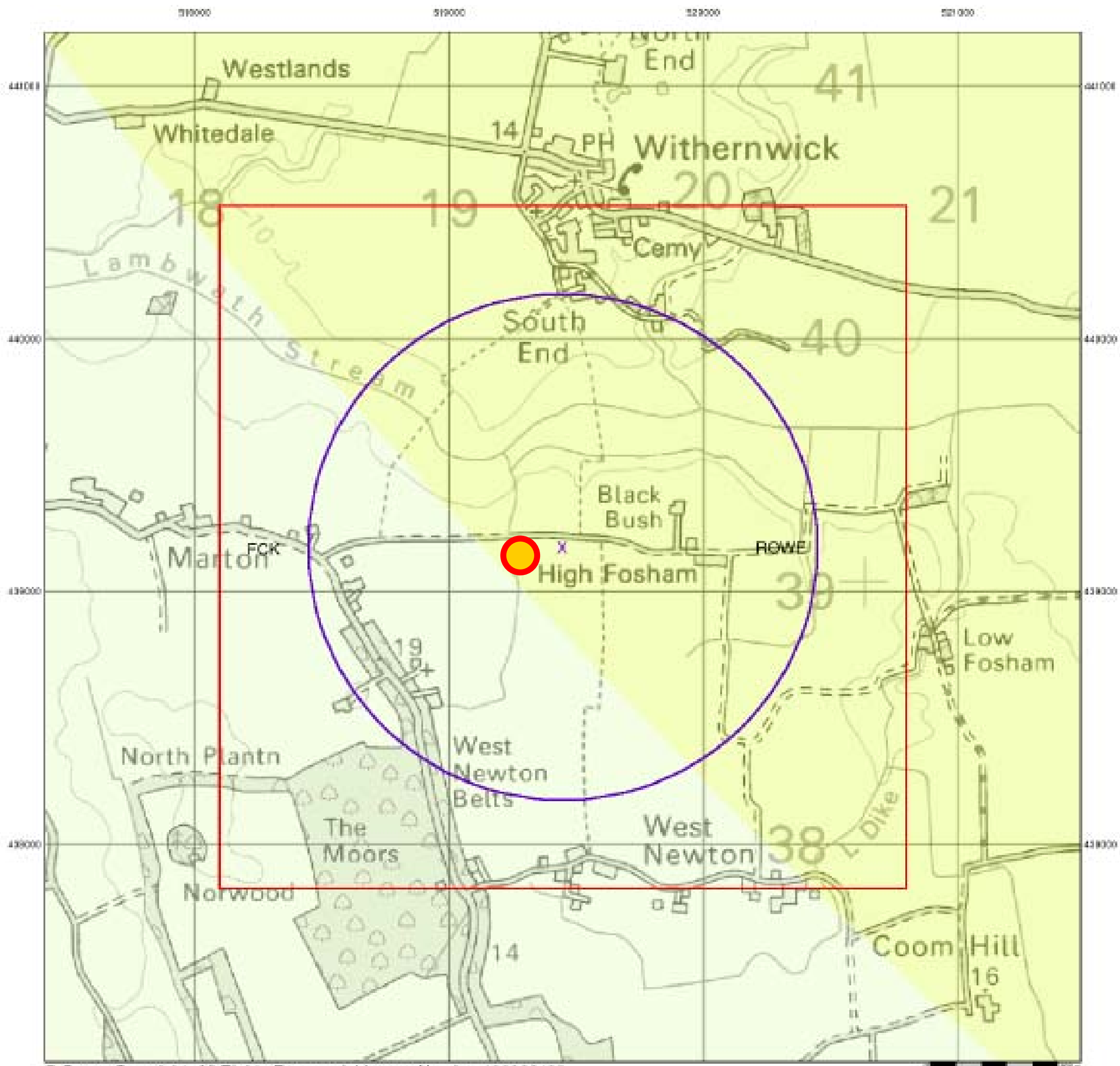


Image provided by Envirocheck report Ref: 40018694_1_1, dated 3 July 2012

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ROWE	Rowe Chalk Formation	Chalk	Maastrichtian - Campanian
	FCK	Flamborough Chalk Formation	Chalk	Campanian - Santonian

Figure 6: Detailed Concealed Bedrock Geology Map for the Immediate Area of the Site (Adapted from Landmark Survey Report, July 2012)

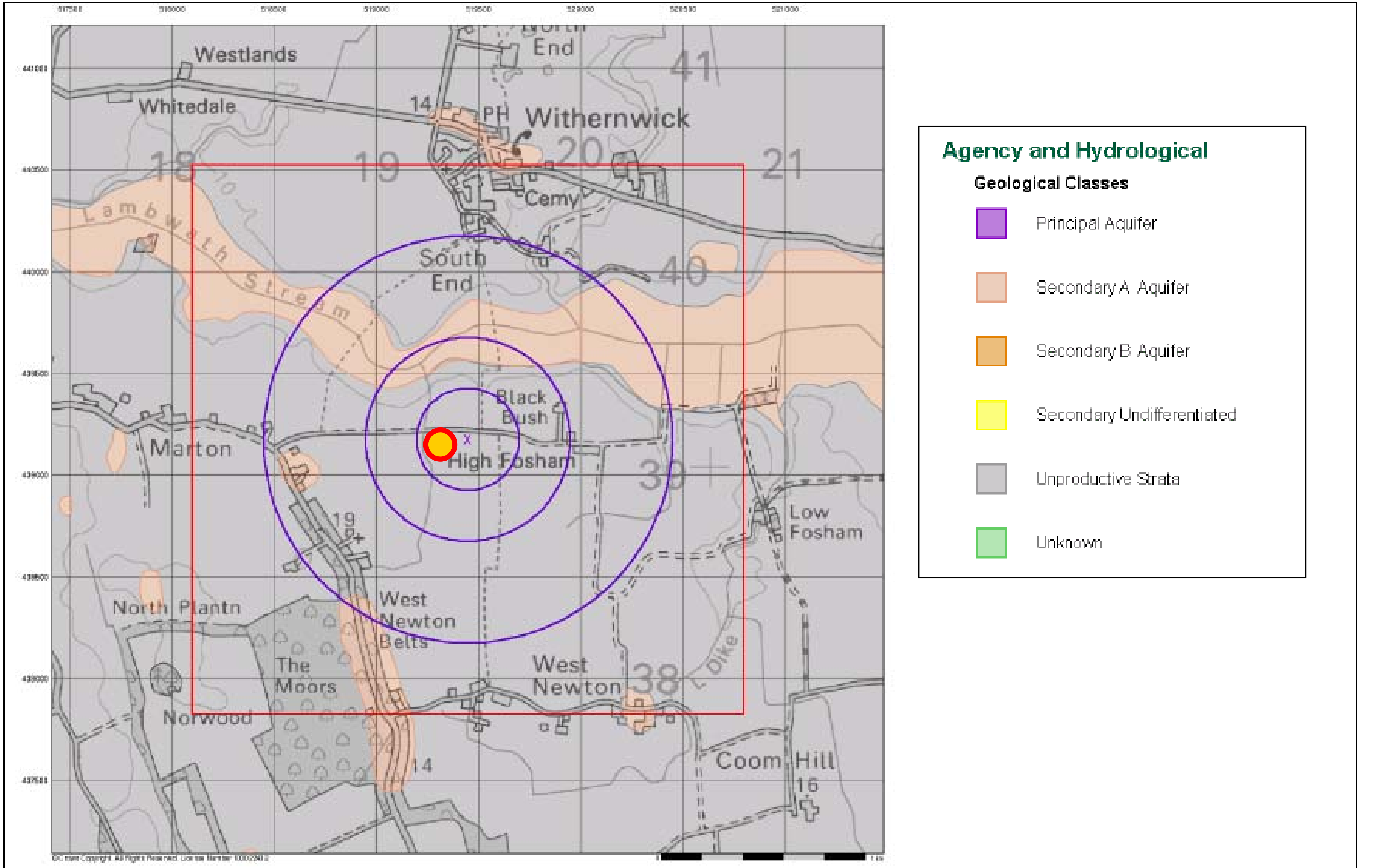


Figure 7: EA Superficial Aquifer Classification (Adapted from Landmark Survey Report, July 2012)

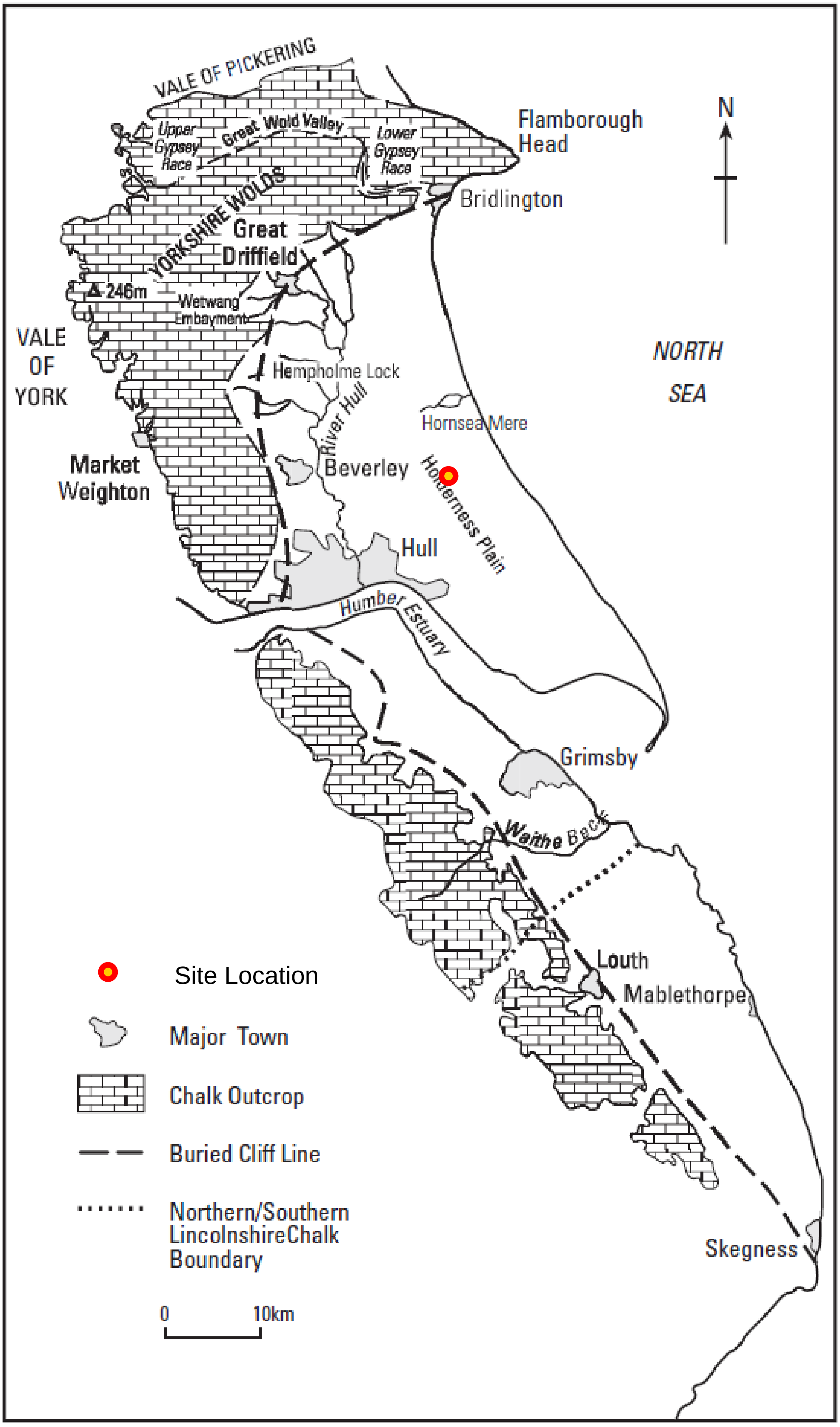


Figure 8: Outcrop Area For the Chalk Aquifer (Allen *et al* 1997)

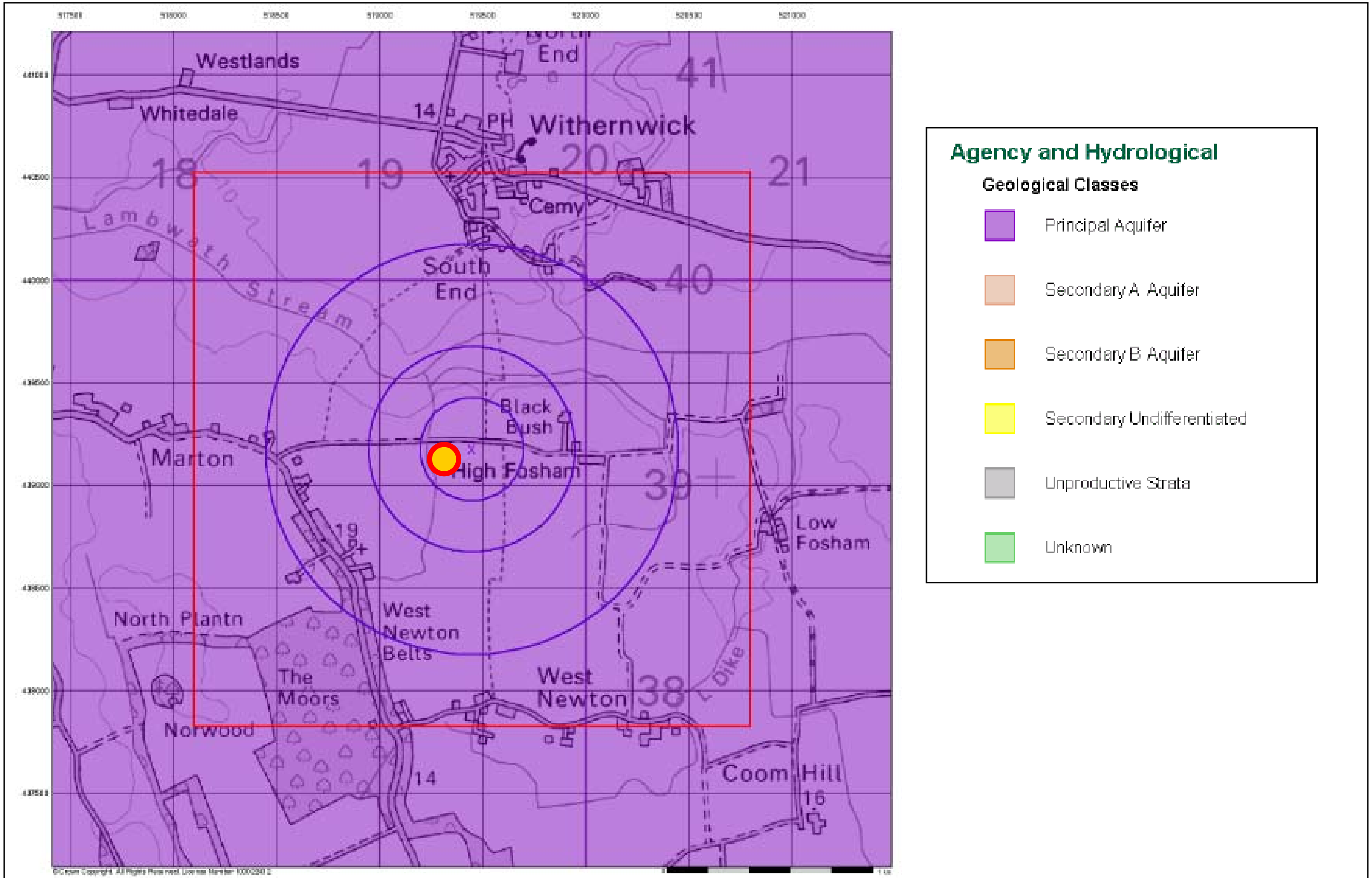
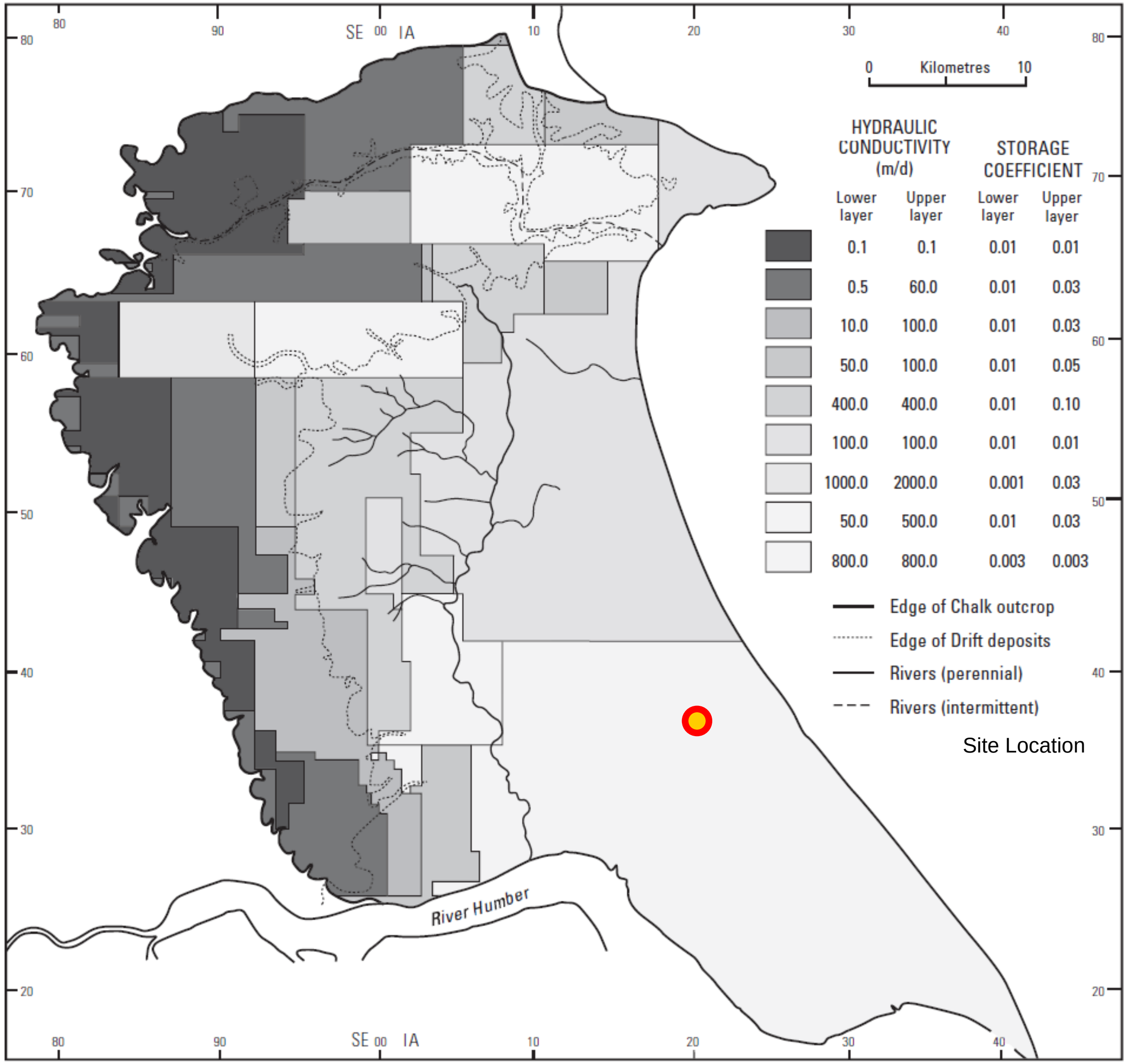


Figure 9: EA Classification for Bedrock Aquifer Concealed beneath Boulder Clay (Adapted from Landmark Survey Report, July 2012)



Source: Aspinwall and Co Ltd (1995) in Allen et al (1997)

Figure 10: Distribution of Modelled Bulk Hydraulic Conductivity for the Yorkshire Chalk Aquifer

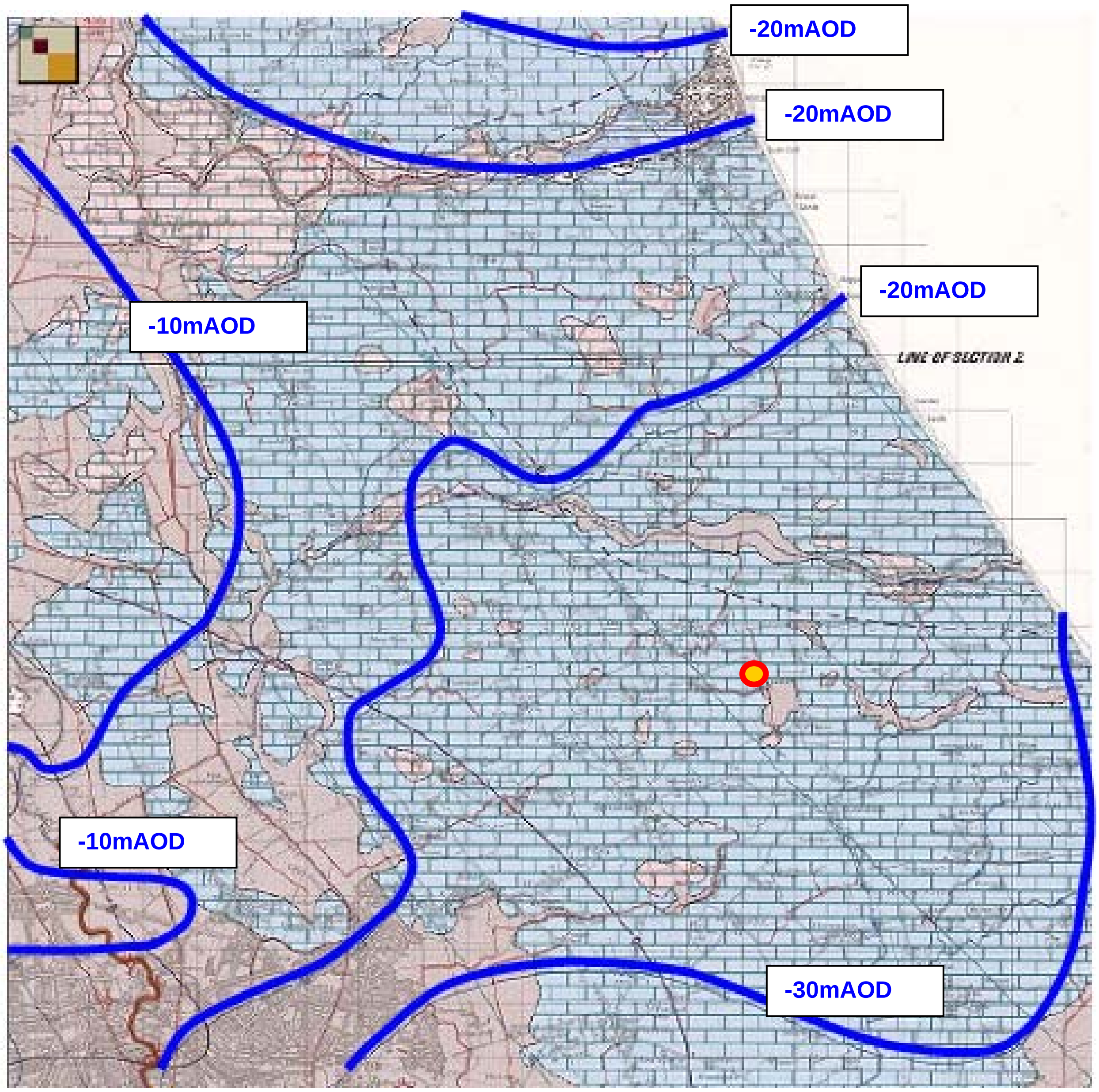
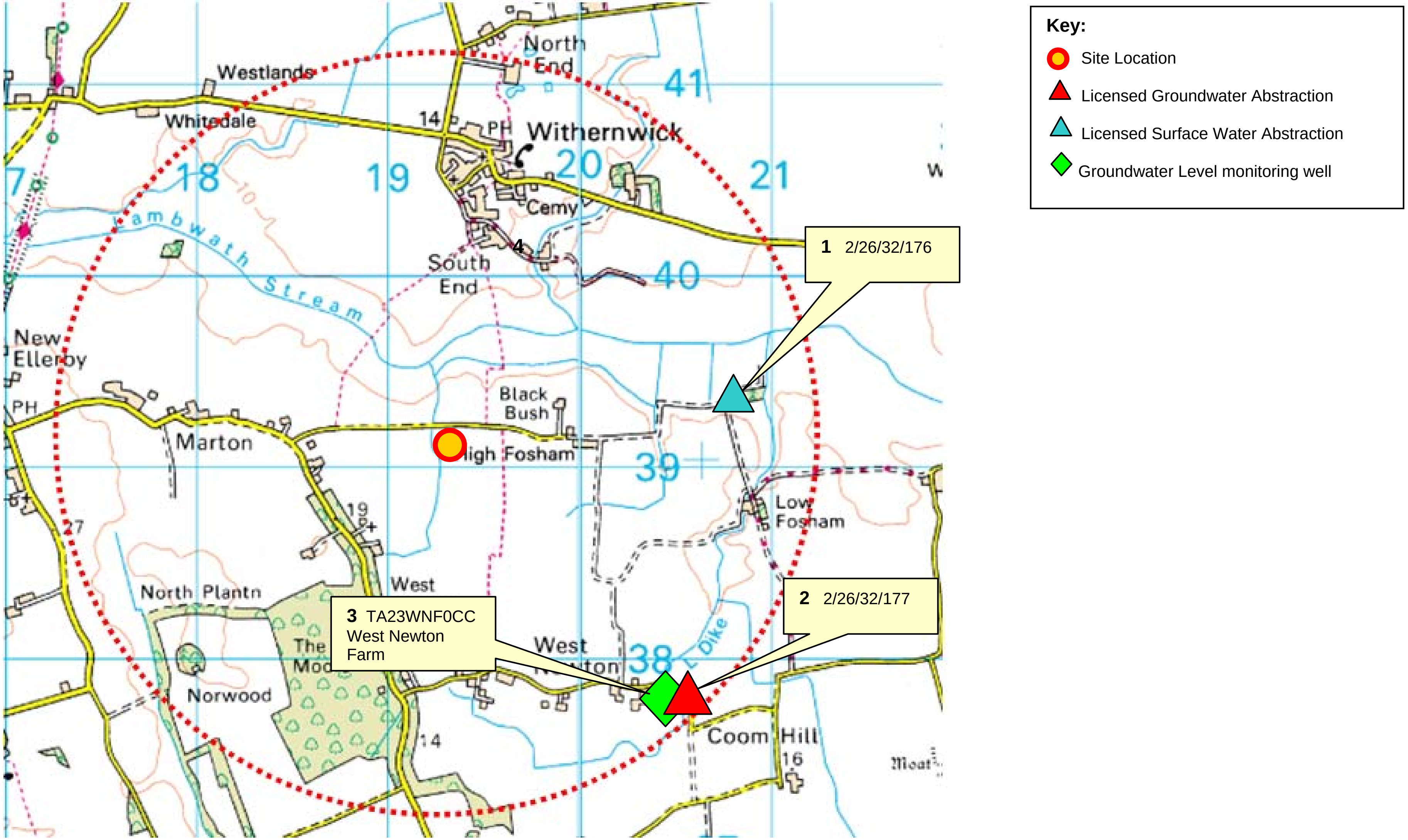


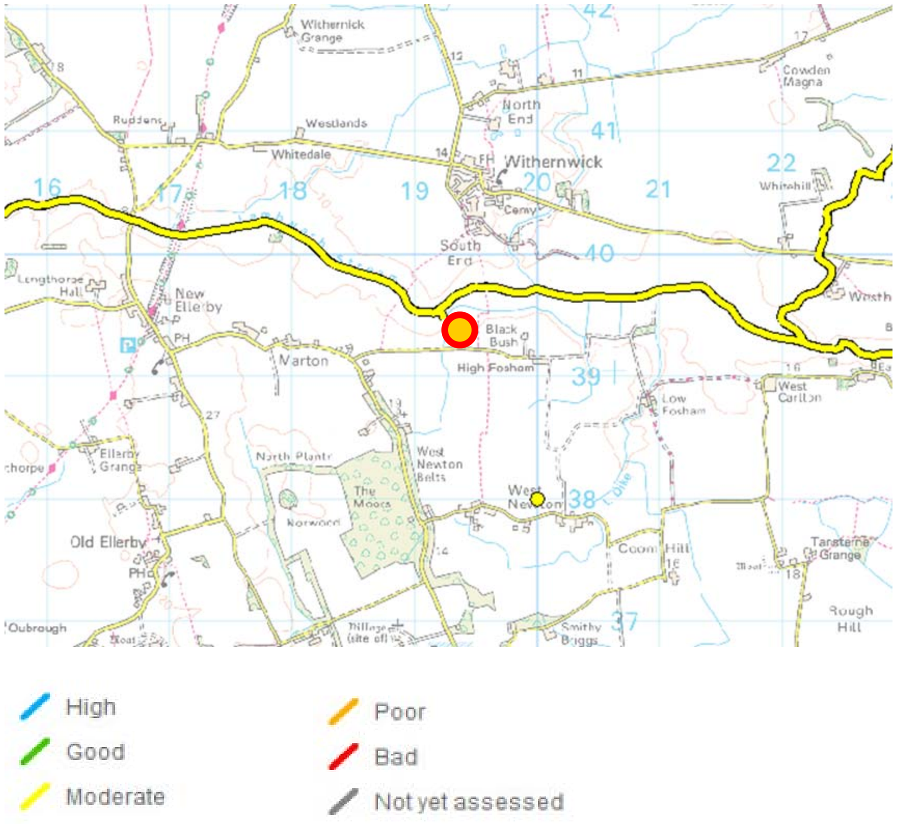
Figure 11: Regional Groundwater level contours from water level readings (1976) in the Chalk in East Yorkshire (NERC, 1980).



Contains Environment Agency information © Environment Agency

Figure 12: Location of Licensed and Private Water Abstractions (License details supplied by Landmark Survey Report, July 2012)

Current Ecology Quality



Current Chemical Quality

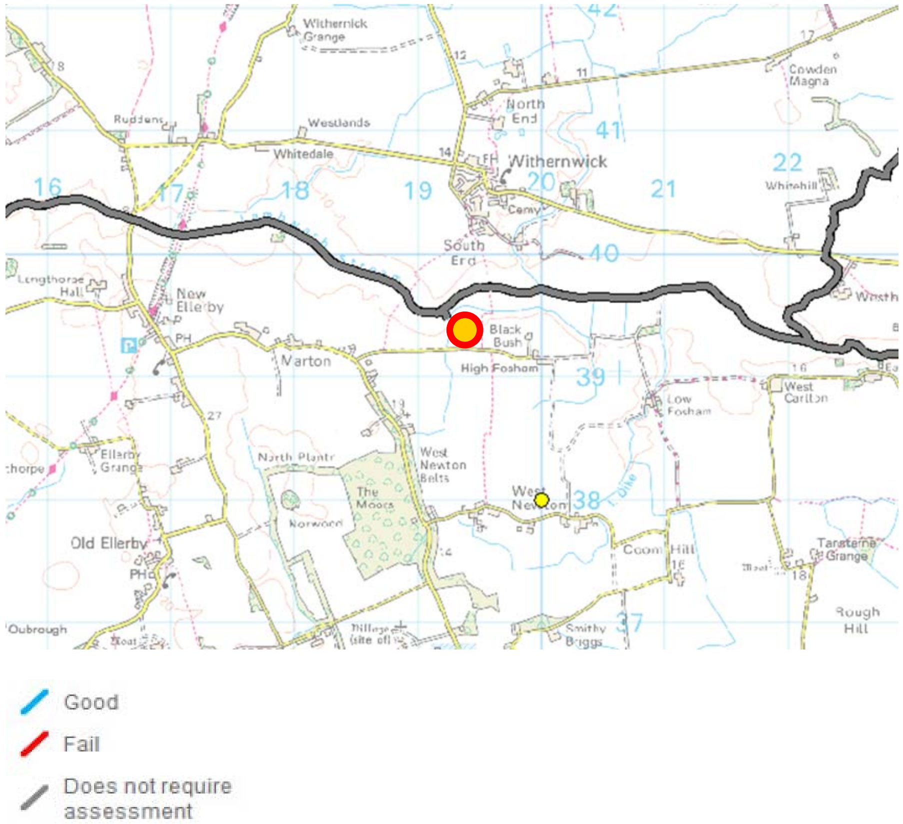
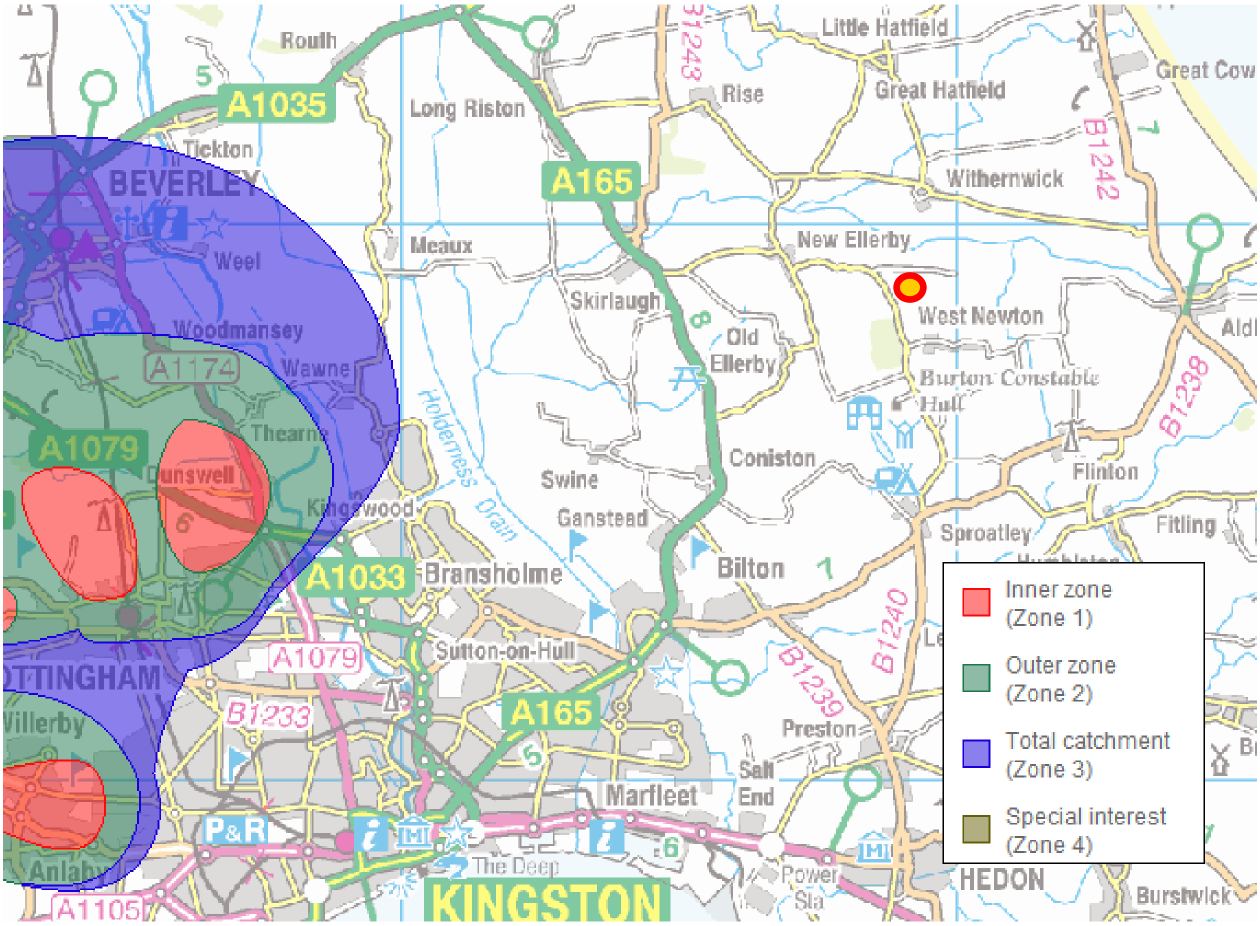


Figure 13 WFD Designation for Surface Waters in the vicinity of the site (EA website July 2012)



Note: No SPZ's defined to the east of the site

Figure 14: Designated Source Protection Zones (Environment Agency Website 2012)

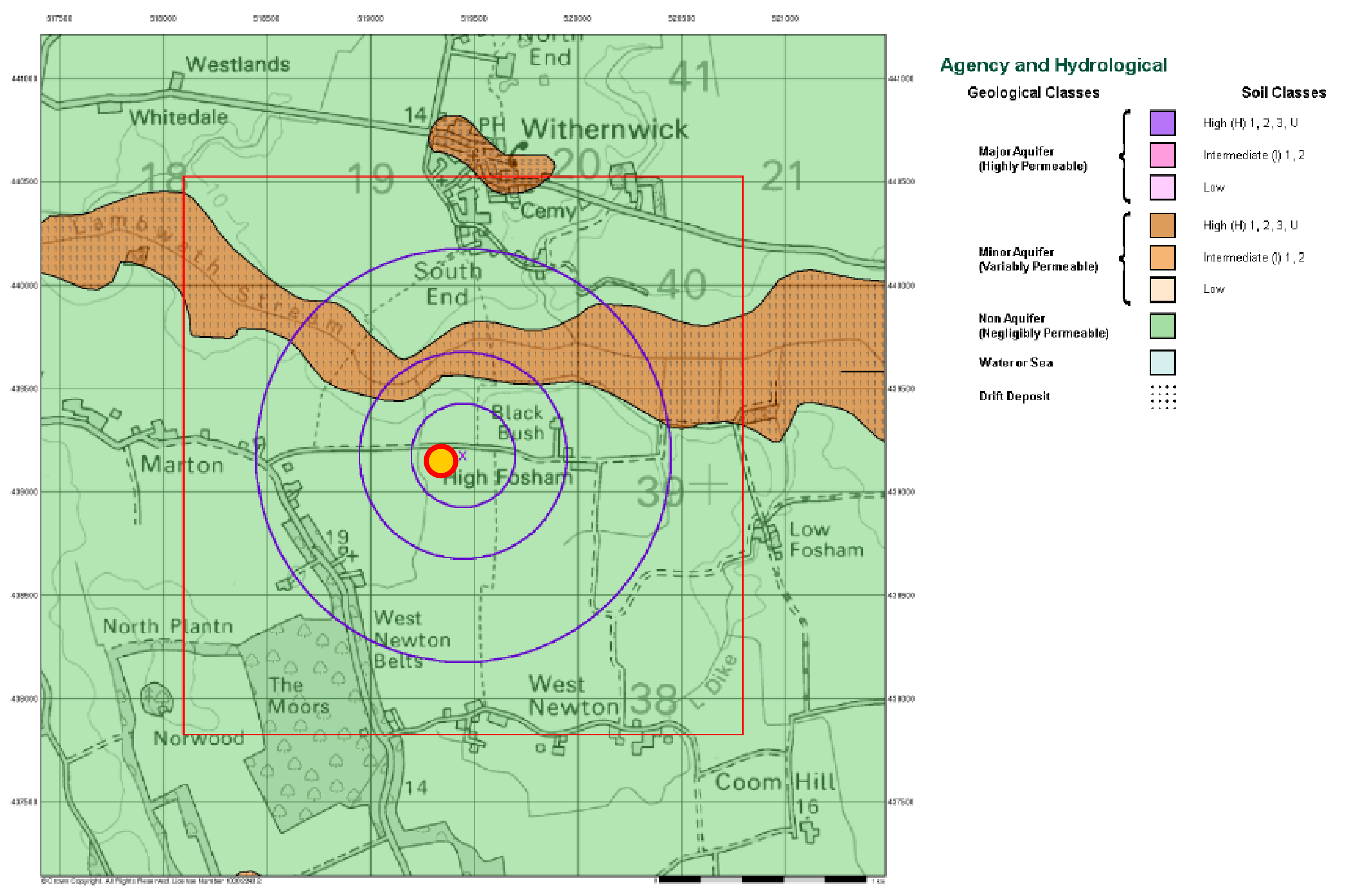


Figure 15: EA Shallow Groundwater Vulnerability Classification (Adapted from Landmark Survey Report, July 2012)

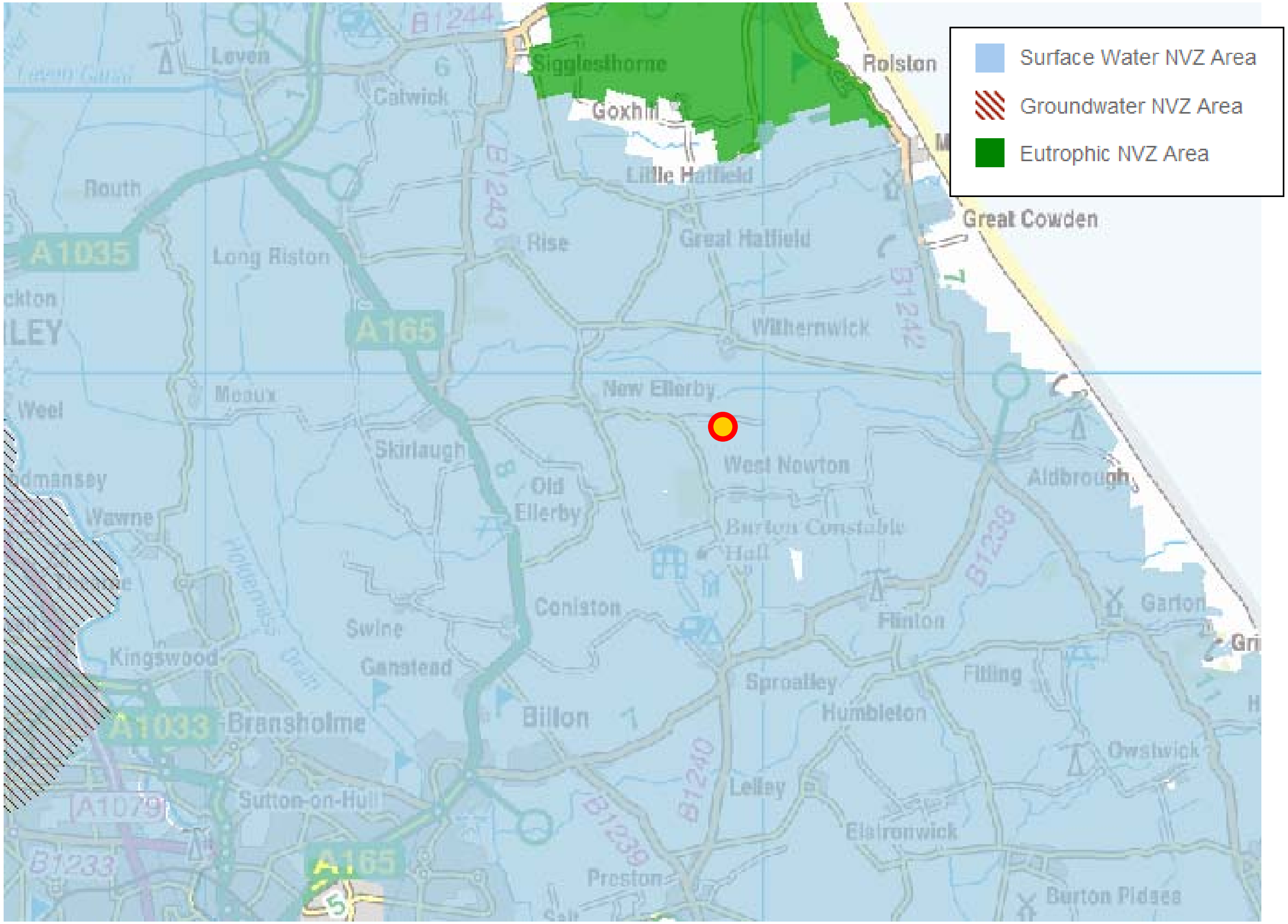


Figure 16 EA Designated Nitrate Vulnerable Zones (EA website, July 2012)

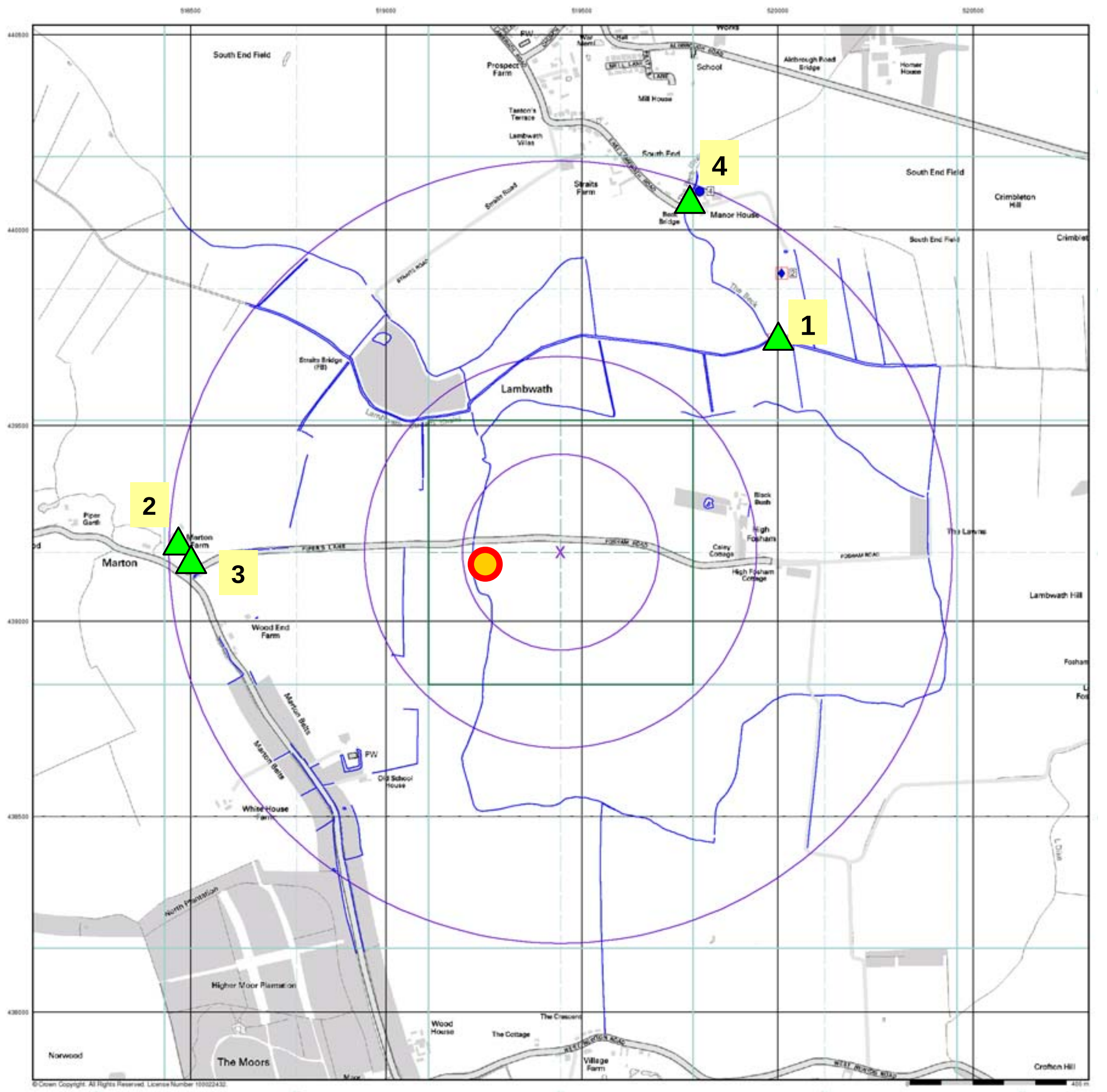


Figure 17 Recorded Activities within a 1km radius of the Site

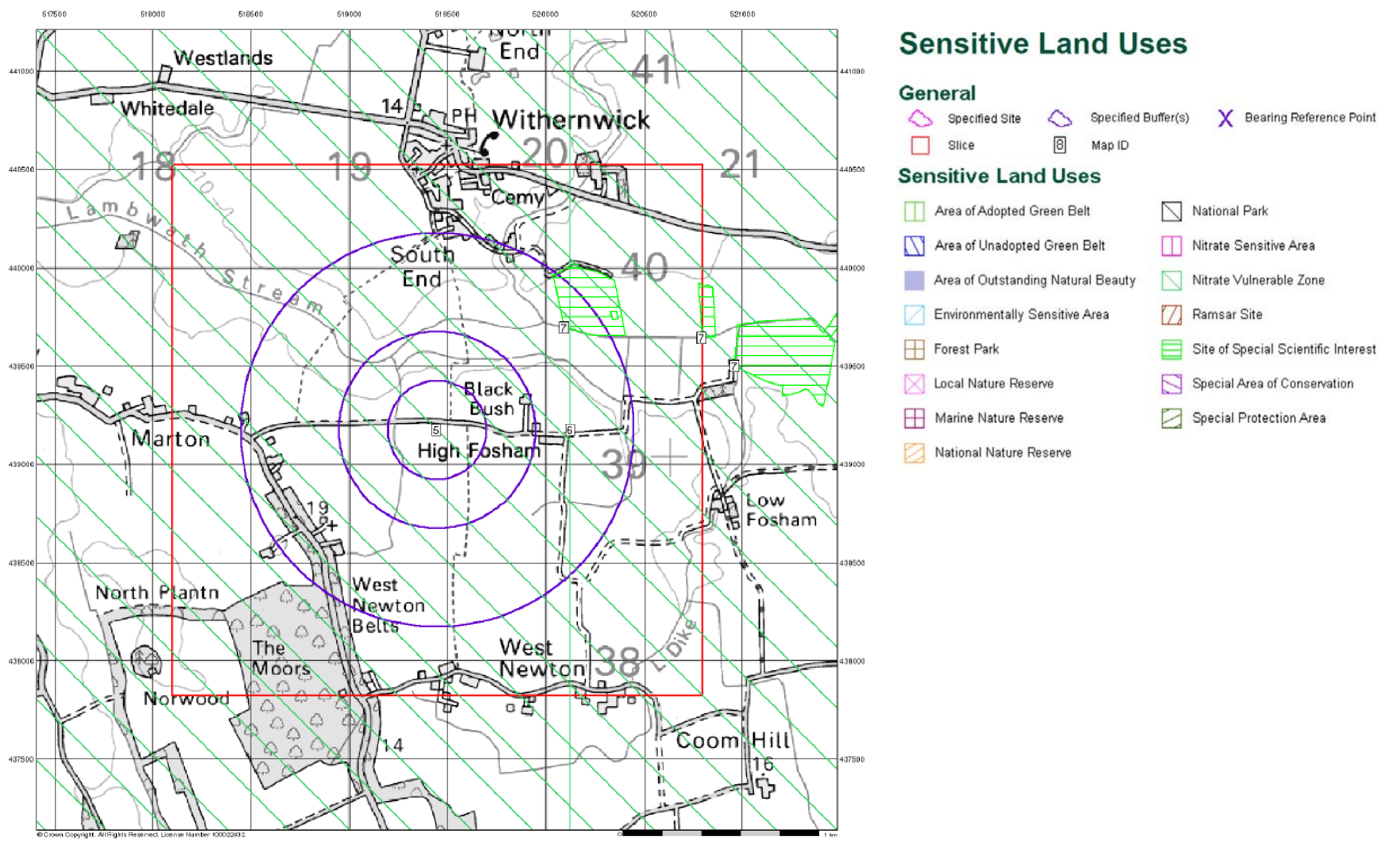


Figure 18 Protected areas within a 1km radius of the Site (Adapted from Landmark Survey Report, July 2012)

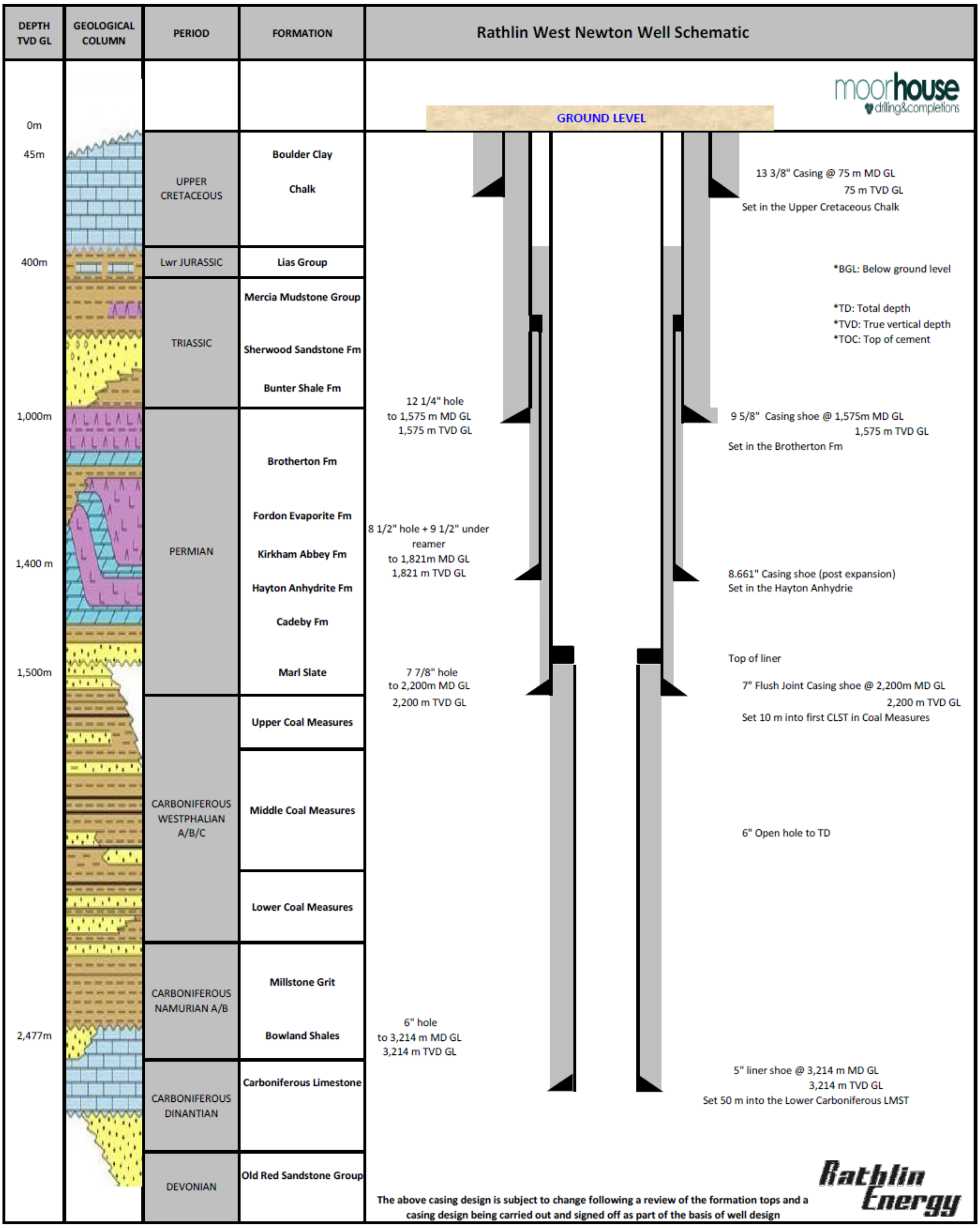


Figure 19: Schematic of Well design.