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Tinker Lane 1 Exploration Well
Application for Mining Waste Permit
EPR/EB3406XP/A001

Hydrogeological Risk Screening
TL-EPA-007
Document prepared by

SLR Consulting Limited
Hydrology and Hydrogeology Team

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<td>0</td>
<td>07/07/2016</td>
<td>Issued for EA comment</td>
<td>Senior Consultant</td>
<td>Technical Director</td>
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<td>Environmental Site Setting</td>
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<td>GW1</td>
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<td>Proposed Site Construction Phase</td>
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<td>TL 3/05A</td>
<td>Proposed Site Drilling Phase</td>
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<td>Proposed Sections – Drilling</td>
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<td>TL 3/07A</td>
<td>Proposed Drilling Lighting Plan</td>
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<td>TL3/13</td>
<td>Cellar Details</td>
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<td>TL3/14</td>
<td>Monitoring Boreholes</td>
</tr>
<tr>
<td>TL3/15</td>
<td>Existing Security Cabins</td>
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<td>TL9/1</td>
<td>Local Hydrology</td>
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<td>TL9/2</td>
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<td>TL9/3</td>
<td>Solid Geology</td>
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<td>TL9/4</td>
<td>Generalised Vertical Section and Proposed Exploratory Well Construction Details</td>
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<tr>
<td>TL9/5</td>
<td>Hydrogeological Map</td>
</tr>
<tr>
<td>TL9/6</td>
<td>Regional Hydrogeology</td>
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1.0 INTRODUCTION

1.1 Background

SLR Consulting Limited (SLR) has been instructed by Dart Energy (East England) Limited (the Applicant), a subsidiary of IGas Energy plc, to prepare an application for a mining waste permit for the proposed Tinker Lane 1 Exploration Borehole.

The application seeks to obtain a bespoke mining waste permit for the management of extractive wastes produced as a result of the drilling, suspension and abandonment of a single exploration well.

The Environment Agency's (EA) Oil and Gas Sector Guidance Consultation Draft describes that where groundwater is considered to be at risk and involves (a) a discharge of pollutants, and/or (b) could result in an input to groundwater that a groundwater activity permit is required as part of the mining waste permit application. Should a groundwater activity permit be required it should be supported by a detailed hydrogeological risk assessment.

1.2 Scope of Work

This assessment considers the environmental setting of the site, the proposed operations, mitigation measures incorporated into the design of the well and its enabling infrastructure, the extractive wastes to be handled and stored at the site, and the borehole testing proposals.

A hydrogeological risk screening assessment is presented and considers whether the proposed development poses a risk to groundwater such that a groundwater activity permit for the operation is required.

The scope of the assessment has been informed by pre-application consultation with the Environment Agency and guidance given in the following Agency guidance documents:

- Risk Assessments for Your Environmental Permit, February 2016;
- Onshore Oil and Gas Sector Guidance Consultation Draft, November 2015; and

This assessment should be read in conjunction with the planning application and accompanying Environmental Impact Assessment which presents further details of the site setting, mitigation incorporated in the site design and an assessment of potential impacts on ground and surface water resources.

---

1 Environment Agency (November 2015). Onshore Oil and Gas Sector Guidance Consultation Draft
2.0 SITE SETTING

2.1 General

The site is located in the Bassetlaw District of Nottinghamshire, on Retford Road (A634) between Blyth and Barnby Moor.

The site is centred on National Grid Reference 465032 385344. The location of the site is illustrated on Drawing TL1.

The application site is currently in agricultural use and is surrounded by farmland to the north, west and south with the A634 forming the site’s eastern boundary. It is located approximately 2.6km to the south-east of the outskirts of Blyth and 1.5km to the north-west of the outskirts of Barnby Moor. The edge of the village of Torworth is located approximately 1.4km to the north-east of the application site.

2.2 Geology, Hydrogeology and Hydrology

2.2.1 Soils and Geology

The site is located upon Triassic Sandstone bedrock known as the Nottingham Castle Sandstone Formation with no recorded superficial deposits.

The regional superficial and bedrock geology is presented on Drawings TL9/2 and TL9/3.

Soils

The soils across the site are classified as “Freely draining slightly acid sandy soils”. The soils are typified as having a low fertility and are freely draining to underlying groundwater.

Superficial Geology

No superficial deposits are shown to be present at the site. Bedrock is therefore anticipated at or close to surface.

Bedrock Geology

The anticipated vertical geological section for the proposed exploratory well is shown in Figure 1 (see Chapter 3.0), review of which confirms:

- the Nottingham Castle Sandstone may be approximately 100m thick beneath the site and typically comprises sandstones, mudstones, limestones, dolomite and conglomerates;
- underlying the sandstone is the Magnesian Limestone of the Permian geological era, which is likely to be approximately 150m thick; and
- below the Magnesian Limestone lies an alternating sequence of mudstones, shales, sandstones and coals associated with the Carboniferous Coal Measures which are expected to be approximately 1,000m thick.

The exploratory well has two main targets, both located below the Coal Measures:

- Primary target: Bowland Shale (expected to be c. 70m thick); and
- Secondary target: Millstone Grit Group shales and tight sands (expected to be approximately 300m thick).
### 2.2.2 Hydrogeology

The hydrogeology of the area is shown on Drawings TL9/5 and TL9/6.

#### Rainfall

The Met Office 1981 – 2010 climate average for Robin Hood airport, located c.10km north-east of the site, indicates that the average annual rainfall for the area is 574.5mm

#### Aquifer Characteristics

The Environment Agency classification for each of the strata that will be encountered by the exploratory well is summarised in Table 1.

<table>
<thead>
<tr>
<th>Age</th>
<th>Strata</th>
<th>Sub-Strata</th>
<th>Aquifer Classification¹</th>
<th>Aquifer Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sherwood Sandstone</td>
<td>Nottingham Castle Sandstone</td>
<td>Principal</td>
<td>Medium to coarse grained pebbly sandstone becoming very fine to medium grained sandstone at base.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lenton Sandstone</td>
<td>Principal</td>
<td>High Intergranular flow with potentially high yields.</td>
<td></td>
</tr>
<tr>
<td>Zechstein Group</td>
<td>Roxby Formation</td>
<td>Secondary B</td>
<td>Mudstones and siltstones with subordinate sandstones.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brotherton Formation</td>
<td>Principal</td>
<td>Limestone aquifers divided by mudstones of the Edlington Formation which acts as a leaky aquitard between the two units.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Edlington Formation</td>
<td>Secondary B</td>
<td>Groundwater flow predominantly through fracture flow within the limestone with significant regional variability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cadeby Formation</td>
<td>Principal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permian &amp; Triassic Magnesian Limestone</td>
<td>Westphalian C</td>
<td>Secondary A</td>
<td>Extensive sequence of coal measures consisting of cyclical sandstone, siltstone, mudstone and coal seams</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Westphalian B</td>
<td>Secondary A</td>
<td>Groundwater flow limited to the higher permeability sandstone and coal horizons, flow potentially altered by presence of historic coal mining where present</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Westphalian A</td>
<td>Secondary A</td>
<td>Fine to very coarse sandstones, interbedded with grey siltstones and mudstones Intergranular flow primarily within the sandstone horizons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Millstone Grit</td>
<td>Secondary A</td>
<td>Dark grey fissile and blocky mudstone with subordinate limestone and sandstone</td>
<td></td>
</tr>
<tr>
<td>Carboniferous</td>
<td>Bowland Shale</td>
<td>Secondary (Undifferentiated)</td>
<td>Primarily unproductive strata, however limited groundwater potentially present within limestone and sandstone horizons</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Strata</td>
<td>Sub-Strata</td>
<td>Aquifer Classification</td>
<td>Aquifer Description</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------</td>
<td>-------------------------------------</td>
<td>------------------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>Carboniferous Limestone</td>
<td>Carboniferous Limestone (Diantion Rocks)</td>
<td>Principal</td>
<td></td>
<td>Limestone formation with potentially high secondary permeability.</td>
</tr>
</tbody>
</table>

Note: 1 Taken from Environment Agency Aquifer Designation maps at outcrop.

Note 2: Given the depth to Coal Measures, Millstone Grit, Bowland Shale and Carboniferous Limestone beneath the site these units cannot be considered as aquifers locally.

The near surface Nottingham Castle Sandstone is a regionally important ‘principal aquifer’ which provides both baseflow to the major watercourses in the area (e.g. River Idle and River Torne) and is an important source for potable water supplies. The Lenton Sandstone is considered to be in hydraulic continuity with the Nottingham Castle Sandstone.

Groundwater flow within the Nottingham Castle and Lenton Sandstones is predominantly intergranular with secondary flow possible within fractures and fissures associated with localised faulting.

Typically, the sandstones exhibit the following properties:

- horizontal hydraulic conductivity: 0.73m/day - 5.5m/day
- vertical conductivity: 0.13m/day - 3.8m/day; and
- transmissivities 100m²/day - 700m²/day.

The Magnesian Limestone consists of two principal limestone aquifers (Brotherton Formation and Cadeby Formation) separated by low permeability mudstones of the Edlington Formation. The limestone outcrops approximately 4km to the north-west of the site and dips in an easterly direction beneath the sandstone at the site and subsequently beneath the Mercia Mudstone to the east.

Groundwater flow within the Magnesian Limestone aquifer is predominantly by fracture flow, although there is some intergranular storage. Regionally there can be significant variation in transmissivity and yield dependent upon the extent of localised faulting and fracturing.

There is significant variation of the porosity, hydraulic conductivity and transmissivity of the Magnesian Limestone. Porosity values for the Cadeby Formation range between 9% and 30% with hydraulic conductivities of between 3.1x10⁻⁴ and 0.85m/day. Transmissivity values are even more variable, ranging from 6m²/day to 4,300m²/day. Overall the hydrogeology of the aquifers is controlled by the lithology and the structure, particularly the extent of fracturing, with transmissivities typically highest along major fault zones. The reported transmissivity values for the Magnesium Limestone Formation are skewed towards relatively shallow water supply boreholes at the outcrop of the Magnesium Limestone. The properties of the aquifer at depth are likely to be closer to the lower end of the reported range as water movement at this depth is limited and the fracturing will be less well developed. Testing of the Wistow borehole, constructed in the Magnesium Limestone sequence through 100m of drift and Triassic sandstone cover, had a transmissivity of only 24.3m²/day.

The Edlington Formation, which separates the two limestone units, is considered to act as a ‘leaky’ aquitard which maintains a slight head difference between the two units.

Although groundwater is potentially present within the lower aquifer units; namely the Coal Measures and Millstone Grit, the depth to these units (in excess of 300m below ground level)
negates the potential for there being any abstractions or receptors within these units at or near to site. This has been confirmed by a review of local groundwater use and abstraction (see below).

**Groundwater Levels and Flow**

Monitoring data provided by the Environment Agency shows that the groundwater surface within the Nottingham Castle Sandstone Formation has a typical seasonal variation of between 0.5m and 1m. The unsaturated thickness of the sandstones on its western edge is up to 27m in thickness and progressively decreases to the east. Water levels near to the eastern edge of the outcrop are typically between 1m and 4m below ground level. Groundwater in the sandstone is expected to be at an elevation of about 13m AOD beneath the site (e.g. c. 15m below ground level). Regional groundwater flow is in a north easterly direction. See Drawing TL 9/6.

The groundwater elevation data indicates that in the east there is hydraulic connection between groundwater and surface water, particularly along the length of the River Idle and its tributaries.

There is potential to the north east and east of the site for groundwater in the Nottingham Castle Sandstone to be locally in hydraulic continuity with more recent superficial deposits and to provide baseflow to watercourses.

No groundwater level monitoring data is available locally for the limestone aquifer but groundwater flow is considered to follow the regional dip of the strata i.e. eastward, although levels and direction can be locally affected by the presence of localised faults.

**Groundwater Quality**

Groundwater within the Nottingham Castle Sandstone has been assessed as part of the 2009 Humber River Basin Management Plan (RBMP) and has recently been reassessed within the proposed 2015 RBMP. The groundwater has been assessed in relation to its chemical and quantitative quality.

Both the chemical and quantitative quality of groundwater in the sandstone is classified as ‘poor’ due to the large number of groundwater abstractions impacting on water availability and the overall poor groundwater quality. The latest RBMP indicates that the groundwater is unlikely to meet its target of achieving a ‘good’ status by 2027.

**Groundwater Vulnerability**

The Environment Agency groundwater vulnerability mapping indicates that the Nottingham Castle Sandstone aquifer has ‘high’ groundwater vulnerability owing to the freely draining nature of the overlying soils, high permeability of the sandstones and relatively shallow depth to groundwater.

**Abstraction Licences and Source Protection Zones**

The Environment Agency has confirmed that there are five licensed groundwater abstractions located within a 2km radius of the site. All of these groundwater abstractions are for agricultural purposes. The locations of abstractions near to site are shown on Drawing TL9/1.

It is understood that all of the groundwater abstractions within a 5km radius of the site, target the sandstones of either the Nottingham Castle Sandstone or Lenton Sandstone. There are
no abstractions from the Coal Measures, supporting the conclusion that it is not a groundwater resource in this area. It is also reported in reference wells nearby, that gas has been observed in the Coal Measures.

The closest downstream groundwater abstraction (ref. A22, Drawing TL9/1) is located 0.9km north-east of site. The abstraction is used for spray irrigation. It is noted that a groundwater abstraction at Jubilee Farm (ref. A21, Drawing TL9/1) is located slightly nearer to the north west of the site (0.8km) but is not located downstream of the proposed exploration well.

Severn Trent Water has an abstraction licence for two boreholes south east of the site at Barnby (ref. A31 and A32, Drawing TL9/1). The licence permits the abstraction of groundwater for potable water supply. The abstraction boreholes are located more than 2km south-east of the proposed exploration well. The proposed exploratory well is located within the Zone 3 (Total Catchment) Source Protection Zone (SPZ) of these abstraction boreholes.

2.2.3 Hydrology

The site is located on an elevated area above the River Ryton to the west and the River Idle to the east.

The River Ryton flows in a predominantly northerly direction, approximately 2.5km to the west of the site at its closest point. The river is a tributary of the River Idle and rises from Lindrick Common in Rotherham and discharges to the River Idle just south of Bawtry.

There are no watercourses, streams or minor drains within the site boundary.

The Environment Agency has confirmed that there are no surface water abstractions within 2km of the site.

2.2.4 Water Dependant Ecosystems

There are two designated sites located within 3km radius of the proposed exploratory well:

- Mattersey Hill Marsh SSSI; and
- Daneshill Local Nature Reserve.

Both sites are down the regional hydraulic gradient from the site and may receive a contribution of groundwater from the Nottingham Castle Sandstone in addition to the superficial deposits that lie adjacent to the reserve locally. The location of these sites are identified in Drawing TL9/1. While these receptors are considered within the Environmental Risk Assessment included in Section 5 of this application, it is not considered that any pathway exists which could lead to an impact upon these sites.
3.0 OPERATIONS

3.1 Overview of Proposed Activities

The Applicant is proposing to drill a single, vertical well to recover core samples from, and to measure the properties of, the Bowland Shale and the Millstone Grit Group geological formations that underlie at depth the Tinker Lane 1 Site.

The well will be drilled through all of the coal and shale formations with core samples taken at multiple intervals whilst drilling. Hydraulic fracturing will not be performed in the well.

The proposed target depth (TD) of the well will be 1,810m TVDSS (True Vertical Depth Subsea) (+/- 300mTVD), to 50m below the top of the Carboniferous Limestone Supergroup (CLS).

Depending on the core analyses, electronic logging results, pressure determination testing and geological evaluation, the well will either be:

- permanently plugged and abandoned in accordance with Oil & Gas UK guidelines, with the site restored back to its current agricultural use; or
- suspended post drilling and logging pending a period of evaluation.

3.2 Well Design and Drilling Process

The proposed drilling technique is common place in the UK and worldwide, and has been used to establish many of the existing deep boreholes both on-shore and off-shore. The well driling process is thus well understood, rehearsed and practised widely.

The well will be drilled using a drill string which comprises drill pipe, a bottom hole assembly (BHA) and drill bit. The drill string will be hollow to allow drilling mud to be circulated inside the pipe, through the bit and returned up the annulus. As the hole gets deeper, additional lengths of drill pipe will be added to the drill string.

Drilling muds are required to be used whilst drilling to:

- maintain hydrostatic pressure;
- keep the drill bit clean and cool;
- lubricate the drill bit;
- produce a filter cake to prevent loss of mud;
- maintain stable borehole conditions;
- transport cuttings to the surface; and
- retain cuttings in suspension if pumping ceases.

The drilling mud will be circulated by pumps. Two types of drilling muds will be used:

- Water based drilling mud (WBM); and
- Low toxicity oil based drilling mud (LTOBM).

Drilling mud volumes will be monitored using a Pit Volume Totaliser throughout the drilling process to identify losses or gains to the system. In the event that losses of fluids are identified, lost circulation materials will be used to plug fractures and fissures to limit the loss of drilling fluid into formations.
The well has been designed with due regard to the requirements of Article 5.2 the MWD.

Diagrams showing the anticipated stratigraphic column, casing depths and diameters are provided in Figure 1.

Steel casing will be installed following the drilling of each section. A spacer fluid will be used to displace drilling muds from the well while cementing the casing in place. The cement will be pumped in accordance with best practice to ensure an effective bond is created between the well casing and the geological formation. The casing and cement in the annulus will therefore provide a barrier between groundwater within the geological formations and the exploration well.

With respect to cementing, the Applicant will:

- employ best industry practice; and
- use competent and experienced contractors – both to ensure an effective bond is created and reduce the volume of waste produced.

Assessment of well integrity will be undertaken after the setting of each casing along with review by an independent well examiner.

The well integrity assessment will consist of a combination of:

- assessment and quality assurance testing of the cement formulation;
- monitoring of mud displacement volumes;
- sampling and monitoring of cement returns;
- pressure testing of the casing;
- Formation Integrity Testing (FIT) on casing shoes; and
- performing cement evaluation logs as required.

Records of testing will be retained until decommissioning of the well and restoration of the site.
Figure 1 Tinker Lane 1 Well Diagrams
4.0 WASTES GENERATION AND MANAGEMENT

4.1 Waste Generation

This section identifies and estimates the quantities of wastes which will be produced as a direct result of the drilling, suspension and abandonment of the exploration well. Further details relating to the management of wastes is given in the Waste Management Plan (see Section 4 of the application).

The drilling operations, well suspension and abandonment works will produce extractive wastes including:

- drill cuttings;
- spent WBM;
- spent spacer fluid; and
- cement returns.

Table 2 identifies the volume and European Waste Catalogue (EWC) code of the anticipated extractive wastes. Table 2 shows that the volume of waste materials that would be produced as a result of the activities is relatively small. In addition, the majority of materials to be produced are estimated to be non-hazardous in nature.

Table 2
Generated Wastes

<table>
<thead>
<tr>
<th>EWC Code</th>
<th>Hazard Status</th>
<th>Waste Catalogue Description</th>
<th>Description of Waste Generated</th>
<th>Estimated Generation Volume / Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 05 05*</td>
<td>AH</td>
<td>wastes containing hazardous substances from physical and chemical processing of non-metalliferous minerals</td>
<td>Drill cuttings separated from LTOBM</td>
<td>180 tonnes</td>
</tr>
<tr>
<td>01 04 08</td>
<td>MN</td>
<td>Waste gravel and crushed rocks other than those mentioned in 01 04 07</td>
<td>Drill cuttings separated from WBM.</td>
<td>600 tonnes</td>
</tr>
<tr>
<td>01 05 04 / 01 05 07 / 01 05 08³</td>
<td>AN / MN</td>
<td>Freshwater drilling muds and wastes</td>
<td>WBDM separated from drill cuttings</td>
<td>650 m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Spent spacer fluid</td>
<td>50 m³</td>
</tr>
<tr>
<td>01 05 05*</td>
<td>AH</td>
<td>Oil-containing drilling muds and wastes</td>
<td>Oil (if encountered)</td>
<td>None anticipated</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Spoiled LTOBM (if any)</td>
<td>None anticipated</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oil contaminated spent spacer fluid (if any)</td>
<td>None anticipated</td>
</tr>
</tbody>
</table>


³ The addition of salts and barite to WBM will depend on conditions encountered during drilling. The resulting concentration in the generated waste will dictate its coding. It is not therefore possible to predict the volume of each waste type which will be generated.
Waste materials will be temporarily stored and handled at the site so as to enable the collection and transportation of the materials off-site. Whilst the storage of the materials will be only temporary in nature, the Applicant will employ measures to ensure that the wastes are handled in an environmentally sound and safe manner.

Throughout the operations, all wastes will be stored in secure containers that will be inspected at least once a day to ensure the following:

- that all waste types are segregated and placed in the correct containers;
- to prevent the overfilling of containers; and
- to prevent spillages occurring.

All storage containers will be stored within an area benefiting from secondary containment comprising an engineered bentomat sandwiched between two layers of geotextile secured within the bund as illustrated in cross section on Drawing TL3/04. The impermeable lining will be overlain by a 100mm depth of type 3 stone, a geogrid and a further 200mm minimum of type 3 stone. The planning and installation of the secondary containment system will be subject to Construction Quality Assurance (CQA).

All storage containers will be removed by a registered waste carrier to an authorised waste management facility as soon as reasonably practicable.

Surface water drains will be inspected on a monthly basis throughout the period of drilling operations and on a six monthly basis following the cessation of drilling.

4.3 Waste Characterisation - Introduction

The sections that follow describe how wastes produced will be characterised and identify the materials which will be used in the drilling, suspension and abandonment of the exploration well. As the exact composition of the wastes cannot be known in advance, compositional information of the materials used in the drilling process is provided instead. Prior to the identification of an off-site recovery or disposal route, where required the Applicant will send samples of the waste streams for analysis at an accredited laboratory for classification in accordance with EA’s WM3 guidance.

4.4 Waste Characterisation - Cement

A list of chemicals that will be used in the cement is provided in Table 3.

---

Table 3
Cement Chemicals

<table>
<thead>
<tr>
<th>Halliburton Product name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuned Spacer E+</td>
<td>Blend gelling agent and dispersant</td>
</tr>
<tr>
<td>Musol</td>
<td>Mutual solvent</td>
</tr>
<tr>
<td>SEM-8</td>
<td>Emulsifier</td>
</tr>
<tr>
<td>Therma Teck</td>
<td>Fluid loss cement plug</td>
</tr>
<tr>
<td>Abanda Cem</td>
<td>Abandonment cement</td>
</tr>
<tr>
<td>Class G Cement</td>
<td>Standard Oil field Cement</td>
</tr>
<tr>
<td>Class G Cement + 35% SSA-1</td>
<td>Standard Oilfield Cement with Silica Flowers</td>
</tr>
<tr>
<td>Expandacem</td>
<td>Non-Shrinking cement</td>
</tr>
<tr>
<td>Expandacem HT</td>
<td>Non-Shrinking cement</td>
</tr>
<tr>
<td>MicroCem 650</td>
<td>Matrix Cement</td>
</tr>
<tr>
<td>Calcium Chloride Liquid</td>
<td>Accelerator</td>
</tr>
<tr>
<td>Econolite Liquid</td>
<td>Extender</td>
</tr>
<tr>
<td>Bentonite</td>
<td>Extender</td>
</tr>
<tr>
<td>Halad 344 L</td>
<td>LT fluid loss additive</td>
</tr>
<tr>
<td>Halad 300 LS</td>
<td>Fluid loss additive</td>
</tr>
<tr>
<td>NF-6</td>
<td>Defoamer</td>
</tr>
<tr>
<td>CFR-8L</td>
<td>Cement slurry dispersant</td>
</tr>
<tr>
<td>HR-4L</td>
<td>Calcium lignosulfonate retarder</td>
</tr>
<tr>
<td>HR 601 L NS</td>
<td>Non dispersing retarder</td>
</tr>
<tr>
<td>SCR-100L</td>
<td>HT retarder</td>
</tr>
<tr>
<td>GasStop Liquid</td>
<td>Anti-Gas Migration/Fluid Loss Control</td>
</tr>
<tr>
<td>WellLife 734</td>
<td>Lost circulation material</td>
</tr>
<tr>
<td>Latex 3000</td>
<td>Lost circulation material</td>
</tr>
<tr>
<td>Silicalite Liquid</td>
<td>Extender/Stabiliser</td>
</tr>
</tbody>
</table>

4.5 Waste Characterisation - Drilling Muds

A summary of the potential drilling mud volumes is given in Table 4.

The composition of the drilling mud, for each section of the proposed drilling operation, is given in the Waste Management Plan in Section 4 of the Environmental Permit application. Note mud composition has been provided based on the maximum amount of each chemical which might be employed.

Hyperlinks to the safety data sheets (SDS) for products comprising the drilling muds have been provided for further information in the Waste Management Plan in Section 4 of the Environmental Permit application.

It should be noted that a mud supplier has yet to be selected for the drilling operations and the final composition, volume and the procedures that would be used to manage the drilling muds will be confirmed with the Environment Agency in writing prior to the commencement of drilling operations.

Table 4
Drilling Mud Volumes

<table>
<thead>
<tr>
<th>Casing size</th>
<th>Displacement and completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>26” section</td>
<td>17-1/2 section 12-1/4” section 8-1/2” section</td>
</tr>
<tr>
<td>Casing depth</td>
<td>60 mMD</td>
</tr>
<tr>
<td>Mud type</td>
<td>26” section</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td></td>
<td>WBM</td>
</tr>
<tr>
<td>Volume[^note]</td>
<td>150 m³</td>
</tr>
</tbody>
</table>

[^note]: Volumes have been rounded up to the nearest 5 m³.

4.6 Waste Characterisation - Spacer Fluid

The formulation and volume of spacers to be employed are also shown in the Waste Management Plan in Section 4 of the Environmental Permit application.

4.7 Waste Characterisation - Contingency Chemicals

A list of contingency chemicals which could be employed depending on the conditions encountered during drilling is given in the Waste Management Plan in Section 4 of the Environmental Permit application. It is proposed that this list will be updated and agreed in writing with the Environment Agency prior to the commencement of drilling operations and once a drilling and chemical supplier has been chosen. The amounts have been based on the maximum amount of each chemical which could be employed.
5.0 ENVIRONMENTAL RISK ASSESSMENT

5.1 Risk Assessment Process

The approach to the risk assessment process follows the best practice source-pathway-receptor approach in order to identify pollution linkages. The source is the activity i.e. management of extractive wastes, the pathway is through the engineered measures and then the migration of potential contaminants through the unsaturated zone and saturated zone to a receptor taking into account dilution, attenuation and degradation. The receptor is groundwater.

5.2 Sources

Sources of potentially polluting materials from the management of extractive wastes at the exploratory well may include:

- oil grease and lubricants;
- cement;
- drilling muds (WBM and LTOBM);
- contingency chemicals;
- spacer fluid;
- gaseous formation hydrocarbons; and
- brackish or saline groundwater.

Fuels, lubricant and hydraulic oils from the use of vehicles, plant and equipment could foreseeably present a possible source. They could be released during operation and maintenance resulting in accidental spillages.

Cement and various drilling fluids and other chemicals will be used within the borehole during the drilling process. Details of the fluids have been provided in Appendix A.

There is the risk of encountering naturally occurring gaseous hydrocarbons at depth, particularly in the Westphalian Coal Measures.

Groundwater in deeper strata, beneath the potable water in the Sherwood Sandstone Group, is likely to be brackish or saline in nature.

5.3 Pathways

Without mitigation measures in place, potential pathways could exist for the migration of potentially polluting materials into the water environment. The following potential pathways have been identified:

- fractures and fissures in formations;
- well bore annulus;
- casing annulus;
- infiltration to ground within the site; and
- infiltration to ground off site.
The Applicant will put in place measures to mitigate the risk to groundwater as a result of the management of extractive wastes. The Applicant is not proposing to directly or indirectly discharge pollutants to groundwater. Any discharges which could result from the activities would either be the ‘consequence of an accident or exceptional circumstance of natural cause that could not have been reasonably foreseen, avoided or mitigated’ or ‘be of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater’. These discharges are described as exempt from the requirement of a groundwater activity permit in the Environmental Permitting Regulations.

5.4 Potential Receptors

Since this assessment considers the need for a groundwater activity permit at the Tinker Lane site, all groundwater is considered to represent a potential receptor. Groundwater is taken to mean ‘all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil’ as defined by the Environmental Permitting Regulations. Differentiation is made between different groundwater bodies since it is necessary to consider the quality of the receiving groundwater and its deterioration should there be a discharge from the activities. The Environment Agency consider that normally the maximum depth for designated groundwater bodies is taken to be 400m. Strata deeper than this are considered to be too deep to hold potable groundwater or be in connection to surface water or groundwater dependent ecosystems.

5.5 Mitigation

Best practice measures have been incorporated into the design and the proposed operational procedures to mitigate risk to groundwater. These measures are designed to remove the source or the pathway so that the source-pathway-receptor linkage will be broken.

The key mitigation measures provided in the design, for the pathways described previously, are given below. A schematic borehole cross section summarising potential pathways is provided in Drawing GW1 and a detailed risk assessment of potential linkages and mitigating factors is provided in Table 5.

Wellbore

Contaminated surface water or surface spillages will be prevented from entering the well bore by the construction of a water tight concrete chamber at the well head. A 20” or 18 5/8” steel conductor pipe will be grouted into the borehole to a depth of 60m and extended into the water tight well head chamber to prevent contaminated surface water or spillages from entering the borehole directly.

The proposed drilling muds contain materials that produce a ‘filter cake’ preventing the flow of fluids into geological formations from the inside surface of the well bore. This protects the geological formations until the steel casing is set.

Wellbore Annulus

Drilling of exploratory wells to this depth and through the same/similar geological sequence has been undertaken on many occasions in the UK (onshore and offshore). As a result measures required to maintain the well design and integrity are very well understood.

Notwithstanding this, the loss of potentially polluting materials to groundwater would be
minimised by good practice well design, and the work would be undertaken in accordance with the following best practice guidance and regulations:

- A guide to the Borehole Sites and Operations Regulations (1995);
- A guide to the well aspects of the Offshore Installations and Wells (Design and Construction) Regulation (1996);
- Oil and Gas UK Well Life Cycle Integrity Guidelines (March 2016); and

In addition, the well design and programme will be submitted to an independent well examiner for review. That examiner must and would be ‘independent’ and ‘competent’. Any concerns that the examiner may have would be addressed. In addition, the HSE will be notifies as required by the guide to the Boreholes Sites and Operations Regulations 1995. The HSE will review and comment if they have any concerns. Well consent is acquired from DECC/OGA; following this well operations can commence.

Steel casing would be used to construct the well. This is cemented in the well in stages to protect groundwater and maintain well integrity.

Figure 1 shows the potential drill diameters, depth and casing that would be used. Cement would be pumped in the form of a slurry inside the well casing. This then rises up through the annular space between the outer face of the casing and the side of the exploratory well. The cement is then set. All case strings would be pressure tested in accordance with the approved drilling programme and the results will be documented.

A water based drilling fluid would be used when the well is being drilled through the Nottingham Castle Sandstone, Lenton Sandstone, Roxby Formation and the Magnesian Limestone. No hazardous substances would be used when drilling through these aquifers beneath the site.

After adequate isolation by casing and cement grout, a low toxicity oil based drilling mud would be used to drill through the deposits below the Magnesian Limestone.

Prior to drilling any potential hydrocarbons formations, a casing wellhead and blow out preventer will be installed. Adequate pressure integrity will be maintained throughout the drilling operations.

The likelihood of lost circulation and required safeguards during drilling would also be considered.

The detailed well design would also consider procedures for monitoring the integrity of the exploratory well.

Well abandonment or suspension would be undertaken in accordance with best practice and regulatory guidance.

The above measures would prevent or minimise the potential impacts of drilling fluids, gas or formation fluids on receptors.
Infiltration to Ground within or External to the Site

The well pad will be lined by an impermeable liner to provide a barrier between surface activities and groundwater.

The well pad will be positively drained. Runoff (and any pollutants that might be in the runoff) will be collected in a lined tank prior to collection and disposal offsite at an appropriately permitted facility.

Bunding will be provided around the well pad to contain the failure of the largest fluid containers that would be used on site.

Materials required or generated by site that might pose a risk to the water environment (e.g. drilling fluid, cuttings, fuel, waste welfare water etc.) will be stored in appropriate containers. Spent or unused materials will be routinely removed from site and either returned for reuse, recycling or disposed of at appropriately licensed facilities.
### Table 5
#### Assessment of Risks

<table>
<thead>
<tr>
<th>Data and Information</th>
<th>Judgement</th>
<th>Action</th>
<th>Residual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receptor</td>
<td>Source</td>
<td>Harm</td>
<td>Pathway</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Losses of drilling muds during drilling</td>
<td>Contamination of groundwater</td>
<td>Pores, fractures and fissures in bedrock</td>
</tr>
</tbody>
</table>

Personnel employed will be competent and qualified.

Well cellar will be constructed to be water tight.
### Data and Information

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>Incomplete mud displacement from wellbore</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Harm</th>
<th>Pathway</th>
<th>Probability of exposure</th>
<th>Consequence</th>
<th>Magnitude of risk</th>
<th>Justification for magnitude</th>
<th>Action</th>
<th>Residual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contamination of groundwater</td>
<td>Wellbore annulus</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Spacer fluids will be used for drilling fluid removal.</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

- **Probability of exposure**: Low
- **Consequence**: Low
- **Magnitude of risk**: Low
- **Justification for magnitude**: Spacer fluids will be used for drilling fluid removal.
- **Action**: Low
- **Residual risk**: Low

---

**Justification for magnitude**:

Spacer fluid used through the Permian and Triassic formations will be 100% fresh water. In other cases, non-hazardous spacer fluid will be used.

- **Risk management**: Spacer fluid used through the Permian and Triassic formations will be 100% fresh water. In other cases, non-hazardous spacer fluid will be used.
- **Consequence**: Low
- **Magnitude of risk**: Low
- **Residual risk**: Low

---

**Action**:

- How will the Applicant manage the risk to reduce the magnitude?
- How likely is this contact?
- How severe will the consequences be if this occurs?
- On what have we based our judgement?
- What is the overall magnitude of the risk?"
<table>
<thead>
<tr>
<th>Receptor</th>
<th>Source</th>
<th>Harm</th>
<th>Pathway</th>
<th>Probability of exposure</th>
<th>Consequence</th>
<th>Magnitude of risk</th>
<th>Justification for magnitude</th>
<th>Action</th>
<th>Risk management</th>
<th>Probability of exposure</th>
<th>Consequence</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>Losses of drilling mud returning via casing annulus</td>
<td>Contamination of overlying groundwater</td>
<td>Casing annulus</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Casing and cementation will have been completed through overlying formations.</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An inner string cementing method will be employed.

Assessment of well integrity will be undertaken after the setting of each casing along with review by an independent well examiner.

The well integrity assessment will consist of a combination of:

- assessment and quality assurance of the cement formulation to be employed;
- monitoring of mud displacement volumes;
- sampling and monitoring of cement returns;
- pressure testing of casing;
- Formation Integrity Testing (FIT) on casing shoes; and
- the running of cement evaluation logs as required.

Contractors employed for well cementation will be competent.

Well cementation will be undertaken in accordance with best practice.
## Data and Information

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Source</th>
<th>Harm</th>
<th>Pathway</th>
<th>Probability of exposure</th>
<th>Consequence</th>
<th>Magnitude of risk</th>
<th>Justification for magnitude</th>
<th>Action</th>
<th>Residual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>Losses of cement into formation via fissures</td>
<td>Contamination of groundwater</td>
<td>Pores, fractures and fissures in bedrock</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>All reasonable effort will be made to seal formation prior to cementing.</td>
<td>Contractors employed for well cementation will be competent.</td>
<td>Very low</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Well suspension and abandonment</td>
<td>Contamination of groundwater</td>
<td>Well not plugged or capped effectively</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Measures in place to close pathways at abandonment.</td>
<td>Well will be plugged and capped in accordance with industry best practice including the OGUK Guidelines for the Abandonment of Wells.</td>
<td>Very low</td>
</tr>
</tbody>
</table>
## Groundwater Spillage of Liquids

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Source</th>
<th>Harm</th>
<th>Pathway</th>
<th>Probability of exposure</th>
<th>Consequence</th>
<th>Magnitude of risk</th>
<th>Justification for magnitude</th>
<th>Action</th>
<th>Residual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>Spillage of liquids</td>
<td>Contamination of groundwater</td>
<td>Transport through soils to groundwater</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Minor spills could occur.</td>
<td>A Pollution Prevention Plan (PPP) will be in place prior to the commencement of operations. Staff will be trained on the PPP. The site will benefit from an impermeable membrane underlying the site, secondary containment bund and drainage system. Spill kits will be available on site. Staff will be trained in the use of spill kits. Any spills will be cleaned up and recorded.</td>
<td>Low</td>
</tr>
</tbody>
</table>

### Data and Information

- **What is at risk? What do I wish to protect?**
- **What is the agent or process with potential to cause harm?**
- **What are the harmful consequences if things go wrong?**
- **How might the receptor come into contact with the source?**
- **How likely is this contact?**
- **How severe will the consequences be if this occurs?**
- **What is the overall magnitude of the risk?**
- **On what have we based our judgement?**
- **How will the Applicant manage the risk to reduce the magnitude?**
- **How likely is this contact?**
- **How severe will the consequences be if this occurs?**
- **What is the magnitude of the risk after management?**

### Justification for magnitude

- Minor spills could occur.
### Data and Information

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Source</th>
<th>Harm</th>
<th>Pathway</th>
<th>Probability of exposure</th>
<th>Consequence</th>
<th>Magnitude of risk</th>
<th>Justification for magnitude</th>
<th>Action</th>
<th>Residual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>Damage to containment system</td>
<td>Contamination of groundwater</td>
<td>Transport through soils to groundwater</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>There will be no direct contact with bentomat and geotextile containment system – see Drawing TL3/04.</td>
<td>A Pollution Prevention Plan (PPP) will be in place prior to the commencement of operations. Staff will be trained on the PPP. Site surfacing will be inspected on a daily basis to check containment system is not damaged.</td>
<td>Very low</td>
</tr>
</tbody>
</table>

**Groundwater**

What is at risk? What do I wish to protect?

What is the agent or process with potential to cause harm?

What are the harmful consequences if things go wrong?

How might the receptor come into contact with the source?

How likely is this contact?

How severe will the consequences be if this occurs?

What is the overall magnitude of the risk?

On what have we based our judgement?

How will the Applicant manage the risk to reduce the magnitude?

How likely is this contact?

How severe will the consequences be if this occurs?

What is the magnitude of the risk after management?

---

- Data and Information
- Judgement
- Action
- Residual risk

**Residual Risk**

- Probability of exposure
- Consequence

**Magnitude of risk**

- Very low
- Low
- Medium
- High

**Justification for magnitude**

- Site surfacing will be inspected on a daily basis to check containment system is not damaged.
- Groundwater monitoring will be undertaken.
- Any spills will be cleaned up and recorded.
### Groundwater

<table>
<thead>
<tr>
<th>Event Description</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overfilling of tanks</td>
<td>Low</td>
</tr>
<tr>
<td>Contamination of groundwater</td>
<td>Medium</td>
</tr>
<tr>
<td>Transport through soils to groundwater</td>
<td>Medium</td>
</tr>
<tr>
<td>Overfilling of tanks is unlikely to happen.</td>
<td>Very low</td>
</tr>
</tbody>
</table>

A Pollution Prevention Plan (PPP) will be in place prior to the commencement of operations. Staff will be trained on the PPP.

The site will benefit from an impermeable membrane underlying the site, secondary containment bund and drainage system.

The impermeable membrane will be installed prior to the commencement of drilling operations. The installation will be inspected to ensure it is properly installed.

Groundwater monitoring will be undertaken.

Pipes, tanks, storage vessels and site surfacing will be inspected on a daily basis.

Water-based drilling muds (WBM) will be non-hazardous.

Only low toxicity oil-based mud (LTOBM) will be used.

The oil-based mud circulation system will be continually monitored when operating.

Drill cuttings will mostly comprise solids and therefore relatively immobile.

Pipes, tanks, storage vessels and site surfacing will be inspected on a daily basis.

Where leaks or damage are identified the equipment will be immediately repaired or taken out of service.

Any spills will be cleaned up and recorded.

### Groundwater

<table>
<thead>
<tr>
<th>Event Description</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure of storage tanks or pipework</td>
<td>Low</td>
</tr>
<tr>
<td>Contamination of groundwater</td>
<td>Medium</td>
</tr>
<tr>
<td>Transport through soils to groundwater</td>
<td>Medium</td>
</tr>
<tr>
<td>Failure of storage tanks or pipework unlikely to happen.</td>
<td>Very low</td>
</tr>
</tbody>
</table>

A Pollution Prevention Plan (PPP) will be in place prior to the commencement of operations. Staff will be trained on the PPP.
<table>
<thead>
<tr>
<th>Data and Information</th>
<th>Judgement</th>
<th>Action</th>
<th>Residual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Receptor</strong></td>
<td><strong>Source</strong></td>
<td><strong>Harm</strong></td>
<td><strong>Pathway</strong></td>
</tr>
<tr>
<td>What is at risk? What do I wish to protect?</td>
<td>What is the agent or process with potential to cause harm?</td>
<td>What are the harmful consequences if things go wrong?</td>
<td>How might the receptor come into contact with the source?</td>
</tr>
</tbody>
</table>

The site will benefit from an impermeable membrane underlying the site, secondary containment bund and drainage system.

The impermeable membrane will be installed prior to the commencement of drilling operations. The installation will be inspected to ensure it is properly installed.

Groundwater monitoring will be undertaken.

Pipes, tanks, storage vessels and site surfacing will be inspected on a daily basis.

Where leaks or damage are identified the equipment will be immediately repaired or taken out of service.

Any spills will be cleaned up and recorded.
## Data and Information

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Source</th>
<th>Harm</th>
<th>Pathway</th>
<th>Probability of exposure</th>
<th>Consequence</th>
<th>Magnitude of risk</th>
<th>Justification for magnitude</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>Vehicle accident on site</td>
<td>Contamination of groundwater</td>
<td>Transport through soils to groundwater</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Vehicle accident unlikely to happen.</td>
<td>A traffic management plan will be employed at the site. The plan will impose speed limits and safe driving practices at the site. Drivers new to the site will be inducted in the site’s safe driving practices. Spill kits will be available on site. Staff will be trained in the use of spill kits. Only companies licensed as waste carriers by the EA will be employed by the Applicant. Safety Data Sheets will accompany drivers transporting liquid materials. A Pollution Prevention Plan (PPP) will be in place prior to the commencement of operations. Staff will be trained on the PPP.</td>
</tr>
</tbody>
</table>

### Judgement

- **What is at risk?** What do I wish to protect?
- **What is the agent or process with potential to cause harm?**
- **What are the harmful consequences if things go wrong?**
- **How might the receptor come into contact with the source?**
- **How likely is this contact?**
- **How severe will the consequences be if this occurs?**
- **What is the overall magnitude of the risk?**
- **On what have we based our judgement?**

### Action

- **How will the Applicant manage the risk to reduce the magnitude?**
- **How likely is this contact?**
- **How severe will the consequences be if this occurs?**

### Residual risk

- **What is the magnitude of the risk after management?**
### Hydrogeological Risk Screening

<table>
<thead>
<tr>
<th>Data and Information</th>
<th>Judgement</th>
<th>Action</th>
<th>Residual Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Receptor</strong></td>
<td><strong>Source</strong></td>
<td><strong>Harm</strong></td>
<td><strong>Pathway</strong></td>
</tr>
<tr>
<td>Groundwater</td>
<td>Failure of well cellar integrity</td>
<td>Contamination of groundwater</td>
<td>Transport through soils to groundwater</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundwater</td>
<td>Flooding</td>
<td>Contamination of groundwater</td>
<td>Surface run off and percolation into ground</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Arson / Vandalism</td>
<td>Contamination of groundwater</td>
<td>Surface run off and percolation into ground</td>
</tr>
</tbody>
</table>

- The well cellar will be constructed to be water tight.
- The integrity of the well cellar will be inspected prior to the commencement of drilling.
- The impermeable membrane will be installed prior to the commencement of drilling operations. The installation will be inspected to ensure it is properly installed.
- A Pollution Prevention Plan (PPP) will be in place prior to the commencement of operations. Staff will be trained on the PPP.
- A sykes or vacuum pump will be available to empty the cellar if required.

- Site will benefit from inner and outer security fencing and “airlock” style access gates.
- CCTV will be installed.
- Visitors to the site will be required to sign a visitor’s book.
- During drilling the site will be continuously occupied.
- Additional security fencing will be installed around well cellar during retention phase.
### Data and Information

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Source</th>
<th>Harm</th>
<th>Probability of exposure</th>
<th>Consequence</th>
<th>Magnitude of risk</th>
<th>Justification for magnitude</th>
<th>Action</th>
<th>Residual risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>Ingress of natural gas or oil into well bore</td>
<td>Could lead to formation kick and/or blow out</td>
<td>Poor well control</td>
<td>Very Low</td>
<td>High</td>
<td>Medium</td>
<td>Mud weight will be adjusted as required to control formation fluids and pressures.</td>
<td>Low</td>
</tr>
</tbody>
</table>

### Judgement

<table>
<thead>
<tr>
<th>What is at risk? What do I wish to protect?</th>
<th>What is the agent or process with potential to cause harm?</th>
<th>How might the receptor come into contact with the source?</th>
<th>How likely is this contact?</th>
<th>How severe will the consequences be if this occurs?</th>
<th>What is the overall magnitude of the risk?</th>
<th>On what have we based our judgement?</th>
<th>How will the Applicant manage the risk to reduce the magnitude?</th>
<th>How likely is this contact?</th>
<th>How severe will the consequences be if this occurs?</th>
<th>What is the magnitude of the risk after management?</th>
</tr>
</thead>
</table>
5.6 Confirmatory Monitoring

In addition to pressure monitoring of the well during construction, recording and monitoring the volumes of materials brought to and removed from site, groundwater quality would be monitored upstream and downstream of the exploratory well to confirm that the proposed well does not impair water resources locally.

The location of the monitoring boreholes has been agreed with the Environment Agency during pre-application discussions. The location of the monitoring boreholes are shown on Drawing EP2.

The monitoring programme would be agreed with the Environment Agency and include baseline, operational and decommissioning monitoring.

5.7 Summary

In summary, the risk screening assessment (see Table 5) shows that the management of extractive waste at the site does not represent a risk to groundwater and that a groundwater activity permit is not required. The proposed method of construction and mitigation measures that will be in place will prevent the discharge of pollutants into groundwater.
6.0 CONCLUSION

The Applicant will put in place measures to mitigate the risk to groundwater as a result of the management of extractive wastes. The Applicant is not proposing to directly or indirectly discharge pollutants to groundwater.

Any discharges which could be made to groundwater would either be the ‘consequence of an accident or exceptional circumstance of natural cause that could not have been reasonably foreseen, avoided or mitigated’ or ‘be of a quantity and concentration so small as to obviate any present or future danger of deterioration in the quality of the receiving groundwater’. These discharges are described as exempt from the requirement of a groundwater activity permit in the Environmental Permitting Regulations.

The hydrogeological risk screening assessment concludes that the management of extractive waste at the site does not represent a risk to groundwater and that a groundwater activity permit is not required. This is because mitigation measures will be in place to prevent the discharge of pollutants into groundwater.