Cloughton 2 Wellsite

Waste Management Plan

Environmental Permitting (England and Wales) Regulations 2016

- **Application for a Bespoke Mining Waste Operation**
- **Application for a Bespoke Installation**
- **Application for a Bespoke Groundwater Activity**

Issue Number:	Details:	Prepared By:	Reviewed By:	Authorised By:
250207	Draft for Client Review	Tony Fildes (Zetland Group)	Jamie McGill (Europa)	Alastair Stuart (Europa)
250424	Initial issue for an Application for a Mining Waste Operation with Flare, a Mining Waste Facility and a Groundwater Activity	Tony Fildes (Zetland Group)	Jamie McGill (Europa)	Alastair Stuart (Europa)

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1. PURPOSE AND CONTEXT

This Waste Management Plan forms part of an application to the Environment Agency to authorise the undertaking of specific 'permitted activities' at the Cloughton 2 Wellsite (herein referred to as the 'Wellsite'). With regards to onshore oil and gas operations, a number of activities are considered applicable to the environmental permitting regime.

The Wellsite within which the 'permitted activities' are undertaken is considered a 'regulated facility' under The Environmental Permitting (England and Wales) Regulations 2016, as amended (EPR2016) [Ref.1]. A 'mining waste operation' is considered a 'regulated facility' under EPR2016. Throughout the life of the Wellsite, this Waste Management Plan shall be considered a live 'operating technique' and must be complied with as it forms part of the environmental permit.

The primary purpose of the Waste Management Plan is to demonstrate that the 'mining waste operation' will meet the requirements of EPR2016 and, in turn, the Mining Waste Directive (MWD) [Ref.2] and the Waste Framework Directive (WFD) [Ref.3].

The Waste Management Plan sets out the necessary measures to ensure that extractive waste is managed in a controlled manner without endangering human health or harming the environment. The purpose of the Waste Management Plan is to demonstrate how Europa Oil & Gas Limited (herein referred to as the 'Operator') will minimise, treat, recover and dispose of extractive waste whilst taking into account the principle of sustainable development.

The Waste Management Plan has been produced in accordance with EPR2016, which has been transposed, in part, from the MWD.

The Waste Management Plan has also been compiled based on the requirements and guidance from the Environment Agency's How to comply with your environmental permit guidance 6.14 [Ref.4].

The Operator is proposing to construct a wellsite ~0.34 km southeast of Burniston, a village and civil parish in the Scarborough borough of North Yorkshire, England.

The Wellsite will be constructed to accommodate the drilling of an appraisal borehole to evaluate the potential for dry natural gas accumulations within the target formations, namely the Carboniferous Sandstones (primary target formation), and the Permian Brotherton Limestone (Plattendolomite) and the Kirkham Abbey (Hauptdolomite) formations (secondary target formations).

An application to the Environment Agency is being proposed under EPR2016 to apply for a 'Mining Waste Operation and Mining Waste Facility with Fracturing and Flare' and for a 'Groundwater Discharge Activity', as defined by reference 1.8.8 and 1.3.12 respectively of the Environment Agency (Environmental Permitting and Abstraction Licensing) (England) Charging Scheme [Ref.5].

For clarity, domestic legislation derived from European Union legislation such as the MWD and the Industrial Emissions Directive (IED) [Ref.6] continue to have an effect in domestic law following the UK's withdrawal from the European Union in accordance with the European Union (Withdrawal) Act 2018 [Ref.7]. European Directives are therefore still applicable to both this Waste Management Plan and the activities performed by the Operator.

All figures included in this document, for example, volumes, tonnages, distances represent best estimates at the time of document production, and may change, as operations develop.

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2. SCOPE

This Waste Management Plan is applicable to the Cloughton 2 Wellsite and all operations conducted therein. It is applicable to the Operator, its contractors and subcontractors and may be used in support of an application to the Environment Agency for an environmental permit under EPR2016.

This Waste Management Plan is the principle document for the management of all extractive wastes associated with the Wellsite.

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3. ABBREVIATIONS AND DEFINITIONS

%:	Percentage
";	Inch
~:	Approximately
AOD:	Above Ordnance Datum
API:	American Petroleum Institute
AQIA:	Air Quality Impact Assessment
BAT:	Best Available Technique
BOP:	Blowout Preventer
BSOR1995:	The Borehole Sites and Operations Regulations 1995
Cl:	Chloride Ions
CO_2:	Carbon Dioxide
dB:	Decibel
DCR1996:	The Offshore Installations and Wells (Design & Construction, etc) Regulations 1996
DFit:	Diagnostic Fracture Injection Test
E:	East
EPR2016:	The Environmental Permitting (England and Wales) Regulations 2016, as amended
EU:	European Union
EWC:	European Waste Catalogue
EWT:	Extended Well Test
FiT:	Formation Integrity Test
Groundwater Activity:	Has the meaning given within Regulation 2 of EPR2016
Groundwater Discharge Activity:	Has the meaning given within Regulation 2 of EPR2016
H_2O:	Water
ha:	Hectare
HCl:	Hydrogen Chloride

HDPE:	High Density Polyethylene
HFP:	Hydraulic Fracture Plan
HIA:	Hydrogeological Impact Assessment
IED:	Industrial Emissions Directive
Installation Activity:	Has the meaning given within Regulation 2 of EPR2016
JAGDAG:	Joint Agencies Groundwater Directive Advisory Group
kg:	Kilogramme
Km:	Kilometre
LOAEL:	Lowest Observable Adverse Effect Level
LOT:	Leak Off Test
m^3:	Cubic Metre
m:	Metre
mbgl:	Metres Below Ground Level
MD:	Measured Depth
mm:	Millimetre
Mining Waste Facility:	Has the meaning given within Regulation 2 of EPR2016
Mining Waste Operation:	Has the meaning given within Regulation 2 of EPR2016
MWD:	Mining Waste Directive.
N:	North
N_2:	Nitrogen
NE:	Northeast
NORM:	Naturally Occurring Radioactive Material
NVIA:	Noise and Vibration Impact Assessment
OGUK:	Oil & Gas UK
Operating Technique:	Documents approved by the regulator to ensure compliance with the issued permit
Operator:	Has the meaning given within Regulation 7 of EPR2016

Permitted Activities:	Any activity or operation defined within Schedule 1 to 29 of EPR2016
pH:	Potential of Hydrogen
psi:	Pounds per Square Inch
Regulated Facility:	Has the meaning given within Regulation 8 of EPR2016
RSR:	Radioactive Substances Regulation
SOAEL:	Significant Observable Adverse Effect Level
STD:	Standard
TVDSS	True Vertical Depth Below Sea Level
UK:	United Kingdom
WCU:	Well Clean Up
WFD:	The Waste Framework Directive
WR11:	Environment Agency's form for 'Notice of the intention to drill for minerals'
WR2011:	The Waste (England and Wales) Regulations 2011

Table 1: Abbreviations and Definitions

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4. REGULATED FACILITY

The proposed wellsite is located in the countryside in the county of North Yorkshire. It is centred on grid reference TA 02081 92802 and located at the following address:

Cloughton 2 Wellsite

Land east of The Mill Yard

Burniston Mill

Coastal Road

Burniston

Scarborough

YO13 0DB

Figure 1: Cloughton 2 Wellsite – Proposed (Source: Google Earth 28/08/2024)

4.1 Site Location Plan and Site Layout Plan

A number of site plans have been provided within Site Plans (04 – Site Plans) and details the extent of the Wellsite, including its location, site layouts and point source emissions.

A copy of the following plans are provided within the Site Plans document (04 – Site Plans) provided in support of the environmental permit application.

- 04A – ZG-EOG-CLTN-EPR-04-01 Location Plan 10000 Scale A3
- 04B – ZG-EOG-CLTN-EPR-04-02 Location Plan 2500 Scale A3
- 04C – ZG-EOG-CLTN-EPR-04-03 Site Layout Plan - Indicative Construction Phase 500 Scale A3
- 04D – ZG-EOG-CLTN-EPR-04-04 Site Layout Plan - Indicative Drilling Phase 500 Scale A3
- 04E - ZG-EOG-CLTN-EPR-04-05 – Site Layout Plan - Indicative Proppant Squeeze Phase with Workover Rig 500 Scale A3
- 04F - ZG-EOG-CLTN-EPR-04-06 – Site Layout Plan - Indicative Proppant Squeeze Phase with Coil Tubing Unit 500 Scale A3
- 04G – ZG-EOG-CLTN-EPR-04-07 Site Layout Plan - Indicative Well Testing Phase 500 Scale A3
- 04H – ZG-EOG-CLTN-EPR-04-08 Extent of Mining Waste Facility Plan 10000 Scale A3

5. PERMITTED ACTIVITIES

The proposed Wellsite has yet to be constructed and does not currently hold an environmental permit. No permitted activities are authorised under EPR2016.

5.1 Current Operational Status (Pre-Application)

The proposed Wellsite currently comprises farmland adjacent to an existing ground-mounted solar photovoltaic array. The Wellsite lies to the south east of the village of Burniston and is accessed from the A165 Coastal Road. The Wellsite falls within Burniston Parish Council and covers an area of approximately 1.2 ha.

The Wellsite lies within a rural area. However, there are a number of industrial units served by the existing access track to the south. An animal feed mill, served by a separate access, lies 200m to the southwest of the Wellsite.

The Wellsite is partially screened by existing woodland on its southern boundary and intermittent (gappy) hedgerows to the wider field boundaries to the north sides.

The Wellsite lies at approximately 57m AOD on the northern edge of the Wellsite and falls in a southerly direction to around 49m AOD in the southern part of the Wellsite.

The closest residential receptors are:

- Wayside Farm – 280m; and
- Burniston – 310m.

The proposal is to construct a temporary Wellsite within an enclosed and secure compound to drill an appraisal borehole. Should natural gas be encountered as predicated, the drilling rig will be demobilised from the Wellsite and the intention is then to undertake a production test. If natural gas is not encountered during the drilling phase, the appraisal borehole will be decommissioned (abandoned) in accordance with industry guidance, the drilling rig and associated equipment then removed from the Wellsite and the Wellsite restored to its former condition.

5.2 Proposed Development

The Operator is proposing to undertake four (4) phases of development as illustrated within Table 2.

Phase	Description	Approximate Timescale
Phase 1	Construction of the Wellsite	7 weeks
Phase 2	Operational Phase (Includes the drilling phase and demobilisation on completion of drilling operations)	8 weeks
Phase 3	Operational Phase (Testing)	(up to) 17 weeks
Phase 4	Site Restoration	6 weeks

Table 2: Phases of Development

Phase 1 – Wellsite Construction

Construction of the Wellsite will be undertaken during Phase 1 and will include construction of an access track, site clearance works, well cellar and hard standing construction.

The active area of the Wellsite hardstanding will be constructed with a perimeter containment ditch and underlaid with a fully welded HDPE environmental membrane. The environmental membrane and perimeter containment ditch ensures that any accidental spillages that may occur during the subsequent phases of operation are contained within the Wellsite.

Wastes Generated

Wastes generated during wellsite construction phase are not considered extractive wastes and, therefore, not detailed within this application.

Phase 2 – Drilling Operation

The second phase of the development is the drilling of an appraisal borehole, which will penetrate the soils from the well cellar. The appraisal borehole will be drilled to the target formations, taking rock samples as the drilling progresses and geophysical logging will then be acquired. If natural gas is encountered and is considered suitable for further testing, production casing will be installed in the borehole.

Wastes Generated

All extractive wastes generated during the drilling phase will be transported offsite by a licensed road haulier to an Environment Agency licensed waste treatment / waste disposal facility.

The anticipated extractive wastes during Phase 2 include:

- Waste Clays and Sand;
- Water Based Drilling Fluids;
- Water Based Rock Cuttings;
- Salt Saturated Water Based Drilling Fluids; and
- Salt Saturated Water Based Rock Cuttings.

Phase 3 – Production Testing

Contingent upon natural gas being encountered during the drilling phase, the third phase of the development is to undertake a proppant squeeze to stimulate the well by creating new localised fractures near to the wellbore, improving the formations permeability.

The proppant squeeze will involve pumping of 300m^3 to 500m^3 of carrier fluid (predominantly water) and proppant into the target reservoir followed by a short period of flowback (proppant carrier fluid recovery) and well clean up.

The proppant squeeze, falls within the definition of a 'groundwater activity under Schedule 22 of EPR2016 and will be considered a groundwater activity for the purpose of EPR2016, namely the injection of any substance into groundwater to increase the flow of fluids or gas to a well or borehole in connection with the extraction or use of any energy source. As such, the proppant squeeze will require a permit.

Mining Waste Facility

During the proppant squeeze, ~50% to 70% of the proppant carrier fluid will be retained within the target formation, having been adsorbed on the charged, high surface area minerals.

As the proppant carrier fluid is retained within the formation, an application for a mining waste facility is being applied for. For clarity, the mining waste facility will not be located at the Wellsite, it will be located in excess of 2.0 Km below ground and up to 1.6 Km distance (deviated borehole). It will extend c.80m in height, c.200m in length and 1 – 2mm in width within the target formation where the proppant fluid will remain.

Wastes Generated

All extractive liquid and solid wastes generated at surface during the production testing phase will be transported offsite by a licensed road haulier to an Environment Agency licensed waste treatment / waste disposal facility. Natural Gas will be flared.

The anticipated extractive wastes during Phase 3 include:

- Circulation Fluid / Well Suspension Brine;
- Spent Acid – Near Wellbore Treatment;
- Proppant (Flowback);
- Proppant (Retained in the Formation);
- Proppant Carrier Fluid (Flowback);
- Proppant Carrier Fluid (Retained in the Formation);

- Formation Water; and
- Natural Gas.

Phase 4 Wellsite Restoration

The fourth phase of the development is wellsite restoration.

Wastes generated during wellsite restoration phase are not considered extractive wastes and, therefore, not detailed within this application.

5.3 Non-Permitted Activities

Additional activities associated with the development, but not regulated under EPR2016 as a 'permitted activity' include, but is not limited to:

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

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6. ENVIRONMENTAL LEGISLATION AND APPLICABILITY

The proposed Wellsite has yet to be constructed and does not currently hold an environmental permit. No permitted activities are authorised under EPR2016.

6.1 Proposed Permitted Activities

The Wellsite will be the subject of several activities which, under current environmental legislation, requires an environmental permit. The Environment Agency regulate all permitted activities under the Environmental Permitting (England and Wales) Regulations 2016, as amended (EPR2016). Under EPR2016, Operators are required to submit environmental permit applications to the Environment Agency to seek approval to undertake such activities.

Onshore oil and gas developments are the subject of the environmental permitting regulations, and as such a number of environmental permits will be required to be obtained from the Environment Agency.

This Waste Management Plan provides details on the proposed operations to be conducted at the Wellsite and provides an explanation as to which permitted activities will be required/applied for.

6.2 Environmental Permitting (England and Wales) Regulations 2016

The Environment Agency regulates all permitted activities under EPR2016 and require Operators to submit environmental permit applications to seek approval to undertake such activities. The Operator has assessed the activities associated with the proposed operations and considers certain activities to fall in scope of EPR2016 and therefore require the necessary environmental permits.

6.2.1 Industrial Emissions Activity

Schedule 1, Part 2 of EPR2016 details a number of activities that are classified as an Industrial Emissions Activity including 'Energy Activities' (Chapter 1) and 'Waste Management' (Chapter 5). Energy Activities include the storage of crude oil, whilst Waste Management includes the incineration of waste.

6.2.1.1 Incineration of Natural Gas

Schedule 1, Part 2 of EPR2016 transposes the requirements of the Industrial Emissions Directive, which requires an environmental permit to authorise an installation operation for the incineration and co-incineration of waste, as detailed within Section 5.1.

Part A(1)

- The incineration of hazardous waste in a waste incineration plant or waste co-incineration plant with a capacity exceeding 10 tonnes per day.

The proposed production testing phase of operations, which include Well Clean up (WCU) and Extended Well Test (EWT) activities, may involve the incineration of natural gas exceeding 10 tonnes per day and therefore an installation permit is being applied for.

6.2.2 Mining Waste Operation including a Mining Waste Facility

Schedule 20 of EPR2016 defines a mining waste operation as being the management of extractive waste, whether or not it involves a waste facility. Under EPR2016, an environmental permit is required to authorise a mining waste operation.

In order to drill, test and undertake well treatments from the proposed Cloughton-2 Well, it is necessary to apply for an environmental permit for a mining waste operation (which includes a flare, mining waste facility and a small fracture operation).

The 'mining waste operation' will consider the extractive waste volumes and waste streams created as a result of both the drilling process and any subsequent testing and well treatment operations.

In addition, the Operator is proposing to undertake a proppant squeeze, which will also require a 'mining waste facility' which permits the permanent storage of waste at the Wellsite, which in the case of the proposed development is the permanent disposal of proppant carrier fluid into the target formation.

6.2.3 Groundwater Activity

Under Schedule 22 of EPR2016, an activity that could involve the discharge of pollutants into groundwater must be notified to the Environment Agency, together with the nature of these pollutants, under EPR2016. The Environment Agency will then determine whether the groundwater activity needs to be permitted.

There is a need, due to the low permeability of the primary and secondary target formations, to undertake a proppant squeeze to stimulate the well by creating new localised fractures near to the wellbore, improving the formations permeability.

The proppant squeeze will involve pumping of 300m^3 to 500m^3 of carrier fluid (predominantly water) and proppant into the target reservoir followed by a short period of flowback (proppant carrier fluid recovery) and well clean up.

The proppant squeeze, falls within the definition of a 'groundwater activity under Schedule 22 of EPR2016 and will be considered a groundwater activity for the purpose of EPR2016, namely the injection of any substance into groundwater to increase the flow of fluids or gas to a well or borehole in connection with the extraction or use of any energy source. As such, the proppant squeeze will require a permit.

This activity falls within the definition of a 'groundwater activity under Schedule 22 of EPR2016. The proppant squeeze has been designed such that it will be confined to the saturated formations, which contain hydrocarbons.

The proppant squeeze is a 'groundwater activity', namely the injection of any substance into groundwater to increase the flow of fluids or gas to a well or borehole in connection with the extraction or use of any energy source, therefore, a groundwater activity permit is being applied for.

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

Under Section 199 of the Water Resources Act 1991 (as amended by the Water Act 2003), a notice of the intention to construct or extend a boring for the purpose of searching for or extracting minerals must be submitted to the Environment Agency using form WR11.

The WR11 requires that a method statement, including drilling and casing designs, together with storage and use of chemicals and drilling muds, accompanies the WR11 application form.

The Cloughton-2 Well will be the subject of an individual WR11 application.

7. CRITERIA FOR DETERMINING THE CLASSIFICATION OF WASTE FACILITIES

In addition to the management of extractive waste, the Wellsite requires an environmental permit that covers the deposit or accumulation of extractive waste in a waste facility. The definition of a waste facility is based on the Wellsite having a designated area for the accumulation or deposit of waste subject to certain timescales, depending on the nature and source of the waste.

Article 3 (15) of the Mining Waste Directive defines a waste facility as:

> 'any area designated for the accumulation or deposit of extractive waste whether in a solid or liquid state or in solution or suspension, for the following time periods:
>
> - No time-period for Category A waste facilities and waste characterised as hazardous in the waste management plan;
> - A period of more than six months for facilities for hazardous waste generated unexpectedly;
> - A period of more than one year for facilities for non-hazardous non-inert waste; and
> - A period of more than three years for facilities for unpolluted soil, non-hazardous prospecting waste, waste, resulting from extraction, treatment and storage of peat and inert waste.'

With the addition of a 'proppant squeeze', the operations will involve the accumulation or deposit of extractive waste exceeding the timescales specified above but is limited to the formation where the 'proppant squeeze' is to be carried out. As such, the formation will be classified as a waste facility. All other extractive wastes stored at the Wellsite will:

(a) Be limited to non-hazardous substances; and

(b) Be of a short duration, significantly less than 1 year.

Details of the extractive waste streams are provided within **Section 11** of this Waste Management Plan.

7.1 Criteria for Determining a Category A Waste Facility

Where the proposed activities include a waste facility, the Operator is required to include an assessment as to whether the proposed facility will be classified as Category A or not.

Where a mining waste facility is to be considered, a review of the mining waste facility against criteria specified within Annex III of the Mining Waste Directive must be undertaken to determine whether or not the mining waste facility should be classified as a Category A Mining Waste Facility. The criteria for the determination of which is as follows:

- A failure or incorrect operation e.g. the collapse of a heap or the busting of a dam, could give rise to a major accident, on the basis of a risk assessment taking into account factors such as the present or future size, the location and the environmental impact of the water facility;
- It contains waste classified as hazardous under Directive 91/689/EEC above a certain threshold: or
- It contains substances or preparations classified as dangerous under Directive 67/548/EEC or Directive 1999/45/EC above a certain threshold.

An Hydrogeological Impact Assessment (08 – Hydrogeological Impact Assessment) has been undertaken to inform the permit application. The Hydrogeological Impact Assessment (HIA) has identified that low permeability formations above and below the target formation will prevent fluids from entering lower groundwater resources.

The proppant squeeze operation will be targeting sandstone formations at around 2,000 mbgl. The targeted Namurian sandstones are interbedded with extensive shales with limited vertical permeability. In addition, there is a proven thick (~500m) world class reservoir seal directly above the targeted reservoir sections in the form of evaporites (anhydrites and halites) which will have zero vertical or horizontal permeability and which have prevented the escape of gas over millions of years.

The limited nature of the induced fracture will ensure it stays within the bounds of the target formation and in addition the physical properties of the overlying evaporites, which will not support shear or fracture, will continue to provide

a robust seal. As such the deeper geology, in combination with the multiple cemented casing strings at depth, will ensure no communication with the active shallow groundwater system that is thousands of metres above.

The Cloughton-2 well will be constructed in accordance with the Offshore Installations and Wells (Design & Construction, etc) Regulations 1996 (DCR1996) [Ref.8]. Casing will be cemented through sensitive formations, isolating aquifers and groundwater zones. Casing shoes will be set into non-porous strata to form a complete seal between well sections. This prevents the direct migration of fluids and gases from the wellbore to the shallow groundwater system during the production and well intervention phases of work.

In this context, Article 4 (4) of the Commission Decision, *April 2009* states:

> *'Where there is no pathway between the source and the receptor, the facility concerned shall not be classified as a Category A on the basis of failure due to loss of structural integrity or incorrect operation.'*

The volume of fluid retained within the target reservoir, within the Carboniferous sandstones, is extremely small (~750m^3 – 1,050m^3) and will be ~2,300m TVDSS.

The risk of proppant squeeze fluid migrating has been assessed, the findings of which are presented within the HIA.

The HIA has assessed the potential impact to groundwater during the well testing phase of operations as 'negligible'.

On completion of the proppant squeeze activity, ~750m^3 – 1,050m^3 of fluid is expected to be present in the mining waste facility. The design of the stimulation activity is 80m in height and 400m in diameter, resulting in the mining waste facility being 100,531m^3 in total volume. Article 7 of the Commission Decision, April 2009 [Ref.9] sets out the basis for determining a Category A facility on a percentage ratio of waste expected to be present in the mining waste facility at the end of the planned period of operation. The ratio is based on the weight of the waste on a dry matter basis.

The classification of a Category A mining waste facility within the Commission Decision does not align itself easily with the type of mining waste operation being proposed at Cloughton 2. The classification is more aligned with waste tips, above ground or below ground, for purpose of disposing of liquid and/or solid waste. It is, therefore, difficult to apply the threshold ratio directly to the Cloughton 2 operation. Further, the classification of a Category A mining waste facility considers the waste expected to be present in the facility at the end of the planned period of operation. At the time of submitting this permit variation application, the waste expected to be present at the end of the planned period of operation is unknown, as the planned period of operation includes hydrocarbon production, followed by well abandonment.

On a volume basis, the percentage of waste present in the mining waste facility immediately following the proppant squeeze activity is 1.04%. Over the life of the production period until the abandonment of the Cloughton-2 well (the end of the planned period of operation), the mining waste facility is expected to be subject to other production activities (produced water reinjection) and workovers, resulting in the proppant squeeze fluid commingling with other fluids and extractive wastes within the reservoir and either be returned to surface with produced hydrocarbons, separated and removed from site or diluted within the mining waste facility. Article 4(3)(a) of the Commission Decision provides some relevance here, in that *inter alia*:

> *'The potential danger of the environment shall be considered to be not serious if:*
>
> (a) The intensity of the potential containment source strength is decreasing significantly within a short time.

Whilst Article 4 relates to failure due to loss of structural integrity or incorrect operations of a waste facility, it does acknowledge that the intensity of a hazardous waste can decrease over time, which is relevant to the proppant squeeze fluid described above and its interaction with other fluids within the mining waste facility during the planned period of operation.

In summary, the HIA concludes that there is significant vertical hydraulic separation (thousands of metres), within which numerous non permeable, hydraulically sealing strata exist, between the active aquifers and the targeted formation of the well test operation.

A copy of the Hydrogeological Impact Assessment (08 – Hydrogeological Impact Assessment) is provided in support of the environmental permit application.

The overall percentage of hazardous waste within the spatial volume of the mining waste facility will be 1.04% immediately following the proppant squeeze activity, reducing during the production of hydrocarbons and/or comingling with other extractive wastes. As such, the proppant squeeze fluid will not lead to a serious danger to the environment and, therefore, should not be classified as a Category A Waste Facility.

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8. OBJECTIVES OF THE WASTE MANAGEMENT PLAN

The objectives of the Waste Management Plan are derived from Article 5 of the MWD and are detailed as follows:

- To prevent or reduce waste production and its harmfulness, in particular, by considering:
  - Waste management in the design phase and in the choice of method used for mineral extraction and treatment;
  - The changes that the extractive waste may undergo in relation to an increase in surface area and exposure to conditions above ground;
  - Placing extractive waste back into the excavation void after extraction of the mineral, as far as is technically and economically feasible and environmentally sound in accordance with existing environmental standards at the community level and with the requirements of the directive, where relevant;
  - Putting topsoil back in place after the closure of the mining waste facility or if this is not practically feasible, reusing topsoil elsewhere; and
  - Using less dangerous substances for the treatment of mineral resources.

With regards to the prevention and reduction of waste production, the location of the Cloughton-2 Well was determined by the target formation and geology. The location was also determined by other considerations such as planning constraints, access agreements etc. The design of the Cloughton-2 Well was informed by all of these factors and as such the minimisation of waste from a design basis is constrained by the selection of hole sizes that would achieve the planned targets.

Extractive waste will be stored at surface in dedicated areas within the 'regulated facility'. Extractive waste will have minimal contact with above ground conditions, as they will be confined to enclosed / partially enclosed tanks with the exception of natural gas.

Placing extractive waste back into the extraction void is not feasible as the well is cased, cemented and then tested for oil and/or gas. In short, the extraction voids need to remain in order to produce from the well.

The Wellsite will be constructed by excavating top soil and sub soil and stored at the Wellsite in a bund acting as both a storage bund and screening against any visible impact from neighbouring properties. The soils will be laid back from whence it came, restoring the site to its pre-development condition and negating any waste.

Where practicable, dangerous substances will be substituted with less dangerous substances for the treatment of mineral resources. However, the substances must be able to fulfil the same function and to the same standard.

(b) To encourage the recovery of extractive waste by means of recycling, reusing or reclaiming such waste, where this is environmentally sound in accordance with existing environmental standards at Community level and with the requirements of the Directive where relevant.

Where possible waste will be recovered to surface and re-used for further well operations. Such examples include the re-use of drilling fluid and brine where applicable.

(c) To ensure short and long term safe disposal of the extractive waste, in particular by considering, during the design phase, management during the operation and after-closure of a mining waste facility and by choosing a design which:

- Requires minimal and, if possible, ultimately no monitoring, control and management of the closed mining waste facility;
- Prevents or at least minimises any long term negative effects for example attributable to migration of airborne or aquatic pollutants from the mining waste facility; and
- Ensures the long-term geotechnical stability of any dams or heaps rising above the pre-existing ground surface.

With regards to the mining waste operation, no extractive waste shall remain at the Wellsite indefinitely.

Upon closure, the Wellsite will be restored to its natural state with the removal of all of the wellsite surface equipment. The wellhead will be mechanically cut off below the surface (after the required monitoring period). All extractive waste shall be treated / disposed of in accordance with the receiving facilities environmental permit.

9. WASTE MANAGEMENT ARRANGEMENTS

9.1 Waste Definition

A waste is defined in Article 3(1) of the MWD by reference to Article 3(1) of the WFD. The definition is; *'waste' shall mean any substance or object which the holder discards or intends or is required to discard.*

The wastes are defined in Article 3 of the Directive as inert, non-hazardous or hazardous and are defined as follows:

Hazardous Waste: A hazardous waste is defined as a waste that has one or more of the fifteen specified hazardous properties listed in Annex III to the WFD. The application of this is determined by the List of Wastes Decision [Ref.10].

Non Hazardous Waste: A waste which is neither classed as inert or hazardous.

Inert Waste: Waste which does not undergo any significant physical, chemical or biological transformations. Inert waste will not dissolve burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant and in particular not endanger the quality of surface water and/or groundwater.

Whilst the UK has withdrawn from the European Union, the Waste (Circular Economy) (Amendment) Regulations 2020 [Ref.11] transposes (transfers requirements into UK law) six amending EU Directives in the field of waste including Directive 2008/98/EC ("the Waste Framework Directive"). The definition provided above is still considered applicable.

9.2 Waste Classification

A list of waste streams, together with their respective European Waste Catalogue (EWC) codes has been provided within Table 5 to Table 17. To ensure that the Waste Management Plan remains suitable and sufficient in the event of contamination, both Hazardous and Non-Hazardous EWC codes have been applied to the waste stream. Such an example includes circulation fluid (brine) which ordinarily would be assessed as EWC code '01 05 08' but may be assessed onsite as EWC code '01 05 06*' should it be contaminated with a hazardous substance above a certain threshold. i.e. oil based fluid or hydrocarbons.

The Operator is required to assess and classify its waste (both extractive and non-extractive) by using the correct code from the Environment Agency's Waste Classification Technical Guidance WM3 [Ref.12].

9.3 Hierarchy of Waste Management

The Operator and its contractors follow the Waste (England and Wales) Regulations 2011 (WR2011) [Ref.13], which lays out a hierarchy of waste management, derived from the WFD. This hierarchy has been outlined in Figure 2.

	Most Preferred	
Prevention		Using less materials in design and manufacture. Keeping products for longer i.e. re-use. Longer term waste prevention includes gas distribution to national transmission system if feasible.
Preparing for Re-Use		Checking, cleaning, repairing, refurbishing, whole items or spare parts.
Recycle		Turning waste into a new substance or product. This can include gas to grid concepts.
Other Recovery		Incineration with energy recovery, gasification and pyrolysis which produce energy and materials from waste.
Disposal		Landfill and incineration without energy recovery.
	Least Preferred	

Figure 2: Waste Hierarchy

The Wellsite Supervisor is appointed by the Operator to exercise overall control of the wellsite operations, in accordance with The Borehole Sites and Operations Regulations 1995 (BSOR1995) [Ref.14]. In addition, the Wellsite Supervisor will also be the person responsible for waste management during operations within the Wellsite.

The management of waste onsite will include:

- Waste management in accordance with WR2011, waste hierarchy;
- Monitoring of all waste storage vessels;
- Liaison with third party waste advisors with respect to waste sampling, analysis and classification;
- Compiling / keeping records of all waste transfer notes where this is not undertaken by the waste carrier; and
- Managing the collection and offsite disposal of all waste streams.

The Operator will appoint competent waste brokers, dealers and carriers where necessary who shall be responsible for the transportation of all waste streams to the relevant Environment Agency permitted waste treatment facility. Waste brokers, dealers and carriers will hold relevant certificates issued by the Environment Agency, which shall be inspected prior to being appointed.

The Wellsite Supervisor shall at all times, together with all employees and contractors:

- Promote awareness of the Waste Management Plan and its effectiveness; and
- Monitor, assess, record and report on waste generation, segregation, treatment and disposal.

9.3.1 Waste Prevention

Every effort will be made to eliminate the waste produced at source. Control measures will include:

- Calculating quantities of required products;
- Avoiding packaged material where practicable;
- Ordering correct quantities;
- Avoiding damage by handling and storing correctly; and
- Using fewer materials in designs and manufacturing.

9.3.2 Preparing for Re-Use

Only dispose of waste which cannot economically or practically be re-used or recycled. Checking, cleaning, repairing and refurbishing of items and spare parts for subsequent re-use.

9.3.3 Recycle

Waste is to be segregated onsite to allow for recycling offsite. Additionally, materials that are recycled shall be procured for use onsite where practicable and where specification permits. Turning wastes into a substance or product including composting, subject to quality protocols.

9.3.4 Other Recovery

Other recovery includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste.

9.3.5 Disposal

Waste that cannot be reused or recycled practicably shall be disposed of responsibly and in compliance with the Operators duty of care obligations. All waste shall be removed from site by a licensed waste carrier to a licensed waste facility.

10. WASTE GENERATING ACTIVITIES

The following section describes the various extractive wastes arising from the proposed Cloughton 2 operations, together with their waste classification and estimated quantities. Non-extractive waste is not subject to an environmental permit under the MWD, and as such has not been included in detail.

For clarity, the source of extractive waste concerned within this Waste Management Plan shall be from drilling operations, well testing operations, well workover operations and well treatment operations. The extractive waste will be produced from the well and be stored in dedicated storage vessels within the 'regulated facility'.

10.1 Proposed Activities

The proposed activities will be undertaken in accordance with the Environment Agency Onshore Oil and Gas Sector Guidance [Ref.15]. Operations will be undertaken in accordance with BSOR1995, DCR1996 and other relevant legislation standards and guidance.

10.2 Phase 1 – Wellsite Construction Activities

The Operator is proposing to construct a temporary Wellsite within an enclosed compound to drill an appraisal borehole. Construction works undertaken in relation to the Wellsite are not considered to fall under the remit of the Environmental Permit with regards to the management of extractive waste, and therefore will not be considered further within this Waste Management Plan.

Details of the proposed wellsite construction have been provided within the Site Condition Report (06 - Site Condition Report) as a means to illustrate and describe the proposed construction design and how the Operator will ensure that it is built so as to ensure so far as reasonably practicable the quality assurances of the build are sufficient and have been designed so as to be suitable to the proposal and mitigates against the potential for pollution offsite.

A copy of the Site Condition Report (06 - Site Condition Report) is provided in support of the environmental permit application.

10.3 Phase 2 – Drilling Operations

The Operator is proposing to drill an appraisal wellbore (Cloughton-2). In the event that hydrocarbons are encountered, the intention would be to proceed with a production test phase. Should no hydrocarbons be encountered during the drilling phase, the drilling rig and associated equipment will be demobilised and plans will be prepared to restore the site to its former condition.

10.3.1 Drilling of the Cloughton-2 Well

The Cloughton-2 Well shall be drilled in sections with an appropriate drilling rig. The exact well design shall be agreed with the Environment Agency by way of WR11 application prior to the drilling of the Cloughton-2 Well. An indicative well design has been provided within the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic), which shows the structure of the well, the formations being drilled and the drilling muds being proposed.

The specific casing depth will not rely on the estimate provided within this application but will be determined by the actual formation tops, as determined by sample and log evaluation during drilling of the Cloughton-2 Well.

Drilling fluid additives shall be the subject of approval by the Environment Agency prior to the undertaking of any drilling activities.

The drilling of the Cloughton-2 Well is anticipated to last no more than eight (8) weeks and the anticipated extractive wastes during this phase includes:

- Water Based Drilling Fluids;
- Water Based Rock Cuttings;
- Salt Saturated Water Based Drilling Fluids; and
- Salt Saturated Water Based Rock Cuttings.

A copy of the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic) is provided in support of the environmental permit application.

10.3.1.1 Geological Prognosis

The formations to be encountered during the drilling and construction of the Cloughton-2 Well and their estimated depths are detailed in the Geological Prognosis provided within Table 4.

Formation	TVDSS (m)	MD (m)	Remarks
Middle Jurassic	6.00	6.00	
Liassic / Lower Jurassic	50.65	50.65	
Mean Sea Level	**54.00**	**54.00**	
Keuper Marl / Mercia Mudstone	564.52	579.00	
Keuper Halite / Mercia Halite	880.88	1011.98	
Bunter Sand / Sherwood Sandstone	905.26	1048.88	
Bunter Shale / Eskdale Group	1135.99	1398.05	
Rotten Marl / Stantondale Group	1318.86	1674.79	
Brotherton Limestone / Teesdale Group	1371.59	1754.59	
Fordon Evaporites / Aislaby Group	1486.79	1928.93	
Kupferschiefer (Kirkham Abbey) / Don Group	1851.93	2481.51	
Rotliegend Sandstone	1897.65	2548.93	
Namurian	**1935.44**	**2599.71**	**Secondary Target**
Sabden	**1947.63**	**2615.32**	**Primary Target**
Skipton Moor Grits / TD	2292.65	2929.24	

Table 3: Cloughton-2 Well Geological Prognosis

10.3.2 Indicative Well Design

The exact well design will be contingent on the actual conditions encountered during drilling, however an indication of how the well will be constructed is summarised in Table 3.

Hole Section (“)	Depth (m)		Mud System	Casing (“)	Formation	Cement
	MD	TVDSS				
36 x 26	30	30	Water Based	30 x 20	Mid Jurassic	Section depth to surface
17 ½	192	192	Water Based	13 $^{3}/_{8}$	Lower Jurassic	Section depth to surface
12 ¼	1,404	1,140	Salt Saturated	9 $^{5}/_{8}$	Bunter Shale	Section depth to surface
8 ½	2,578	1,919	Salt Saturated	7	Rotliegendes	Section depth to within 7” casing
6	2,988	2,293	Salt Saturated	4 ½	Sabden Base	Section depth to within 7” casing

Table 4: Cloughton-2 Well Construction Summary

A conductor casing shall be set from surface, this section is typically constructed by using a smaller drilling rig. The conductor casing shall be drilled in two (2) stages with an initial 36" hole drilled and setting a 30" casing, followed by a 26" hole drilled and setting a 20" casing.

The conductor holes shall be drilled using water-based mud and / or air and the annulus shall be cemented back to surface. The main reason for a conductor section is usually to create a stable start to the well whilst allowing the main rig to start drilling from a deeper depth.

The surface casing shall be drilled using water-based mud. This section shall be drilled in a smaller diameter hole size than the conductor casing (typically 17 ½"), and steel casing (typically 13 $^{3}/_{8}$") shall be run and cemented back to surface. This casing shall isolate the upper wellbore from any deeper porous formations.

The intermediate section shall be drilled using salt saturated water based mud. This section shall be drilled in a smaller diameter hole size than the surface casing (typically 12 ¼"), and steel casing (typically 9 $^{5}/_{8}$") shall be run and cemented back to surface.

Production casing shall be run across the primary target section (Sabden Sands). This section shall be drilled in a smaller diameter hole size than the intermediate casing (typically 8 ½"), and steel casing (typically 7") shall be run and cemented into place.

A 4 ½" Liner will be set and cemented over the primary target and tied back to surface.

An indicative well schematic depicting the Cloughton-2 Well design, together with the location each drilling mud may be used, is provided within the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic).

A copy of the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic) is provided in support of the environmental permit application.

10.3.3 Logging

Geological logging is undertaken during well construction to determine whether formations encountered during drilling may contain petroleum. The borehole logs assist the Operator in determining specific zones, which justify subsequent testing. Coring may also be undertaken.

10.3.4 Perforation

In order to establish communication between the formation(s) being tested and the wellbore, the casing must be perforated.

The perforating operation, in particular the use of explosive charges, is regulated by the Police Authority and the Health and Safety Executive. Perforating may be undertaken several times as deemed necessary by the Operator.

Once the casing has been perforated, the fired perforating guns will be recovered at a time determined within the operation. The perforation process may be repeated a number of times.

The anticipated extractive wastes during this phase includes:

- Circulation Fluid / Suspension Brine; and
- Metal Debris / Metal Scrapings.

10.3.5 Well Integrity

Regulation 13 of The Offshore installations and Wells (Design and Construction, etc) Regulations 1996 requires that well-operators ensure that a well is designed, constructed and controlled (throughout its lifecycle) so there can be no escape of fluids from the well and that the risks to strata to which it is connected are as low as reasonably practicable. This is done by (Regulation 14) taking into account the geological strata and formations, and fluids within them and any hazard which such strata and formations may contain at pre-design stage and (Regulation 16) ensuring that every part of a well is composed of material suitable to achieving these purposes.

The design and well activities must be independently reviewed (Regulation 18) and submitted to the Health and Safety Executive prior to constructing the well.

As per the OGUK Well Life Cycle Integrity Guidelines [Ref.16], integrity tests shall be undertaken during the construction of the well. These shall include pressure testing of the casing once cemented and the BOP installed, prior to drilling out the cement shot, to a higher pressure than the maximum potential pressure the casing will be subjected, and then the cement seal around the shoe will be tested by a Leak Off Test (LOT) or a Formation Integrity Test (FIT).

By following these regulations and guidelines to ensure integrity of the well, this should limit the risk of contamination to the environment.

10.4 Well Testing

If the drilling programme provides evidence of hydrocarbons in the target formations the well will be completed and made safe with completion fluids, and the installation of a wellhead at surface level. The drilling rig and associated equipment will then be demobilised from the Wellsite.

Upon completion, the well will be the subject to subsequent clean up and testing.

The well casing will then be perforated at target interval depth and stimulated with a proppant squeeze as detailed within Section 10.3.4 and Section 10.8 respectively.

The purpose of the well test is to evaluate the commercial viability of the hydrocarbon reservoir, if encountered. The test will be conducted in 2 (two) parts consisting of a Well Clean Up (WCU) and an Extended Well Test (EWT). During the well test hydrocarbons will be produced.

A Waste Gas Management Plan (10 – Waste Gas Management Plan) has been developed for the purpose of demonstrating Best Available Technique (BAT) for the management of waste gas as a result of each well testing phase.

The testing of the Cloughton-2 Well is anticipated to last no more than seventeen (17) weeks.

The anticipated extractive wastes during this phase include:

- Natural Gas;
- Circulation Fluid / Suspension Brine; and
- Formation Water / Produced Water.

A copy of the Waste Gas Management Plan (10 – Waste Gas Management Plan) is provided in support of the environmental permit application.

10.4.1 Well Clean-up Phase

A WCU is conducted when trying to bring the reservoir fluids to surface for the first time, either after drilling, after a period of in-operation or after any maintenance has been conducted in the well. The aim of the WCU is to get the reservoir fluids to surface and flowing at a consistent rate for testing or production.

A WCU will involve the use of a well testing spread, typically consisting of at least a choke manifold, surface safety valve, three-phase separator, fluid storage tanks, vent line(s) and a combustion unit(s). Waste gas produced as a result of the well clean-up operations shall be managed in accordance with the approved BAT as demonstrated by the Waste Gas Management Plan.

Ordinarily, natural gas flows to surface however, during a WCU the rate of natural gas produced is likely to fluctuate unpredictably. Any natural gas composition data acquired during a WCU may not be accurate due to being comingled with wellbore fluids. Once at surface, natural gas and produced fluids will be diverted by temporary pipework to a three-phase separator, which will separate out crude oil and condensate, formation water and natural gas. Crude oil and condensate, which for clarity is not a waste, will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to a permitted refinery for sale. Formation water, which is considered a waste, will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to an Environment Agency permitted water treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.

Any natural gas separated during the three-phase separation will be managed in accordance with the identified BAT as identified within the Waste Gas Management Plan.

If the well does not flow on its own after perforation then a proppant squeeze, which is described below, may be conducted in order to bring the reservoir fluids to surface.

For clarity, it is anticipated that wellbore fluids from the Cloughton-2 Well will be dry natural gas and therefore the potential for crude oil, condensate and formation water is limited.

A copy of the Waste Gas Management Plan (10 – Waste Gas Management Plan) is provided in support of the environmental permit application.

10.4.2 Extended Well Test

Should the WCU phase indicate that hydrocarbons are present then testing operations will continue with the EWT stage. An EWT is a longer duration test, which is carried out to assess the commercial viability of the well and establish detailed gas and oil composition.

Once at surface, produced fluids and hydrocarbons will be diverted by temporary pipework to a three (3) phase separator, which will separate out crude oil and condensate, formation water and associated natural gas. Crude oil and condensate, which for clarity is not a waste, will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to a permitted refinery for sale. Formation water, which is considered a waste, will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal by a licenced haulier to an Environment Agency permitted water treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.

Formation water produced during the EWT has the potential to contain low levels of Naturally Occurring Radioactive Material (NORM). Samples of formation water will be sent to a laboratory holding the appropriate accreditations for radionuclide analysis by gamma spectrum. Depending on the outcome of the radionuclides analysis, formation water will be transported via a licenced haulier to either an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility, or to a bespoke RSR permitted waste treatment facility for treatment and disposal in accordance with BAT.

Again, any natural gas separated during the three-phase separation will be managed in accordance with BAT as identified within the Waste Gas Management Plan.

The purpose of an extended well test is to analyse the flow characteristics of a formation, which may contain petroleum, over an extended period. The duration of the extended well test will differ, whether oil or gas is being flow tested.

A copy of the Waste Gas Management Plan (10 – Waste Gas Management Plan) is provided in support of the environmental permit application.

10.5 Well Completion

Once the well has been drilled (in accordance with details included in the WR11) a completion assembly shall be run into the well to allow the production of reservoir fluids. The completion may consist of production tubing, packers, sliding sleeves, down hole pumps or other equipment to allow the reservoir fluids to move to surface. The completion is semi-permanent and will be retrieved at the end of the life of the well or during well maintenance.

On completion of the drilling phase, or prior to testing, circulation runs will be conducted to remove residual muds or debris from the drilling using a clean fluid, as shown in the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic). The waste from the circulation run will be managed at surface using the same techniques as the drilling phase.

The anticipated extractive wastes during this phase includes:

- Circulation Fluid / Suspension Brine;
- Water Based Drilling Fluids; and
- Salt Saturated Water Based Drilling Fluids.

A copy of the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic) is provided in support of the environmental permit application.

10.6 Borehole Clean Up

A clean up assembly will be run into the well and will scrape and remove any debris from the perforations. A clean fluid will be circulated down the work string during the wellbore cleaning operation and will circulate out to surface any debris. The debris, consisting of small steel scrapings, will be separated from the fluid at surface using conventional shakers and circulating tanks. The steel scrapings are anticipated to be very small in volume, due to the design of the perforation guns, insofar as they have been designed to minimise debris by reducing external burrs (steel edges) which form as the jet exists the casing.

The anticipated extractive wastes during this phase includes:

- Circulation Fluid / Suspension Brine; and
- Metal Debris / Metal Scrapings.

10.7 Proppant Squeeze

In order to re-establish permeability within the target formation, it may be necessary to undertake a proppant squeeze, which is designed to create channels of communication through the near wellbore formation, the natural permeability having been impeded by formation damage as a result of the initial drilling and completion operation.

For clarity, the primary purpose of the proppant squeeze is to re-establish permeability, however, due to the design of the proppant squeeze, although as minimal as is reasonably practicable, the proppant squeeze will extend beyond the near wellbore damage, providing some degree of secondary benefit in the form of enhanced permeability within the target formation.

In the case of Cloughton 2 operations, a proppant squeeze involves a slurry of proppant (typically 20/40 grade sand) and a gelled hydrocarbon-based fluid (carrier fluid) being pumped through the perforations into the target formations at a pressure exceeding the fracture pressure of the formation. Injecting pressure and pump rates high enough to propagate a fracture in the formation, creates channels of communication through the near wellbore formation damage. When the pressure is released, the proppant remains in situ propping open the small fractures, through which hydrocarbons can flow at enhanced rates.

The proppant squeeze will be carried out as a multi-stage treatment in the Cloughton-2 borehole with up to 4 treatments being undertaken. Carrier fluid volumes for a single stage treatment are 300m^3 - 500m^3 with 12.5 tonnes of proppant entrained. The fluid mix is injected at a surface pressure of 9,000psi at a low rate for less than one (1) hour, then flowed back to surface in a controlled manner through well clean-up equipment.

A Diagnostic Fracture Injection Test (DFiT) may be undertaken using up to 15m^3 of gelled hydrocarbon-based fluid prior to the proppant squeeze to determine the breakdown pressure, propagation pressure and carrier fluid leak-off rate, which, in turn, will inform the main proppant treatment. Should the DFiT indicate that the main proppant treatment may extend further than the design, the fluid volumes, proppant size and amount, and pressures will be adjusted accordingly to ensure the design objective is achieved. This calibration process will be documented within the Hydraulic Fracture Plan (HFP).

As the proppant squeeze will involve pressures exceeding fracture gradient, the use of gelled hydrocarbon based fluid and proppant, an HFP must be submitted and assessed independently by both the North Sea Transition Authority and the Environment Agency, with the Health and Safety Executive having opportunity to comment, in advance of the operation being undertaken.

The proppant squeeze within the Cloughton-2 borehole is designed to extend circa 100m to 200m in a lateral direction and 40m to 80m in a vertical direction and will be confined to the primary and secondary target formations.

A proppant squeeze falls within the definition of a ‘groundwater activity’ under Schedule 22, 8(l) of EPR2016, namely the injection of any substance into groundwater to increase the flow of fluids or gas to a well or borehole in connection with the extraction or use of any energy source. Whilst the definition provides for the injection of ‘any substance’, the Environment Agency has indicated that it will still take a risk-based approach when considering whether to issue a groundwater activity permit, including the carrier fluids proposed and the rationale for not using, for example, a water-based fluid. In the case of the Cloughton-2 proppant squeeze, the carrier fluid proposed is a water-based fluid.

A full disclosure of the proposed proppant fluid is provided within the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic) provided in support of the environmental permit application.

A copy of the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic) is provided in support of the environmental permit application.

10.7.1 Flowback Fluid and Disposal

Approximately 30% to 50% of the proppant carrier fluid will be returned to surface via the well clean-up equipment and stored on site for subsequent offsite transfer to an Environment Agency approved waste treatment facility for disposal in accordance with the receiving waste treatment facility's environmental permits.

Flowback fluid has the potential to contain low levels of NORM. Samples of the flowback fluid will be sent to a laboratory holding the appropriate accreditations for radionuclide analysis by gamma spectrum. Depending on the outcome of radionuclides analysis, the flowback fluid will be transported via a licenced haulier to either an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility, or to a bespoke RSR permitted waste treatment facility for treatment and disposal in accordance with the BAT.

10.7.2 Retained Fluid within the Target Formation

The remaining 50% to 70% of proppant fluid will be retained within the target formation, having been adsorbed on the charged, high surface area minerals within the target formation.

The constituents within the proppant fluid have been assessed using the Joint Agencies Groundwater Directive Advisory Group (JAGDAG) assessment methodology [Ref.17].

A copy of the JAGDAG Assessment has been provided in support of the environmental permit application.

The target formation within which the fluid is retained is expected to be classified by the Environment Agency as a Non-Hazardous Mining Waste Facility, the extent of which will be determined through fracture height and growth modelling.

An indicative well path design which shows the indicative well path of the Cloughton-2 Well has been provided within the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic).

A copy of the Chemical Inventory and Well Schematic (09 – Chemical Inventory and Well Schematic) is provided in support of the environmental permit application.

As a result of the retention of proppant fluid with the target formation being classified as a Mining Waste Facility, there is a requirement, through assessment, to establish BAT for the management of the retained proppant fluid. The options considered as part of the BAT assessment include:

- Recovery of all proppant carrier fluid over prolonged flowback periods during hydrocarbon production;
- Increased recovery of proppant fluid using artificial lifting (submersible pumps);
- Recovery of proppant fluid by excavation; and
- Retention of proppant fluid within the target formation.

The BAT assessment identified that both the prolonged flowback periods and artificial lift are unlikely to result in a 100% recovery of proppant fluid from the target formation.

Recovery by excavation is not feasible due to the depth of formation within which the fluid is retained. Such methods of excavation would have a significant environmental impact. This would involve the development of a mineshaft considerably wider than the Cloughton-2 borehole to a depth of circa 2,988m MD (2,293 TVDSS), sufficiently large enough to accommodate structural supports for safety against collapse and of entry of necessary personnel, machinery and supplies.

The development of a mine would create significant extractive waste, the volume of which would far exceed the volume of waste the development seeks to retrieve from the target formation. This option offers no environmental benefit and would cause significant local amenity impacts and disruption to the local community. Economically, the

development of a mine would render the exploration and subsequent production of hydrocarbons from the target formation unviable.

As it is not feasible to retrieve 100% flowback, either by a prolonged flowback period or by artificial lift and the removal of proppant fluid by excavation is not feasible, retention within the target formation is considered BAT. The alternative options are unrealistic and/or theoretical in nature. Injected proppant fluid, retained at depth, does not present a credible environmental risk

Proppant retained within the target formation prevents the fractures from closing and provides the permeability for hydrocarbons to flow. As the proppant fulfils a purpose, it is not considered a waste.

10.8 Well Lifting Techniques

If the well does not flow (lift) naturally, the following techniques are available to artificially lift hydrocarbons to surface:

- Nitrogen (N_2) or Carbon Dioxide (CO_2) lift (Gas Lift); and/or
- Mechanical lift.

The anticipated extractive wastes during this phase includes:

- Circulation Fluid / Suspension Brine;
- Nitrogen (N_2);
- Carbon Dioxide (CO_2);
- Formation Water / Produced Water; and
- Natural Gas.

10.8.1 Nitrogen Lift

To aid the initial flow of hydrocarbons (oil and gas), Nitrogen may be injected into the wellbore to displace wellbore fluids, reducing its hydrostatic weight. Nitrogen is classified as an inert waste and venting of such considered a closed loop system, insofar as Nitrogen is extracted from the atmosphere and is vented back to atmosphere. No Nitrogen would remain in the formation.

10.8.2 Carbon Dioxide Clean Out

The purpose of a CO_2 cleanout is to assist in the removal of all wellbore fluids and near wellbore debris sustained during the drilling operation, thus restoring near wellbore permeability. In comparison to Nitrogen lifting, a CO_2 cleanout allows for greater debris lifting as it is circulated down as a liquid and produced back as a gas. The liquified CO_2 is pumped down the well at a pressure, high enough to facilitate the liquified form of the CO_2.

The pressure is maintained within the well as it is pumped down to the target area and is left under pressure to permeate in its liquid form behind the debris of the near wellbore formation, this is applied below the fracture gradient of the formation.

The well is then opened at surface in a controlled manner to reduce the pressure within the wellbore and in turn cause the downhole liquid CO_2 to rapidly change from a liquid to a gas. This process results in a rapid expansion of CO_2, which forces the near wellbore debris from the perforations into the wellbore and back to surface. All liquid CO_2 injected into the formation will return to surface in a gaseous state and will be passed through the three-phase separator.

Whilst the pumping of liquid CO_2 into the perforations within deep saline water bearing formations is a 'groundwater activity', the liquid CO_2 will return to surface in a gaseous state. No injected CO_2 will remain in the formation and therefore the injection of liquid CO_2 is considered de-minimis and can be excluded under Schedule 22 3 (3) of EPR2016 from requiring a groundwater activity permit.

10.8.3 Mechanical lift

In the event the well is not able to flow to surface naturally a number of lifting techniques are available to the onshore oil and gas industry, including the aforementioned N_2 / CO_2 lift. Another lifting technique is a mechanical lift. The use of mechanical lifting techniques is common place within oil production wells and can take a number of forms.

As a contingency, the Operator may use a mechanical lifting technique known as swabbing to aid in the lifting of wellbore fluids to surface. Swabbing is performed by unloading liquids from the well using a specific tool string incorporating a swab cup assembly that can be run into the wellbore by various means (wireline, coiled tubing or drill pipe).

When the assembly is run, the specially shaped swab cups have a tight tolerance on the wellbore casing or tubing and allow both lifting of the liquids from the wellbore and temporary removal of the hydrostatic column within the well.

The methods of longer term mechanical lifting include 'Beam Pump', 'Rod Pumping Hydraulic Pump Jack' and an 'Electric Submersible Pump' all of which are lifting techniques the Operator has identified as being suitable for the well. The techniques involve either running a rod string into the well attached to a downhole pump located in the bottom of the tubing string and the rods are then lifted and lowered into the well by the surface equipment, or by pumping liquids up the tubing from downhole.

A downhole pump does not work effectively when completing a gas reservoir. Downhole pumps are required to be submerged in liquid to avoid becoming 'gas locked'. Therefore, the operator requires certainty that the reservoir fluids to be lifted are mainly liquids prior to running a completion with a downhole pump.

As it is not possible to be certain of the reservoir fluids that will be encountered in an exploration well, a gas lift may be necessary to evacuate the borehole of wellbore liquids to flow reservoir fluids into the well to ascertain their composition in the first instance.

Furthermore, if the reservoir liquids are known to have a high concentration of gas, a downhole pump would not be run but a means to evacuate the wellbore of liquids maybe required. In this instance a gas lift may be deemed the most effective method.

Once at surface, fluids will be diverted by temporary pipework to a three (3) phase separator, which will separate out oil, gas and produced fluids. Oil and produced fluids will be diverted via temporary pipework to dedicated storage tanks onsite for subsequent offsite removal for sale and disposal respectively. Oil, which for clarity is not considered a waste, will be transported by a licenced haulier to a permitted refinery for sale. Formation water cannot be reused onsite due to unknown components within the formation water and high salinity. Therefore, formation water is considered a waste, and will be tested at a laboratory and its components determined and will be transported by a licenced haulier to an Environment Agency permitted water treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.

Natural gas separated during the three (3) phase separation will be diverted by temporary pipework and managed in accordance with the BAT.

Waste classification and quantities are estimated in Section 11 of this Waste Management Plan.

10.9 Well Abandonment and Partial Well Abandonment

In the event that the well is not successful in establishing commercially producible hydrocarbons or the well comes to the end of its producing life, the well will be abandoned in accordance with Oil & Gas UK Guidelines for the suspension and abandonment of wells [Ref.18].

In addition to the Oil & Gas UK Guidelines for the suspension and abandonment of wells, the well abandonment(s) will be undertaken in accordance with the following regulations:

- The Borehole Sites and Operations Regulations 1995;
- Offshore Installations and Wells (Design & Construction) Regulations 1996; and
- Any other legislation relevant at the time.

The Oil and Gas UK guidelines stipulate a well must be constructed by taking into consideration the abandonment of the borehole. Therefore, the initial design and construction of the well(s) takes into consideration the permeable zones encountered during the drilling operation and whether any of these zones are hydrocarbon-bearing or over-pressured and water-bearing.

Based on a borehole construction, which complies with the Oil & Gas UK guidance for the suspension and abandonment of wells, the internal section of last cemented casing sting will be subject to well abandonment. The

operation involves the setting of cement barriers, extended above and below the permeable zone(s). Once the well is abandoned, the casing strings will be mechanically cut off at 1.5m below original ground level and a steel plate welded over the top. The pre-cast concrete drilling cellar would then be removed, and the site restored to its former use.

The site restoration of the Cloughton-2 Well is anticipated to last no more than six (6) weeks.

11. EXTRACTIVE WASTE MANAGEMENT

An assessment of the potential extractive waste arising from the proposed permitted activities has been undertaken.

The information obtained as part of the initial assessment includes each extractive waste's classification, quantity and storage method together with the prevention, minimisation, treatment and disposal options as required by the MWD.

The activities, which result in the production of extractive waste, are as follows:

- Drilling activities including the drilling of the Cloughton-2 Well.
- Well clean up and extended well testing.
- Proppant squeeze of the Cloughton-2 Well.
- Nitrogen lifting and CO_2 lifting;
- Well abandonment and/or partial well abandonment.

11.1 Waste Description and Management Arrangements

An assessment of the potential extractive waste arising from the WNA appraisal operations has been undertaken. The potential waste, together with its classification, anticipated quantities, prevention, minimisation, treatment and disposal is provided within this section.

- Table 5 – Waste Clays and Sand;
- Table 6 – Water Based Drilling Fluids;
- Table 7 – Water Based Rock Cuttings;
- Table 8 – Salt Saturated Water Based Drilling Fluids; and
- Table 9 – Salt Saturated Water Based Rock Cuttings.
- Table 10 – Circulation Fluid / Well Suspension Brine;
- Table 11 – Proppant (Flowback);
- Table 12 – Proppant Carrier Fluid (Flowback);
- Table 13 – Proppant Carrier Fluid (Retained in the Formation);
- Table 14 – Formation Water / Produced Water;
- Table 15 – Natural Gas (Incinerated by an Shrouded Ground Flare).
- Table 16 – Nitrogen (N_2);

11.2 Waste Description Tables

Waste Clays and Sand				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	01 04 09
	Potential Classification:	Hazardous	**EWC Code:**	01 05 06*
	Estimated Quantity:	86 Tonnes	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	Storage Container	**Storage Duration:**	<2 Weeks
Operation / Activity	The drilling of the borehole will commence with the drilling and installation of a casing string known as a surface conductor. The near surface clays and sands within which the surface conductor casing will be set will be removed. The clay and sand will be circulated out of the well using either an auger or water-based drilling fluids and return to the surface where it is transferred to an open tank.			
Prevention and Minimisation	The ability to prevent or minimise clay and sand is limited given that the formation needs to be removed to allow the conductor casing to be installed.			
Treatment and Disposal	The clay and sand will be transported offsite via licenced haulier to a permitted facility for treatment and reuse.			
Remaining in the Formation	None, all clay and sand shall be removed to allow the conductor casing to be installed.			
Monitoring	The Operator provides onsite competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the storage tanks that contain the waste clay and sand shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.			

Table 5: Waste Table – Clays and Sand

Water Based Drilling Fluids (Fresh Water)				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	01 05 04
	Potential Classification:	Hazardous	**EWC Code:**	01 05 06*
	Estimated Quantity:	185 Tonnes	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	Enclosed / Partially Enclosed Storage Tank	**Storage Duration:**	<2 Weeks
Operation / Activity	Drilling fluids are used to aid the drilling process by lubricating the drill bit, circulating rock cuttings to surface and by maintaining a prescribed hydrostatic pressure within the well to prevent the uncontrolled release of natural gas or formation pressure.			
Prevention and Minimisation	Drilling fluid waste is minimised by continually reusing the drilling fluid in a closed loop system, sustained by filtering out any rock cuttings and/or finer particles of rock. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling fluid that coats the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop drilling fluid system.			
Treatment and Disposal	Drilling fluid becomes a waste when it is no longer required in the operation and will be transferred from the circulating mud system on the drilling rig to a vacuum tanker for removal offsite via licenced haulier to a permitted facility for treatment.			
Remaining in the Formation	None, all drilling fluid shall be circulated out.			
Monitoring	The Operator provides onsite competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the storage tanks that contain the water based drilling fluid shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.			

Table 6: Waste Table – Water Based Drilling Fluids (Fresh Water)

Water Based Rock Cuttings (Fresh Water)				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	01 05 04
	Potential Classification:	Hazardous	**EWC Code:**	01 05 06*
	Estimated Quantity:	120 Tonnes	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	Enclosed / Partially Enclosed Storage Tank	**Storage Duration:**	<2 Weeks
Operation / Activity	Drilling muds are used in a closed loop system, within which the rock cuttings are circulated to surface and removed by vibrating screens (shakers) into an open top tank, which is also a fluid separator tank. Finer particles of rock cuttings are then extracted from the drilling mud by a centrifuge and the drilling mud is circulated back down the well.			
Prevention and Minimisation	The ability to prevent or minimise rock cuttings recovery is limited given that the formation needs to be removed to allow the casing to be installed. The selection of the drilling bit will be such that it minimises hole size required to install each string of casing which in turn keeps the waste recovery to a minimum. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling mud coating the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop mud system.			
Treatment and Disposal	Rock cuttings will be transferred from the rock cuttings tank to a sealed road bulker by a hydraulic grab arm fitted to the rock cuttings tank. Rock cuttings are transported offsite via a licenced haulier to an Environment Agency permitted composting facility where it is blended into compost after the compost has been sanitised.			
Remaining in the Formation	None. Extractive process only.			
Monitoring	The Operator provides onsite competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the storage tanks that contain the rock cuttings shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.			

Table 7: Water Based Mud (Fresh Water) Waste Table

Water Based Drilling Fluid (Salt Saturated)				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	01 05 08
	Potential Classification:	Hazardous	**EWC Code:**	01 05 06*
	Estimated Quantity:	620 Tonnes	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	Enclosed / Partially Enclosed Storage Tank	**Storage Duration:**	<2 Weeks
Operation / Activity	Drilling fluids are used to aid the drilling process by lubricating the drill bit, circulating rock cuttings to surface and by maintaining a prescribed hydrostatic pressure within the well to prevent the uncontrolled release of natural gas or formation pressure.			
Prevention and Minimisation	Drilling fluid waste is minimised by continually reusing the drilling fluid in a closed loop system, sustained by filtering out any rock cuttings and/or finer particles of rock. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling fluid that coats the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop drilling fluid system.			
Treatment and Disposal	Drilling fluid becomes a waste when it is no longer required in the operation and will be transferred from the circulating mud system on the drilling rig to a vacuum tanker for removal offsite via licenced haulier to a permitted facility for treatment.			
Remaining in the Formation	None, all drilling fluid shall be circulated out.			
Monitoring	The Operator provides onsite competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the storage tanks that contain the water based drilling fluid shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.			

Table 8: Waste Table – Water Based Drilling Fluid (Salt Saturated)

Water Based Rock Cuttings (Salt Saturated)				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	01 05 08
	Potential Classification:	Hazardous	**EWC Code:**	01 05 06*
	Estimated Quantity:	625 Tonnes	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	Storage Container	**Storage Duration:**	<2 Weeks
Operation / Activity	Drilling muds are used in a closed loop system, within which the rock cuttings are circulated to surface and removed by vibrating screens (shakers) into an open top tank, which is also a fluid separator tank. Finer particles of rock cuttings are then extracted from the drilling mud by a centrifuge and the drilling mud is circulated back down the well.			
Prevention and Minimisation	The ability to prevent or minimise rock cuttings recovery is limited given that the formation needs to be removed to allow the casing to be installed. The selection of the drilling bit will be such that it minimises hole size required to install each string of casing which in turn keeps the waste recovery to a minimum. The rock cuttings tank is a fluid separator tank (perforated false floor), which allows drilling mud coating the rock cuttings to percolate down through the false floor where it is collected and pumped back into the closed loop mud system.			
Treatment and Disposal	Rock cuttings will be transferred from the rock cuttings tank to a sealed road bulker by a hydraulic grab arm fitted to the rock cuttings tank. Rock cuttings are transported offsite via a licenced haulier to an Environment Agency permitted composting facility where it is blended into compost after the compost has been sanitised.			
Remaining in the Formation	None. Extractive process only.			
Monitoring	The Operator provides onsite competent supervision to ensure the operation is carried out in accordance with an approved drilling programme. An inspection of the storage tanks that contain the rock cuttings shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.			

Table 9: Water Based Mud (Salt Saturated) Waste Table

Well Suspension Brine				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	01 05 08
	Potential Classification:	Hazardous	**EWC Code:**	01 05 06*
	Estimated Quantity:	25 Tonnes	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	Enclosed / Partially Enclosed Storage Tank	**Storage Duration:**	<2 Weeks
Operation / Activity	The well throughout its lifespan will be the subject of a period of suspension, which is undertaken using brine. In addition, brine is also used as circulation fluid following well treatments to recover well treatment additives such as proppant fluid. Following suspension or circulation operations, the brine will be circulated out of the well to an onsite storage tank. Brine remaining within the well during suspension operations is not considered a waste as it is serving a 'well control' function.			
Prevention and Minimisation	The suspension brine will be stored onsite for subsequent reuse if it is required at a later date.			
Treatment and Disposal	Once the suspension fluid has fully served its purpose, it will be removed from site via a licenced haulier to an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.			
Remaining in the Formation	None. Suspension brine is circulated out prior to production, formation testing and proppant operations.			
Monitoring	An inspection of the storage tanks that contain the suspension fluid shall is carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.			

Table 10: Waste Table – Well Suspension Brine

Proppant (Flowback)				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	01 04 09
	Potential Classification:	N/A	**EWC Code:**	N/A
	Estimated Quantity:	30 Tonnes	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	Enclosed / Partially Enclosed Storage Tank	**Storage Duration:**	N/A
Operation / Activity	Flowback water will contain proppant (resin-coated ceramic) which is removed at surface.			
Prevention and Minimisation	The quantity of proppant used is determined by the required composition of the proppant fluid. Proppant retained within the formation is not classified as a waste as it serves the purpose of 'propping open' fractures within the formation.			
Treatment and Disposal	The proppant will be transported offsite via licenced haulier to an Environment Agency permitted composting facility, where it is blended into compost after compost has been sanitised.			
Remaining in the Formation	Not Applicable.			
Monitoring	The Operator provides onsite competent supervision to ensure the operation is carried out in accordance with an approved proppant squeeze programme. An inspection of the storage tanks that contain the proppant carrier fluid (flowback) shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.			

Table 11: Proppant (Flowback) Waste Table

Proppant Carrier Fluid (Flowback)				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	01 01 02
	Potential Classification:	N/A	**EWC Code:**	N/A
	Estimated Quantity:	75 m^3	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	Enclosed / Partially Enclosed Storage Tank	**Storage Duration:**	N/A
Operation / Activity	The technique is used to undertake low volume hydraulic fracturing of the formation and prop open the fractures using proppant. This in turn provides permeability, allowing natural gas and oil from within the formation to flow up into the wellbore and up to surface.			
Prevention and Minimisation	Due to the nature of the formation, it is anticipated that up 50% of proppant fluid will unavoidably return to surface.			
Treatment and Disposal	Flowback fluid will be transported via a licenced haulier to either an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility, or to a bespoke RSR permitted waste treatment facility for treatment and disposal in accordance with BAT.			
Remaining in the Formation	Not Applicable.			
Monitoring	The Operator provides onsite competent supervision to ensure the operation is carried out in accordance with an approved solvent treatment programme. An inspection of the storage tanks that contain the proppant carrier fluid (flowback) shall be carried out prior to being used and will be subject to regular visual inspections and annual thickness checks.			

Table 12: Proppant Carrier Fluid (Flowback) Waste Table

Proppant Carrier Fluid (Retained in the Formation)				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	01 01 02
	Potential Classification:	N/A	**EWC Code:**	N/A
	Estimated Quantity:	105 m^3	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	N/A	**Storage Duration:**	N/A
Operation / Activity	The technique is used to undertake low volume hydraulic fracturing of the formation and prop open the fractures using proppant. This in turn provides permeability, allowing natural gas and oil from within the formation to flow into the wellbore and up to surface.			
Prevention and Minimisation	It is anticipated that up 50% of proppant fluid will return to surface. The remaining fluid will be retained within the target formation and, as such, is classified as a Non-Hazardous Mining Waste Facility.			
Treatment and Disposal	Not Applicable.			
Remaining in the Formation	No less than 50% of the proppant fluid will be retained within the target formation.			
Monitoring	None.			

Table 13: Proppant Carrier Fluid (Retained in the Formation) Waste Table

Formation Water / Produced Water				
Classification, Quantity and Storage	**Default Classification:**	Non-Hazardous	**EWC Code:**	16 10 02
	Potential Classification:	Hazardous	**EWC Code:**	16 10 01
	Estimated Quantity:	75 m^3	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	Enclosed / Partially Enclosed Storage Tank	**Storage Duration:**	N/A
Operation / Activity	Formation water may be produced together with petroleum. Formation water is separated from the petroleum on surface using fluid separation equipment and transferred to cylindrical storage tanks located onsite for offsite removal. The formation water has the potential to contain low levels of Naturally Occurring Radioactive Material (NORM). Samples of formation water will be sent to a laboratory holding the appropriate accreditations for radionuclides analysis by gamma spectrum.			
Prevention and Minimisation	The ability to prevent or minimise recovery of formation water is extremely limited. Formation water cannot be reused onsite due to unknown components within the formation water and high salinity.			
Treatment and Disposal	Depending on the outcome of radionuclides analysis, formation water will be transported via a licenced haulier to either an Environment Agency permitted waste water treatment works facility or a bespoke RSR permitted waste treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the treatment facility.			
Remaining in the Formation	None. Formation water naturally occurs within the formation and is only considered as a waste when produced from the well.			
Monitoring	A contamination monitoring programme will be devised and include the wellhead, separator equipment and storage tanks. Consignments of formation water will be screened externally for contamination prior to leaving site. An inspection of the fluid tanks that contain the formation water shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.			

Table 14: Formation Water / Produced Water

Natural Gas (Incinerated by an Shrouded / Enclosed Ground Flare)				
Classification, Quantity and Storage	**Default Classification:**	Hazardous	**EWC Code:**	16 05 04*
	Potential Classification:	N/A	**EWC Code:**	N/A
	Estimated Quantity:	>10 Tonnes per Day	**Dust / Odour Potential:**	Some Potential
	Onsite Storage:	N/A	**Storage Duration:**	N/A
Operation / Activity	During production testing operations, natural gas is produced from the formation and flowed at different rates to determine the characteristics of the formation, allowing for the determination on whether or not the reservoir is capable of producing commercial quantities of natural gas.			
Prevention and Minimisation	The ability to prevent or minimise natural gas is extremely limited during this operation, as it is required to determine the condition and state of the reservoir.			
Treatment and Disposal	Natural gas is separated from produced fluids at surface and diverted via pipework to the Shrouded Ground Flare located onsite for incineration.			
Remaining in the Formation	None. Natural gas naturally occurs within certain hydrocarbon bearing formations and is only considered as a waste when produced from the well.			
Monitoring	An inspection of the relevant plant shall be carried out prior to being used and will be subject to regular inspections and maintained in accordance with manufacturers recommendations. During WCU / EWT operations the Shrouded Ground Flare will be supervised during periods of flaring activity to ensure its effectiveness to incinerate the natural gas. In addition, air emissions monitoring will be carried out.			

Table 15: Natural Gas Waste Table

Nitrogen (N_2)				
Classification, Quantity and Storage	**Default Classification:**	Inert	**EWC Code:**	N/A
	Potential Classification:	N/A	**EWC Code:**	N/A
	Estimated Quantity:	Unknown	**Dust / Odour Potential:**	Limited Potential
	Onsite Storage:	N/A	**Storage Duration:**	N/A
Operation / Activity	Nitrogen is injected into the well to aid the initial lifting of wellbore fluids, thus reducing the hydrostatic pressure and allowing hydrocarbons to flow to surface.			
Prevention and Minimisation	The use of Nitrogen can be classified as a closed loop system, having first been extracted from the atmosphere during its manufacturing process and subsequently released to atmosphere. The quantities of Nitrogen required are small and a detailed measurement cannot be provided at this stage.			
Treatment and Disposal	As an inert gas, Nitrogen that has been extracted from the atmosphere will be comingled with any natural gas that flows to surface, where it will be combusted. Unburnt Nitrogen will be released to atmosphere during the natural gas combustion process.			
Remaining in the Formation	None. Nitrogen injected into the well to aid the initial lifting of wellbore fluids will flow to surface.			
Monitoring	The volumes of Nitrogen will be monitored both in and out of the well.			

Table 16: Nitrogen Waste Table

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12. MANAGEMENT OF NON-EXTRACTIVE WASTE

Throughout the various phases of the development, non-extractive wastes will be generated onsite, which may include, but is not limited to:

- Surface run-off water;
- Waste water and sewage;
- Potential minor fuel oil spills;
- Waste engine, gear and lubricating oils;
- Waste hydraulic oils;
- Oil rags and absorbents;
- Waste oil filters;
- Paper and cardboard;
- Canteen waste;
- Cement;
- Wood;
- Mixed Municipal waste; and
- Metal.

12.1 Treatment of Non-Extractive Waste

Non-extractive wastes will not be treated at the wellsite. Non-extractive waste will be segregated and stored according to their EWC pending collection and will be transported offsite by a licensed road haulier to an Environment Agency licensed waste treatment / waste disposal facility.

12.1.1 Waste Supervision and Carriers

The Operator is ultimately accountable for waste management at the Wellsite. During operations, the management of waste generated at the Wellsite will be delegated to the Wellsite Supervisor, appointed by the Operator to exercise overall control of the wellsite operations, in accordance with the Borehole Sites and Operations Regulations 1995 and the Waste (England and Wales) Regulations 2011.

The management of waste onsite will include:

- Management of waste in accordance with the waste hierarchy, as set out in the Waste (England and Wales) Regulations 2011;
- Monitoring of all waste storage units such as skips and storage tanks;
- Liaison with third party waste advisors with respect to sampling and analysis of waste;
- Compiling all waste transfer notes; and
- Managing the collection and offsite disposal of all waste streams.

The Operator will appoint competent waste dealers or brokers and carriers, responsible for the transportation of all waste streams to the relevant Environment Agency permitted waste treatment facility. Waste dealers or brokers and carriers will hold relevant certificates issued by the Environment Agency, which shall be inspected prior to being appointed.

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13. MANAGEMENT OF NATURALLY OCCURRING RADIOACTIVE MATERIAL

Formation water produced during the EWT has the potential to contain low levels of Naturally Occurring Radioactive Material (NORM). Samples of formation water will be sent to a laboratory holding the appropriate accreditations for radionuclide analysis by gamma spectrum. Depending on the outcome of radionuclides analysis, formation water will be transported via a licenced haulier to either an Environment Agency permitted waste water treatment works facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility, or to a bespoke RSR permitted waste treatment facility for treatment and disposal in accordance with BAT.

A competent Radiation Protection Supervisor and/or Radioactive Waste Advisor has been appointed to ensure that NORM is managed correctly.

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15. RISKS POSED TO THE ENVIRONMENT AND HUMAN HEALTH

The risks posed by the 'mining waste operation' have been addressed within an Environmental Risk Assessment (07 – Environmental Risk Assessment) which forms part of any application to the Environment Agency and is considered an 'operating technique'.

The Environmental Risk Assessment (which is qualitative) considers activities which have the potential to cause harm to the environment and human health (pollution damage).

The Environmental Risk Assessment has concluded that the risk to the Environment and Human Health is 'insignificant' not least due to the type of activities being undertaken, the nature of the waste and the mitigation measures adopted by the Operator.

The Environmental Risk Assessment follows the Environment Agency's source-pathway-receptor' model and includes the risks posed from the site operations in relation to:

- Accidents & Incidents;
- Air Emissions;
- Noise and Vibration;
- Odour Emissions;
- Releases to Surface Water;
- Releases to Groundwater;
- Visible Emissions;
- Climate Change; and
- Global Warming Potential.

A copy of the Environmental Risk Assessment (07 – Environmental Risk Assessment) is provided in support of the environmental permit application.

In addition, the Operator has employed the services of specialist consultants to address the risks posed specifically to air, groundwater, surface water and noise. Each impact assessment / risk assessment will be verified by the Environment Agency as part of the permit determination process.

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16. POINT SOURCE EMISSIONS

There are a number of point source emissions identified within the Wellsite comprising of emissions to air and groundwater.

16.1 Point Source Emissions to Air

There are a number of point source emissions to air identified within the Wellsite. The primary emission point is the flare unit used to incinerate waste gas. Additional emission points include the stock tank and the surge tank which utilise a conjoined vent line.

16.2 Point Source Emissions to Groundwater

The proppant squeeze, falls within the definition of a 'groundwater activity under Schedule 22 of EPR2016, and will be considered a groundwater activity for the purpose of EPR2016, namely the injection of any substance into groundwater to increase the flow of fluids or gas to a well or borehole in connection with the extraction or use of any energy source. As such, the proppant squeeze will require a permit.

16.3 Point Source Emissions to Surface Water

Surface run-off water contained within the perimeter ditch will be tested prior to being transported offsite by a licensed road haulier to an Environment Agency licensed waste water treatment / waste water disposal facility.

Discharges to surface water are not permitted and will not be undertaken.

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17. CONTROL AND MONITORING OF WASTE AND EMISSIONS

The Environmental Risk Assessment (07 – Environmental Risk Assessment) provided in support of the environmental permit application, has identified the requirement to control and monitor waste generated from hydrocarbon production, near wellbore treatments and proppant squeeze operations. A brief description of the control and monitoring of waste is provided below.

17.1 Releases to Groundwater

The potential for a release to groundwater exists both at surface and within the subsurface and have been assessed by way of a Hydrogeological Impact Assessment (08 – Hydrogeological Impact Assessment), provided in support of the environmental permit application.

17.1.1 Surface Releases

The potential for a release to groundwater exists both at surface and within the subsurface.

Incorporated into the design of the Wellsite is an impermeable membrane constructed using fully welded HDPE, protected above and below with non-needle punch geotextile. The impermeable membrane prevents surface run-off water (mainly rainwater) penetrating the underlying subsoils. Surface fluids will migrate along the surface of the impermeable membrane to a perimeter ditch, where it will be contained.

Daily inspections of the drainage ditch will be undertaken to ensure the level does not exceed the maximum containment of the ditch.

Surface run-off water contained within the perimeter ditch will be tested prior to being transported offsite by a licensed road haulier to an Environment Agency licensed waste water treatment / waste water disposal facility.

If the results of the test identify that the surface run-off water is contaminated from any site spillages, arrangements will be made for the surface run-off water to be transported offsite by a licensed road haulier to a relevant Environment Agency permitted waste treatment facility.

17.1.2 Subsurface Release

Drilling muds and other fluids used in well operations will be strictly monitored to ensure an accurate understanding of fluid volumes lost, gained, or in the case of cement, placed in the subsurface. During drilling operations, the volumes of fluids pumped, together with the volumes of fluid within the tanks will be continually monitored by a geological logging company (mud loggers). Such monitoring can identify loss of drilling muds to the formation. In the event that subsurface fluid losses occur, lost circulation material is provided onsite to stem the losses.

Subsurface releases are mitigated by adopting the best practice approach to wellsite construction, hydrocarbon production, near wellbore treatments and proppant squeeze operations.

17.2 Releases to Air

The impact of emissions on air quality has been assessed within the Air Quality Impact Assessment (AQIA) (11 – Air Quality Impact Assessment) provided in support of the environmental permit application.

A scheme of air quality monitoring will be agreed with the Environment Agency prior to the commencement of the proposed activities and implemented prior to the well being constructed, which will provide a baseline for air quality. The scheme will be implemented during well construction and will be conducted during the subsequent appraisal operations.

17.2.1 Foul Water and Sewage

The proposed development does not require nor does it propose the installation of a permanent connection to the existing sewerage. During the proposed operations temporary welfare facilities will be provided onsite, with each facility having an independent under-unit sewage tank. The temporary welfare facilities will remain onsite during the lifetime of the wellsite, with any replacement welfare cabins (if necessary) also being of a temporary nature.

Sewage will be collected periodically throughout the periods when the wellsite is manned and removed by a licenced waste carrier to an Environment Agency permitted waste water treatment works for subsequent treatment and/or disposal.

The criteria for determining whether waste will be recycled or disposed of will be determined by the receiving waste treatment facility upon receipt of the waste at the treatment facility. The waste will be tested by the waste treatment facility, the results of which will determine the treatment and/or disposal method to be used. Such treatment and/or disposal method will be in accordance with the waste treatment facility's environmental permits.

17.2.2 Waste Recovery or Disposal

The criteria for determining whether waste generated at the Wellsite will be recycled or disposed of will be determined by the receiving waste treatment facility upon receipt of the waste at the treatment facility. Where required, the waste will be tested by the waste treatment facility, the results of which will determine the treatment and/or disposal method to be used. Such treatment and/or disposal method will be in accordance with the waste treatment facility's environmental permits.

17.3 Noise

A Noise and Vibration Impact Assessment (NVIA) (12 – Noise and Vibration Impact Assessment) has been undertaken and has determined that:

> *'The conclusion of the assessments is that for all but one phase of the proposed development, the impacts will be low. During part of phase 3 (Flow testing), specifically subphase 3b (proppant squeeze), the threshold of adverse impact (LOAEL) of 50 dB, will be very marginally exceeded by 1dB at one location (NSR 4), however the levels will remain well below the threshold of a significant adverse impact (SOAEL) which is 65 dB. This marginal value will occur for just 3-5 hours on one single day, and for context represents about the same level of noise that is currently occurring from road traffic at this position, all day and every day. Also, this will only arise under downwind propagation conditions namely a N, NE or E wind. Under normal more common prevailing wind conditions the level of noise will typically be 5 dB lower at 46 dB.'*

A copy of the Noise and Vibration Impact Assessment (12 – Noise and Vibration Impact Assessment) has been provided in support of the environmental permit application.

17.4 Release of Natural Gas or Oil

In the event of any unexpected release of natural gas or oil, the Environment Agency will be notified in accordance with the environmental permit requirements. Details of the quantities of unexpected releases will be recorded by the Operator along with the measures taken to manage them and made available to the Environment Agency on request.

17.5 Release of Odorous Emissions

Extractive wastes generated are not ordinarily malodorous, nor are any of the associated processes that will be performed. Measures will be taken to minimise all fugitive emissions which may cause odours.

There is a risk of fugitive releases of natural gas during drilling and well testing operations which may contain Sulphur compounds which are potentially odorous. An Odour Impact Assessment within the AQIA has concluded that fugitive releases pose a negligible risk to loss of amenity due to odour at the nearest residential neighbours.

The potential of odour release has been assessed within the Odour Management Plan (14 – Odour Management Plan) provided in support of the environmental permit application.

17.6 Waste Management Records

The quantity of each waste will be recorded as it is removed from site. All records of waste movements (extractive and non-extractive wastes) will be retained by the Operator and made available for inspection by the Environment Agency on request.

18. WELLSITE MANAGEMENT

18.1 Wellsite Monitoring

The Operator is responsible for the day to day monitoring of the Wellsite. The Operator will identify potential leaks and emissions from site equipment and materials stored within the Wellsite and ensure that any action required to remediate such leaks or emissions is undertaken as soon as they are identified, thus preventing potential impact on the environment.

During well operations, such as drilling, and proppant squeeze, the supervision of the Wellsite will be delegated to the Wellsite Supervisor, appointed by the Operator to exercise overall control of the wellsite operations, in accordance with the BSOR1995 and WR2011.

The Wellsite Supervisor will be responsible for monitoring the Wellsite and temporary well operations equipment and will identify potential leaks and emissions from such temporary equipment and temporary materials stored within the Wellsite and ensure that any action required to remediate such leaks or emissions is undertaken as soon as they are identified, thus preventing potential impact on the environment.

During well operations, a written record of monitoring (Environmental Checklist) will be completed as part of the monitoring schedule by the Wellsite Supervisor. Copies of the Environmental Checklist will be held onsite and will be made available for review by the Environment Agency.

18.2 Contractor Performance

The Operator is ultimately responsible for any waste generated onsite during the operations and will not delegate its responsibilities or accountabilities as Operator to a contractor. Contractors, who are involved in the generating of waste and subsequent reuse, recycle or disposal will first have been selected in accordance with the Operators own management system.

18.3 Security

Security of the Wellsite will be provided in the form of a security fence and lockable access gates. The positioning of, both permanent and temporary equipment, will be within the confines of the security fence. During operations it may be necessary to have manned security.

Manned security will control access and egress to the Wellsite and will play a key role in the control of personnel in the event of an emergency situation.

18.4 Complaints

In the event that a complaint is received from stakeholders, including neighbours, the complaint shall be recorded and investigated in accordance with the Operators complaints process.

Complaints relating to the environment will be reported to the Environment Agency within the required timescales, as determined by the severity and environmental impact of the incident initiating the complaint and/or permit conditions. In some cases, permit conditions will require notification to the Environment Agency within 24 hours or without delay for a potentially polluting incident.

Following notification, measures to prevent reoccurrence will be agreed with the Environment Agency, together with a programme for implementation. Implementation of the actions will be monitored and the Environment Agency informed.

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19. ENVIRONMENTAL INCIDENT MANAGEMENT

The potential for an environmental incident to occur during the operation is minimal. The Wellsite and operations undertaken therein are designed to contain the source of any such incident within the wellbore and/or the Wellsite.

19.1 Containment within the Wellbore

Well control equipment is deployed on the well in accordance with API STD 53 'Recommended Practice for Blowout Prevention Equipment Systems for Drilling Wells' [Ref.19]. Primary well control is achieved by the hydrostatic weight of the fluid column in the wellbore. Blowout prevention equipment is considered secondary well control in the event that the primary well control is compromised and is subject to a schedule of certification and testing, together with a requirement for those operating the equipment to be certified competent.

19.2 Wellsite Containment

Incorporated into the design of the Wellsite is an HDPE impermeable membrane. The impermeable membrane prevents surface fluids (mainly rainwater) from penetrating the underlying subsoils. Surface fluids migrate along the surface of the impermeable membrane to a perimeter ditch, where it is contained.

In addition, general spillage containment and clean up equipment shall be provided onsite. In the very unlikely event of an environmental incident occurring beyond the capabilities of the equipment or personnel onsite then a specialist contractor will be called to assist the Operator in dealing with the incident.

19.3 Fire Response

Whilst a fire is associated more so with the health and safety of the personnel onsite, a fire does have the potential to lead to an environmental incident. It is imperative, therefore, that any potential for a fire and subsequent emergency response is identified and included in the operational planning. The Site Safety Document, which is a requirement under Regulation 7 of the Boreholes Sites and Operations Regulations 1995, specifies the arrangements for identification and mitigation in the event of a fire, including consultation with the local Fire & Rescue Service.

Containment of any firefighting fluid is provided by the impermeable membrane incorporated in to the design of the wellsite. In the event that such requirements were to be necessary, continued monitoring of the containment ditch shall be implemented to ensure it does not exceed its containment capacity.

Additional water is available onsite and should be used to keep the areas adjacent to the fire cool to avoid any damage being sustained to the impermeable membrane.

19.4 Incident Reporting and Investigation

All incidents, no matter how minor, are reported in accordance with the Safety and Environmental Management System. A procedure therein provides for the investigation of all incidents to ensure lessons are captured and actions implemented to avoid reoccurrence.

In addition, the procedure provides for the notification to the relevant Regulatory Authority in the event of an incident, which extends beyond the containment of the wellsite.

Environmental incidents will be reported to the Environment Agency within the required timescales, as determined by the severity and environmental impact of the incident and/or permit conditions. In some cases, permit conditions may require notification to the Environment Agency within 24 hours or without delay for a potentially polluting incident.

Following notification, measures to prevent reoccurrence will be agreed with the Environment Agency, together with a programme for implementation. Implementation of the actions will be monitored and the Environment Agency informed.

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20. PROPOSED PLAN FOR CLOSURE AND SITE AFTERCARE

Prior to the site closure, abandonment of the well and restoration of the Wellsite, a Site Closure Plan will be developed by the Operator and submitted to the Environment Agency for approval.

As a minimum, the Site Closure Plan will consider both the decommissioning and abandonment of the well and the restoration and aftercare of the Wellsite.

20.1 Well Abandonment and Decommissioning

Upon cessation of activities the well will be abandoned in accordance with industry guidance, in force at the time of well decommissioning. Industry guidance currently requires all distinct permeable zones penetrated by the well to be isolated from each other and from surface by a minimum of one permanent barrier.

The initial design and construction of the well takes into consideration the permeable zones encountered during the drilling operation and whether any of these zones are hydrocarbon-bearing or over-pressured and water-bearing. Construction of the borehole has provided adequate sealing of these zones when cementing in the various steel casing strings.

If any permeable zone penetrated by the well is hydrocarbon-bearing or over-pressured and water-bearing then the requirement is for two permanent barriers from surface, the second barrier being a back-up to the first.

Once the well is abandoned, the casing strings will be mechanically cut off at 1.5m below original ground level and a steel plate welded over the top. The pre-cast concrete drilling cellar would then be removed and the Wellsite restored to its former use.

In addition to industry guidance, the well abandonment will be undertaken in accordance with BSOR1995 and DCR1996 and all other applicable industry guidance and standards and reviewed by independent well examiner.

20.2 Restoration and Aftercare

All extractive waste shall be removed from the Wellsite prior to restoration.

All surface equipment will be purged clean, dismantled and removed from the Wellsite. Buildings and structures will be demolished and removed. The containment systems and associated management of surface water will continue to be implemented until all equipment has been removed from the Wellsite.

Once plant and structures have been removed from the Wellsite, the Wellsite surface will be inspected for contaminants and placed within skips pending collection. Any material which shows evidence of contamination shall be segregated and collected independently of its uncontaminated counterparts.

Samples will be obtained throughout the restoration process to demonstrate that there has been no deterioration to the environment. Samples taken will include surface water, groundwater and soil analysis.

The results of the monitoring will form part of the Site Condition Report, which will be issued to the Environment Agency upon surrender of the environmental permit.

Upon completion of the restoration phase the Wellsite will be the subject of an aftercare programme to ensure the condition of the land is comparable with adjacent land and its pre-development condition.

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21. ALTERATIONS TO THE PLAN

No changes to or deviations from this plan are to be implemented until the required changes or deviations have been reviewed and approved by the Operator and the relevant approvals obtained in writing from the Environment Agency for any changes to the plans and operating techniques approved under the environmental permit to be issued.

Within the environmental permit there will be a requirement the Operator to review the Waste Management Plan every five (5) years and amend where necessary. The review date shall take place five (5) years from the date of permit issue. Reviews and amendments will also be required in the event of a substantial change(s) to the operations taking place onsite.

In some cases, changes to operations may require the environmental permit to be varied in order to accommodate such changes. In this instance an application will be made to the Environment Agency to vary the existing permit or apply for a new permit.

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   Available at: https://www.legislation.gov.uk/uksi/1996/913/contents

9. Article 7 of the Commission Decision, April 2009

   Available at: https://www.legislation.gov.uk/eudn/2009/337/contents

10. Commission Decision (2000/532/EC) replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste.

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12. Environment Agency. (2021). *Waste Classification [Guidance on the classification and assessment of waste.* 1st Edition v1.2 GB]

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14. The Borehole Sites and Operations Regulations 1995

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Available at: https://oeuk.org.uk/product/well-life-cycle-integrity-guidelines-issue-4/

17. Joint Agencies Groundwater Directive Advisory Group (JAGDAG) assessment Methodology

Available at: https://www.wfduk.org/sites/default/files/Media/JAGDAG%20-%20Substance%20Determination%20Methodology.pdf

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