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Prepared By: Jonathan Foster	Uncontrolled, If Printed	Rev: 1.00

EMS SUPPORTING DOCUMENTATION - EPRA – CRAWBERRY HILL EXPLORATORY OPERATIONS - SCR

Crawberry Hill Wellsite Site Condition Report Exploratory Operations

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1. INTRODUCTION

Rathlin Energy (UK) Limited (Rathlin Energy) is a wholly owned subsidiary of Connaught Oil & Gas Ltd, a private company with its head office in Calgary, Canada. Connaught Oil & Gas Ltd is an international petroleum exploration, development and production company with operations in Western Canada and the United Kingdom. The experienced senior management team has an average of 30 years of direct operating experience in Canada and internationally. The United Kingdom operations are conducted through Rathlin Energy (UK) Limited and are directed from the Rathlin office in London.

Rathlin Energy is engaged in the exploration and production of petroleum onshore United Kingdom and holds 100% interest in Petroleum Exploration and Development Licence (PEDL) 183, within which it has drilled two exploration boreholes, Crawberry Hill 1 and West Newton 1.

The Crawberry Hill exploration wellsite was granted planning permission by East Riding of Yorkshire Council in September 2012 (Decision No. DC/12/02945/STPLF/STRAT). The site was constructed in 4th quarter 2012 and the drilling of the Crawberry Hill 1 well was completed in 2nd quarter 2013. The well has subsequently been suspended pending analysis of the data gathered during the drilling operation.

The purpose of this document is to document the condition of the site prior to and in support of an environmental permit being submitted to the Environment Agency

2. SCOPE

This Site Condition Report is applicable to the Crawberry Hill wellsite and all exploratory operations permitted therein, in accordance with the existing planning consent. It is applicable to Rathlin Energy, its contractors and subcontractors and can be used in support of applications to the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2010, where there is a requirement to provide a Waste Management Plan.

It has been provided as a record of the site condition prior to recommencing exploratory 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 operation when surrendering the environmental permit.

3. DEFINITIONS

BGS: British Geological Society

EA: Environment Agency

HDPE: High Density Polyethylene

MOT: Ministry of Transport

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SSSI: Special Site of Scientific Interest

4. WELLSITE DETAILS

The proposed Crawberry Hill exploratory operations are being undertaken at the following location:

Crawberry Hill Wellsite
Rathlin Energy (UK) Limited
Walkington Heads
Bishop Burton
Beverley
East Riding of Yorkshire

National Grid Ref: SE 97669 37720

Site Area: 0.99 hectares

Waste Registration Number: OGA961

The site surface boundary is detailed in green on the site plans included within document RE-05-EPRA-CH-SP-004.

5. SITE CONDITION PRIOR TO PERMIT ISSUE

The following section provides a detailed report on the current site condition at the point of which the Crawberry Hill Exploratory Operations permit application is submitted to the Environmental Agency.

5.1 Sources of Information

A desk study has been completed for the Crawberry Hill wellsite in order to document the current status of the wellsite immediately prior to submitting an application for an Environmental Permit. A range of information sources have been used, including Envirocheck, Environment Agency, BGS and MAGIC.

In addition to the desk study, primary data has been collected from a number of other sources including geotechnical evaluations (soil samples/chemical analysis) and air emissions monitoring.

5.2 Wellsite Location and Land Use

The Crawberry Hill wellsite is located to the north east of Walkington and south west of Bishop Burton. It is located within the parish of Bishop Burton, in the East Riding of Yorkshire. A site location map is included in Appendix 1.

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The landscape is a mix of rolling hilltops and agricultural land with interspersed woodland. The field is bordered by a mixture of fencing and a number of hedgerows which have been identified as species poor. The site is south of the National Grid 400kva electricity pylons.

Access to the site will be gained from Walkington Heads, which is a wide unclassified road. The Applicant has identified that HGV's accessing the site are to travel from the A1079, along Killingwoldgraves Lane, Coppleflat Lane and then Walkington Heads before turning into the site.

The nearest conurbations are Walkington, 1500m to the south-west and Bishop Burton, 1966m to the north east. The nearest residential properties are:

Coldharbour Farm	–	870m North
Westfield Farm	–	1070m South East
Walkington Wold Farm	–	1050m South West

5.3 Wellsite Construction

The Crawberry Hill wellsite was constructed in 4th quarter 2012, 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 northern boundary of the wellsite. Due to the archaeological potential of the site, a scheme of archaeological investigation was required whilst the topsoil stripped.

Once all of the topsoil was stripped, site construction continued with the removal of the subsoil to create a level surface and was used to form a cut to fill across the wellsite. 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 non-woven 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 it's 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 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.

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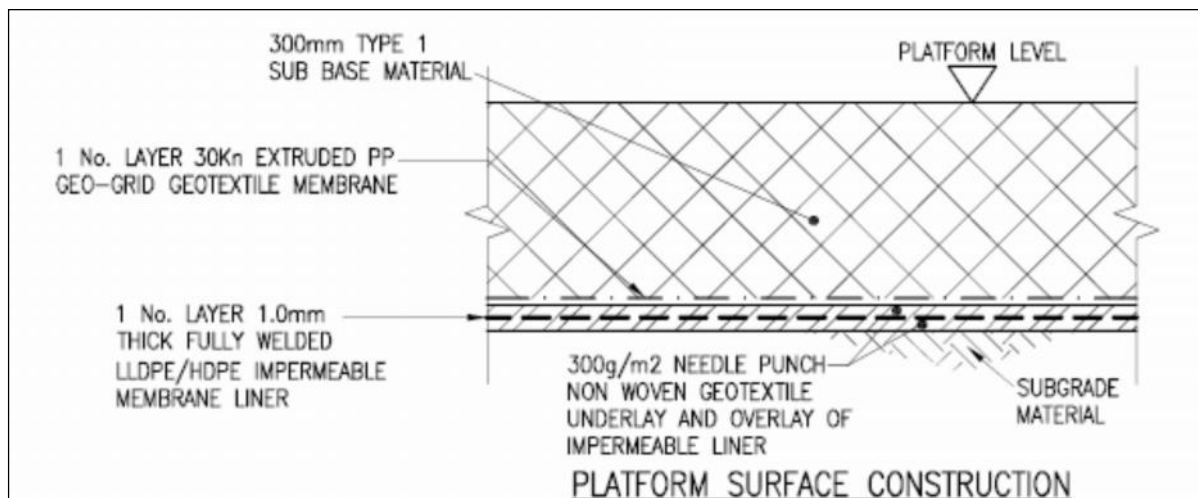


Figure 1. Cross section drawing of site surface construction

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.

5.4 Environmental Setting

The Crawberry Hill wellsite is not situated on or within a statutory or non-statutory designated site.

This site is located within a sloping field of arable farmland, adjacent to the Walkington Heads road. The northern, western and southern boundaries of the field are more or less hedgerows. The eastern field boundary is a timber post and rail fence. The site is within the Yorkshire Wolds Area of High Landscape Value.

A non-statutory designated site, Crawberry Hill, is located 600m to the north east of the site, designated a Local Wildlife Site. The area is predominantly arable fields with interspersed woodland and hedgerows.

An independent phase 1 habitat survey was completed and submitted in support of the planning application. This identified that the wellsite area is unlikely to provide significant habitat for protected or notable species of flora and fauna.

5.5 Geological Setting

The near surface geology across the Crawberry Hill wellsite is Upper Cretaceous Chalk.

The Upper Cretaceous Chalk is designated by the Environment Agency as a principal aquifer of regional importance. The Chalk in the region is sub-divided into the following sub-units (in increasing age and depth) Rowe, Flamborough, Burnham, Welton and Ferriby Chalks.

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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 within the conceptual model included as Appendix 5, derived from a true representation of the subsurface geology encountered during the CH1 drilling operation.

5.6 Hydrogeology

The Crawberry Hill wellsite is situated on the Upper Cretaceous Chalk formation, which is designated a principal aquifer by the Environment Agency. This aquifer is used for water supply in the local region, including Hull.

Records obtained from the Environment Agency as part of the monitoring network has provided information on the expected groundwater level fluctuations. At the site, this has been estimate to be in the region of 9 m AOD up to 34 m AOD.

Borehole Reference	Eastings & Northings (OS Grid)	Groundwater Level		
		Minimum (maOD)	Maximum (maOD)	Fluctuation (m)
'Lowland' Sites				
SE94ET04CC	496615,443047	8.9	26.8	17.9
SE94BBW0CC	496510,440824	5.5	32.6	27.1
SE94CBU0CC	498614,442213	5.9	23.8	17.9
TA04MPS0CC	500595,440095	5.6	22.0	16.3
SE93NL00CC	498661,438281	5.5	37.7	32.2
TA03WSW0CC	502009,437969	4.2	13.6	9.3
TA03BL00CC	501893,435930	5.7	28.0	11.5
SE93RNK0CC	500018,433948	4.5	29.4	24.9
'Wold' Sites				
SE94EWH0CC	494609,442896	16.7	30.9	14.2
SE93NBL0CC	494350,439222	25.8	43.7	17.9
SE93WKW0CC	497540,436351	27.8	36.3	8.5
SE93DPT0CC	492124,436350	46.3	51.0	3.4
SE93LTW0CC	498728,433854	25.1	36.4	11.3
SE93WLP0CC	495831,432922	39.3	53.2	13.8

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

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rather than saline intrusion). Under the Water Framework Directive classification, the aquifer has been designated by the Environment Agency as poor quality.

The Crawberry Hill site is within zone 3 of a Source Protection Zone, which identifies it being within the whole groundwater catchment for public supply.

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.

Prior to drilling the CH1 borehole a WR11 application was submitted to the Environment Agency and subsequently approved. A copy of the WR11 is included in Appendix 3.

Prior to the commencement of drilling operations and throughout the drilling operations, Rathlin has collected groundwater samples from three local boreholes. One borehole is up hydraulic gradient of the wellsite and two down hydraulic gradient. These sample locations were selected, as they provide a spread of locations around the wellsite.

Two of the sample boreholes are owned by the Environment Agency. A passive groundwater sampling method is used to collect the samples. A double valve disposable bailer is lowered into the borehole and captures grab samples at around 2.5 – 5 m below the surface of the water.

The third borehole is privately owned. Water from this borehole is collected from an outside tap, which has a direct feed from the pump in the borehole. The tap is run for approximately 15 – 20 minutes before a sample is collected.

The samples collected have been sent to a UKAS accredited laboratory for analysis of the following parameters:

- Turbidity
- pH
- Total suspended solids
- Alkalinity
- Hardness
- Sulphate
- Chloride
- Nitrate
- Calcium
- Magnesium
- Potassium

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- BTEX
- TPH

Two baseline samples were collected prior to operations commencing. Samples were then collected approximately every 4 weeks during drilling operations. A copy of the baseline analysis results is included in Appendix 4.

5.7 Crawberry Hill 1 Well Construction

Drilling of the Crawberry Hill 1 borehole commenced in early 2nd quarter 2013 and was completed by early 3rd quarter 2013.

Construction of the borehole began with the mobilisation of a small waterwell rig, which drilled a 36" hole through the Chalk to a depth of approximately 103 metres Below Ground Level. Once the borehole was drilled, steel casing was run and cemented back to surface. The rig then drilled a 26" hole through the remaining chalk, to a depth of 194 meters below ground level using reverse circulation. Once this section 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.

A summary of the well construction is included in Figure 2 overleaf

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.

A conceptual model of the CH1 well derived from a true representation of the subsurface geology encountered during the drilling is included as Appendix 6.

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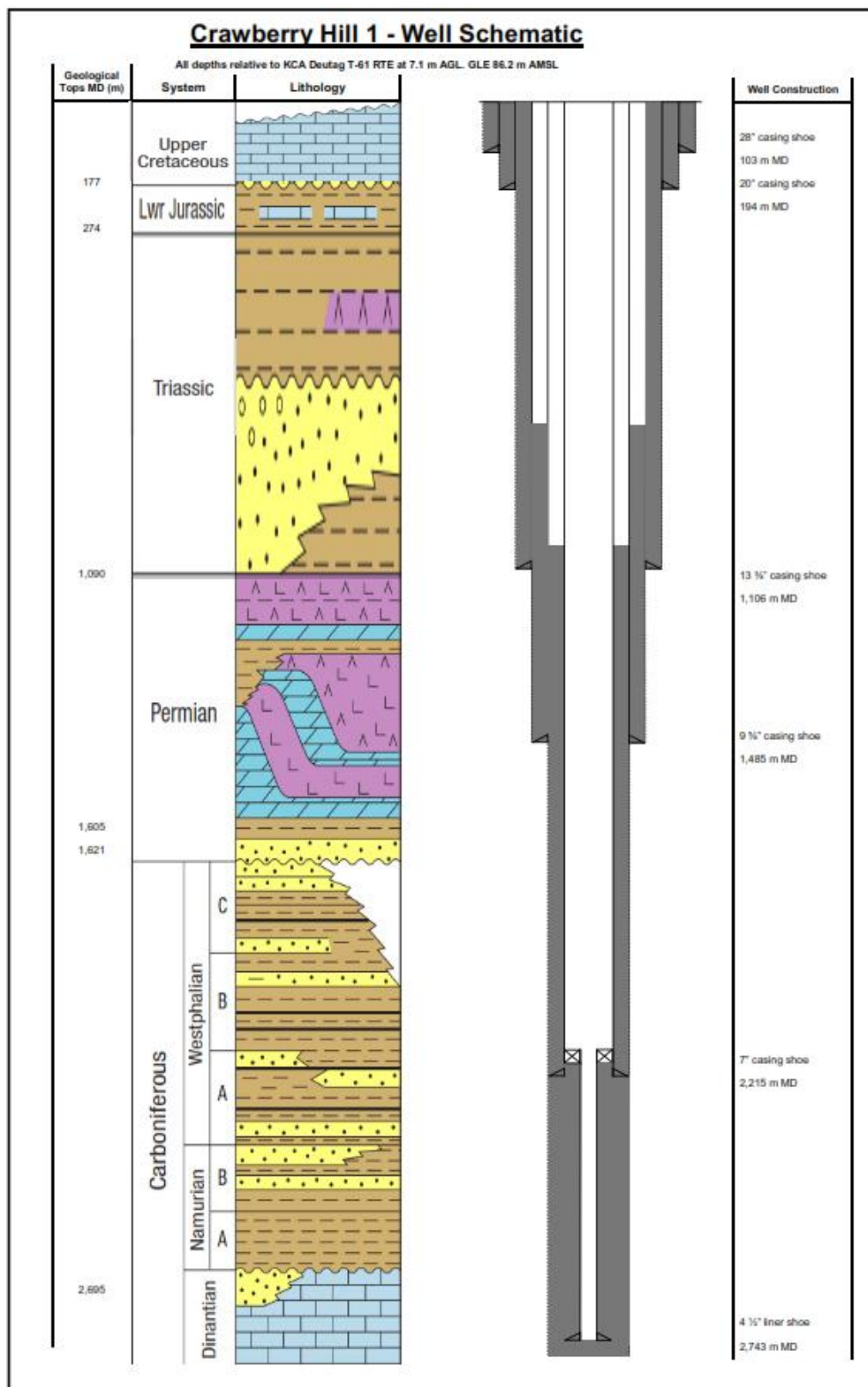


Figure 2. Summary well schematic

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5.8 Soils

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 0.25 – 0.3 m. The subsoil consists of disturbed soft clay with a lower glacial till layer with some gravel content. There was no indication of groundwater within these shallow boreholes.

Figure 3 identifies where the geotechnical boreholes were drilled and soil samples collected.

Samples were collected at a range of depths in each borehole and sent to an accredited laboratory for analysis. Each sample was analysed for a range of parameters and a copy of the results is included overleaf.

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.



Figure 3. Site plan identifying location of shallow geotechnical boreholes and soil analysis

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Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

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5.9 Surface Water and Drainage

There are no surface water features within the survey area of the Crawberry Hill site. There are a series of dry valleys that cross the Wolds and are identified in Figure 4. Streams begin to emerge further east of the wellsite, which form tributaries of the River Hull and Humber.

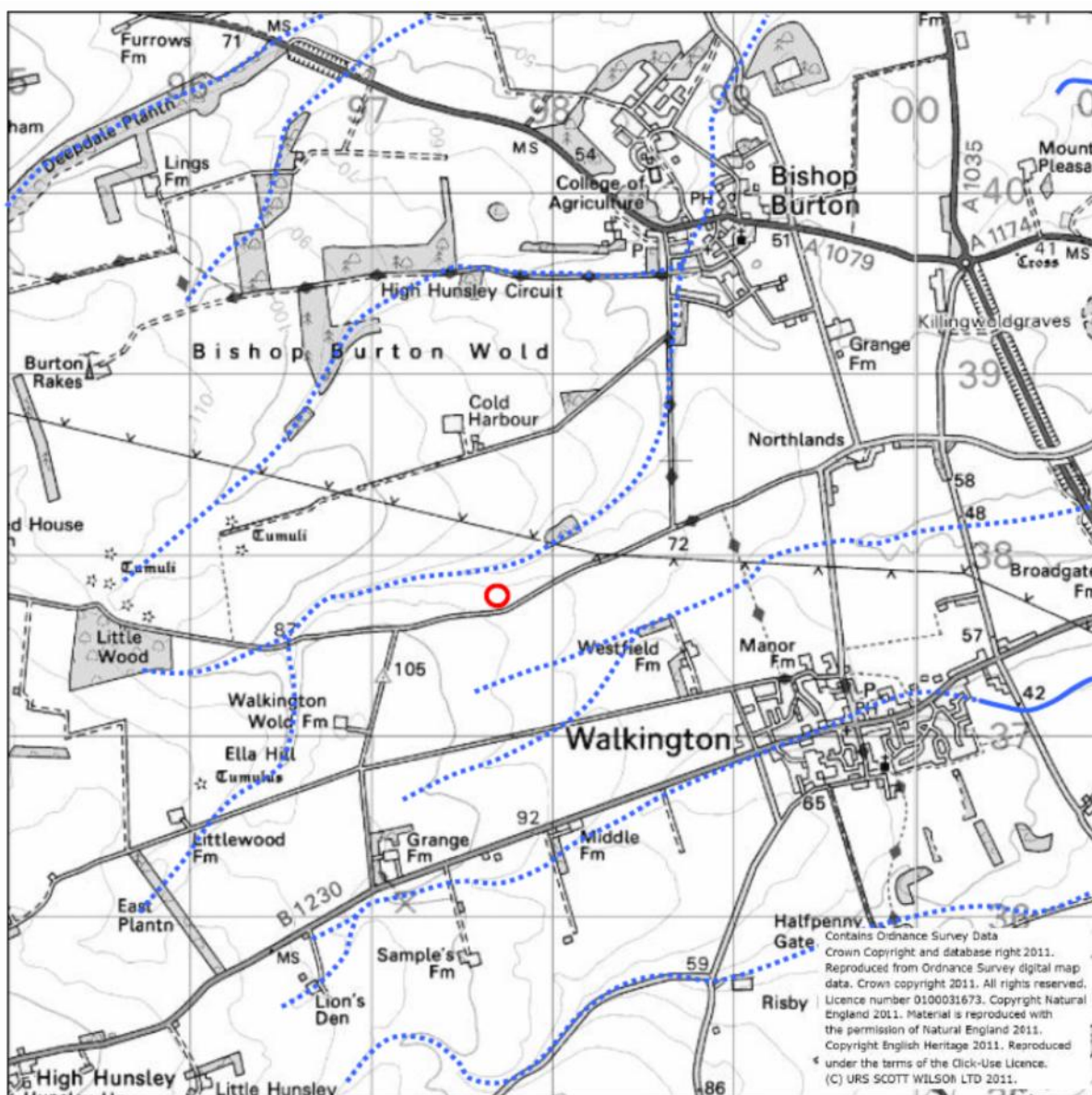


Figure 4. Site location map highlighting surface water features (URS)

A review was made of the EA flood maps. Figure 5 indicates that the site is located in an area of low risk of flooding.

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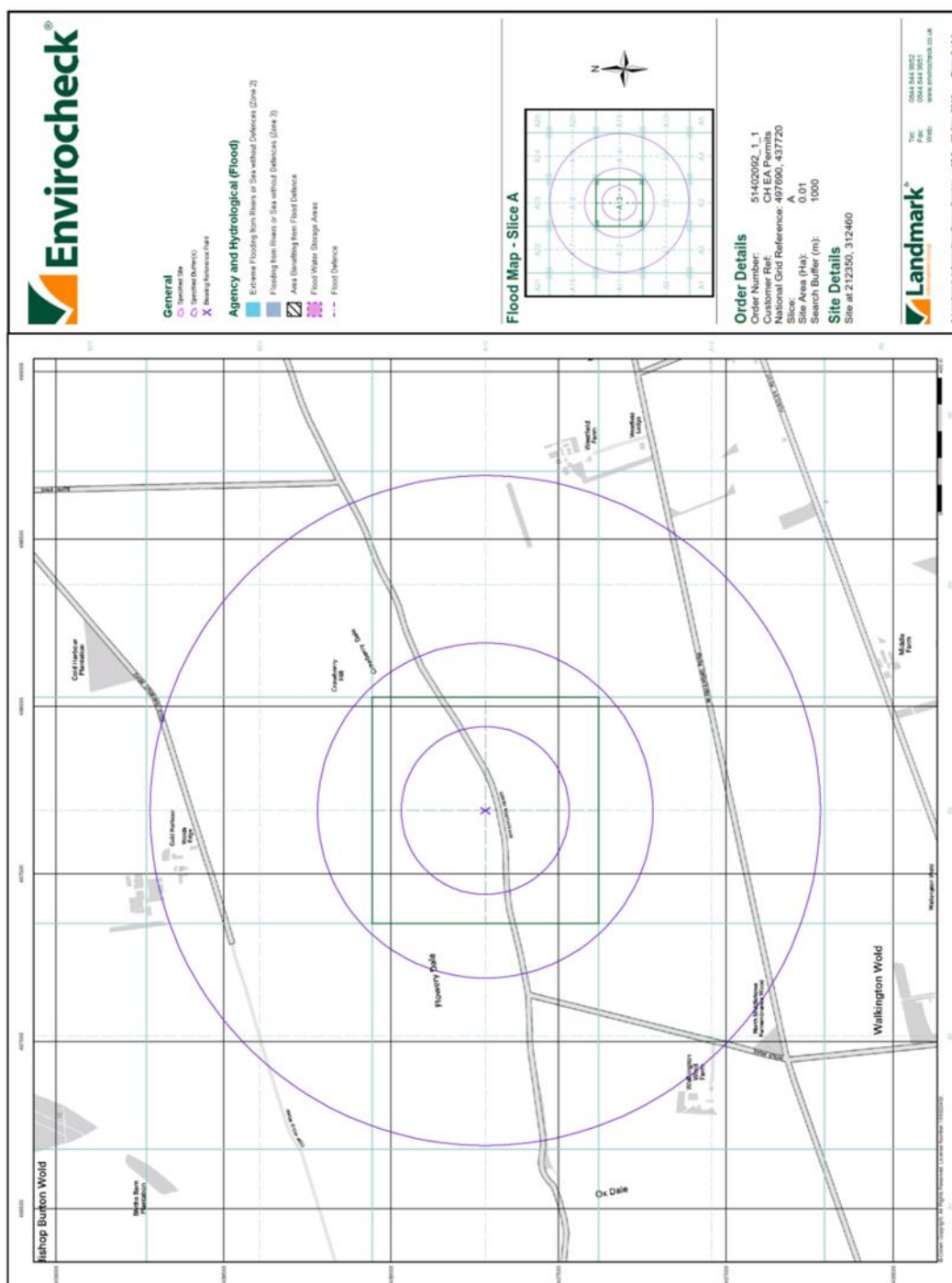


Figure 5. Flood Zone Map.

5.10 Site Drainage

The drainage on the Crawberry Hill wellsite has been designed to provide complete containment for the operations which take place onsite. The site has been constructed with an HDPE impermeable membrane, which lines the site including the perimeter ditches. The perimeter ditch is open along

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the northern and western boundary, whilst on the other two boundaries it has been installed with a twin walled perforated pipe and then back filled with stone. Figure 6 and Figure 7 provide a schematic of the constructed ditches. Figure 8 identifies the open and piped perimeter ditch which provides the containment onsite. The impermeable membrane has been integrated into the cellar walls to ensure its integrity.

Any surface water captured within the perimeter ditches onsite is removed by a licensed waste carrier.

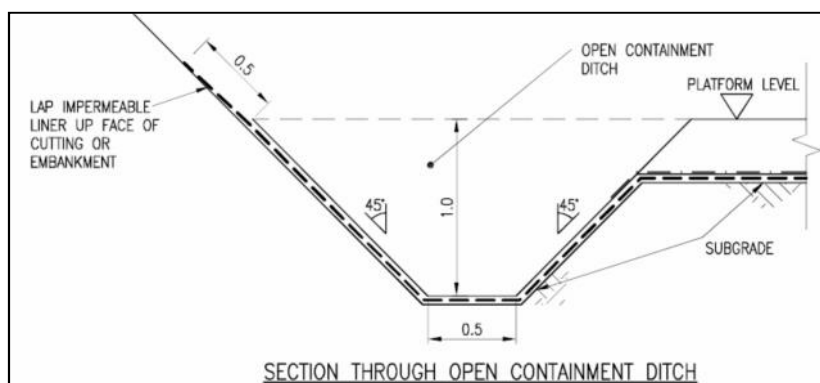


Figure 6. Schematic of open ditch on the wellsite

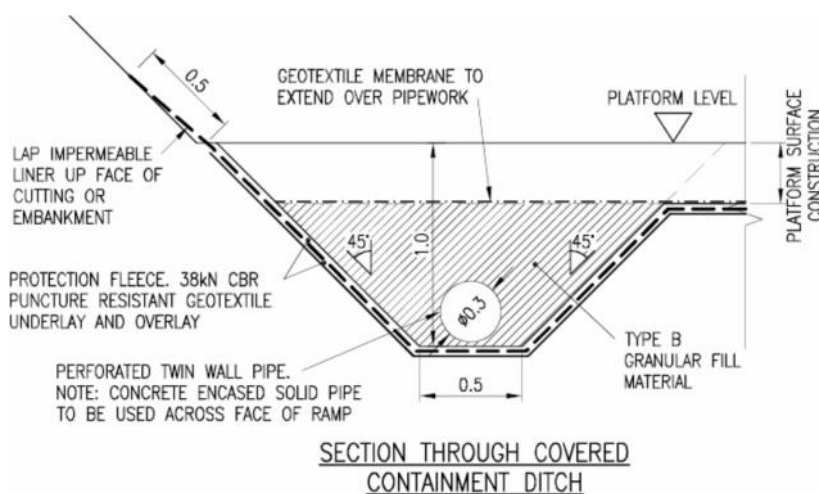


Figure 7. Schematic of piped ditches on the wellsite

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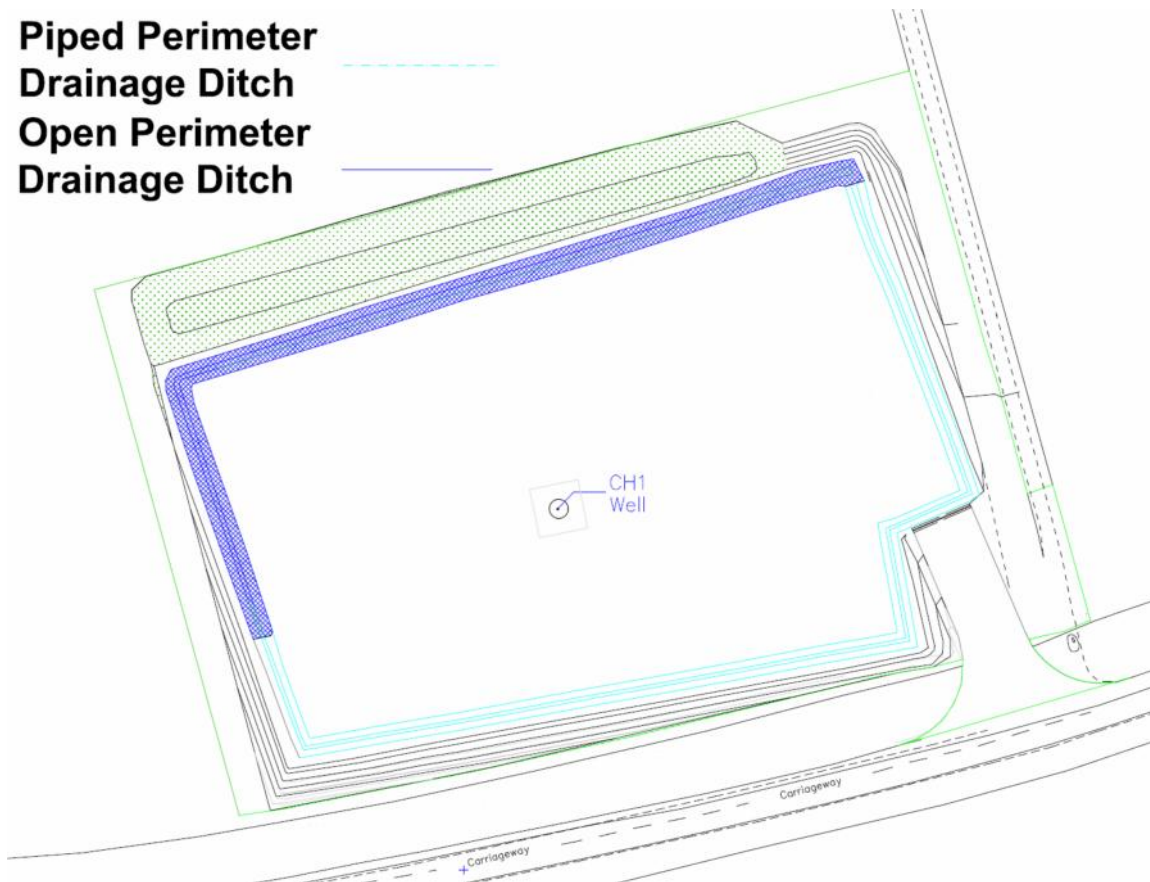


Figure 8. West Newton Wellsite Drainage Schematic

5.11 Groundwater Abstraction

Information was requested from the Environment Agency and Local Authority to identify any licensed or unlicensed abstractions. There are no licensed abstractions within 2km of the wellsite.

5.12 Air Quality

A baseline survey was conducted to understand the existing air quality; a copy of the results is included in Appendix 5. Diffusion tubes were installed and exposed for a two week period and monitored the following parameters:

- H2S
- VOC's
- BTEX

In addition to monitoring these parameters through diffusion tubes, spot samples were collected for methane. Table 1 provides an overview of the analysis methodology.

Samples were collected from all four sides of the wellsite, as shown in Figure 9.

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Parameter	Sampling Method	Sampling Period	Analysis Method	Detection Limit
Methane	Grab Sample	Seconds	GC-FID	5 ppm
VOC's and BTEX	Diffusion Tube	2 Weeks	ATD G-MS 10 Most Abundant	5 ng/tube BTEX
Hydrogen Sulphide	Diffusion Tube	2 Weeks		ppb

Table 1. Summary of air quality monitoring parameters and methodology

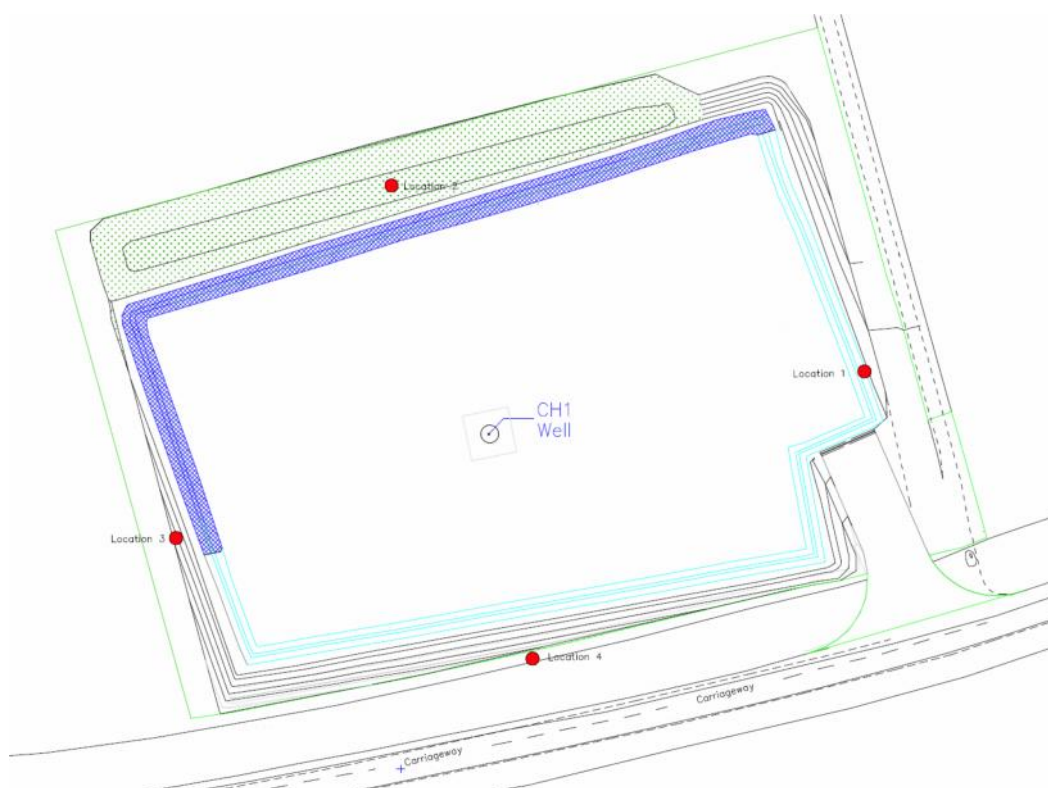


Figure 9. Wellsite layout showing air quality monitoring locations

5.13 Historic Land Use

Prior to the Crawberry Hill wellsite being constructed, the land formed part of an arable field. A search of Environment Agency records identifies that there are four small waste pits within 2 km of the wellsite. All of these pits have been closed for more than 20 years, according to records held by the Environment Agency. These pits could have accepted a range of wastes and provide a potential source for groundwater contamination. The pit at Middlehowe is approximately 1 km up hydraulic gradient from the wellsite and may influence water quality at the site.

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5.14 Pollution Incidents and Contamination

A review of the Environment Agency website shows that there are no records of historic or active landfills within a 2 km radius of the wellsite.

A search completed by Envirocheck notes that there are the following activities within 1 km of the wellsite:

1. Discharge Consent (NGR 498230 438020) approximately 620m northeast from site: Storm sewage overflow discharge into Swinney Beck operated by Yorkshire Water Services Ltd at Mansham Swinton Pumping Station, Consent authorised by the Environment Agency – not known.
2. Discharge Consent (NGR 497450 438670) approximately 982m north from site: Sewage discharge of final/treated effluent (not water company) to land/soakaway at The Clock Tower, Cold Harbour Farm, Consent authorised by the Environment Agency – current status active.

6. PERMITTED ACTIVITIES

A number of the activities that are to be conducted are considered a Mining Waste Operation, as defined by the Mining Waste Directive and Schedule 20 of the Environmental Permitting (England and Wales) Regulation 2010, as amended, relating to the management of extractive waste.

7. FACILITY CLASSIFICATION

A number of non-permitted activities will be conducted during this phase including, but not limited to:

- Well maintenance
- Well monitoring
- Storage and disposal of non-hazardous and hazardous wastes not directly associated with the permitted activities
- Discharge of uncontaminated rainwater run-off to controlled waters

8. BASELINE MONITORING

Baseline monitoring has been undertaken with respect to noise, air quality, water quality and soils. Noise, air quality and water quality monitoring will be undertaken during subsequent operations at the site.

Rev:	Prepared By:	Checked By:	Approved By:	Issued:
1.00	Jonathan Foster	Tom Selkirk	D Montagu-Smith	16/01/2014

<i>Rathlin Energy</i>	Applies To: Rathlin Energy	RE-05-EPRA-CH- SCR-006
Prepared By: Jonathan Foster	Uncontrolled, If Printed	Rev: 1.00

EMS SUPPORTING DOCUMENTATION - EPRA – CRAWBERRY HILL EXPLORATORY OPERATIONS - SCR

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APPENDIX 1 – SITE LOCATION MAPS

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Key:

Site Boundary



Rathlin Energy (UK) Limited
8 Wimpole Street
London
W1G 9SP

Job Title:
Crawberry Hill Wellsite

Drawing Title:
Site Plan (Environmental &
Waste Management Plan)

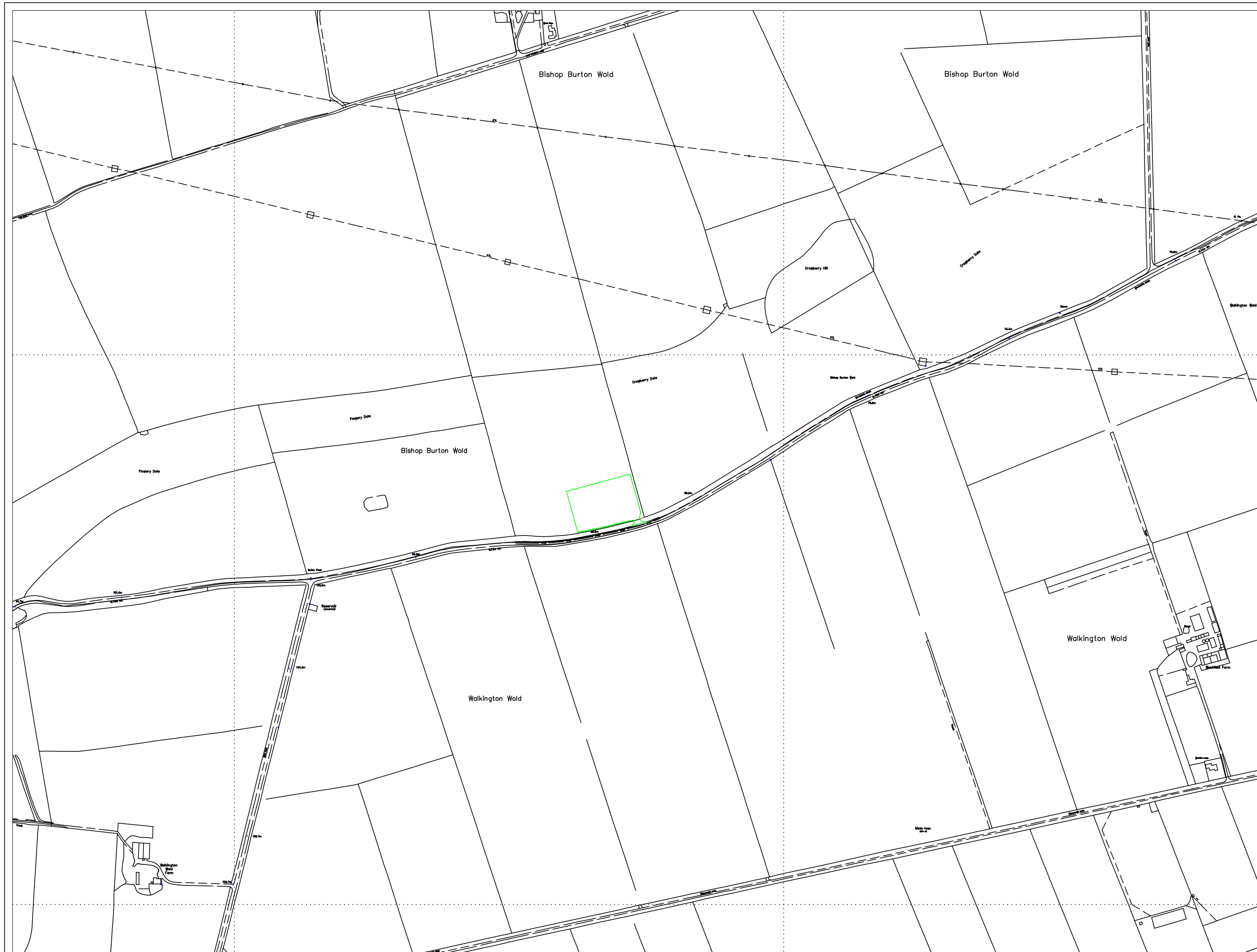
Scale: 1:5,000 (Print A3)

Date: 16th January 2014

Drawn By:
Jonathan Foster

Drawing No:
RE-05-EPRA-CH-SP-004-01

Rev: 0





Key:

- Site Boundary 
- Topsoil Storage Bund 
- Open Perimeter Drainage Ditch 
- Piped Perimeter Drainage Ditch 
- Air Quality Monitoring Locations 



Rathlin Energy (UK) Limited
8 Wimpole Street
London
W1G 9SP

Job Title:
Crawberry Hill Wellsite

Drawing Title:
As-Built Plan
(Environmental & waste
Management Plan)

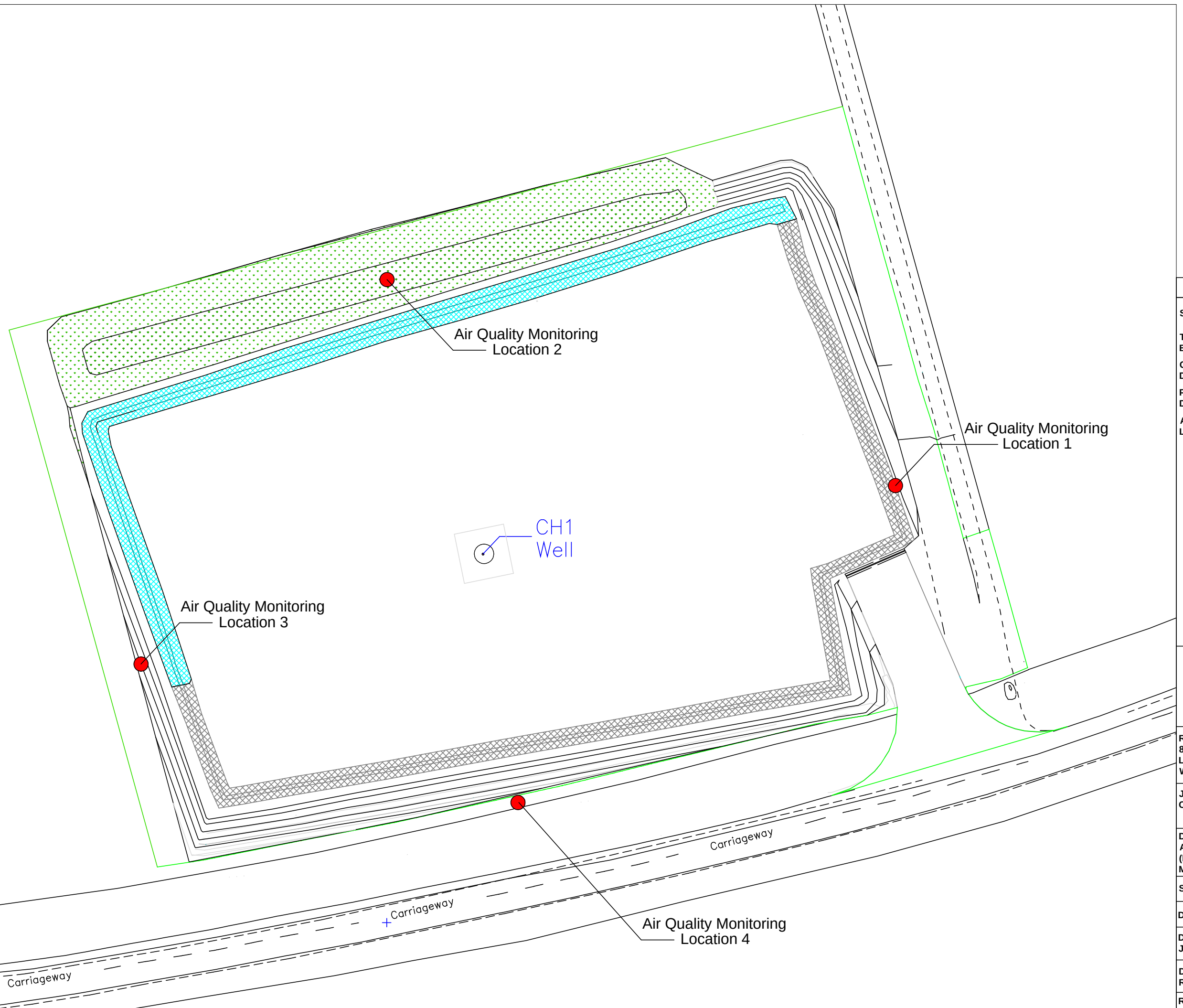
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Date: 16th January 2014

Drawn By:
Jonathan Foster

Drawing No:
RE-05-EPRA-CH-SP-004-02

Rev: 0



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Prepared By: Jonathan Foster	Uncontrolled, If Printed	Rev: 1.00

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APPENDIX 2 – GEOLOGY MAPS

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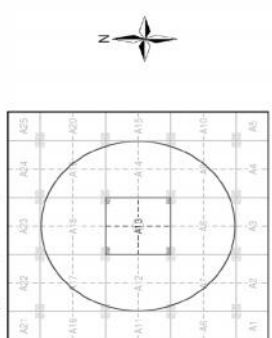


Geology 1:50,000 Maps
This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.
The various geological layers - artificial and landslide deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID:	1
Map Sheet No:	072
Map Name:	1:50,000 Crawberry
Map Date:	1995
Bedrock Geology:	Available
Superficial Geology:	Available
Artificial Geology:	Not Available
Landslip:	Not Available
Rock Segments:	Not Available

Geology 1:50,000 Maps - Slice A



Order Details:

Order Number: 51402092, 1.1
Customer Reference: CH-EPRA-Permits
National Grid Reference: 497690, 437720
Site: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details:
Site at 212350, 312460

Geology 1:50,000 Maps Legends

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	TILLD	Till, Devensian	Diamicton	Devensian - Devensian
	HEAD	Head	Clay, Silt, Sand and Gravel	Quaternary - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	FOK	Flamborough Chalk Formation	Chalk	Campanian - Santonian
	BCK	Burnham Chalk Formation	Chalk	Santonian - Turonian

Landmark
v15.0 29-Nov-2013

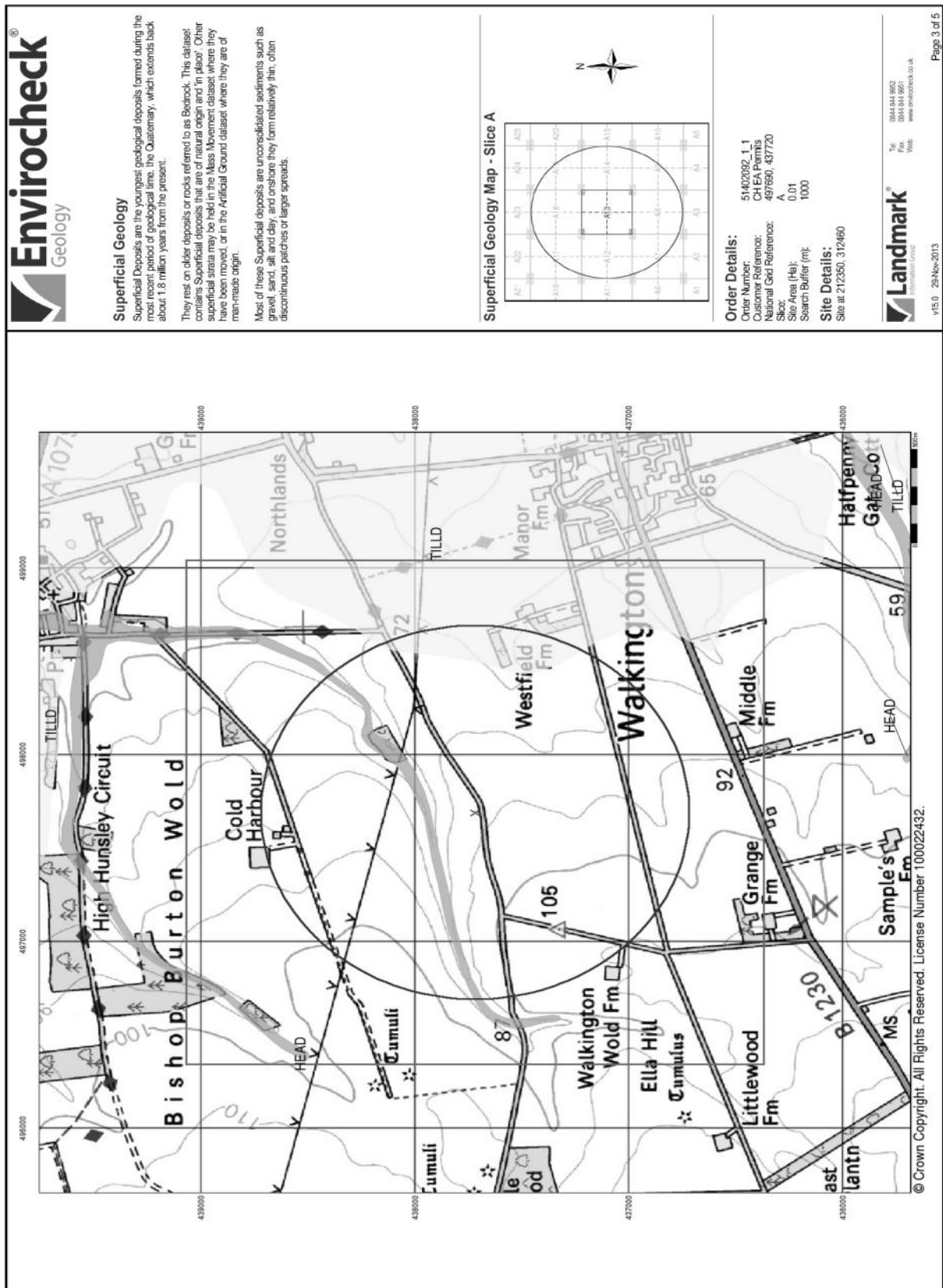
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Page 1 of 5

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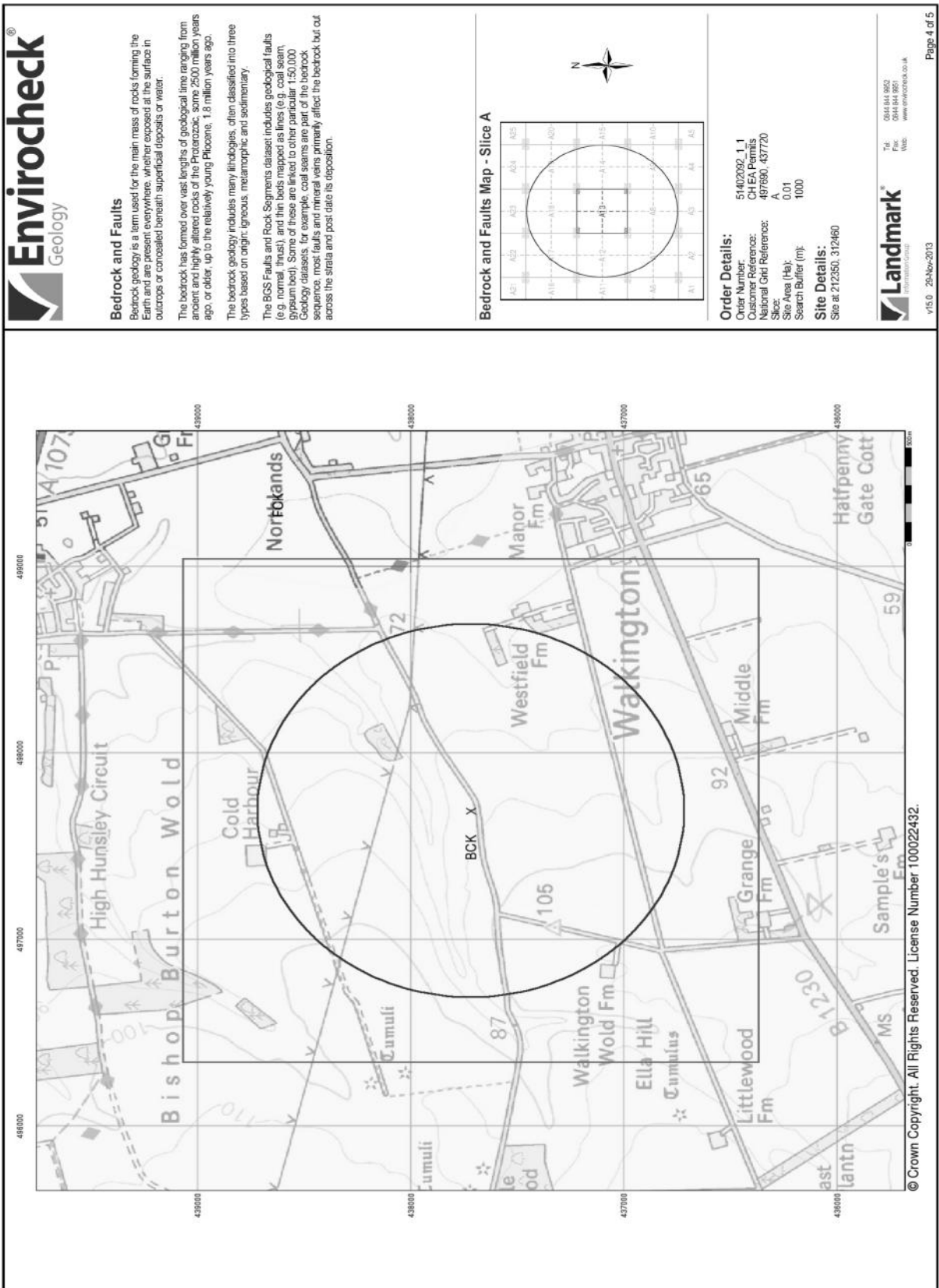
EMS SUPPORTING DOCUMENTATION - EPRA – CRAWBERRY HILL EXPLORATORY OPERATIONS - SCR



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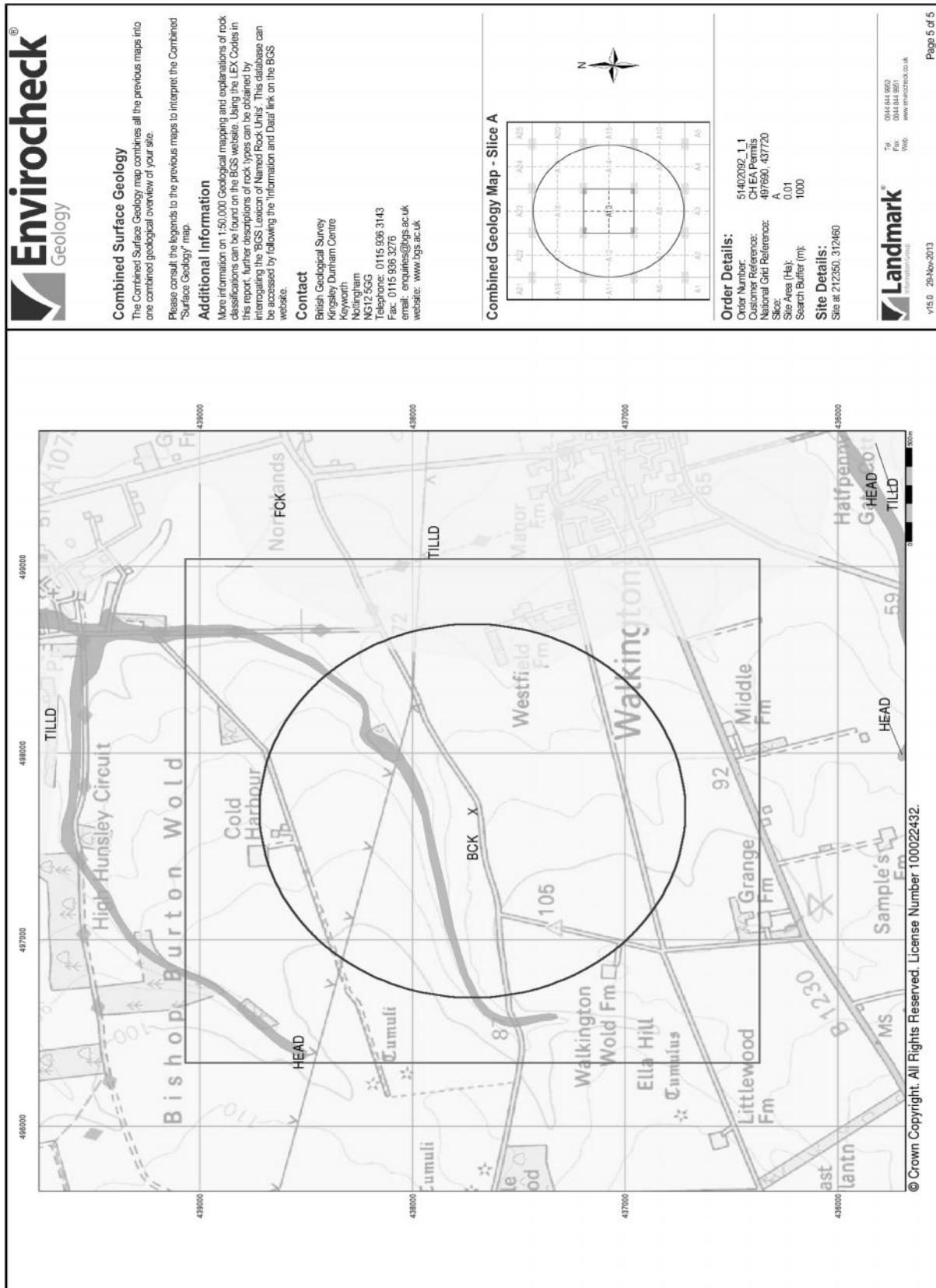
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APPENDIX 3 – WR11 APPLICATION

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WR11 APPLICATION

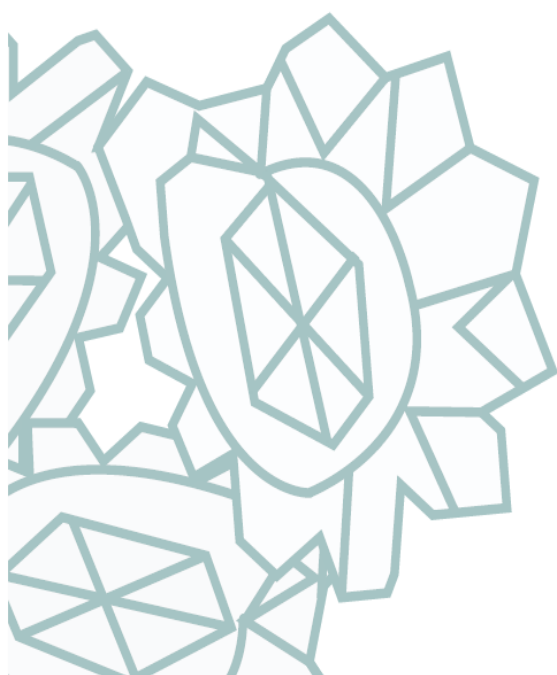
RATHLIN ENERGY
(UK) LIMITED

CRAWBERRY HILL WELLSITE,
WALKINGTON HEADS,
BEVERLEY,
EAST YORKSHIRE

DECEMBER 2012

Moorhouse Petroleum Limited
Moor House
Bessingby Way
Bessingby Industrial Estate
Bridlington
East Yorkshire
YO16 4SJ

Tel: (01262) 608731
Fax: (01262) 608390



APPROVAL LIST

	Title	Name	Signature	Date
Prepared By	Planning and HSE Engineer	Philip Silk		12 th December 2012
Reviewed By	Drilling Engineer	Ben Mason		13 th December 2012
Approved By	Planning and HSE Manager	Jonathan Foster		13 th December 2012

REVISION RECORD

Version	Date	Description
P0	12/12/12	Draft for Comments
Rev 0	13/12/12	Initial Release
Rev 1		
Rev 2		

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SECTION I – ENVIRONMENT AGENCY WR11 APPLICATION FORM

Form WR - 11
Water Resources Act 1991 (Section 199(1))



Notice to the Environment Agency of intention to construct or extend a boring for the purpose of searching for or extracting minerals

Name of person or organisation

Take notice that RATHLIN ENERGY (UK) LIMITED

Date - except in emergency this should be at least one month after service of this notice (**See below #**)

intends on or after 15th JANUARY 2013

to construct borings at the place in the area

marked RED on the accompanying map (**see below §**)

for the purpose of searching for and extracting minerals.

Give all relevant details of works e.g. depth, diameter, orientation, method of construction or extension, etc.

The proposed construction will be

AS PER THE CRAWBERRY HILL WR 11 APPLICATION SUPPORTING STATEMENT, WHICH INCLUDES A

GEOLOGICAL SUMMARY FOR THE WELL

State e.g. 'water will be pumped and allowed to run to waste'. If to be used, state use and proportion of water used that will be discharged afterwards

Water entering the boring during or after its construction will be disposed of by

ON SITE STORAGE AND SUBSEQUENT DISPOSAL TO AN

APPROVED OFF SITE LOCATION

Your address or if applicable the name and address of your agent or professional adviser

To the best of my knowledge the statements made above are true.

Communications about this notice should be addressed to MOORHOUSE DRILLING AND COMPLETIONS

BESSINGBY WAY, BESSINGBY INDUSTRIAL ESTATE,

BRIDLINGTON, EAST YORKSHIRE, YO16 4SJ

PHILIP SILK

for the attention of

Signed

Insert 'the undersigned', agent's name, etc.

Name/on behalf of RATHLIN ENERGY (UK) LTD Date 09/12/11

- # Note that the Environment Agency may serve a counter-notice on you requiring you to take measures to conserve water. You may incur additional expense if you begin work before the Environment Agency has had a reasonable time to serve such a conservation notice.
- * Delete as appropriate.
- § Unless agreed otherwise with the Environment Agency this should be an Ordnance Survey map with scale not less than 1:10,000 (6" to a mile)

This notice should be sent to your local Environment Agency office. You can find the address of your local office by calling us on 08708 506 506.

SECTION II – WR11 APPLICATION SUPPORTING STATEMENT

1 GLOSSARY

Casing	-	Is made from steel and is used to line the well bore to maintain stability and prevent fluids escaping from the well
Cuttings	-	Small pieces of rock break away due to the action of the drilling bit teeth cutting through the rock
DECC	-	Department for Energy and Climate Change
Drilling Fluid	-	A fluid pumped into the borehole to circulate cuttings to surface. Drilling fluid also provides a hydrostatic barrier against reservoir pressure and can be adjusted in weight according to anticipated pressures.
KCl	-	Potassium Chloride
M	-	Metres
MD GL	-	Measured Depth Ground Level
NCB	-	National Coal Board
PEDL	-	Petroleum Exploration and Development Licence
Tubing	-	Tubing is hung inside the casing and petroleum is flowed through it to surface
TD	-	Total Depth (Note: Can also be used to signify hole section total depth)
TVD	-	True Vertical Depth
TVD GL	-	True Vertical Depth Ground Level
"	-	Imperial Inch (Note: Equivalent to 2.54 metric centimetres)

2 INTRODUCTION

2.1 THE APPLICANT

Rathlin Energy (UK) Limited ("the Applicant") is a wholly owned subsidiary of Connaught Oil & Gas Ltd, a private company with its head office in Calgary, Canada.

Connaught Oil & Gas Ltd. is an international petroleum exploration, development and production company with operations in Western Canada and the United Kingdom. The experienced senior management team has an average of 30 years of direct operating experience in Canada and internationally.

The United Kingdom operations are conducted through Rathlin Energy (UK) Limited and Rathlin Energy Limited and are directed from the Rathlin office in London.

The Applicant is engaged in the exploration and production of petroleum onshore United Kingdom and holds a 100% interest in Petroleum Exploration and Development Licence (PEDL) 183. This license covers approximately 241,000 acres and was granted by the Secretary of State for the Department of Energy and Climate Change (DECC). The licence gives the Applicant the exclusive right to search for subsurface petroleum by physical means within the licence boundaries.

The Applicant is an experienced oil and gas field operator and through its parent company, Connaught Oil & Gas Ltd, has drilled numerous exploration and development wells in Canada. This has been achieved to the complete satisfaction of all stakeholders and governmental regulatory authorities which have the responsibility to monitor and supervise all petroleum drilling operations. Furthermore, Connaught's Northern Ireland subsidiary, Rathlin Energy Limited, participated in the drilling of an onshore exploration well during 2008, which again was completed in full compliance with all regulatory and stakeholder agreements.

The Applicant is committed to safe, compliant and environmentally conscious operations for the benefit of employees, contractors, shareholders, stakeholders and the communities in which the Applicant works.

The purpose of this document is to provide an overview of the proposed drilling and casing programme for the forthcoming Crawberry Hill 1 drilling operation, in support of a WR11 application.

2.2 BACKGROUND

Rathlin Energy (UK) Limited is the holder of PEDL 183, which encompasses approximately 241,000 acres in the North Humberside region of England. In September 2012, the Applicant received planning permission from East Riding of Yorkshire Council (Application No. DC/12/02945/STPLF/STRAT) to construct a temporary drilling site with associated access, to drill an appraisal borehole for the purposes of mineral exploration (petroleum). The planning permission permits the drilling of up to two petroleum wells, however, the Applicant will only be drilling one well at this stage. Any future wells will require a separate WR11 application to be submitted.

The wellsite is located to the north east of Walkington and the south-west of Bishop Burton, at National Grid Reference SE 976 377 (Easting: 497668.6 Northing: 437719.9). The site is approximately 86m Above Ordnance Datum (AOD).

The Crawberry Hill wellsite is currently being constructed and is due to be completed by the end of December 2012.

2.3 GEOLOGICAL SETTING

In January 2011, Rathlin conducted a 29 sq km 3D seismic survey to delineate a geological lead that had been identified on previously acquired 2D seismic data in the Walkington area. The results of this survey are shown below. The previously existing 2D data was acquired by other industry operators between 1981 and 1988 and did not provide adequate definition of the Crawberry Hill Prospect.

In 1972 Candecca Resources Plc. drilled the Risby-1 well, 4 km south east of the proposed Crawberry Hill location. The Risby well was drilled to a total depth of 1,503 meters, into the Carboniferous Coal Measures. Candecca's primary objective, the Basal Permian Sand, was present; however no hydrocarbons were encountered in that formation. The Risby well did, however, exhibit hydrocarbon shows in the Permian-aged Kirkham Abbey carbonates.

Rathlin recognises up to six (6) potential reservoir target horizons, in the proposed Crawberry Hill prospect including the Permian age Brotherton, Kirkham Abbey and Cadeby carbonate sequences and the Carboniferous age Coal Measures and Millstone Grit sand sequences as well as the Carboniferous Dinantian carbonate. These formations will be encountered between 1,100m (3608ft) and 2,580m (8462ft) in the proposed well. Source rock potential is present within the Permian basinal sediments the Westphalian Coal Measures and the Bowland shale sequence. It is anticipated that hydrocarbons may be either oil or gas, as is the case in Keddington and Saltfleetby fields.

The primary target, based on 3D mapping is a Permian-aged Cadeby carbonate reef build up which would provide a stratigraphic trap for hydrocarbons. A deeper structural lineament controls structural closure at the secondary Carboniferous (Westphalian and Namurian) sandstone and (Dinantian) carbonate target levels.

The Crawberry Hill well will be drilled to a total depth of +/- 2,677m (8781ft) MD GL / 2,487m (8157ft) TVD GL.

At the site the Burnham Chalk Formation outcrops (roughly equivalent to the Upper Chalk), beneath this is the Welton Chalk Formation (Middle Chalk) and below this the Ferriby Chalk Formation (Lower Chalk). The Cretaceous Chalk is classified as a Principal Aquifer (as defined by the Environment Agency). The public water supply for the region including the conurbation of Hull is entirely derived from this Chalk aquifer. Yorkshire Water is licensed to abstract 65 Ml/d from sources in the Cottingham and Beverley area. Section 3 of this document provides a summary of the proposed drilling and casing programme which has been developed to ensure the protection of the aquifer.

3 DRILLING AND CASING PROGRAMME

The Crawberry Hill 1 well will be drilled to a Total Depth (TD) of 2487m (8159ft) TVD GL in accordance with the drilling program detailed below.

The well is to be drilled in two separate phases. The first section will be drilled by a waterwell drilling rig. Once this is completed, a conventional oilfield drilling rig will be mobilised to site and drill to TD.

Prior to a drilling rig arriving onsite, a 40" steel casing will be installed in the base of the cellar to provide a conduit whilst drilling the initial section.

3.1 SURFACE CONDUCTOR SETTING to 203m TVD GL

A conventional waterwell drilling rig is proposed to drill the surface conductor to 203m (666ft) TVD GL. The rig will be mobilised to site and rigged up over the cellar and commissioned.

The drilling of the surface conductor will start with the drilling of a 36" hole, to a depth of +/- 100m (328ft). This initial section will be drilled conventionally with water. Once this section has been drilled, 28" steel casing will be run into the hole. The casing will then be cemented into position and a pressure test completed. A 26" hole will then be drilled to 203m (666ft), a prognosed depth based on the geological column, and 20" casing run, cemented and pressure tested. This section will be drilled using reverse circulation, with water and food grade polymers forming the drilling fluid.

Once this section is completed, the waterwell drilling rig will be demobilised from the site.

3.2 17 ½" HOLE SECTION to 1,009m TVD GL (1,096m MD GL)

Once the surface conductor has been set, a conventional oilfield drilling rig will be mobilised to site. It will be rigged up over the cellar and commissioned.

A 17 ½" hole will be drilled from 203m (666ft) TVD GL to 1,096m (3595ft) MD GL using a bentonite polymer water based mud system. The well will be directionally drilled and kick off from 223m (731ft) TVD GL building up to an angle of approximately 33° and set a minimum of 20m below the Sherwood Sandstone. 13 ⅝" casing will be ran into the hole and cemented back to surface. The casing will be pressure tested to 1,800 psi. A Formation Integrity Test will also be completed.

3.3 12 ¼" HOLE SECTION to 1,260m TVD GL (1,395m MD GL)

The 12 ¼" well will continue to be drilled at a tangent of 33° to just above the primary target with a salt saturated water based mud drilling fluid. It will be drilled from 1,096m (3595ft) MD GL to 1,395m (4576ft) MD GL. 9 ⅝" casing will be run into the hole and set a minimum of 7m (23ft) into the Permian Hayton Anhydrite Formation. It will be cemented 700m (1300ft) MD above the previous casing shoe and then pressure tested to 2,200 psi to confirm its integrity.

3.4 8 ½" HOLE SECTION to 1,509m TVD GL (1,679m MD GL)

Prior to drilling the next section, a Formation Integrity Test will be completed to confirm the formation and casing shoe pressures. The 8 ½" borehole will be drilled from 1,395m (4576ft) MD GL to 1,679m (5507ft) MD GL, with the borehole gradually dropping the inclination

through the formations. A salt saturated water based mud drilling fluid will be used in this section, which will be drilled a minimum of 10m into the first claystone in the Upper Carboniferous Coal Measures (Westphalian C). Once drilled, 7" casing will be run into the hole from surface and cemented to 1,050m (1130ft) MD above the previous cement shoe. It will then be pressure tested to 4,400 psi.

3.5 6" HOLE SECTION 2,487m TVD GL (2,677m MD GL)

Prior to drilling the next section, a Formation Integrity Test will be completed to confirm the formation and casing shoe pressures. The 6" hole will be drilled from 1679m (5507ft) MD GL to 2,677m (8781ft) MD GL, with a potassium chloride water based mud drilling fluid. From 1679m (5507ft) MD GL, the well will continue to drop inclination and will return to vertical at approximately 2393m (7849ft) MD GL, where it will continue to drill to a TD of 2,677m (8781ft) MD GL. The casing will be pressure tested to 4,400 psi.

3.6 4 1/2" LINER

If the 6" hole is successful in encountering petroleum and following some initial tests, a 4 1/2" liner will be run 50m (164ft) into the Lower Carboniferous Limestone, with the liner hanger to be set 100m (328ft) inside the 7" casing.

A 3 1/2" completion and tubing will be run for the upper zone and a 2 7/8" completion and tubing for the lower zone. The various targets identified will be perforated to allow any hydrocarbons to flow into the annulus. Hydraulic packers will be set in the well to isolate the petroleum reservoirs. The selective completions have been designed to allow production from either the upper target (the Permian Formations) only, the lower Carboniferous secondary targets only, or both perforated zones combined. The completion and tubing will provide a conduit for the petroleum to flow to surface.

3.7 GEOLOGICAL MONITORING AND LOGGING

In order to confirm the depth of formations being drilled during the operation, a team of geologists will be on site logging cuttings returning to surface.

Verticality surveys will be conducted whilst drilling the surface conductor. Whilst drilling the 17 1/2" section and subsequent hole sections, Measurements Whilst Drilling (MWD) tools will be in place and multiple surveys taken as directed by the Directional Driller.

A suite of electric logs will be run in each open hole section prior to setting casing. Logging will allow evaluation of the potential reservoir intervals and provide basis for further testing. On completion of the drilling, a series of wireline conveyed logs will be run into the borehole to determine the presence of petroleum and whether sufficient petroleum exists to justify subsequent testing and production.

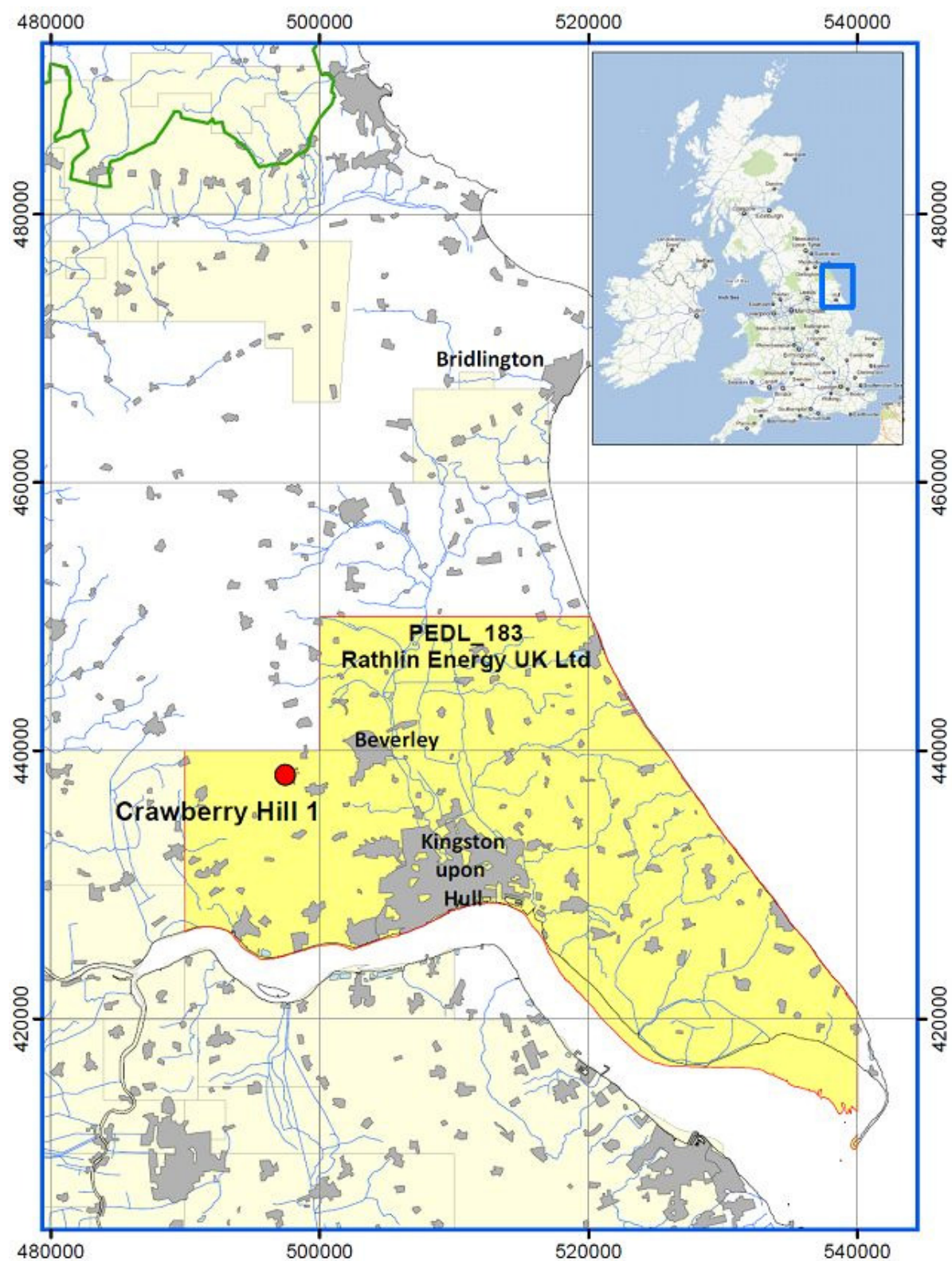
During the drilling, it is anticipated that the primary target zone, the Cadeby Formation, will be conventionally cored to analyse the reservoir potential of the zone. If the wellsite geologist decides it is prudent to do so, then the millstone grit may also be conventionally cored. As well, it is expected that the Bowland shale interval will be wireline cored to evaluate the source rock potential of that zone.

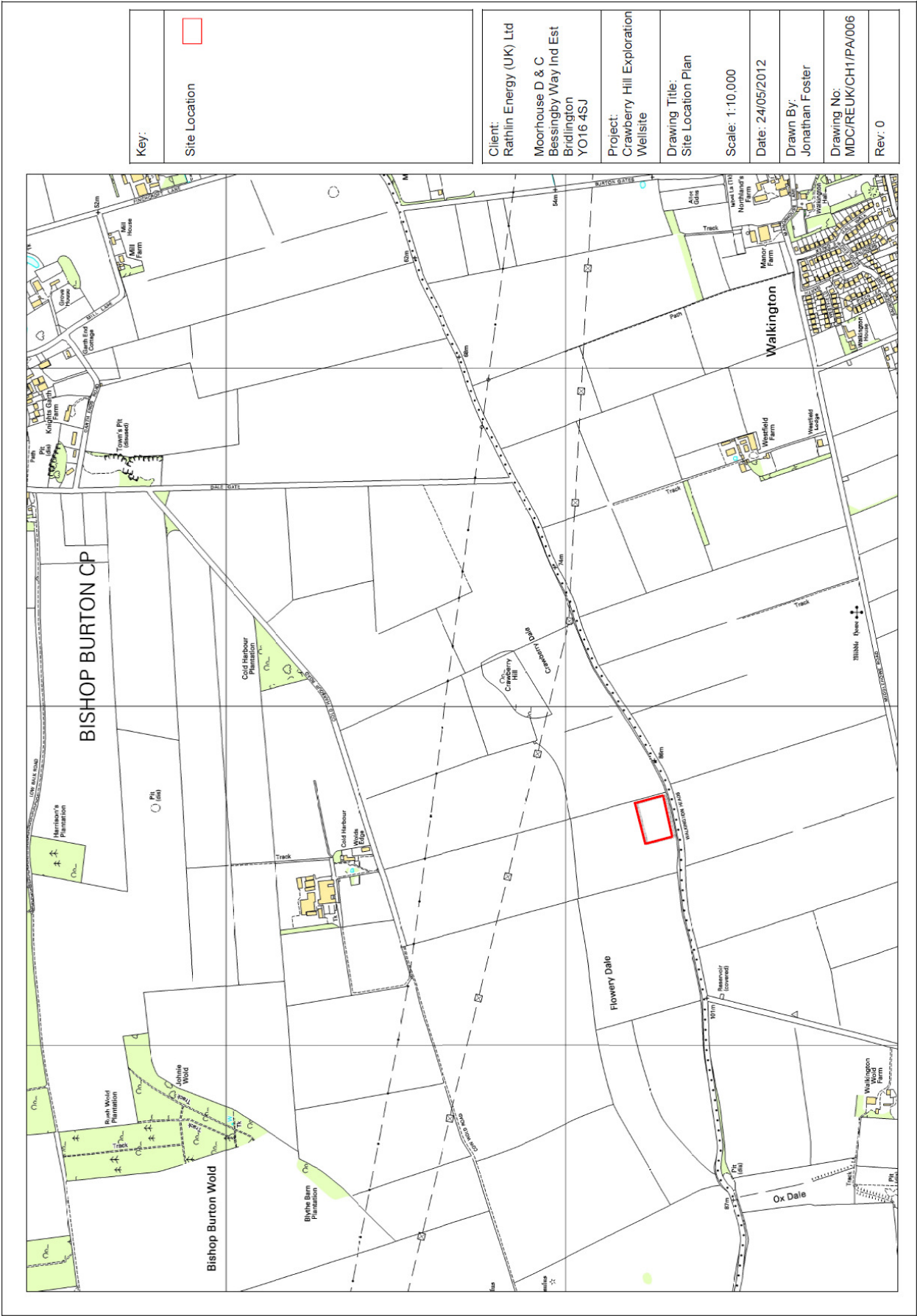
3.8 WELL SUSPENSION / ABANDONMENT

Upon completion of the operations a decision will be made by the Applicant as to whether the well has encountered commercial quantities of petroleum. If the Applicant believes the well has indeed encountered commercial quantities of petroleum then the well will be suspended. A new planning application would then need to be submitted to permit any production from the wellsite. If the well does not encounter commercial quantities of petroleum then the well will be abandoned in accordance with Oil and Gas UK guidance. The wellhead and all site equipment will be removed and the site reinstated to its original condition.

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APPENDIX 1 – SITE LOCATION





APPENDIX 2 – CRAWBERRY HILL 1 WELL SUMMARY SHEET

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Rathlin Energy Well Summary	Well Name: Strawberry Hill 1					WELLHEAD LOCATION (OSGB36) (Prior to site survey) Northings: 437720 m Eastings: 497669 m		TARGET LOCATION CRAWBERRY HILL 1 (OSGB36) 1,271 m TVD GL Northings: 438183 m Eastings: 497887 m		DRILLING INFO (Rev 9.1 09/11/12 directional) Total planned measured depth: 2,677 m MD-GL Total planned vertical depth: 2,487 m MD-GL Planned days: 40.1 excluding rig moves (completed hole) 10.3 rig mob and demob 50.4 Total		OBJECTIVES No accidents or injuries, minimal environmental impact Evaluate the Lower Permian Cadeby Formation (primary) Evaluate the following secondary targets: Upper Permian Brotherton, Kirkham Abbey, Rotligendes Upper Carboniferous Millstone Grit, Bowland Shale. Lower Carboniferous Limestone Development gas well	
	Operator: Rathlin Energy Rig: TBC Spud Date: Feb-12 RT - GL: TBC GL - MSL: 86.6 m							BH LOCATION CRAWBERRY HILL 1 (OSGB36) 2,487 m TVD GL Northings: 438432 m Eastings: 498004 m					
HOLE CONFIGURATION						GEOLOGY	HOLE CONSTRUCTION						
SIZE in	BOPS/WELL CONTROL	MDKB m	TVDKB m	Casing	F.I.T ppg	FORMATION	MUD SUMMARY	CEMENT PROPOSAL	SURVEYING/ ELECTRIC LOGGING/ EVALUATION	BHA	INCL /AZI / DOG LEG (max)	SECTION RISKS	
26"	No well control Site evacuation procedures in place	203	203	20" K55 Buttress	N/A		Section drilled and cased prior to main rig arrival	Grouted to surface with ordinary portland slurry	Single shot surveys	N/A	Vertical	Unconsolidated gravels - low Boulders - low Shallow gas - low Crooked hole - medium Ledging - medium Drilling fluid losses - medium	
17 1/2"	21 1/4" x 3M Annular operated as a diverter 6" internal diameter diverter line with remote operated valve	1,096	1,009	13 3/8" 68 lb/ft K55 Buttress Pressure tested to 1,800 psi	12 ppg FIT		Bentonite polymer mud system Weight 8.6-9.2 ppg YP TBC pH TBC Fluid loss TBC 6 rpm TBC Chlorides TBC Ca mg/l TBC	Conventional top and bottom plug system. Lead: 12.5 ppg to surface. Tail: 16 ppg to 150 m above 13 3/8" shoe. 10% excess over calipered open hole volume.	MWD/GR survey on every other connection Wireline logs: Gamma, Calliper, Spontaneous potential, Photon electric, Latrolog, Neutron compensated log NPHI, Density RHOB, Borehole compensated sonic.	Steerable motor assembly	Directional 0° to 33° inc 25° azimuth 2.0° / 30m DL	Drilling fluid losses - medium Hole cleaning - medium Differential sticking - medium Directional control - low Well control - low Abnormal pressure - low Reactive clays - low H2S & CO2 - low Hole instability - low	
12 1/4"	13 5/8" x 5M BOP Annular Pipe Rams Blind Rams Shut well in 5" pipe rams	1,395	1,260	9 5/8" 40 lb/ft K55 (with 53.5 lb/ft, L80 or P110 over Carnallitic Marl formation) Buttress Pressure tested to 2,200 psi	13 ppg FIT		Salt saturated WBM Weight 10.2-10.4 ppg YP TBC PV TBC 6 rpm TBC Chlorides TBC	Conventional top and bottom plug system. Tail: 14 ppg to 700 m MD 10% excess over calipered open hole volume.	MWD/GR survey on every other connection Wireline logs: Gamma, Calliper, Spontaneous potential, Photon electric, Latrolog, Neutron compensated log NPHI, Density RHOB, Borehole compensated sonic, FMI.	Stabilised rotary assembly	Directional 33° inc 25° azimuth 0° / 30m DL	Drilling fluid losses - medium Hole cleaning - low Differential sticking - low Directional control - low Well control - medium Abnormal pressure - low Reactive clays - low H2S & CO2 - high Hole instability - low Ledging - medium	
8 1/2"	13 5/8" x 5M BOP Annular Pipe Rams Blind Rams Shut well in 5" pipe rams	1,679	1,509	7" 23 lb/ft L80 Premium Gas Tight Pressure tested to 4,400 psi	13 ppg FIT		Salt saturated WBM Weight 10.2-10.4 ppg YP TBC PV TBC 6 rpm TBC Chlorides TBC	Conventional top and bottom plug system. Tail: 14 ppg to 1,050 m MD or 100 m MD above Carnallitic Marl, whichever is shallower 10% excess over calipered open hole volume.	MWD/GR survey on every other connection Wireline logs: Gamma, Calliper, Spontaneous potential, Photon electric, Latrolog, Neutron compensated log NPHI, Density RHOB, Borehole compensated sonic, FMI.	Stabilised rotary assembly	Directional 33° to 24° inc 25° azimuth 1.0° / 30m DL	Drilling fluid losses - high Hole cleaning - low Differential sticking - low Directional control - low Well control - medium Abnormal pressure - low Reactive clays - low H2S & CO2 - high Hole instability - low Ledging - medium	
6"	13 5/8" x 5M BOP Annular Pipe Rams Blind Rams Shut well in 3 1/2" pipe rams	2,677	2,487	4 1/2" liner 11.6 lb/ft L80 Premium Gas Tight Pressure tested to 4,400 psi	N/A		Potassium Chloride WBM Weight 9.8 ppg YP TBC PV TBC 6 rpm TBC Chlorides TBC	Liner cementing - cement dart system. Lead: 12.5 ppg to top of 4 1/2" liner. Tail: 14 ppg from 4 1/2" shoe to 150 m above shallowest hydrocarbon bearing zone. 10% excess over calipered open hole volume plus 150 m above liner with running tool in place.	MWD/GR survey on every other connection Wireline logs: Gamma, Calliper, Spontaneous potential, Photon electric, Latrolog, Neutron compensated log NPHI, Density RHOB, Cross dipole sonic, FMI.	Stabilised rotary assembly	Directional 24° to 0° inc 25° azimuth 1.0° / 30m DL	Drilling fluid losses - low Hole cleaning - low Differential sticking - low Directional control - low Well control - low Abnormal pressure - low Reactive clays - low H2S & CO2 - low Hole instability - low	

<i>Rathlin Energy</i>	Applies To: Rathlin Energy	RE-05-EPRA-CH- SCR-006
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APPENDIX 4 – GROUNDWATER MONITORING RESULTS

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1.00	Jonathan Foster	Tom Selkirk	D Montagu-Smith	16/01/2014

<i>Rathlin Energy</i>	Applies To: Rathlin Energy	RE-05-EPRA-CH- SCR-006
Prepared By: Jonathan Foster	Uncontrolled, If Printed	Rev: 1.00

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Table 1
Groundwater Monitoring Round 1: 5th December 2012
Groundwater Results

	Location	Northlands	Walkington Wold	Private Borehole	Duplicate Private Borehole	Laboratory Blank
	URS ID	BH N	BH W	BH P	BH D	Blank
	Sample Date	05/12/2012 10:30	05/12/2012 12:00	05/12/2012 15:00	05/12/2012 15:00	-
Chemical	Units					
Inorganics						
Metals						
Calcium	µg/l	127000	176000	121000	122000	<200
Magnesium	µg/l	2640	3360	12500	12800	<200
Potassium	µg/l	4400	1070	4390	4620	<200
Alkalinity						
HCO ₃	mg/l as CaCO ₃	257	202	328	-	<3
CO ₃	mg/l as CaCO ₃	<3	<6	<6	-	<3
OH	mg/l as CaCO ₃	<3	<6	<6	-	<3
Traditionals						
Chloride	mg/l as Cl	32.1	698	20.6	19.2	<0.1
Nitrate	mg/l as NO ₃	9.9	23.6	12.2	7.55	<0.1
Sulphate	mg/l as SO ₄	38.6	71.9	32.7	32.4	<0.1
Hardness (Total)	mg/l as CaCO ₃	367	1053	380	-	<5
pH	pH units	7	7.2	7	7	-
TSS	mg/l	6.4	109	4	-	<2
Turbidity	as FTU	<2	26	5	-	<2
Organics						
BTEX						
tert-butyl methyl ether (MTBE)	µg/l	<1	<1	<1	<1	<1
Benzene	µg/l	<0.8	<0.8	<0.8	<0.8	<0.8
Toluene	µg/l	1	<1	<1	<1	<1
Ethylbenzene	µg/l	<0.8	<0.8	<0.8	<0.8	<0.8
m&p-Xylene	µg/l	<1.5	<1.5	<1.5	<1.5	<1.5
o-Xylene	µg/l	<0.8	<0.8	<0.8	<0.8	<0.8
Total Petroleum Hydrocarbons (TPH CWG)						
Volatile Aliphatics						
C5-C6	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1
>C6-C8	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1
>C8-C10	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1
Extractable Aliphatics						
>C10-C12	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
>C12-C16	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
>C16-C21	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
>C21-C36	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Volatile Aromatics						
Benzene (C5-C7)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Toluene (>C7-C8)	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
>C8-C10	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
Extractable Aromatics						
>C10-C12	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
>C12-C16	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
>C16-C21	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
>C21-C36	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

xx	Exceedance of Screening Criteria
xx	Limit of detection above Screening Criteria
-	Analysis not requested

Screening Criteria Sources

- [1]: UK Drinking Water Standards (2010)
[2]: EC Directive (1980) relating to the quality of water intended for human consumption (80/778/EEC)
[3]: UK Water Supply (Water Quality) regulations (2000)
[4]: Environmental Protection Agency (2003) Interim report towards setting guideline values for the protection of groundwater in Ireland.
[5]: Scottish Environment Protection Agency (2009) Groundwater Resource Protection Value
[6]: World Health Organisation (2005) Petroleum Products in Drinking Water

Screening Criteria		
Criteria	Unit	Source
250000	µg/l	UK DWS (2010) [1]
50000	µg/l	EEC MAC 1980 [2]
12000	µg/l	EEC MAC 1980 [2]
-	-	-
-	-	-
-	-	-
250	mg/l	UK DWS (2010) [1]
50	mg/l	UK DWS (2010) [1]
250	mg/l	UK DWS (2010) [1]
-	-	-
6.5-10	pH units	UK DWS (2010) [1]
-	-	-
4	FTU	WS (WQ) Regs 2000 [3]
30	µg/l	Ireland IGV (2003) [4]
1	µg/l	UK DWS (2010) [1]
700	µg/l	SEPA GW RPV 2009 [5]
300	µg/l	SEPA GW RPV 2009 [5]
500	µg/l	SEPA GW RPV 2009 [5]
500	µg/l	SEPA GW RPV 2009 [5]
15	mg/l	WHO Petroleum Products in DW 2008 [6]
15	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.001	mg/l	UK DWS (2010) [1]
0.7	mg/l	SEPA GW RPV 2009 [5]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.09	mg/l	WHO Petroleum Products in DW 2008 [6]
0.09	mg/l	WHO Petroleum Products in DW 2008 [6]
0.09	mg/l	WHO Petroleum Products in DW 2008 [6]
0.09	mg/l	WHO Petroleum Products in DW 2008 [6]

Table 1
Groundwater monitoring Round 2: 9th January 2013
Groundwater results

	Location	Northlands	Walkington Wold	Private Borehole	Duplicate Walkington Wold	Filtered Sample Walkington Wold	Laboratory Blank
	URS ID	BH N	BH W	BH P	BH D2	BH-WF2	Blank
	Sample Date	09/01/2013 10:00	09/01/2013 11:00	09/01/2013 13:20	09/01/2013 11:00	09/01/2013 11:00	-
Chemical	Units						
Inorganics							
Metals							
Calcium	µg/l	130000	172000	123000	168000	-	200
Magnesium	µg/l	2800	3420	8680	3350	-	200
Potassium	µg/l	3850	1060	1680	986	-	200
Alkalinity							
HCO ₃	mg/l as CaCO ₃	251	250	260	-	-	<3.0
CO ₃	mg/l as CaCO ₃	<3.0	<6.0	<6.0	-	-	<3.0
OH	mg/l as CaCO ₃	<3.0	<6.0	<6.0	-	-	<3.0
Traditionals							
Chloride	mg/l as Cl	56.8	664	32.5	615	651	<0.10
Nitrate	mg/l as NO ₃	11.3	20.1	59.1	20.5	19.1	<0.1
Sulphate	mg/l as SO ₄	69.5	72.2	47.4	74	61.9	<0.1
Hardness (Total)	mg/l as CaCO ₃	178	235	184	-	-	<5.0
pH	pH units	7.2	7.3	7.4	7.2	-	-
TSS	mg/l	6.8	61.2	2.5	-	-	<2.0
Turbidity	as FTU	<2.0	25	<2.0	-	-	<2.0
Organics							
BTEX							
tert-butyl methyl ether (MTBE)	µg/l	<1	<1	<1	<1	-	<1
Benzene	µg/l	<0.8	<0.8	<0.8	<0.8	-	<0.8
Toluene	µg/l	<1	<1	<1	<1	-	<1
Ethylbenzene	µg/l	<0.8	<0.8	<0.8	<0.8	-	<0.8
m&p-Xylene	µg/l	<1.5	<1.5	<1.5	<1.5	-	<1.5
o-Xylene	µg/l	<0.8	<0.8	<0.8	<0.8	-	<0.8
Total Petroleum Hydrocarbons (TPH CWG)							
Volatile Aliphatics							
C5-C6	mg/l	<0.1	<0.1	<0.1	<0.1	-	<0.1
>C6-C8	mg/l	<0.1	<0.1	<0.1	<0.1	-	<0.1
>C8-C10	mg/l	<0.1	<0.1	<0.1	<0.1	-	<0.1
Extractable Aliphatics							
>C10-C12	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
>C12-C16	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
>C16-C21	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
>C21-C36	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
Volatile Aromatics							
Benzene (C5-C7)	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
Toluene (>C7-C8)	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
>C8-C10	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
Extractable Aromatics							
>C10-C12	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
>C12-C16	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
>C16-C21	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01
>C21-C36	mg/l	<0.01	<0.01	<0.01	<0.01	-	<0.01

xx	Exceedance of Screening Criteria
xx	Limit of detection above Screening Criteria
-	Analysis not requested

Screening Criteria Sources

- [1]: UK Drinking Water Standards (2010)
 [2]: EC Directive (1980) relating to the quality of water intended for human consumption (80/778/EEC)
 [3]: UK Water Supply (Water Quality) regulations (2000)
 [4]: Environmental Protection Agency (2003) Intern report towards setting guideline values for the protection of groundwater in Ireland.
 [5]: Scottish Environment Protection Agency (2009) Groundwater Resource Protection Value
 [6]: World Health Organisation (2005) Petroleum Products in Drinking Water

Screening Criteria		
Criteria	Unit	Source
250000	µg/l	UK DWS (2010) [1]
50000	µg/l	EEC MAC 1980 [2]
12000	µg/l	EEC MAC 1980 [2]
-	-	-
-	-	-
-	-	-
250	mg/l	UK DWS (2010) [1]
50	mg/l	UK DWS (2010) [1]
250	mg/l	UK DWS (2010) [1]
-	-	-
6.5-10	pH units	UK DWS (2010) [1]
-	-	-
4	FTU	WS (WQ) Regs 2000 [3]
30	µg/l	Ireland IGV (2003) [4]
1	µg/l	UK DWS (2010) [1]
700	µg/l	SEPA GW RPV 2009 [5]
300	µg/l	SEPA GW RPV 2009 [5]
500	µg/l	SEPA GW RPV 2009 [5]
500	µg/l	SEPA GW RPV 2009 [5]
15	mg/l	WHO Petroleum Products in DW 2008 [6]
15	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.001	mg/l	UK DWS (2010) [1]
0.7	mg/l	SEPA GW RPV 2009 [5]
0.3	mg/l	WHO Petroleum Products in DW 2008 [6]
0.09	mg/l	WHO Petroleum Products in DW 2008 [6]
0.09	mg/l	WHO Petroleum Products in DW 2008 [6]
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0.09	mg/l	WHO Petroleum Products in DW 2008 [6]

<i>Rathlin Energy</i>	Applies To: Rathlin Energy	RE-05-EPRA-CH- SCR-006
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APPENDIX 5 – AIR QUALITY BASELINE DATA

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1.00	Jonathan Foster	Tom Selkirk	D Montagu-Smith	16/01/2014

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire

Site: Crawberry Hill - Well Site

Location: Location 1 - Eastern Boundary

General Comments



Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire



Laboratory/Location	Analyte	Sample Media /Collection Method	Analytical Method	Analytical Limit of detection (units)	Method Reference	Relevant Standard	UKAS Accredited	UKAS Accreditation Number
ESG Bretby Gas Analysis	Hydrocarbons	Tedlar Bag	Infra Red/GC FID/GC FPD	0.0005 (%)	GAS 01/GAS 03		Yes except H ₂ S	1205
3rd party laboratory (Gradko)	Hydrogen Sulphide	Diffusion Tube	UV Spectrophotometry - subcontracted to third party lab	0.1ppb based on 0.04µg at 313.50 hrs	In house method GLM5		Yes*	2187
ESG Specialist Chemistry Bretby	Ambient VOC's	ATD Tube	ATD-Gas Chromatography with Mass Spectrometry (GC-MS)	Typically 5 (ng)	ASC/SOP/209 & ASC/SO HSE MDHS		Yes**	1015

*excluding further calculations & assessments requiring exposure details/conditions
**excluding any results above the calibration range (as these carry a higher uncertainty)

We have used a traffic light system on some results to highlight if the results are high (red), low (green) or near (amber) to the acceptable limits.

Location 1 - Eastern Boundary

[illegible]

Top 10 VOC's and BTEX - UK Air Quality Objective: Benzene $5\mu\text{g.m}^{-3}$ annual mean

Detail of sample

Date Out	Date Collected	Sample ID Number	Exposure Time (mins)
21/03/2013	02/04/2013	60126	17130.00
02/04/2013	15/04/2013	60528	18565.00

Results of sample

Results for VOCs tentatively identified in sample

Sample ID No.	Compound	Mass (ng)	Conc. (ppb)	Conc. ($\mu\text{g.m}^{-3}$)
60126	No VOC's detected and identified (above 20ng on tube) for any samples	-	-	-

Sample ID No.	Compound	Mass (ng)	Conc. (ppb)	Conc. ($\mu\text{g.m}^{-3}$)
60528	Benzene	18	1.4	4.5
	Toluene	9.9	0.52	1.9
	Ethylbenzene	<5	<0.1	<0.6
	m.p-Xylene	<5	<0.2	<0.8
	o-Xylene	<5	<0.2	<0.8

UKAS

Results for BTEX compounds expressed in units of ng are within the scope of our UKAS accreditation

Results for BTEX compounds expressed in units of ppb and $\mu\text{g/m}^3$ are not within the the scope of our UKAS accreditation

Results for top 10 VOCs in units of ng, ppb and $\mu\text{g/m}^3$ are semi-quantitative and are not within the scope of our UKAS accreditation

Benzene Only

< $2.5\mu\text{g.m}^{-3}$	Less than 50% of UK Air Quality Objective
>2.5 - < $5\mu\text{g.m}^{-3}$	Between 50% and 100% of UK Air Quality Objective
> $5\mu\text{g.m}^{-3}$	Above the Air Quality Objective

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire

Location 1 - Eastern Boundary



Hydrogen Sulphide Diffusion Tubes - Potential source of odour complaints

Please Note: these tubes are sub contracted to a third party laboratory.

Date Out	Date Collected	Sample ID Number	Exposure Time (hours)	LoD (µg)	H ₂ S µg (Total)	H ₂ S µg (minus blank)	H ₂ S (µg.m ⁻³)*	H ₂ S (ppb)*	Date Analysed	Comments
21/03/2013	02/04/2013	60125	285.50	0.04	0.05	0.03	0.135	0.095	22/04/2013	
02/04/2013	15/04/2013	60527	309.42	0.04	0.20	0.17	0.870	0.614	22/04/2013	

*These results have been obtained using exposure data

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire

Site: Crawberry Hill - Well Site

Location: Location 2 - Northern Boundary

General Comments



Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire



Laboratory/Location	Analyte	Sample Media /Collection Method	Analytical Method	Analytical Limit of detection (units)	Method Reference	Relevant Standard	UKAS Accredited	UKAS Accreditation Number
ESG Bretby Gas Analysis	Hydrocarbons	Tedlar Bag	Infra Red/GC FID/GC FPD	0.0005 (%)	GAS 01/GAS 03		Yes except H ₂ S	1205
3rd party laboratory (Gradko)	Hydrogen Sulphide	Diffusion Tube	UV Spectrophotometry - subcontracted to third party lab	0.1ppb based on 0.04µg at 313.50 hrs	In house method GLMS		Yes*	2187
ESG Specialist Chemistry Bretby	Ambient VOC's	ATD Tube	ATD-Gas Chromatography with Mass Spectrometry (GC-MS)	Typically 5 (ng)	ASC/SOP/209 & ASC/SOIHSE MDHS		Yes**	1015

*excluding further calculations & assessments requiring exposure details/conditions

**excluding any results above the calibration range (as these carry a higher uncertainty)

We have used a traffic light system on some results to highlight if the results are high (red), low (green) or near (amber) to the acceptable limits.

Location 2 - Northern Boundary



Sample Identifications			Analysis (%V/V)							
			UKAS Accredited Analysis							
Date Taken	Report No.	Sample Ref	Methane (CH ₄)	Ethane (C ₂ H ₆)	Propane (C ₃ H ₈)	n-Butane (C ₄ H ₁₀)	Pentane (C ₅ H ₁₂)	n-Hexane (C ₆ H ₁₄)	n-Heptane (C ₇ H ₁₆)	n-Octane (C ₈ H ₁₈)
21/03/2013	46184	Northern Boundary	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005
02/04/2013	46208	Northern Boundary	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire
Location 2 - Northern Boundary



Top 10 VOC's and BTEX - UK Air Quality Objective: Benzene $5\mu\text{g.m}^{-3}$ annual mean

Detail of sample

Date Out	Date Collected	Sample ID Number	Exposure Time (mins)
21/03/2013	02/04/2013	60128	17143.00
02/04/2013	15/04/2013	60530	18610.00

Results of sample

Results for VOCs tentatively identified in sample

Sample ID No.	Compound	Mass (ng)	Conc. (ppb)	Conc. ($\mu\text{g.m}^{-3}$)
60128	No VOC's detected and identified (above 20ng on tube) for any samples	-	-	-

Sample ID No.	Compound	Mass (ng)	Conc. (ppb)	Conc. ($\mu\text{g.m}^{-3}$)
60530	Benzene	6.8	0.52	1.7
	Toluene	7.5	0.39	1.5
	Ethylbenzene	<5	<0.1	<0.6
	m.p-Xylene	<5	<0.2	<0.8
	o-Xylene	<5	<0.2	<0.8

UKAS

Results for BTEX compounds expressed in units of ng are within the scope of our UKAS accreditation

Results for BTEX compounds expressed in units of ppb and $\mu\text{g/m}^3$ are not within the the scope of our UKAS accreditation

Results for top 10 VOCs in units of ng, ppb and $\mu\text{g/m}^3$ are semi-quantitative and are not within the scope of our UKAS accreditation

Benzene Only

<2.5 $\mu\text{g.m}^{-3}$	Less than 50% of UK Air Quality Objective
>2.5 - <5 $\mu\text{g.m}^{-3}$	Between 50% and 100% of UK Air Quality Objective
>5 $\mu\text{g.m}^{-3}$	Above the Air Quality Objective

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire

Location 2 - Northern Boundary



Hydrogen Sulphide Diffusion Tubes - Potential source of odour complaints

Please Note: these tubes are sub contracted to a third party laboratory.

Date Out	Date Collected	Sample ID Number	Exposure Time (hours)	LoD (µg)	H ₂ S µg (Total)	H ₂ S µg (minus blank)	H ₂ S (µg.m ⁻³)*	H ₂ S (ppb)*	Date Analysed	Comments
21/03/2013	02/04/2013	60127	285.72	0.04	0.14	0.12	0.630	0.445	22/04/2013	
02/04/2013	15/04/2013	60529	310.17	0.04	0.06	0.04	0.174	0.123	22/04/2013	
15/04/2013	29/04/2013	61090	335.42	0.04	<0.04	<0.04	<0.185	<0.130	20/05/2013	
29/04/2013	13/05/2013	61590	336.08	0.04	0.141	0.116	0.536	0.378	20/05/2013	
13/05/2013	30/05/2013	62273	407.92	0.04	0.059	0.035	0.132	0.093	14/06/2013	

*These results have been obtained using exposure data

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire

Site: Crawberry Hill - Well Site

Location: Location 3 - Western Boundary

General Comments



Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire



Laboratory/Location	Analyte	Sample Media /Collection Method	Analytical Method	Analytical Limit of detection (units)	Method Reference	Relevant Standard	UKAS Accredited	UKAS Accreditation Number
ESG Bretby Gas Analysis	Hydrocarbons	Tedlar Bag	Infra Red/GC FID/GC FPD	0.0005 (%)	GAS 01/GAS 03		Yes except H ₂ S	1205
3rd party laboratory (Gradko)	Hydrogen Sulphide	Diffusion Tube	UV Spectrophotometry - subcontracted to third party lab	0.1ppb based on 0.04µg at 313.50 hrs	In house method GLMS		Yes*	2187
ESG Specialist Chemistry Bretby	Ambient VOC's	ATD Tube	ATD-Gas Chromatography with Mass Spectrometry (GC-MS)	Typically 5 (ng)	ASC/SOP/209 & ASC/SOIHSE MDHS		Yes**	1015

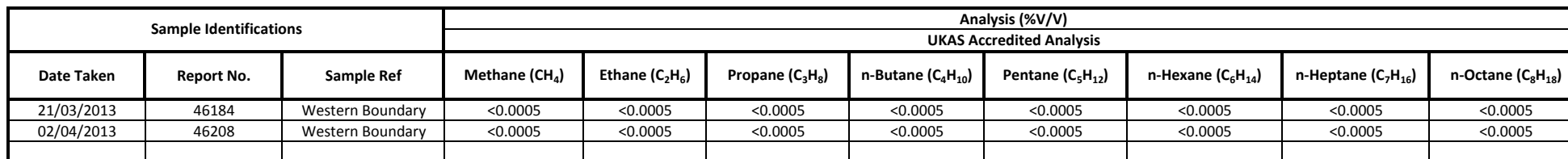
*excluding further calculations & assessments requiring exposure details/conditions

**excluding any results above the calibration range (as these carry a higher uncertainty)

We have used a traffic light system on some results to highlight if the results are high (red), low (green) or near (amber) to the acceptable limits.

Location 3 - Western Boundary

Lower Hydrocarbons



Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire
Location 3 - Western Boundary



Top 10 VOC's and BTEX - UK Air Quality Objective: Benzene 5 $\mu\text{g.m}^{-3}$ annual mean

Detail of sample

Date Out	Date Collected	Sample ID Number	Exposure Time (mins)
21/03/2013	02/04/2013	60130	17150.00
02/04/2013	15/04/2013	60532	18585.00

Results of sample

Results for VOCs tentatively identified in sample

Sample ID No.	Compound	Mass (ng)	Conc. (ppb)	Conc. ($\mu\text{g.m}^{-3}$)
60130	No VOC's detected and identified (above 20ng on tube) for any samples	-	-	-

Sample ID No.	Compound	Mass (ng)	Conc. (ppb)	Conc. ($\mu\text{g.m}^{-3}$)
60532	Benzene	5.8	0.45	1.4
	Toluene	9	0.47	1.8
	Ethylbenzene	<5	<0.1	<0.6
	m.p-Xylene	<5	<0.2	<0.8
	o-Xylene	<5	<0.2	<0.8

UKAS

Results for BTEX compounds expressed in units of ng are within the scope of our UKAS accreditation

Results for BTEX compounds expressed in units of ppb and $\mu\text{g/m}^3$ are not within the the scope of our UKAS accreditation

Results for top 10 VOCs in units of ng, ppb and $\mu\text{g/m}^3$ are semi-quantitative and are not within the scope of our UKAS accreditation

Benzene Only

<2.5 $\mu\text{g.m}^{-3}$	Less than 50% of UK Air Quality Objective
>2.5 - <5 $\mu\text{g.m}^{-3}$	Between 50% and 100% of UK Air Quality Objective
>5 $\mu\text{g.m}^{-3}$	Above the Air Quality Objective

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire

Location 3 - Western Boundary



Hydrogen Sulphide Diffusion Tubes - Potential source of odour complaints

Please Note: these tubes are sub contracted to a third party laboratory.

Date Out	Date Collected	Sample ID Number	Exposure Time (hours)	LoD (µg)	H ₂ S µg (Total)	H ₂ S µg (minus blank)	H ₂ S (µgm ⁻³)*	H ₂ S (ppb)*	Date Analysed	Comments
21/03/2013	02/04/2013	60129	285.83	0.04	0.08	0.06	0.325	0.229	22/04/2013	
02/04/2013	15/04/2013	60531	309.75	0.04	<0.04	<0.04	<0.200	<0.141	22/04/2013	
15/04/2013	29/04/2013	61092	335.83	0.04	<0.04	<0.04	<0.185	<0.130	20/05/2013	
29/04/2013	13/05/2013	61592	335.75	0.04	0.054	0.03	0.137	0.097	20/05/2013	
13/05/2013	30/05/2013	62277	407.92	0.04	<0.04	<0.04	<0.152	<0.107	14/06/2013	

*These results have been obtained using exposure data

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire

Site: Crawberry Hill - Well Site

Location: Location 4 - Southern Boundary

General Comments



Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire



Laboratory/Location	Analyte	Sample Media /Collection Method	Analytical Method	Analytical Limit of detection (units)	Method Reference	Relevant Standard	UKAS Accredited	UKAS Accreditation Number
ESG Bretby Gas Analysis	Hydrocarbons	Tedlar Bag	Infra Red/GC FID/GC FPD	0.0005 (%)	GAS 01/GAS 03		Yes except H ₂ S	1205
3rd party laboratory (Gradko)	Hydrogen Sulphide	Diffusion Tube	UV Spectrophotometry - subcontracted to third party lab	0.1ppb based on 0.04µg at 313.50 hrs	In house method GLMS		Yes*	2187
ESG Specialist Chemistry Bretby	Ambient VOC's	ATD Tube	ATD-Gas Chromatography with Mass Spectrometry (GC-MS)	Typically 5 (ng)	ASC/SOP/209 & ASC/SOP/212	HSE MDHS	Yes**	1015

*excluding further calculations & assessments requiring exposure details/conditions

**excluding any results above the calibration range (as these carry a higher uncertainty)

We have used a traffic light system on some results to highlight if the results are high (red), low (green) or near (amber) to the acceptable limits.

Location 4 - Southern Boundary



Lower Hydrocarbons

[illegible]

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire
Location 4 - Southern Boundary



Top 10 VOC's and BTEX - UK Air Quality Objective: Benzene $5\mu\text{g.m}^{-3}$ annual mean

Detail of sample

Date Out	Date Collected	Sample ID Number	Exposure Time (mins)
21/03/2013	02/04/2013	60132	17098.00
02/04/2013	15/04/2013	60534	18660.00

Results of sample

Results for VOCs tentatively identified in sample

Sample ID No.	Compound	Mass (ng)	Conc. (ppb)	Conc. ($\mu\text{g.m}^{-3}$)
60132	No VOC's detected and identified (above 20ng on tube) for any samples	-	-	-

Sample ID No.	Compound	Mass (ng)	Conc. (ppb)	Conc. ($\mu\text{g.m}^{-3}$)
60534	Benzene	<5	<0.4	<1
	Toluene	<5	<0.3	<1
	Ethylbenzene	<5	<0.1	<0.6
	m,p-Xylene	<5	<0.2	<0.8
	o-Xylene	<5	<0.2	<0.8

UKAS

Results for BTEX compounds expressed in units of ng are within the scope of our UKAS accreditation

Results for BTEX compounds expressed in units of ppb and $\mu\text{g/m}^3$ are not within the the scope of our UKAS accreditation

Results for top 10 VOCs in units of ng, ppb and $\mu\text{g/m}^3$ are semi-quantitative and are not within the scope of our UKAS accreditation

Benzene Only

<2 $\mu\text{g.m}^{-3}$	Less than 50% of UK Air Quality Objective
>2.5 - <5 $\mu\text{g.m}^{-3}$	Between 50% and 100% of UK Air Quality Objective
>5 $\mu\text{g.m}^{-3}$	Above the Air Quality Objective

Rathlin Energy (UK) Ltd, Crawberry Hill Well Site, East Yorkshire

Location 4 - Southern Boundary



Hydrogen Sulphide Diffusion Tubes - Potential source of odour complaints

Please Note: these tubes are sub contracted to a third party laboratory.

Date Out	Date Collected	Sample ID Number	Exposure Time (hours)	LoD (μg)	H ₂ S μg (Total)	H ₂ S μg (minus blank)	H ₂ S ($\mu\text{g m}^{-3}$)*	H ₂ S (ppb)*	Date Analysed	Comments
21/03/2013	02/04/2013	60131	284.97	0.04	<0.04	<0.04	<0.218	<0.154	22/04/2013	
02/04/2013	15/04/2013	60533	311	0.04	0.14	0.11	0.553	0.390	22/04/2013	

*These results have been obtained using exposure data

<i>Rathlin Energy</i>	Applies To: Rathlin Energy	RE-05-EPRA-CH- SCR-006
Prepared By: Jonathan Foster	Uncontrolled, If Printed	Rev: 1.00

EMS SUPPORTING DOCUMENTATION - EPRA – CRAWBERRY HILL EXPLORATORY OPERATIONS - SCR

APPENDIX 6 – CH1 WELL SUMMARY

Rev:	Prepared By:	Checked By:	Approved By:	Issued:
1.00	Jonathan Foster	Tom Selkirk	D Montagu-Smith	16/01/2014

<i>Rathlin Energy</i>	Applies To: Rathlin Energy	RE-05-EPRA-CH- SCR-006
Prepared By: Jonathan Foster	Uncontrolled, If Printed	Rev: 1.00

EMS SUPPORTING DOCUMENTATION - EPRA – CRAWBERRY HILL EXPLORATORY OPERATIONS - SCR

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Rev:	Prepared By:	Checked By:	Approved By:	Issued:
1.00	Jonathan Foster	Tom Selkirk	D Montagu-Smith	16/01/2014

West Newton 1 - Conceptual Model

All depths relative to KCA Deutag T 61 RTE at 6.9 m AGL. GLE 13.38 m											
Geological Tops (MD m)	System	Lithology					Well Construction	Geology	Hydrogeology	Control Measures / Mitigation	
77	Upper Cretaceous						26" casing shoe 69 m MD	Glacial Till with large boulders and interbedded sandstones and gravels	Classified as a low permeability aquitard. Unlikely to be any hydraulic connection with the chalk	Drill with Water Based Fluids Monitoring for fluid losses Casing to isolate principal aquifer Monitoring of cementing operations Confirmation of casing integrity Isolated from deeper formations due to thick impermeable strata above and below Multiple casing strings isolating aquifer	
515		Middle Jurassic					18 ¾" casing shoe 525 m MD	Cretaceous Chalk which dips to the east. Unconformity between the Till and Chalk	Designated a Principal Aquifer. There are no known licensed or un-licensed abstractions within 2 km of the site. The chalk is understood to be naturally saline and under the WFD classification the aquifer has been designated poor quality by the Environment Agency		
632		Lwr Jurassic						Marly Mudstones	Low permeability aquitard		
1,597	Triassic							Mudstones	Low permeability aquitard	Monitoring for fluid losses Casing to isolate principal aquifer Monitoring of cementing operations Confirmation of casing integrity Isolated from deeper formations due to thick impermeable strata above and below Multiple casing strings isolating aquifer	
								Sandstone	Aquifer that retains localised permeability but not considered economically usable. Likely to contain saline or mineralised groundwater quality		
2,119 2,143	Permian						13 ¾" casing shoe 1,611 m MD	Marls, Limestones, Dolomites, Anhydrites, Halites and Sandstones	Low permeability aquitard	Target reservoirs below this depth	
								9 ¾" casing shoe 1,915 m MD			
3,116	Carboniferous						4 ½" liner hanger top 2,484 m MD 7" casing shoe 2,634 m MD	Sandstones, Siltstones, Mudstones, Coals and Shales			
	Westphalian	C									
B											
	Namurian	A									
B											
	Dinantian	A									
							4 ½" liner shoe 3,173 m MD	Limestone			

KEY

Impermeable / Low Permeability Strata

Permeable Strata

Reservoir Targets