Cloughton 2 Wellsite

Waste Gas 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)

Contents

Figures

Tables

***Page Left Blank Intentionally**

1. PURPOSE AND CONTEXT

This Waste Gas 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 [Ref.1] (EPR2016). A 'mining waste operation' is considered a 'regulated facility' under EPR2016. Throughout the life of the Wellsite, this Waste Gas Management Plan shall be considered a live 'operating technique' and must be complied with as it forms part of the environmental permit.

This Waste Gas Management Plan has been produced in accordance with EPR2016, which has been transposed, in part, from the Mining Waste Directive [Ref.2] (MWD), the Environment Agency Report: SC170013/R [Ref.3] and follows the principles of the Waste Framework Directive's (WFD) [Ref.4] waste hierarchy.

The purpose of this Waste Gas Management Plan is to demonstrate to the Environment Agency how Europa Oil & Gas Limited (herein referred to as the 'Operator') established Best Available Technique (BAT) for the management of waste gas associated with the Cloughton 2 production testing phase (herein referred to as the 'Production Testing Phase'), whilst also providing an explanation into how the BAT assessment was undertaken.

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 Gas Management Plan and the activities performed by the Operator.

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

***Page Left Blank Intentionally**

2. SCOPE

This Waste Gas 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 Gas Management Plan is applicable to the Production Testing Phase of operations at the Wellsite and is specific to the potential for associated (waste) gas produced from the Cloughton-2 Well.

For clarity, Table 1 below sets out the scenario in terms of associated (waste) gas produced, its potential use and potential management as a waste product.

Operation	Timeline	Potential Gas Use	Waste Gas
Testing of Clouighton-2	Production testing to establish gas rates	No use of gas	Incinerated via flare; above 10 tonnes/day

Table 1: Gas Use / Waste Scenarios

As context, the long-term aim will be to produce natural gas and export this gas to the main gas network. Once this is achieved, natural gas will be a usable resource and not a waste. However, there are operational scenarios that must be considered before this happens, where there may be waste gas that has to be managed. This document therefore covers for the scenario as set out within Table 1, where waste gas may be produced.

The Waste Gas Management Plan will be reviewed in the event of newer technologies or increased availability of existing technologies.

***Page Left Blank Intentionally**

3. Abbreviations and Definitions

%:	Percentage
~:	Approximately
^{oC}:	Degrees Celsius
ALARP:	As Low as Reasonably Practicable
AOD:	Above Ordnance Datum
AQIA:	Air Quality Impact Assessment
BAT:	Best Available Technique
CH_4:	Methane
CNG:	Compressed Natural Gas
CO_2:	Carbon Dioxide
EPR2016:	The Environmental Permitting (England and Wales) Regulations 2016
Extractive Waste:	Has the meaning given within Regulation 2 of EPR2016
EWC:	European Waste Catalogue
EWT:	Extended Well Test
Groundwater Activity:	Has the meaning given within Regulation 2 of EPR2016
Ha:	Hectare
HDPE:	High Density Polyethylene
IED:	Industrial Emissions Directive
Installation Activity:	Has the meaning given within Regulation 2 of EPR2016
JAGDAG:	Joint Agencies Groundwater Directive Advisory Group
Km:	Kilometre
kPa:	Kilopascal
m:	Metre
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
MMscf:	Million Standard Cubic Feet
MMscfd:	Million Standard Cubic Feet per Day
MWD:	Mining Waste Directive
NGL:	Natural Gas Liquids

Nm^3/s:	Newton Metres Cubed per Second
NPPF:	National Planning Policy Framework
NTS:	National Transmission System
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
PSE:	Point Source Emission
PVT:	Pressure, Volume, Temperature
Regulated Facility:	Has the meaning given within Regulation 8 of EPR2016
UK:	United Kingdom
Water Discharge Activity:	Has the meaning given within Regulation 2 of EPR2016
WCU:	Well Clean Up
WFD:	Waste Framework Directive
WR11:	Environment Agency's form for 'Notice of the intention to drill for minerals'

Table 2: Abbreviations and Definitions

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. Environmental Permitting (England and Wales) Regulations 2016

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 3.

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 3: 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 Phase

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.

***Page Left Blank Intentionally**

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 Gas 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.

This Waste Gas Management Plan demonstrates to the Environment Agency that the Operator has considered the Best Available Techniques (BAT) for the management of waste gas.

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. ESTABLISHING BEST AVAILABLE TECHNIQUE FOR WASTE GAS MANAGEMENT

BAT is defined within the Industrial Emissions Directive as:

> *'the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole:*
>
> *(a) 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned;*
>
> *(b) 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;*
>
> *(c) 'best' means most effective in achieving a high general level of protection of the environment as a whole;*

7.1 Proposed Operations and Identification of Waste Gas Streams

The development will commence with the construction of an access track and the Cloughton 2 Wellsite. Upon completion of the construction activities, the Operator will drill the Cloughton-2 Well.

Upon completion of the drilling phase, the Cloughton-2 Well will be the subject of a testing regime known as a well test. The purpose of the well test is to evaluate the commercial viability of the hydrocarbon reservoir, if encountered.

For clarity, the WCU and EWT may be undertaken a number of times throughout the development 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).

The reason for multiple well tests is due to the zones within the target formations being distinct and isolated. Information obtained from a specific zone is not likely to provide details and information on another.

The well test will be conducted in two (2) parts consisting of a WCU and an EWT. During the well test, there is the potential for natural gas and wellbore fluids to be produced. 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 BAT as identified within this Waste Gas Management Plan.

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.

Disposal of produced natural gas by incineration will employ a PW Well Services shrouded ground flare with a maximum disposal capacity of 6.5 MMscfd (2.01 Nm^3/s).

The Operator's indicative test program anticipates that the Cloughton-2 Well will initially produce at:

1. 2 MMscf/d for 24 hours, followed by a 24 hour shut in.
2. Multi stage flow for 36 hours at an average of 3 MMscf/d, followed by another 24 hour shut in.
3. Finally, a sampling period with an average flow rate of 3 MMscf/d for 48 hours, followed by a 24 hour shut in.

There is also a discretionary flow period of 4 MMscf/d for up to two weeks, which may be required to prove well commerciality if not already established from earlier stages of the test.

This equates to a test disposal volume of 12.5 MMscf and a potential additional disposal requirement of 56.0 MMscfd.

In order to establish BAT, it is necessary to identify every point source of natural gas as a waste stream throughout the operation phase. In addition, the quantity of natural gas from each point source also needs to be understood, as this will be a factor in selecting BAT. A review of the proposed operations has confirmed each natural gas point source and referenced them as point source emissions (PSEs) within Table 4.

Activity	Unit	PSE	EWC	Quantity	
				MMSCF	Tonnes[1]
Well Clean Up (WCU)	As Determined by BAT	PSE-01	16 05 04*	68.5	1,106
Extended Well Test (EWT)	As Determined by BAT	PSE-02	16 05 04*		
Oil Storage & Transfer	Storage Tank(s)	PSE-03	-	Residual Volumes	
Produced Water Tank	Storage Tank(s)	PSE-04	-	Residual Volumes	

Table 4: Identification of Waste Gas Streams

The Operator's Air Quality consultant has assessed the air quality impact from the proposed Production Testing Phase of operations with the assessment based on the flare operating at its maximum disposal capacity, continuously, for the entire 17 week production test operation. This clearly represents a worst case scenario in terms of natural gas disposal and pollutant release and subsequent air quality impact.

The Air Quality Impact Assessment (AQIA) concluded that, *'based on an assessment of worst case operation, it is considered that proposed development lifetime greenhouse gas releases are largely insignificant in relation to the UK's current inventory and future budgets at around 9,900 tonnes CO_2 equivalent.'*

This Waste Gas Management Plan is concerned with establishing BAT for the management of waste gas associated with the Production Testing Phase of operations.

7.2 Initial Screening of BAT

The Environment Agency has identified a "*long list of technologies*" within report: SC170013/R, which has been summarised below:

- Cold venting
- Reinjection to well
- Recycling through gas processing
- Incineration (Flaring)
- Mini liquefied natural gas
- Gas processing and natural gas liquids recovery
- Heat generation
- Vapour recovery
- Compressed natural gas
- Power generation
- Conversion to fuels
- Energy storage

The long list was then screened against the definition of BAT within the report with a number of technologies not currently considered BAT at the time of writing this report. For clarity, BAT as a concept will continue to change as technologies improve or become increasingly available for use within the onshore oil and gas industry. Full details of the "*long list of technologies*" from the Environment Agency Report can be found within Appendix 1.

Table 4 provides a list of technologies that have been identified with the potential of being considered BAT for the onshore oil and gas industry.

[1] Tonnes derived natural gas conversion conditions of 0.57 specific gravity, 273.15K & 101.325 kPa at 0^{oC}

This Waste Gas Management Plan has been produced to assess the techniques considered 'best available' for the Production Testing Phase of operations.

As the development progresses, the selected BAT may no longer be considered 'best available' due to either advancement in technologies or changes in the volume of waste gas produced. The "*long list of technologies*" from the Environment Agency Report is provided in Appendix 1.

To summarise, where a technology / technique has not been considered suitable for the onshore oil and gas industry this is due to one or more of the following reasons:

- The technology was not readily available for supply in England - due to economics or the lack of supplier base.
- The technology was considered unproven or novel.
- There was no widespread market for the product or resource produced.
- The working capacity or specification of the technology did not meet the onshore oil and gas sector requirements.

Techniques for BAT Assessment				
Option	**Technology / Process**	**WCU**	**EWT**	**Reason for Considering / Not Considering**
Cold Venting	Direct Release to atmosphere	×	✓	Worst environmental impact with Methane (CH_4) being 28 times greater in global warming potential. Potential use during very short term low flow.
Incineration	Elevated Flares	✓	×	Produces a visible flame and excessive noise. May be suitable for sour gas or WCU given its ability to incinerate across a wide range of flow.
	Shrouded Flare	✓	✓	Considered to have a reduced combustion efficiency. Able to accommodate variable and unpredictable flow (associated gas).
	Enclosed Flare / Incinerator	✓	✓	Provides the best combustion efficiency and reduced noise and visible flame. Can only operate within a defined range of flow specification.
Heat Generation (Harness Gas)	Incinerators / Boilers	×	×	No demand for heat, steam or hot water at site ordinarily, however some operators who produce oil will use bath heaters to heat wellbore fluids to ensure good separation. Natural gas may be used to fuel bath heaters but only if the gas volumes and composition allow.

Techniques for BAT Assessment				
Option	**Technology / Process**	**WCU**	**EWT**	**Reason for Considering / Not Considering**
Power Generation (Harness Gas)	Spark Engines	×	✓	Well understood technology and available to rent/buy in the UK. May need to be used in combination with a flare system. Gas may be used to fuel the generators but only after a significant understanding of gas rate and PVT has been established. Small scale spark engines are available.
	Gas Turbines	×	✓	Well understood technology and available to rent/buy in the UK. May need to be used in combination with a flare system. Gas can be used to fuel the turbine but only after a significant understanding of gas rate and PVT has been established. Gas volume may hinder their use.
	ORC (waste heat recovery)	×	✓	Not available to rent. Used in conjunction with gas turbine.
Mini Liquefied Natural Gas	Liquefaction of Natural Gas	×	×	Limited infrastructure and therefore not an economical proposal.
Conversion to Fuels	Natural Gas Liquid	×	×	Lack of equipment in the UK together with unproven technology.
	Hydrogen	×	×	Small scale hydrogen production is available but untested within the UK.
Recycling Through to Gas Processing	Recycling of Waste Gases	×	×	Subject to limitations, only after a significant understanding of gas PVT has been established.
	Pipeline Export	×	×	Only considered if pre-existing pipelines are present and available.
Compressed Natural Gas	Compression to CNG for collection or direct export.	×	×	Limited infrastructure and therefore not an economical proposal. Direct export only considered if pre-existing pipelines are present and available.

Techniques for BAT Assessment				
Option	**Technology / Process**	**WCU**	**EWT**	**Reason for Considering / Not Considering**
Gas Processing / Gas Liquids Recovery	Recovery of NGL from Natural Gas	×	×	Export of raw condensate to refinery considered a more practical option.
Vapour Recovery	Compression to CNG for collection or direct export.	×	×	Logistics and lack of equipment in the UK. So not considered available. Direct export only considered if pre-existing pipelines are present and available.
	Compression to CNG for export via a pipeline	×	×	Logistics and lack of equipment in the UK. So not considered available. Direct export only considered if pre-existing pipelines are present and available.
Energy Storage	Electricity - Battery Storage	×	×	Intermittent gas supply and supply unknown
	Thermal - Thermal Storage	×	×	Technology not yet available.

Table 5: BAT Options - Results of Initial BAT Screening

7.3 Short List of Technologies

The technologies which have been considered for a more detailed assessment to establish whether they can be considered BAT are outlined below within each subsection. For clarity, this information has been sourced from the Environment Agency Report: SC170013/R.

In short, the hierarchy for the management waste gas can be classified as follows:

- Harness natural gas for alternative use;
- Incineration of natural gas by flare; and
- Cold venting of natural gas directly to atmosphere.

This section evaluates whether the short list of activities identified below can be considered for the management of associated (waste) gas with regards to the Production Testing Phase.

7.3.1 Harness of Natural Gas for Alternative Use

The extent of the sub surface formation has not been appraised. Therefore, the assumptions on how to harness natural gas are multiple and will be refined as further appraisal data improves the understanding of natural gas production during the Production Testing Phase of operations.

The preferred method for waste gas management is to harness the associated gas from the Wellsite. This could be a number of options including installation of a pipeline or the use of the associated gas at the Wellsite to produce energy i.e. electrical / heat or transmitted offsite.

This has many benefits including reducing the running cost of the Wellsite and reduces the carbon intensity by displacing diesel powered generators.

Following the initial screening process, a number of options have been assessed further for the harnessing of associated gas.

7.3.1.1 Onsite Power Generation

It is anticipated during the well testing phase that the natural gas will reach a steady state with regards to flowrates and pressures. During the initial part of the EWT it is unlikely that the harnessing of natural gas can be achieved. Representative samples of gas will need to be taken and analysed to determine the gas composition. With this in mind the use of a temporary 'gas fuelled' generator could be considered part way through the EWT, however by the time the relevant information has been obtained it is likely that the EWT will have been completed and therefore no longer required. This would result in significant time and effort without any benefit.

It is not feasible at this stage to design or order appropriate generators due to having unknown/unreliable gas composition or PVT.

For clarity the WCU operations will not provide the necessary information to inform the selection or specification of a gas generator.

The harnessing of natural gas for the purpose of providing electricity for internal use only has not been considered further as part of the Production Testing Phase of operations.

7.3.1.2 Power Export (Gas to Wire)

For the reasons set out in Section 7.3.1.1, the harnessing of natural gas for the purpose of providing electricity for export has not been considered further as part of the Production Testing Phase of operations, not least due to the short duration of the Production Testing Phase of operations and the infrastructure required to achieve this.

7.3.1.3 Gas Export (Gas to Grid)

The volume of associated gas anticipated during the Production Testing Phase of operations is expected to be below the volumes that would make commercial benefit for a grid entry and so unlikely to be feasible in the first instance.

A proposal to export natural gas is not considered possible as further assessment is required on the gas composition to demonstrate compliance with the Gas Safety (Management) Regulation 1996 [Ref. 8] and subsequent Safety Case for grid entry. Additional plant may also be required to introduce Mercaptans to the gas so it becomes odorous and identifiable, depending on the receiving pipeline i.e. National Transmission System (NTS) or private. This would also create additional emission points.

Depending on the composition of the gas and its pressure, further treatment packages e.g., compressor, dehydration, dual monitoring skids, may also be required to ensure it meets the minimum standard of the NTS.

The harnessing of natural gas, specifically providing natural gas for export has not been considered further as part of the Production Testing Phase of operations.

7.3.1.4 Heat Generation

The Wellsite may require the intermittent production of heat for very short periods for a well treatment known as hot water washing. There is no permanent requirement for a heat source and as such, heat generation is not considered feasible.

The harnessing of natural gas for the purpose of providing heat generation for either internal or export use has not been considered further as part of the Production Testing Phase of operations.

7.3.2 Incineration of Natural Gas

Hydrocarbon gases, such as Methane (CH_4) have a Global Warming Potential 28 times greater than Carbon Dioxide (CO_2), based on a 100-year time horizon, therefore, the incineration of unburnt hydrocarbons represents a decrease in the environmental impact over the venting of natural gas. In addition, the incineration of large volumes of hydrocarbons presents a decreased risk of fire and/or explosion.

7.3.2.1 Elevated Flare

Elevated pipe flares generally have a single burner flare tip, elevated some metres above ground to provide greater dispersion performance. The flare tip is not enclosed nor is it shrouded, resulting in a visible flame and no noise attenuation. Elevated flares are capable of incinerating natural gas with high methane content across a significantly variable range of flowrates and inlet pressures, such as those likely to be experienced during the initial phase of hydrocarbon exploration, such as WCU, where the gas composition, pressure and flow rates are unknown.

Whilst technically feasible, an elevated flare can be used for EWT, however their combustion efficiency and environmental impacts regarding noise and light have meant that their use within onshore oil and gas wells has diminished.

The Operator has identified alternative incineration units which generate a lesser environmental impact.

Although a lesser preferred option to that of harnessing waste gas, the incineration of natural gas by means of an elevated flare is not being considered further as part of the Production Testing Phase due to its potential environmental impact.

7.3.2.2 Shrouded Flare

A shrouded flare, is essentially an open pipe flare, which is designed to incinerate natural gas with high Methane content across a significantly variable range of flowrates and inlet pressures, such as those likely to be experienced during the initial phase of hydrocarbon exploration such as WCU, where the gas composition, pressure and flow rates are unknown.

Whilst having a slightly lower combustion efficiency due to not having multiple burners, a shrouded flare provides confidence of natural gas combustion across the significantly variable range of flowrates and inlet pressures. Due to their simplicity of design, shrouded ground flares can be easily modified to aid combustion efficiency at low inlet pressures. This can be achieved by increasing the flow of support gas (propane). Historically, pre- August 2013, open pipe flares have been used extensively onshore UK without significant impact or concern.

As a shrouded flare can operate efficiently across a wide operating envelope it is also feasible that it can be used for an EWT.

The shroud placed around the flare tip aids in the reduction of the environmental impact, with respect to noise and visual impact. The size of the shroud is largely dictated by transportation restrictions onshore UK. As stated in National Planning Policy Framework (NPPF) [Ref. 9], minerals, which includes oil and gas, 'can only be worked where they are found', often resulting in wellsite's being located in areas with minimal and restrictive highway infrastructure.

Some shrouded flares have been analysed and assessed during operation to ensure that data on their efficiency is available. Should an enclosed flare be considered, the Operator will ensure that evidence of the shrouded flares efficiency (that is, above 98% combustion efficiency) is provided.

A shrouded flare unit is being considered for use as part of the Production Testing Phase of operations, largely due to its design to accommodate a wide variance of flowrates and ensure high combustion efficiency across the expected range.

7.3.2.3 Enclosed Flares and Incinerators

Enclosed units, such as those used in landfill, are designed with either a single or multiple burner, to incinerate natural gas with lower Methane (CH_4) contents, typically around 56% Methane (CH_4) and 31% Carbon Dioxide (CO_2). However, their environmental performance is based on consistent pressures and flow rates.

These burner tips are limited insofar as inlet pressure and flowrate capabilities and therefore can only be used for oilfield purposes when there is significant confidence that any associated natural gas pressures and/or flow rate is low.

Whichever unit is selected needs to have the capability to operate as a gas management technique and also as a safety device, where flow rates may be very high in the first instance, before being reduced and the well(s) closed in.

Although a lesser preferred option to that of harnessing waste gas, the incineration of natural gas by means of an enclosed flare is not being considered further as part of the Production Testing Phase due to its limited ability to operate in a defined range of flow specification.

7.3.3 Cold Venting

Ordinarily, venting of natural gas is only considered in the event that low volumes of natural gas are anticipated and, evidence is available to support that the cost of installing a flare for this activity would be disproportionate to the environmental benefit and subject also to the health and safety risks of cold venting having been deemed as being 'As Low as Reasonably Practicable' (ALARP).

When determining BAT for onshore oil and gas appraisal operations, the following points are considered with respect to cold venting:

- An increase in environmental impact;
- An increase of the risks associated with safety; and
- Minimal cost increase using a filtration unit, which in turn reduces both environmental impact and safety risks.

The cold venting of associated natural gas is not being considered further due to the volume of gas and the impact on both the environment and the associated safety concerns.

7.4 Initial Conclusion on Potential Techniques

Following an appraisal of each available technology, initial conclusions have been made as to the BAT for the proposed Production Testing Phase of operations and is detailed within Table 6.

Option	Technology	Considered	Reason
Cold Venting	-	No	Potential for significant global warming emissions (Methane (CH_4)). Environmentally beneficial to incinerate at the very least.
Incineration	Elevated Flares	No	Whilst feasible for use during WCU and EWT due to its ability to operate over a wide operating envelope and incinerate gas safely, the use of an open flare causes environmental impacts such as visual and noise impact.
	Shrouded Flare	Yes	A shrouded flare is suitable for use for both WCU and EWT due to its ability to operate over a wide operating envelope and incinerate gas safely. It provides a reduced environmental impact in comparison to an elevated pipe flare. Combustion efficiency whilst expected to be above 98% can be more difficult to regulate than that of enclosed units. A shrouded flare can be considered for WCU due to its ability to incinerate gas at variable flow rates and pressures efficiently. A shrouded flare can be considered for EWT due to its ability to incinerate inconsistent flowrates efficiently.
	Enclosed Flare / Incinerator	No	Environmental performance is based on consistent pressures and flow rates. These flares are limited insofar as inlet pressure and flowrate capabilities, therefore, can only be used for oilfield purposes when there is significant confidence that any associated natural gas pressures and/or flow rate is known. Gas may result in being cold vented, if pressure and volumes are too low or too high.

Option	Technology	Considered	Reason
Harness Gas	Heat Generation	No	There is no permanent requirement for a heat source.
	Onsite Power Generation	No	Not suitable for WCU or early stages of EWT due to unknown gas composition. Potential for use part way through the EWT for gas once the gas composition and flowrate have been established. However, once the correct generator has been identified, supplied and installed the EWT is likely to have been concluded.
	Export via Pipeline	No	The volume of associated gas anticipated during the Production Testing Phase of operations is expected to be below the volumes that would make commercial benefit for a grid entry.

Table 6: BAT Options - Result of Short List

Following the initial screening process, the 'Operator' considers the disposal of natural gas via incineration (shrouded flare) to be necessary to, either in part or fully manage, the waste gas as a result of the Cloughton-2 Production Testing Phase.

7.5 Quantitative BAT Assessment

7.5.1 Well Clean Up and Extended Well Test

The Operator has considered that a shrouded flare is BAT and suitable for use for both the WCU and EWT due to its ability to operate over a wide operating envelope and incinerate gas safely.

To this end a qualitative BAT assessment has not been undertaken, as the only safe option is to incinerate the gas whereby the fluctuation in flowrates and composition can be safely managed. It is acknowledged that this perhaps is not the most environmentally beneficial, however the safe undertaking of the well test is paramount.

7.6 BAT Conclusion

This Waste Gas Management Plan has been produced to demonstrate the process which has been undertaken to identify the Best Available Technique with regards to the management of waste gas generated during the Production Testing Phase of operations.

Any subsequent production phases would be covered by a revised Waste Gas Management Plan once additional information (during the EWT) has been obtained.

This Waste Gas Management Plan has been written in line with the Environment Agency Report: SC170013/R *'Waste gas management at onshore oil and gas sites: framework for technique selection'.*

The Cloughton-2 Well will be tested to ascertain whether commercial hydrocarbon rates can be achieved. The test will involve two (2) phases, a WCU and an EWT. The quantities of associated natural gas cannot be confirmed; however, the proposal is expected not to exceed an aggregated volume of 68.5 MMscf.

The Environment Agency has identified a '*long list of technologies*' within report**:** SC170013/R which provided the initial list of technologies that had the potential to be considered BAT. The long list was then screened against the definition of BAT and the proposed operation which resulted in a number of technologies being screened out and not being considered further.

For clarity, BAT as a concept will continue to change as technologies improve or become increasingly available for use within the onshore oil and gas industry.

Technologies which have passed through the initial screening process have been considered for a more detailed assessment to establish whether they can be considered BAT. The technologies which were the subject of further assessment were placed onto a short list. Each technology was then assessed for compatibility against the proposed

exploration development. It was considered that the incineration of natural gas using a shrouded flare was considered BAT.

A cost benefit analysis was not undertaken as the only consideration was the incineration of natural gas using a shrouded flare.

Although the enclosed unit has a slightly greater combustion efficiency than that of the shrouded flare and neither option can generate revenue for the operator, it can therefore be considered that the environmental cost of the enclosed unit is cheaper than that of the shrouded unit on combustion efficiency alone, without considering rental cost. However, when assessing the feasibility of each option, the shrouded unit is expected to perform better than an enclosed unit due to being able to operate across a wider operating envelope.

The ability to operate across a wider operating envelope is a necessary requirement when we consider that the natural gas flowrates and volumes will vary throughout both the WCU and the EWT.

REFERENCES

1. The Environmental Permitting (England and Wales) Regulations 2016

   Available at: https://www.legislation.gov.uk/uksi/2016/1154/contents/made

2. Council Directive 2006/21/EC on the management of waste from extractive industries and amending Directive 2004/35/EC

   Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0021

3. Environment Agency. (2021) *Waste gas management at onshore oil and gas sites: framework for technique selection* [Version: SC170013]

   Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1035936/Waste_gas_management_at_onshore_oil_and_gas_sites_-_report.pdf

4. Council Directive 2008/98/EC on waste and repealing certain Directives

   Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098

5. Environment Agency (Environmental Permitting and Abstraction Licensing) (England) Charging Scheme

   Available at: https://www.gov.uk/government/publications/environmental-permits-and-abstraction-licences-tables-of-charges

6. Council Directive 2010/75/EU on the industrial emissions (integrated pollution prevention and control)

   Available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0075&from=EN

7. European Union (Withdrawal) Act 2018

   Available at: https://www.legislation.gov.uk/ukpga/2018/16/contents

8. Gas Safety (Management) Regulation 1996

   Available at: https://www.legislation.gov.uk/uksi/1996/551/contents

9. National Planning Policy Framework

   Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2

***Page Left Blank Intentionally**

APPENDIX 1 - LONG LIST OF TECHNOLOGIES

***Page Left Blank Intentionally**