KIRBY MISPERTON A WELLSITE

KM8 PRODUCTION WELL

HYDRAULIC FRACTURE STIMULATION

WASTE MANAGEMENT PLAN
(REF: TE-EPRA-KM8-HFS-WMP-05)

Revision 8

09th October 2017

APPROVAL LIST

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1 DEFINITIONS

Provided below is a list of definitions for words or phrases used within this Waste Management Plan:

“:	Inch (equivalent to 0.0254m)
>:	Greater than
Abandonment:	The permanent plugging (sealing) of the well (or part thereof) following a decision that the well is no longer required for use
ADMS:	Atmospheric Dispersion Modelling System
ALC:	Agricultural Land Classification
AOD:	Above Ordnance Datum
API RP53:	American Petroleum Institute – Recommended Practices for Blowout Prevention Equipment Systems for Drilling Wells Standard
AQO:	Air Quality Objective
AQS:	Air Quality Standards
BAT:	Best Available Technique
BIF:	Business Integrity Framework
BMS:	Business Management System
CCTV:	Closed Circuit Television
DCLG:	Department for Communities and Local Government's
DECC:	Department for Energy and Climate Change
EMS:	Environmental Management System
EPR 2016:	Environmental Permitting (England & Wales) Regulations 2016
EWC:	European Waste Catalogue
Flood Zone:	An area identified by the Environment Agency as having the probability of sea and river flooding
ft:	Feet (equivalent to 0.3048m)
Ha:	Hectare

HDPE:	High Density Polyethylene
HSE:	Health, Safety& Environmental
HSEQ:	Health, Safety, Environmental and Quality
IWCF:	International Well Control Forum
Kg:	Kilogram
KM1:	Kirby Misperton 1 Well
KM3:	Kirby Misperton 3 Well
KM7:	Kirby Misperton 7 Well
KM8:	Kirby Misperton 8 Well
KMA:	Kirby Misperton 1 Wellsite and Kirby Misperton 1 Wellsite Extension, known collectively as KMA
Km:	Kilometre
KPI:	Key Performance Indicators
LMP:	Lighting Management Plan
m^3:	Cubic Metre
m:	Metres (equivalent to 3ft 3/8”)
mm:	Millimetre
MS:	Management System
NORM:	Naturally Occurring Radioactive Material
NYCC:	North Yorkshire County Council
PL:	Production Licence
RSR:	Radioactive Substances Regulations
SAC:	Special Areas of Conservation
Sidetrack:	To drill a secondary wellbore from an original wellbore
SMS:	Safety Management System
Suspended:	Temporary plugging (sealing) of the well, pending further well operations
Suspension:	Solid material held in a liquid

TE: Third Energy

TMP: Traffic Management Plan

UK: United Kingdom

Zone: A particular location within the formation being targeted for petroleum production

2 INTRODUCTION

2.1 THIRD ENERGY UK GAS LIMITED

Third Energy UK Gas Limited ("Third Energy") is the operator of gas fields within the Ryedale area and, at the time of submitting this application, holds interests in a total of six (6) Petroleum Licences and one (1) Petroleum Appraisal Licence, granted by the Secretary of State [Ref.1] at the Department of Energy and Climate Change (DECC) [Ref.2]. Under the Petroleum Licensing system [Ref.3] this permits the licence holder to '*search and bore for and get petroleum within the licence boundary*' subject to the granting of planning permission, in accordance with the Town and Country Planning Act 1990 [Ref.4].

Many of the Ryedale gas fields were originally discovered by Taylor Woodrow Exploration Limited and subsequently developed by Kelt UK Limited. Kelt sold its interest in the Ryedale Gas Fields to Tullow Oil and Edinburgh Oil and Gas. Tullow Oil went on to acquire the interest held by Edinburgh Oil and Gas. Third Energy acquired the interests of the Ryedale Gas Fields from Tullow in 2003 and has subsequently undertaken an active drilling and workover programme to enhance production of gas from the gas fields located at Kirby Misperton, Pickering, Marishes and Malton.

Third Energy also holds a number of exploration licences and has previously constructed and drilled wells at Ebberston Moor, within the North York Moors National Park.

2.2 SITE DETAILS AND GENERAL DESCRIPTION

The KM8 hydraulic fracturing operation and subsequent production testing will be undertaken at the following location:

Kirby Misperton A Wellsite
Off Habton Road
Kirby Misperton
North Yorkshire
YO17 6XS
England

National Grid Ref: SE 771789

Site Area: 1.465 ha

Waste Registration Number: NHS489

The site boundary is detailed in green on the site plan included within document TE-EPRA-KM8-HFS-SP-004.

The KMA welliste is located within open countryside in the county of North Yorkshire, in the District of Ryedale and within the Parish of Kirby Misperton. An extension to the original Kirby Misperton 1 wellsite was constructed in 2013 by Third Energy. It sits adjacent to and north of the original Kirby

Misperton 1 wellsite, which was constructed by Taylor Woodrow Exploration in 1984. The site is located 700m southwest of Kirby Misperton village. The site is located at National Grid Reference SE 771789 (Easting 477113, Northing 478936) and is approximately 30m Above Ordnance Datum (AOD).

The nearest residential properties to the KM8 wellsite are Alma Farm, located 300m northwest of the site, and Kirby-O-Carr Farm, located 210m south of the site. Sugar Hill Bungalow, located 170m from the KMA wellsite, is not habitable and Third Energy's understanding is that the Owner has no immediate plans to renovate it.

Adjacent to Kirby Misperton and north of the wellsite is Flamingo Land leisure park and zoo, which is a regionally significant theme park and tourist attraction. It is the most visited paid visitor attraction in North Yorkshire with figures indicating 1.4m visitors in 2009. The busiest period with this attraction is during the Easter and summer holiday periods. Established in 1959, Flamingo Land has co-existed alongside natural gas production since its discovery in the early 1980s.

The KMA wellsite is not located within or close to any statutory or non-statutory designations. The following two designations have been identified as being relevant to the KMA wellsite:

- The River Derwent SAC, 6.2km to the south east of the KMA wellsite; and
- The North York Moors National Park, park boundary being 5.7km to the north of the KMA wellsite.

The KMA wellsite is screened to the south by the existing established landscaping associated with the original wellsite (Kirby Misperton 1). The screening to the east and north is the subject of a landscaping scheme accompanying the current planning consent, implemented in March 2014. Once mature, the screening will provide additional mixed woodland planting to the site boundaries.

The site is located within the Vale of Pickering which is a relatively low lying area of land. It is a predominantly agricultural landscape with pockets of woodland and interspersed hedgerows. The farmland upon which the KMA wellsite is constructed has been given an Agricultural Land Classification (ALC) of three (3) [Ref.5].

The site is situated within Flood Zone 1 (annual flood probability of less than 0.1%) as defined on the Environment Agency Flood Zone Map [Ref.6].

A full description of the KMA wellsite is included within the KMA Site Condition Report (TE-EPRA-KM8-HFS-SCR-06) submitted together with this Waste Management Plan in support of the KM8 hydraulic fracturing environmental permit application.

2.3 THE DEVELOPMENT

Planning permission was granted by North Yorkshire County Council (NYCC) on the 9th January 2013 for the construction of an extension to an existing wellsite (Kirby Misperton 1), to drill and test up to two (2) production boreholes followed by subsequent production of gas at Kirby Misperton 1

Wellsite (East), Alma Farm, Habton Road, Kirby Misperton (Decision Notice C3/12/00989/CPO) [Ref.7]. The KM1 extension wellsite is referred to as Kirby Misperton 8 (KM8).

In 2013 Third Energy drilled the first of two permitted boreholes from the Kirby Misperton 1 extension, KM8. Third Energy is now proposing to hydraulically stimulate and test the various geological formations previously identified during the 2013 KM8 drilling operation and subsequent analysis of the data, followed by the production of gas from one or more of these formations into the existing production facilities.

The development will consist of five principal phases:

1. Pre-Stimulation Workover;
2. Conduct Hydraulic Fracture Operation;
3. Installing the Completion String;
4. Conduct Flow Tests
5. Production; and
6. Site Restoration.

A detailed description of the purpose and nature of the development is provided in Chapter 4 of this Waste Management Plan.

2.4 SCOPE

This Waste Management Plan is applicable to the KM8 hydraulic fracturing operation, described in detail within Chapter 4.

It is applicable to Third Energy UK Gas Limited, its contractors and subcontractors and can be used in support of applications to the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016 [Ref.8], where there is a requirement to provide a Waste Management Plan. The Waste Management Plan is the principal document for the management of all activities permitted at the wellsite under applicable environmental legislation.

3 ENVIRONMENTAL LEGISLATION AND APPLICABILITY

Activities associated with the exploration and subsequent production for oil and gas onshore in England fall to be considered within the scope of a number of pieces of legislation. A review of the proposed KM8 hydraulic fracturing operations against environmental legislation has identified the following legislation as being applicable.

3.1 WATER RESOURCES ACT 1991 (AS AMENDED BY THE WATER ACT 2003)

Under Section 199 of the Water Resources Act 1991 [Ref.9] (as amended by the Water Act 2003) [Ref.10], a notice of the intention to construct or extend a boring for the purpose of searching for or extracting minerals must be submitted to Environment Agency using form WR11. A method statement, including drilling and casing designs, together with storage and use of chemicals and drilling muds, shall accompany the WR11 application form.

The KM8 production borehole was the subject of a WR11 application to the Environment Agency in March 2013, the outcome of which was confirmation that the Environment Agency were satisfied with the information provided within the WR11 application and that the Environment Agency had no requirement for a WR12 (Notice to Conserve Water Resources) to be issued for the proposal.

The KM8 hydraulic fracturing operation is also the subject of a WR11, which is included within Appendix 6 of the KMA Site Condition Report (TE-EPRA-KM8-HFS-SCR-006) provided in support of the environmental permit application.

3.2 ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS 2016

A number of activities to be undertaken during the KM8 hydraulic fracturing operations may require permitting under the Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016).

3.2.1 A Groundwater Activity

Under Schedule 22 of EPR 2016, 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. The Environment Agency will then determine whether the groundwater activity needs to be permitted.

Schedule 22 3 (1) of EPR 2016 provides that “Subject to sub-paragraphs (2) and (3) “groundwater activity” means any of the following:

(c) any other discharge that might lead to the direct or indirect input of pollution to groundwater.

Although the risk to groundwater is very low due to the way in which Third Energy has constructed the KM8 borehole and that only non-hazardous constituents will be used within the hydraulic fracturing fluid, Third Energy is taking a precautionary approach by determining the KM8 hydraulic fracturing operations as requiring a groundwater activity permit.

3.2.2 A Mining Waste Activity

The Mining Waste Directive 2006/21/EC [Ref.11] requires that extractive wastes are managed in such a way that it minimises harm to human health and the impact on the environment. It applies to the management of waste resulting from the prospecting, extracting, treatment and storage of mineral resources and working under quarries, which the Mining Waste Directive refers to as extractive waste. The waste can take the form of a solid, liquid or gas.

Schedule 20 of the EPR 2016 defines a mining waste operation as being the management of extractive waste, whether or not it involves a waste facility. Under EPR 2016, an environmental permit is required to authorise a mining waste operation.

The KM8 hydraulic fracturing operation will include the management of non-hazardous extractive waste during:

- the pre-stimulation workover;
- during the flow back to surface of the hydraulic fracture treatment fluid following the fifth hydraulic fracture treatment; and
- residual flow back water during well testing operations.

For clarity, the extraction of natural gas is considered a product not waste and will be transported from the site via an existing underground pipeline to the Knapton Generating Station where it will be used to produce electricity.

It is anticipated that between 50% and 70% of the hydraulic fracturing fluid used within each zone being stimulated will be retained within the formation. Article 3 (15) of the Mining Waste Directive defines a waste facility *any area designated for the accumulation of 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 facilities for 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 none-inert waste;*
- *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.*

Hydraulic fracture fluid has been classified as non-hazardous. Not all of the hydraulic fracture fluid will return to surface and will be retained in the formation for a period exceeding one year. In accordance with Article 3 (15) of the Mining Waste Directive, the formation within which the hydraulic fracture fluid is retained is designated as a mining waste facility.

As the retained hydraulic fracture fluid is classified non-hazardous, a Mining Waste Facility categorised M3 has been assigned, based on the Environment Agency permit application *form guidance EPR: Application for an environmental permit – Part B5 new bespoke mining waste operation permit* [Ref.12].

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 determining a Category A Mining Waste Facility is as follows:

a) A failure or incorrect operation e.g. the collapse of 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 waste facility;
b) It contains waste classified as hazardous under Directive 91/689/EEC [Ref.13] above a certain threshold; or
c) It contains substances or preparations classified as dangerous under Directives 67/548/EEC [Ref.14] or 1999/45/EC [Ref.15] above a certain threshold.

An Environmental Risk Assessment has been undertaken to inform the permit application. The risk assessment did not identify any environmental risk associated with the retention of hydraulic fracture fluid within the formation being stimulated as having the potential to give rise to a major accident.

The hydraulic fracturing process will generate fractures within each of the five (5) zones, at a depth between 2,123m (6,965ft) and 3,043m (9,984ft). The exact depth of the five (5) zones is detailed within Section 4.3.1.1 of this Waste Management Plan.

The existing KM8 well was constructed in 2013, in accordance with the Offshore Installation and Wells (Design and Construction, etc.) Regulations 1996. The groundwater and water bearing formations present above the Carboniferous strata were cased, grouted and sealed before the well was progressed into the target hydrocarbon bearing formations. This will prevent direct migration of fluids and gases from the wellbore to the shallow groundwater system during the hydraulic fracturing, well testing phases and subsequent production.

The evaporitic deposits of the Zechstein Group form a world class regional seal which acts as a barrier to the upward migration of gas and liquids, hence its ability to trap hydrocarbons. The reason for its excellent sealing ability is the ductile nature of the evaporites which, under the subsurface pressure and temperature, are able to anneal fractures. The Zechstein succession is the top seal to many of the gas fields in the Southern North Sea Basin with a proven ability to hold back substantial gas columns. Over 1,829m (6,000ft) of rock, including the Zechstein “Super Seal” and several additional regional seals separate the shallowest proposed fracture and the deepest potential aquifer. This section will prevent the upward migration of hydraulic fracturing fluids and, in doing so, prevent any potential contamination of the shallow groundwater system.

These regional seals could, in theory, be crossed, which will have a low permeability.

Only non-hazardous constituents will be used within the hydraulic fracturing fluid. Each constituent not having previously been approved by the Environment Agency, has been assessed using the Joint Agencies Groundwater Directive Advisory Group (JAGDAG) assessment methodology. The assessment concluded that all constituents assessed for use in the KM8 hydraulic fracturing operation are classified as non-hazardous to groundwater. A copy of the JAGDAG substances assessment is provided within Appendix 4 of this Waste Management Plan.

It is anticipated that between 30% and 50% of the hydraulic fracture fluid will return to surface following each hydraulic fracture treatment. The remaining 50% to 70% of the hydraulic fracturing fluid will be retained within the formation, having been absorbed on the charged, high surface area clays within the formation. None of the constituents used within the hydraulic fracturing fluid are classified as hazardous under Directive 91/689/EEC nor classified as dangerous under Directive 67/548/EEC or Directive 1999/45/EC.

In accordance with Annex III of the Mining Waste Directive, the formation within which hydraulic fracture fluid will be retained (Mining Waste Facility) is not considered a Category A Mining Waste Facility.

3.2.3 An Industrial Emissions Activity

Industrial Emissions Directive 2010/75/EU [Ref.16] lays down rules on integrated prevention of pollution arising from industrial activities, whilst also laying down rules designed to prevent or, where that is not practicable, to reduce emissions into the air, water and land and to prevent the generation of waste, in order to achieve a high level of protection of the environment taken as a whole.

Part 2 of the EPR 2016 details a number of activities that are classified as an Industrial Emissions activity. These include, but not limited to:

- Chapter 1 - Energy Activities
    - Section 1.1 - Combustions Activities
    - Section 1.2 - Gasification, Liquefaction and Refining Activities
- Chapter 2 - Production and Processing of Metals
    - Section 2.1 - Ferrous Metals
    - Section 2.2 - Non-Ferrous Metals
- Chapter 3 - Mineral Industries
    - Section 3.1 - Production of Cement and Lime
    - Section 3.2 - Activities Involving Asbestos
- Chapter 4 - The Chemical Industry
    - Section 4.1 - Organic Chemicals
    - Section 4.2 - Inorganic Chemicals
- Chapter 5 - Waste Management
    - Section 5.1 - Incineration and Co incineration of Waste
    - Section 5.2 - Disposal of Waste by Landfill
- Chapter6 – Other Activities
    - Section 6.1 - Paper, Pulp and Board Manufacturing Activities
    - Section 6.2 - Carbon Activities

Schedule 1, Part 2 of EPR 2016 transposes the requirements of the Industrial Emissions Directive, requires an environmental permit to authorise an installation operation for gasification, liquefaction and refining activities, as detailed within Section 1.2, Part A(1), as detailed below.

Part A(1)

(a) Refining gas where this is likely to involve the use of 1,000 or more tonnes of gas in any 12-month period.
(b) Operating coke ovens.
(c) Gasification or liquefaction of coal or other fuels in installations with a total rated thermal input of 20 megawatts or more.
(d) Refining mineral oils.
(e) The loading, unloading, handling or storage of, or the physical, chemical or thermal treatment of—
  (i) crude oil;
  (ii) stabilised crude petroleum;
(f) Activities involving the pyrolysis, carbonisation, distillation, liquefaction, gasification, partial oxidation or other heat treatment of—
  (i) coal (other than the drying of coal);
  (ii) lignite;
  (iii) oil;
  (iv) other carbonaceous material; or
  (v) mixtures of any of these,
  Otherwise than with a view to making charcoal.
(g) Activities involving the liquefaction or gasification of other carbonaceous material.

Schedule 1, Part 2 of EPR2016 transposes the requirements of the Industrial Emissions Directive, 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), as detailed below.

For the purpose of information and clarity, the KM8 hydraulic fracturing operations will not involve the storage and handling of crude oil at the KMA wellsite and therefore does not require an installation permit.

Part A(1)

(a) The incineration of hazardous waste in a waste incineration plant or waste co-incineration plant with a capacity exceeding 10 tonnes per day;
(b) The incineration of non-hazardous waste in a waste incineration plant or waste co-incineration plant with a capacity exceeding 3 tonnes per hour; and
(c) The incineration, other than incidentally in the course of burning landfill gas or solid or liquid waste, of any gaseous compound containing halogens.

For the purpose of information and clarity, the KM8 hydraulic fracturing operations will not involve the incineration of natural gas at the KMA wellsite and therefore does not require an installation permit. Natural gas produced as part of the well test, production test and subsequent production will be transported from the site via an existing underground pipeline to the Knapton Generating Station where it will be used to produce electricity.

The Knapton Generating Station, which will receive the natural gas from the KM8 well testing, is subject to Environmental Permitting, independent of the KM8 hydraulic fracturing operation.

3.2.4 A Radioactive Substances Activity

Schedule 23 of EPR 2016 provides for the control of Naturally Occurring Radioactive Material (NORM). Schedule 23 defines the production of oil and gas as a NORM industrial activity and therefore any accumulation of radioactive waste, which exceeds concentrations set out in Table 1 of Schedule 23 of EPR 2016 and its subsequent disposal, requires an environmental permit to authorise a radioactive substances activity.

The KM8 hydraulic fracturing operations will involve the circulating back to surface of hydraulic fracture treatment fluid, which has been exposed to the formation being stimulated. The hydraulic fracture treatment fluid returning to surface may or may not contain NORM at levels exceeding those set out in Table 1 of Schedule 23 of the EPR 2016. Until such time as the concentration of NORM can be established, an environmental permit is required to authorise the management and disposal of NORM.

4 DESCRIPTION OF THE FACILITY

4.1 SITE LOCATION

The KMA wellsite (KM8 well) is located within the county of North Yorkshire within the Vale of Pickering. It is situated within the Parish of Kirby Misperton and is located 700m to the south west of Kirby Misperton Village. The KM8 borehole is positioned adjacent to the Kirby Misperton 1 and 3 boreholes, constructed in 1985 and 1987 respectively, which benefits from natural screening. The site was formally in agricultural use and is surrounded by land in agricultural use. The nearest residential properties are Alma Farm, located 300m west of the site and Kirby-o-Carr Farm located 210m south of the site. Sugar Hill Bungalow, located 170m from the KMA wellsite, is not habitable and Third Energy’s understanding is that the Owner has no immediate plans to renovate it.

4.2 SITE DESCRIPTION AND CURRENT STATUS

The KMA wellsite is an existing wellsite that is surrounded by flat arable farmland, consisting of natural screening around the boundary. The access track to the wellsite is off Habton Road opposite Kirby-o-Carr Farm, and then immediately to the right. The site boundary is detailed in green on site planes included within TE-EPRA-KM8-HFS-SP-004.

The KMA wellsite consists of two independent sites, constructed immediately adjacent to each other and share the same access. The Kirby Misperton 1 wellsite was constructed in the mid 1984 to accommodate the drilling of a petroleum exploratory borehole, KM1. The Kirby Misperton 1 wellsite was extended in 2013 to accommodate the drilling of the KM8 petroleum production borehole. Collectively, the wellsites are referred to as Kirby Misperton A wellsite (KMA).

The Kirby Misperton 1 wellsite was constructed in 1984 by Taylor Woodrow Exploration in order to accommodate the drilling of a petroleum exploratory borehole, KM1. The topsoil was carefully removed in accordance with best practice and relocated to the north and eastern boundary of the wellsite, where it has continued to be retained for subsequent wellsite restoration. The subsoil was then levelled using a technique known as cut to fill, removing subsoil from the higher areas of the site and spreading them over the lower sections of the site thus creating a level plateau, upon which the site can be constructed. The site was then covered with a layer of low permeability clay, which was the technique at the time to provide an environmental barrier between the wellsite activities and the underlying subsoils. Above the environmental clay barrier, a layer of geotextile was laid to provide a physical separation membrane between the clay and site stone, which overlaid the site. A drainage channel was constructed along the perimeter of the wellsite, which captures surface run-off water from the adjacent land and diverts it around the perimeter of the site to a discharge point in to Sugar Hill Drain. Production equipment located on the site is individually bunded and connected to an interceptor via drainage pipes beneath the surface, which discharge water to Sugar Hill Drain.

Within the centre of the wellsite a drilling cellar was constructed, using reinforced concrete base and concrete walls, from which the KM1 exploratory borehole was drilled in 1985. The well was successful in proving commercial quantities of natural gas in place and was subsequently completed as a Namurian gas producer. In 2012, the well was re-entered and sidetracked (KM7) but was unsuccessful in producing gas. The well has since been suspended pending further evaluation of the Kirby Misperton Gas Field.

Planning permission for the construction of an extension to the existing Kirby Misperton 1 wellsite and drill and test up to two gas production boreholes followed by subsequent gas production was granted by North Yorkshire County Council on 9th January 2013. The planning application provided full details of the geological justification for the wellsite location and was accompanied by independent specialist consultant reports, which assessed the impact of the development upon ecology and archaeology. In addition the original site selection process considered existing constraints, including proximity to sensitive buildings, environmental and heritage designations. The granting of planning permission showed that Third Energy had demonstrated the site presented the best available option.

Construction of the Kirby Misperton 1 extension was completed in 2013. A geotechnical evaluation, including chemical analysis of the underlying soils was undertaken prior to construction. The geotechnical evaluation, together with a topographic survey formed the basis of the site design, which, due to the level difference between the exiting Kirby Misperton 1 wellsite and the proposed Kirby Misperton 1extension wellsite, included a gabion retaining wall and access ramp to minimise the volume of subsoil excavated and the environment risks associated therewith.

The topsoil was stripped from the site area and placed in a storage bund along the northern boundary of the wellsite. Subsoil was removed from the higher areas of the site and laid across the lower areas of the site to create a level surface. A ditch was then excavated along the perimeter of the wellsite to provide environmental containment.

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

Within the centre of the site a concrete cellar was constructed, formed from 2.7m internal diameter pre-cast concrete rings. A large diameter steel casing was pre-installed to 1.5m below the base of cellar to provide stability and protection of the soil during the initial stages of drilling. The cellar rings were sealed together using a tokstick sealant and a 200mm concrete jacket surround cast. The impermeable membrane has been integrated into the cellar walls using foam back metal batons to ensure that the integrity of the site is maintained. The cellar provides an additional containment and houses the wellhead. An integrity test was carried out following construction to confirm the cellar provided a sealed containment. The integrity test consisted of filling the cellar with water and monitoring water loss over a period of 24 hours. In order to account for any water loss through evaporation or water gain through precipitation, a container was filled with water and positioned immediately adjacent to the drilling cellar. After a period of 24 hours no water loss was observed and the test was determined as successful.

Geogrid was then laid across the site area and overlaid by 300mm thick layer of MOT Type 1 stone to provide a suitable working surface.

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

A surface conductor casing was drilled and set immediately following site construction and in advance of the main drilling operation.

A larger oilfield drilling rig was then mobilised to site to drill the remaining sections of the borehole. Following the drilling of each hole section, steel casing was then installed, cemented into position and pressure tested to confirm pressure integrity. A schematic of the well construction is provided in the KMA Site Condition Report (TE-EPRA-KM8-HFS-006), together with a lithology log showing formations encountered.

On completion of the drilling operation the well was suspended pending analysis of the data gathered during the drilling operation.

The KM8 well is currently suspended pending the pre stimulation workover and hydraulic fracturing operation, which are the subject of this Waste Management Plan and scheduled to be undertaken once all relevant planning and environmental permits have been issued.

A copy of the KM8 conceptual model is provided within KMA Site Condition Report (TE-EPRA-KM8-SCR-006).

4.3 WELLSITE DRAINAGE

Both the Kirby Misperton 1 wellsite and the Kirby Misperton 1 extension (collectively known as KMA wellsite) have independent surface water drainage systems. Both sites have an impermeable membrane separating site activities from the underlying subsoils.

The Kirby Misperton 1 wellsite is clay lined with a drainage channel constructed along the perimeter of the wellsite, which captures surface run-off water from the adjacent land and diverts it around the perimeter of the site to discharge points in to Sugar Hill Drain. The discharge points are located on the western boundary of the KMA wellsite, one immediately adjacent to the wellsite access gates and the second adjacent to the interceptor, as indicated in drawing Figure 1 KMA Wellsite Drainage (Surface Water Management) within Appendix 1 of the KMA Site Condition Report.

The Kirby Misperton 1 extension is lined using HDPE and has a perimeter containment system. The purpose of the impermeable membrane is to capture any surface run off liquids such as rainwater, but also captures any spillages incurred onsite and contains them within the site perimeter ditches, ensuring environmental harm is averted and any spillages can be rectified onsite.

The Kirby Misperton 1 extension perimeter containment system is currently connected to an interceptor, located within the Kirby Misperton 1 wellsite. During periods of activity, such as drilling or intervention activities, the flow line connecting the perimeter containment system within the interceptor is isolated and the surface run-off water collected for reuse within the operation or removed from site via road tanker to an Environment Agency approved waste water treatment works for subsequent treatment and recycling or disposal.

4.4 WASTE GENERATING ACTIVITIES

A summary of the proposed KM8 hydraulic fracturing operation is detailed below in chronological order, with a more detailed description of each activity provided within each subsection:

1. Pre-Stimulation Workover
2. Conduct Hydraulic Fracturing Operation
3. Completion String Installation
4. Production test

The following section provides a summary of the proposed development together with extractive wastes they produce.

4.4.1 Pre Stimulation Workover

Steps:

1. Rig up a typical workover rig and supporting equipment to conduct a Workover.
2. Pull the surface circulating string out of the hole.
3. Clean out the well by running in with a set of downhole scrapers (commonly referred to as a clean-up assembly) and circulating the well clean. This will be the first time that any waste could be seen at surface and all measuring and mitigation procedures must be in place.
4. Run a 4.5" casing string from surface to TD and cement in place with a calculated top of cement depth of 5,000ft.

This phase can be conducted independently and ahead of the planned fraccing operation.

A full disclosure of the fracture treatment fluid, including a breakdown of each component and its quantity is provided within Appendix 5. The components of the hydraulic fracture fluid have been selected based on their non-hazardous to groundwater properties and have been approved for use by the Environment Agency. The components of the hydraulic fracture fluid are commonly used substances and can be found within most households, such as food and toiletries.

4.4.2 Conduct Hydraulic Fracture Operation

Steps:

1. Starting with the bottom zone (Zone E), rig up electric wireline and perforate 20ft as per the depths shown in Figure 3-1 of the Hydraulic Frac Plan (HFP).
2. Connect the frac equipment and conduct 1) a step down test and 2) a mini-frac test to gather pump and rock data. These tests are conducted according to the guidance published by the Secretary of State for Energy and Climate Change (Davey, 2012): the hydraulic fraccing plan will be progressive, starting with the injection of small volumes of fluid during a step down test and

mini frac test before embarking on the main frac. The purpose of these pre-tests is to gather and analyse the data to optimise the job parameters. Note that if the mini-frac does not provide the required pump rates, suggesting that the perforation exit holes sizes are not large enough, then as a contingency, the decision may be taken to apply standard jetting technology. This incorporates running coiled tubing into the well and pumping a mixture of sand and water through a jetting nozzle to cut the required hole size in the casing.

3. Conduct the main frac using the volumes and fluids described in the HFP Table 3-1 and monitor closure pressure. The main frac is expected to last approximately 2.5 – 3.5 hours and all three operations (ie. step down test, mini test and main test) should be able to be conducted during daylight hours in one day. The other 4 main fracs are much smaller and would last approximately 1 – 2 hours each.
4. If required, run in hole with coiled tubing to clean out the well by circulating any unused proppant in the hole as well as any "flowback water". The returns will be captured in the storage tanks on surface, prior to being taken off site to a permitted waste treatment plant.
5. Set a plug in the hole using wireline to isolate the fracced zone.

These steps will be repeated for each stage. All volumes, chemical compositions and rates should follow very closely to those presented in the actual planning application for these zones.

4.4.3 Installing the Completion String

With all zones fracced and all plugs set, the next step will be to drill out the plugs. This can be achieved by using either the workover rig or a coiled tubing unit and a standard circulating system (as per normal drilling operations) with shakers, sand cleaners etc. Once the plugs have been drilled and the well cleaned up, the well will be circulated to an over-balanced clean brine. The next phase of the operation will be to use a workover rig to run a completion string that will allow comingled production from the lower three zones and zonal isolation of the upper two zones.

4.4.4 Conduct Flow Tests

Due to the significant distance and difference in pressure between the bottom 3 zones and the top 2 zones, the bottom 3 zones will be flow tested independently of the upper 2 zones. As indicated in the planning application, no flaring will be conducted on site. The decision to run a PLT logging tool could be taken at this point to determine the individual flow from each of the 3 lower zones. This would be preceded by hooking up the production test facility at surface along with a corresponding amount of flow lines to carry out the production tests. The main purpose of a production test is to monitor the deliverability of the well and also the formation over both short and long time periods. To help the well flow during the initial stages, coiled tubing will be run in the hole to displace fluid from the well using nitrogen to create an under balance situation that should allow the well to flow on its own. It will be during this period that we can expect quantities of flowback fluid, including proppant, to appear at surface. The fluids and solids will be separated and the proppant directed into an enclosed cuttings skip beside the shakers and the fluid re-directed into one of the surface brine storage tanks. The flowback fluids will be sampled at surface and sent to an approved laboratory for analysis. It is not anticipated that any formation fluids will come to surface based on log analysis.

At a convenient point in time, the fluids in the storage tanks will be pumped into double skinned road tankers for taking to an EA approved and permitted waste treatment plant for disposal. The fluids and any particulate matter would be separated there with the solids going to an approved land disposal site and the fluids being sent to an approved water treatment plant which would clean the water further and once sufficiently clean and tested, the water would ultimately be introduced back into the natural water cycle.

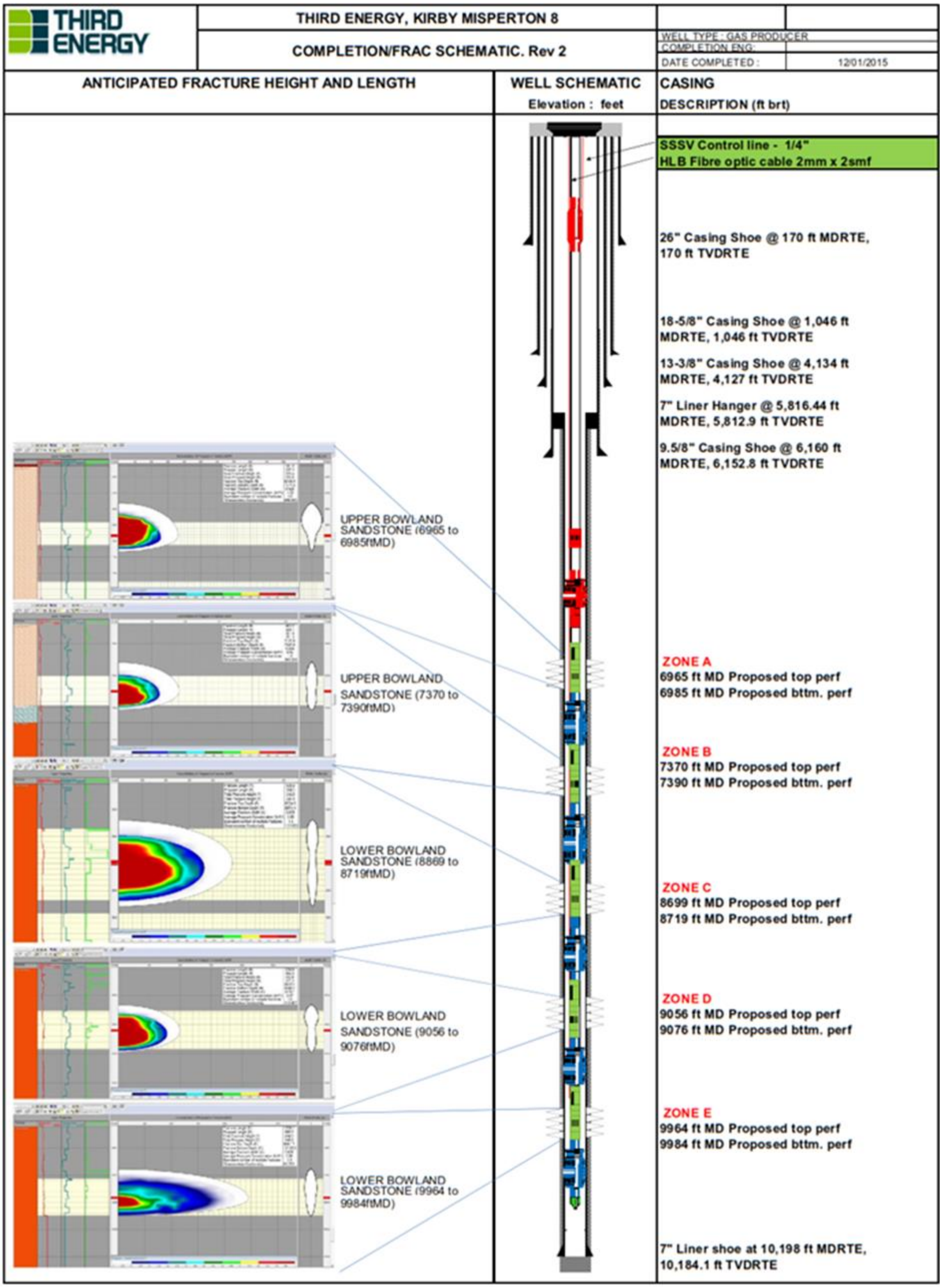

Figure 4.1: Completion String and Hydraulic Fracture Design

4.5 WASTES ARISING

4.5.1 Pre-Stimulation Workover

The setting up of the workover rig and the pulling to surface of the casing does not produce any extractive waste.

The clean-up assembly will be run into the well and will scrape and remove any debris. Clean Sodium Chloride brine will be circulated down the workstring during the wellbore cleaning operation and will circulate out the debris. The debris, consisting of small steel scrapings, will be separated from the fluid at surface using a conventional shale shaker and circulating tank. The shale shaker will capture any debris from the circulated fluid and divert them to a cuttings skip and the produced water stored within an enclosed horizontal fluid tank for subsequent removal from site for offsite recycling and/or disposal at an Environment Agency permitted waste 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.

The running of a 114.3mm (4 ½") casing string does not produce any extractive wastes.

In order to ensure that the mains water being transported by the existing pipeline to the KMA wellsite remains of the same quality when reaching the KMA wellsite, the existing pipeline will be purged clean. A sample of mains water taken at the Knapton Generating Station will be analysed and compared with a sample of mains water received at the KMA wellsite. If the samples are not consistent further purging of the pipeline will be required. Only when sample taken at the Knapton Generating Station and the receiving sample taken at the KMA wellsite are consistent will the water from the pipeline be permitted for use.

The pre-stimulation workover can be conducted independently and ahead of the planned hydraulic fracturing operation.

4.5.2 Hydraulic Fracture Operation

Prior to perforating, the volume of brine which has been in the well following the drilling operation will be displaced with clean brine. The intention is to utilise the Applicant's existing underground water pipeline, which ordinarily is used for the transportation of produced water from Knapton Generating Station to the KM3 reinjection well, to provide water to the KMA wellsite. Mains water will be pumped from Knapton Generating Station to the KMA wellsite via the existing pipeline, from where it will be transferred into temporary storage tanks on site, negating the requirement for road transportation. Approximately 94m3 of fresh water will displace (push) the brine to surface where it will be transferred from the KM8 well to on site storage tanks for subsequent reuse as suspension brine within the hydraulic fracturing stimulation operation or considered for use at one of Third Energy's other wellsite operations. In the event brine cannot be reused it will be transported off site for treatment and disposal at an Environment Agency permitted waste treatment facility.

The criteria for determining whether wastes 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.

No extractive wastes are produced during the Step Down and Mini Frac phase. Only following the completion of the main fracture within the zone will fluids be circulated to surface if required.

A percentage of the hydraulic fracture fluid used in each of the five (5) fracture treatments will be returned to surface (flowback water) via the well test separator. The percentage returned is anticipated to be circa 30% with the maximum of 50% having been recorded in previous hydraulic fracturing operations. All flowback water may be diverted directly to storage tanks on site, where it will be held for subsequent offsite treatment and/or disposal at an Environment Agency permitted waste 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.

Naturally Occurring Radioactive Material (NORM)

Flowback water has the potential to contain low levels of Naturally Occurring Radioactive Material (NORM), which predominantly relate to radioisotopes of radium (and associated progeny), which find their way into the water due to their chemical solubility. Elevated concentrations of radium-226 and radium-228 progeny may also be present due to dissolved Rn-222 (radon) and, to a lesser extent, Rn-220 (thoron) gas. Samples of flowback water shall be sent to a laboratory holding the appropriate accreditations for radionuclide analysis. Available storage of flowback water on site is 1,330m^3 and therefore sufficient to accommodate turnaround times associated with the analytical techniques required. The management of NORM waste is the subject of a BAT assessment, provided as Appendix 6.

Retained Fluid within the Formation

The remaining 50% to 70% of hydraulic fracturing fluid will be retained within the formation, having been absorbed on the charged, high surface area clays within the formation. None of the constituents used within the hydraulic fracturing fluid are classified as hazardous under Directive 91/689/EEC nor classified as dangerous under Directive 67/548/EEC or Directive 1999/45/EC, therefore, the 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 microseismic fracture growth monitoring, providing evidence of the height and distance of each hydraulic fracture growth. Table 4.2 sets out the classification of waste streams associated with the KM8 hydraulic fracturing operation, including hydraulic fracture fluid. Waste management arrangements for each waste stream, including hydraulic fracture fluid, in detailed within Section 5.3 of this Waste Management Plan.

An indication of the areal extent of the Non-Hazardous Mining Waste Facility for the hydraulic fracture treatment is included within document TE-EPRA-KM8-HFS-SP-004 and is based on the maximum anticipated fracture length (Zone E), which is approximately 378m in length and 133m in height. The base of the KM8 well is approximately 54m offset southeast of the surface location, which, for clarity, is the top of the borehole within the KMA wellsite. The maximum anticipated fracture lengths of Zones A to D are much less linear distance than that of Zone E, well within the areal extent indicated within document TE-EPRA-KM8-HFS-SP-004.

4.5.3 Completion String Installation

It is anticipated at this point that proppant together with fracture fluid may circulate to surface. Both proppant and returning fracture fluid will be circulated to surface and screened over shakers which will allow sludge (predominantly sand with water) to precipitate through and separate from metal cuttings. The sludge, which is expected to be small in volume at this stage will then be stored within an enclosed cuttings skip and will be monitored for NORM and await offsite removal via the licenced carrier to a licenced waste facility.

4.5.4 Production Test (Flow Test)

As with the current arrangement on site for gas production, gas will be flowed to the surface and into the existing production facilities, from where it will be transported via pipeline to the Knapton Generating Station for subsequent generation of electricity.

If formation water is produced with the natural gas, it will be removed as part of the routine production activity, which includes phase separation and liquid storage on site for subsequent off site treatment and/or disposal at an Environment Agency permitted waste 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.

Coil tubing will first be run into the base of well. Nitrogen will then be pumped through and out of the coil tubing positioned at the base of the well. The nitrogen will then flow to surface displacing (pushing) the fluid in the well back to surface. This process reduces the hydrostatic weight of the fluid column in the wellbore, which in turn allows the gas to flow to surface. Nitrogen is classified as inert and, as such, considered a closed loop system, having first been extracted from the atmosphere during its manufacturing process and subsequently released to atmosphere during the natural gas combustion process within the gas turbine at the Knapton Generating Station. No nitrogen will remain in the formation.

The volume of nitrogen pumped into the well to displace (pushing) the fluids in the well will be closely monitored. To minimise the amount of nitrogen used, calculations will be used to determine the amount required to displace the fluids before gas reaches surface. The volume of nitrogen required to displace the well fluid is low and will comingle with the gas. The volume of nitrogen within the gas is not considered sufficient to compromise the composition of the gas feeding the GE LM6000 gas turbine at the Knapton Generating Station. Table 4.1 below provides the gas composition, based on a detailed evaluation of the log and core data, which identifies Nitrogen as a component of the gas, ranging from 0.41% to 10.2% with a 4.13% average over the five (5) zones being hydraulically fractured.

Once gas reaches surface it is diverted via the well testing tree, through the well test separator system and into the existing production equipment via temporary flow lines, from where it will be exported off site via an existing underground pipeline to Knapton Generating Station where it will be used to generate electricity. Table 4.1 below provides the gas composition, based on a detailed evaluation of the log and core data. From the analysis of the core data, there is no indication that of water being present within the formation. The gas composition will be free of waste at the point of entry into the pipeline.

Sample	DS-09	DS-24	DS-45	DS-55	DS-79	Average
Depth	2072.64m (6800 ft)	2196.69m (7207 ft)	2396.64m (7863 ft)	2658.16m (8721 ft)	2919.98m (9580 ft)	
Gas Component	**Composition Mole %**	**Composition Mole %**	**Composition Mole %**	**Composition Mole %**	**Composition Mole %**	**Composition Mole %**
Hydrocarbons						
Methane (CH_4)	84.79	89.78	97.21	98.31	85.54	91.13
Ethane (C_2H_6)	8.37	4.61	1.89	1.18	0.45	3.30
Propane (C_3H_8)	2.09	0.65	0.06	0.02	0.02	0.57
i-Butane (C_4H_{10})	0.00	0.00	0.00	0.00	0.00	0.00
n-Butane (C_4H_{10})	0.00	0.00	0.00	0.00	0.00	0.00
i-Pentane (C_5H_{12})	0.00	0.00	0.00	0.00	0.00	0.00
n-Pentane (C_5H_{12})	0.00	0.00	0.00	0.00	0.00	0.00
Hexane (C_6H_{14})	0.00	0.00	0.00	0.00	0.00	0.00
Subtotals	**95.26**	**95.03**	**99.16**	**99.51**	**86.01**	**94.99**
Non-Hydrocarbons						
Carbon Dioxide (CO_2)	0.30	0.08	0.14	0.08	3.79	0.88
Carbon Monoxide (CO)	0.00	0.00	0.00	0.00	0.00	0.00
Helium (He)	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen (H_2)	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide (H_2S)	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen (N_2)	4.44	4.88	0.70	0.41	10.20	4.13
Oxygen (O_2)	0.00	0.00	0.00	0.00	0.00	0.00
Subtotals	**4.74**	**4.97**	**0.84**	**0.49**	**13.99**	**5.01**
Totals	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 4.1: KM8 Gas Composition based on Core Analysis

Residual flowback fluid which will contain proppant, is brought to surface with the gas. The sand is removed from the comingled substances by a sand trap, removing the sand from the produced fluid and gas. The resulting flowback fluid and natural gas is separated on site via the well test separator and diverted to storage tanks on site, where it is held for subsequent off site treatment and/or disposal at an Environment Agency permitted waste 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.

A number of tests will be performed to establish flow characteristics, with the aim of determining whether the formation being tested is capable of producing commercial quantities of gas.

4.6 EXISTING KM7 WELL

In 1985, the then current owners of the wellsite, Taylor Woodrow Energy, drilled the first well from the Kirby Misperton 1 wellsite, KM1. The well was successful in proving commercial quantities of natural gas in place and was subsequently completed as a Namurian gas producer. In 2012, the well was re-entered and sidetracked. KM7, but was unsuccessful in producing gas. The well has since been suspended pending further evaluation of the Kirby Misperton Gas Field

For clarity, there is no direct connection between the existing KM7 well (flowline) and the KM8 well. The original KM1 well was abandoned in accordance with Oil & Gas UK guidelines immediately below the point at which the well was sidetracked.

A schematic showing the proximity of KM7 well and KM3 well to the KM8 well is provided within Figure 4.2.

4.6.1 Retained Fluid BAT Assessment

In order to determine what is considered Best Available Technique (BAT) for the disposal of retained hydraulic fracture fluid, Third Energy has considered a number of alternative techniques.

The options considered as part of the BAT assessment include:

- Recovery of all hydraulic fracture fluid over prolonged flowback periods during gas production;
- Increased recover of hydraulic fracture fluid using artificial lifting (submersible pumps);
- Recover of hydraulic fracture fluid by excavation; and
- Retention of hydraulic fracture fluid within the formation being stimulated.

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

Recover by excavation is not considered feasible due to the depth of formation within which the hydraulic fracture 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 original KM8 borehole to a depth of circa 3,048m, 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 natural gas from the Bowland 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 hydraulic fracture fluid by excavation is not feasible, retention within the formation is considered BAT. The alternative options are unrealistic and/or theoretical in nature.

Injected non-hazardous hydraulic fracturing fluid, retained at depth does not present a credible environmental risk.

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

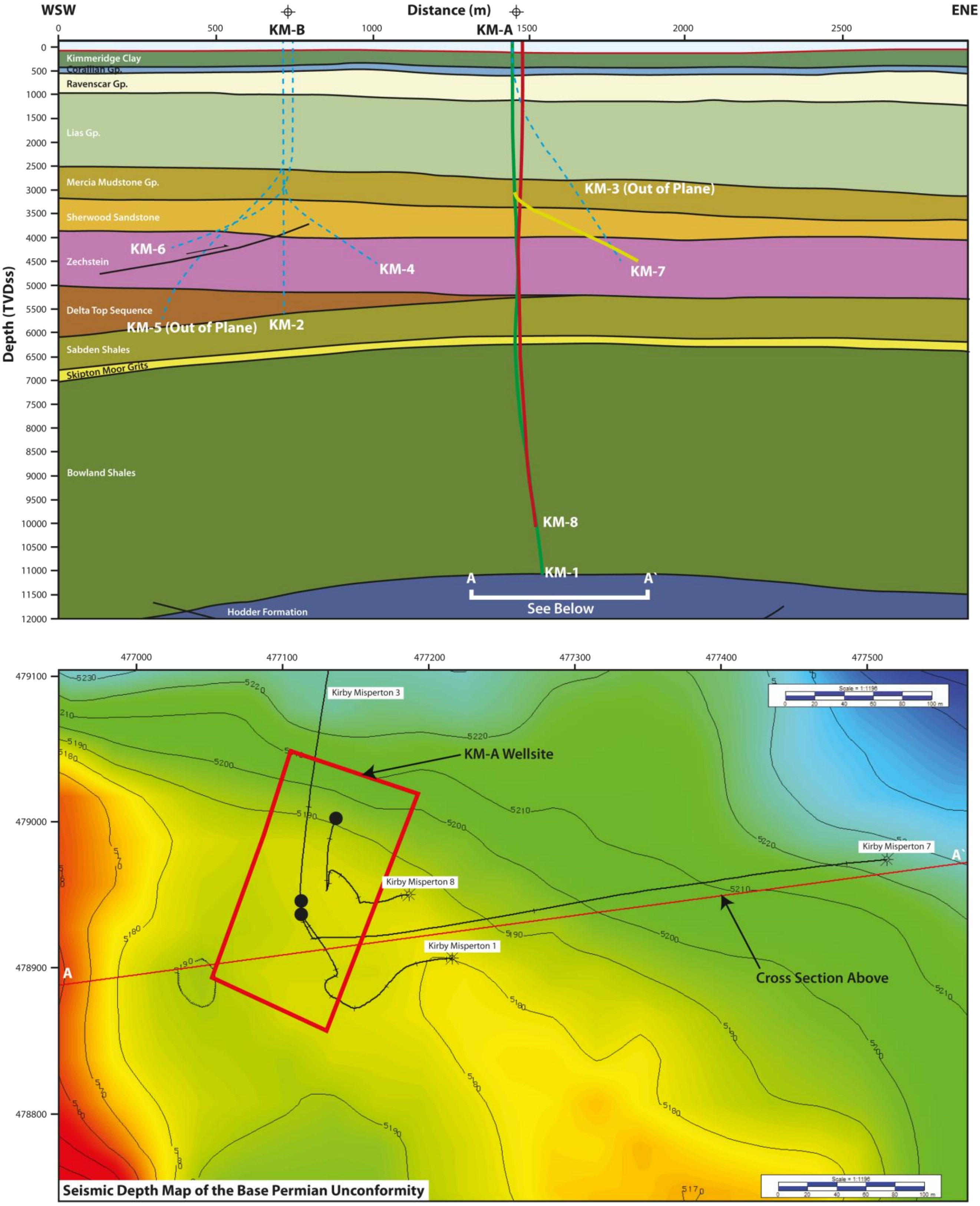

Figure 4.2: Well Proximity Schematic

4.7 EXISTING KM3 PRODUCED WATER REINJECTION WELL

In 1987, the then current owners of the wellsite, Kelt UK Limited, drilled a second well from the Kirby Misperton 1 wellsite, KM3. The well was subsequently completed as a produced water reinjection well in to the Kirkham Abbey formation and is permitted under a Consent to Discharge (Ref: NPSWQD001330) issued 15th February 2010 to discharge *Trade Effluent comprising formation water and gas condensate* from *The gas extraction wells and Knapton Generating station* [Ref.17].

For the purpose of absolute clarity, the KM8 hydraulic fracturing operation, including the well test, production test and subsequent production, does not contemplate nor propose the use of the existing KM3 produced water reinjection well to dispose of flowback water. There is no physical connection (flowline) between the KM8 well and the KM3 well.

Based on a detailed evaluation of the log and core data it is anticipated that any gas produced from the Bowland formation will be dry. Whilst very unlikely, if formation water is produced with the natural gas, it will be removed as part of the routine production activity, which includes phase separation and liquid storage on site for subsequent off site treatment and/or disposal at an Environment Agency permitted waste 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.

The onsite removal of any moisture or formation water during the KM8 well test, production test and subsequent production will ensure that no waste (flowback water) enters the pipeline, thus eliminating the commingling of formation water and gas condensate produced from other producing wells, which ultimately is reinjected in to the Kirkham Abbey formation via the KM3 well.

4.8 EXISTING PRODUCTION EQUIPMENT

To facilitate the production of natural gas at the wellsite, production equipment consisting of corrosion inhibitor and glycol tanks, separator module, pig launcher and control room has been installed. The KMA wellsite also accommodates the separator module for the Pickering 1 well. The production equipment is skid mounted, individually bunded and sits upon dedicated concrete bases.

The production equipment has a number of emergency vent points throughout the process. These vent points, together with anticipated flow rates, gas composition, leak rates and potential fugitive gas from flowback water has been assessed and an emissions dispersion model established using the ADMS 5 model. The emissions dispersion modelling is included within the Air Quality Impact Assessment included as Appendix 7.

4.9 ACCEPTABLE GAS COMPOSITION (KNAPTON GENERATING STATION)

Natural gas produced from the KM8 well will be transferred to Knapton Generating Station via pipeline where it will be used to generate electricity by way of a gas powered turbine. The gas powered turbine (GE LM6000) is capable of operating within a range of gas compositions. In the unlikely event, however, that the natural gas produced from the KM8 well or likewise, any other well within the Ryedale Gas Fields, is outside of the operating range of gas composition for the GE LM6000 turbine, production will be suspended, the responsible well identified and production from that well suspended.

Based on a detailed evaluation of the log and core data it is anticipated that any gas produced from the Bowland formation will be within the acceptable gas composition range of the GE LM6000 turbine.

4.10 CLASSIFICATION OF OPERATION

A review of the proposed KM8 hydraulic fracturing operations against applicable environmental legislation has identified the following classifications as being applicable to the wellsite.

4.10.1 A Groundwater Activity

The Environmental Permitting (England & Wales) Regulations 2016, which transposes the requirements of the Water Framework Directive 2000/60/EC [Ref.18], requires groundwater activities to be authorised. A groundwater activity is defined in schedule 22 Paragraph 3 (1) (c) *any other discharge that might lead to the direct or indirect input of a pollutant to groundwater.*

Although the risk to groundwater is very low due to the way in which Third Energy has constructed the KM8 borehole and that only non-hazardous constituents will be used within the hydraulic fracturing fluid, Third Energy is taking a precautionary approach to the KM8 hydraulic fracturing operations by applying for a groundwater activity permit.

For the purpose of this Waste Management Plan, the KM8 exploratory operations are expected to be classified by the Environment Agency as a groundwater activity, namely, any other discharge that might lead to the direct or indirect input of a pollutant to groundwater.

4.10.2 Mining Waste Operation and Mining Waste Facility

The Environmental Permitting (England and Wales) Regulations 2016, which transposes the requirements of the Mining Waste Directive 2006/21/EC, requires mining waste operations to be authorised. A mining waste operation is defined in Schedule 20 paragraph 2 (1) of EPR 2016 as ‘the management of extractive waste, whether or not involving, a mining waste facility.

For the purpose of this Waste Management Plan, the KM8 hydraulic fracturing operations are classified as:

- A Non-Hazardous Mining Waste Operation for the management of extraction waste, whether or not involving a mining waste facility. Non-hazardous extractive waste will be produced during the pre-stimulation workover, the flow back to surface of the hydraulic fracture fluid and residual flow back water during well testing operations. A permit subject to the mining waste directive covers the management of extracted waste and not the extraction process;
- A Non-Hazardous Mining Waste Facility for the accumulation of hydraulic fracture fluid which will not return to the surface and will remain within the formation being stimulated. A

Waste Facility is defined 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’

- a period of more than one year for facilities for non-hazardous non-inert waste;

Table 4.2 below demonstrates the classification of each waste stream.

Waste Stream	Management	Classification	
Well Suspension Brine	Suspension brine shall be circulated out of the well and stored onsite within cylindrical tanks.	Non Hazardous	Waste Operation: M4.
Casing Scraper	Casing will be scraped clean using a casing scraper, the metal scrapings will attach to magnets set above the casing scraper and/or circulated to surface, separated and stored on site for subsequent removal.	Non Hazardous	Waste Operation: M4.
Hydraulic Fracture Fluid (In Formation)	A volume of >50% of the hydraulic fracture fluid per treatment will remain in the formation being stimulated. The KM8 hydraulic fracturing operation provides for five individual zones within the Bowland formation to be fractured.	Non Hazardous	Waste Facility: M3.
Hydraulic Fracture Fluid (Flowback at Surface)	Upon completion of the fifth hydraulic fracture treatment the flowback water is considered a waste.	Non Hazardous	Waste Operation: M4.
Proppant (Sand)	Upon completion of each hydraulic fracture treatment the flowback water will be filtered to remove any proppant from within the fluid.	Non Hazardous	Waste Operation: M4.
Milling of the Packers	Milling of the packers, the metal cuttings circulated to surface, separated and stored on site for subsequent removal.	Non Hazardous	Waste Operation: M4.
Nitrogen	Nitrogen may be used for the initial lifting of the well. It is considered a closed loop system, being flowed to the Knapton Generating Station, comingled with natural gas, where the natural gas is combusted to generate electricity. For clarity, nitrogen is also a component of the natural gas composition, as detailed in Table 4.1.	Non Hazardous	Waste Operation: M4.

Table 4.2: Classification of Waste Streams

5 EXTRACTIVE AND NON-EXTRACTIVE WASTE MANAGEMENT

The following sections describe the various extractive and non-extractive wastes arising from the KM8 hydraulic fracturing operation, their classification and anticipated quantities. This section also describes the objectives of Third Energy of appropriately manage waste and how these objectives are achieved through waste minimisation, methods of treatment and disposal.

5.1 OPERATOR WASTE OBJECTIVES

The Third Energy UK Gas Limited's policy on waste Duty of Care, waste segregation, waste handling and waste transfer are set out and based upon the Environmental Management System, Knapton Generating Station Waste Management Plan.

The Site Waste Champion for the KMA wellsite will be the Third Energy HSE Supervisor who reports directly to the Third Energy HSE Manager, who in turn reports to the Third Energy Operations Director. In addition to his HSE duties, the Third Energy HSE Supervisor will:

- Promote awareness of the Waste Management Plan;
- Monitor and report on waste generation;
- Monitor and enforce on waste segregation;
- Monitor the effectiveness of the Waste Management Plan;
- Form a good working relationship with the waste management contractor; and
- Encourage suggestions for better waste management on site.

Article 5(2) of the Mining Waste Directive sets out the objective of the waste management plan.

(a) to prevent or reduce waste production and its harmfulness, in particular by considering:

(i) waste management in the design phase and in the choice of the method used for mineral extraction and treatment;

(ii) the changes that the extractive waste may undergo in relation to an increase in surface area and exposure to conditions above ground;

(iii) 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 Community level and with the requirements of this Directive where relevant;

(iv) putting topsoil back in place after the closure of the waste facility or, if this is not practically feasible, reusing topsoil elsewhere;

(v) using less dangerous substances for the treatment of mineral resources;

(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 this Directive where relevant;

(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 waste facility and by choosing a design which:

(i) requires minimal and, if possible, ultimately no monitoring, control and management of the closed waste facility;

(ii) prevents or at least minimises any long-term negative effects, for example attributable to migration of airborne or aquatic pollutants from the waste facility; and

(iii) ensures the long-term geotechnical stability of any dams or heaps rising above the pre-existing ground surface.

In accordance with Article 5(2)(i) of the Mining Waste Directive, two possible methods for the management of flowback water were identified during the design phase of the KM8 hydraulic fracturing operations.

The first method of flowback water management involves the treatment and reuse of flowback water, which reduces the overall volume of waste water disposal off site. In doing so, however, it introduces an additional waste stream, in the form of a post treatment sludge (85% water and 15% suspended solids). This method is contingent on flowback rates encountered post hydraulic fracture treatment. If flowback rates are slow, the time required to accumulate sufficient flowback fluid for treatment and reuse will increase significantly, extended the overall duration of hydraulic fracturing operations. In turn, this will increase the volume of other waste streams associated with the operation.

The second method of flowback water management involves the offsite treatment and/or disposal at an Environment Agency permitted waste treatment facility. This method of flowback water management provides a degree of certainty over the duration of the operation and negates any risk of having to extend the duration to allow for the treatment and reuse of flowback water. In turn, this will negate an increase in the volume of other waste streams associated with the operation.

On that basis that both methods of flowback water management are intended to minimise overall waste production, both methods can be considered as meeting the requirements of Article 5(2)(a) of the Mining Waste Directive.

With reference to Article 5(2)(ii) of the Mining Waste Directive, extractive waste generated during KM8 hydraulic fracturing operation does not undergo any changes in relation to surface area or exposure to conditions above ground. It is the intention that all extractive waste generated during the KM8 hydraulic fracturing operation will be temporarily stored on site for subsequent off site treatment and/or disposal at an Environment Agency permitted waste treatment facility.

In the case of the KM8 hydraulic fracturing operation, the operation does not generate extraction voids nor does current environmental legislation support the reinjection of flowback water from a high volume hydraulic fracture operation. Article 5(2)(iii) of the Mining Waste Directive is, therefore, not applicable to the KM8 hydraulic fracturing operation.

The KMA wellsite is subject to a closure plan upon cessation of natural gas production. The closure plan will set out the details for wellsite restoration, including the replacement of topsoil currently stored on site. The reuse of topsoil after closure accords with Article 5(2)(iv) of the Mining Waste Directive.

With reference to Article 5(2)(v) of the Mining Waste Directive, only non-hazardous constituents will be used within the hydraulic fracturing fluid. Each constituent not having previously been approved by the Environment Agency, has been assessed using the Joint Agencies Groundwater Directive Advisory Group (JAGDAG) assessment methodology. The assessment concluded that all constituents assessed for use in the KM8 hydraulic fracturing operation are classified as non-hazardous to groundwater. A copy of the JAGDAG substances assessment is provided within Appendix 4 of this Waste Management Plan.

5.2 WASTE PREVENTION AND MINIMISATION

Third Energy and its specialist contractors follow Article 4 of the revised EU Waste Framework Directive which is transposed within UK law through The Waste (England and Wales) Regulations 2011.

5.2.1 Waste Prevention

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

- Avoiding packaged material where practicable;
- Ordering correct quantities;
- Avoiding damage by handling and storing correctly;
- Using less materials in designs and manufacturing;

5.2.2 Preparing for Re-Use

Only dispose of waste which cannot economically or practically be re-used or recycled. Materials such as drilling fluids can be readily re-used. Checking, cleaning, repairing and refurbishing or items and spare parts for subsequent re-use.

5.2.3 Recycle

Waste is to be segregated onsite to allow for recycling off site. Additionally, materials that are recycled shall be procured for use on site where practicable and where specification permits. Turning waste into a substance or product including composting or for the treatment of soils subject to quality protocols.

5.2.4 Other Recovery

Anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste, some backfilling.

5.2.5 Dispose

Waste that cannot be reused or recycled practicably shall be disposed of responsibly and in compliance with Third Energy UK Gas Limited duty of care obligations. All waste shall be removed from site by a licenced waste carrier to a licenced waste site.

5.3 WASTE DESCRIPTION AND MANAGEMENT ARRANGEMENTS

An assessment of the potential waste arising from the KM8 hydraulic fracturing operations has been undertaken. The potential waste, together with its classification anticipated quantities, prevention, minimisation, treatment and disposal is provided in this section.

For the purpose of information, storage tanks will be located at various positions on the KMA wellsite. Storage tanks will be positioned on the southern and western boundaries of the KM1 wellsite extension. Storage tanks will also be placed on the northern section of the original KM1 wellsite, immediately south of the gabion wall, which separates the two sites. A site layout drawing, showing the location of the storage tanks, together with the hydraulic fracturing equipment is included within Appendix 8 of this Waste Management Plan.

The storage tanks will be fully sealed and hydrostatically tested following construction and routinely tested as part of an ongoing maintenance system. Each storage tank is fitted with an emergency relief vent, which under normal operating conditions is in the closed position. In the unlikely event that the storage tanks should see a build-up of pressure, the pressure relief vent will open to release the pressure.

Air quality monitoring, together with real-time gas detection, will be used to monitor fugitive releases from storage tanks. Real-time gas detection is primarily used for occupational safety monitoring, providing site personnel with early warning in the event of a gas release. Such occupational safety monitoring will also provide early indication of a gas release, which may have the potential to impact on Air Quality Standards (AQS). The early warning will initiate emergency actions on site to minimise and control the release.

All storage tanks and skips will be located upon an impermeable membrane. Storage tanks and skips located within KM1 wellsite extension will utilise the existing HDPE impermeable membrane. Storage tanks and skips located within the original Kirby Misperton 1 wellsite will be sited upon an impermeable membrane with bunded walls.

Third Energy has assessed the potential waste streams arising from the KM8 hydraulic fracturing operations and understands its responsibility to ensure that all waste streams are characterised and carried out to ensure that the waste produced is treated or disposed of appropriately. All waste arising from the KM8 hydraulic fracturing operations are accepted by a number of permitted waste treatment and/or disposal facilities in the UK.

5.3.1 Extractive Waste

Well Suspension Brine		
Waste Classification, Quantity and Storage	**Classification**	Non Hazardous
	EWC Code	01 05 08
	Estimated Quantity	25m^3
	On Site Storage	1 x 70m^3 Horizontal Closed Tank
	Storage Duration	Maximum 28 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	The KM8 well is currently suspended using suspension brine and mechanical plugs. During the pre-stimulation workover the suspension brine will be circulated out of the well to an onsite storage tank via temporary surface pipework.	
Waste Prevention and Minimisation	The suspension brine will be stored onsite for subsequent reuse as suspension brine within the well operation or considered for use at one of Third Energy's other wellsite operations. If it cannot be reused then the suspension brine will be become a waste.	
Waste Treatment and Disposal	Once the suspension fluid has fully served its purpose at the wellsite or one of Third Energy's other wellsite operations, the suspension brine will be removed from site via a licenced haulier to an Environment Agency permitted waste water treatment facility where it is processed, treated and discharged in accordance with the permitted controls of the water treatment facility.	
Waste Remaining in the Formation	None. Suspension brine circulated out prior to perforating the casing.	
Monitoring	An inspection of the fluid tanks that contain the suspension fluid shall be carried out prior to being used and will be subject to visual weekly inspections and annual thickness checks.	

Table 5.1: Extractive Waste – Well Suspension Brine

Casing Clean-Up		
Waste Classification, Quantity and Storage	**Classification**	Non Hazardous
	EWC Code	20 01 40
	Estimated Quantity	50kg
	On Site Storage	1 x Open Top Builder's Skip
	Storage Duration	Maximum 7 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	A clean up assembly will be run into the well and will scrape and remove any debris from the perforations. Fresh water will be circulated down the workstring during the wellbore cleaning operation and will circulate out the debris.	
Waste Prevention and Minimisation	Debris minimisation, as a result of the casing perforating operation, is provided by minimising the sections of casing to be cleaned, thus reducing the amount of debris circulated to surface.	
Waste Treatment and Disposal	The debris, consisting of small steel scrapings, will be separated from the fluid at surface using a conventional shale shaker and circulating tank. The shale shaker will capture any debris from the circulated fluid and divert them to a cuttings skip for subsequent removal from site for offsite recycling and/or disposal at an Environment Agency permitted waste treatment facility where it recycled as metal. 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.	
Waste Remaining in the Formation	None.	
Monitoring	Skips will be inspected prior to use to ensure they are suitable for holding metal scrapings from the casing and subject to visual weekly inspections. Visual inspection to ensure no over loading occurs.	

Table 5.2: Extractive Waste – Casing Clean-Up

Hydraulic Fracture Fluid (Retained in Formation)		
Waste Classification, Quantity and Storage	**Classification**	Non Hazardous
	EWC Code	01 01 02
	Estimated Quantity	Total over 5 fractures 450m^3 to 3,291m^3
	On Site Storage	Not Applicable
	Storage Duration	Indefinitely
	Odour Potential	Not Applicable
Operation / Activity	Third Energy intends to carry out up to 5 hydraulic fracture treatments within the Bowland formation. The technique is used to hydraulically fracture the formation and prop open the fractures using proppant. This in turn provides permeability, allowing natural gas from within the formation to flow into the wellbore and up to surface.	
Waste Prevention and Minimisation	Due to the poor permeability of the Bowland formation, it is anticipated that up to 50% of the hydraulic fracture fluid will return to surface. The remaining hydraulic fracture fluid will be retained within the Bowland formation and, as such, is classified as a Non-Hazardous Mining Waste Facility.	
Waste Treatment and Disposal	Not Applicable.	
Waste Remaining in the Formation	No less than 50% of the hydraulic fracture fluid will be retained within the Bowland formation.	
Monitoring	Hydraulic fracture growth will be determined through micro seismic monitoring, providing evidence of the height and distance.	

Table 5.3: Extractive Waste – Hydraulic Fracturing Fluid (Retained in Formation)

Hydraulic Fracture Fluid (Flowback Water)		
Waste Classification, Quantity and Storage	**Classification**	Non Hazardous
	EWC Code	01 01 02
	Estimated Quantity	Up to 450m^3 (if flowback is treated &reused 987m^3 to 1646m^3 (flowback not treatment & reused)
	On Site Storage	15 x 70m^3 Horizontal Closed Tank
	Storage Duration	Maximum 28 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	Third Energy intends to carry out up to 5 hydraulic fracture treatments within the Bowland formation. The technique is used to hydraulically fracture the formation and prop open the fractures using proppant. This in turn provides permeability, allowing natural gas from within the formation to flow into the wellbore and up to surface.	
Waste Prevention and Minimisation	Due to the poor permeability of the Bowland formation, it is anticipated that between 30% and 50% of the hydraulic fracture fluid will return to surface. Reuse of the flowback water in subsequent zones being hydraulically fractured will minimise the volume of waste generated. The reuse of hydraulic fracture fluid will be dependent on flow back rates. If flowback rates are slow, the time required to accumulate sufficient flowback fluid for treatment and reuse will increase significantly, extended the overall duration of hydraulic fracturing operations. In turn, this will increase the volume of other waste streams associated with the operation, including the addition of a post treatment sludge (85% water and 15% suspended solids).	
Waste Treatment and Disposal	Depending on the outcome of radionuclides analysis, flowback 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 the Best Available Technique (BAT).	
Waste Remaining in the Formation	Not Applicable.	
Monitoring	A contamination monitoring programme will be devised and include the wellhead temporary separator equipment and storage tanks. Consignment 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 5.4: Extractive Waste – Hydraulic Fracturing Fluid (Flowback Water)

Proppant (Sand) from Fifth Hydraulic Fracture Treatment		
Waste Classification, Quantity and Storage	**Classification**	Non Hazardous
	EWC Code	01 04 09
	Estimated Quantity	150 Tonnes
	On Site Storage	8 x 20 Tonne Sealed Tanks / Enclosed cuttings skip
	Storage Duration	Maximum 28 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	Flowback water will contain proppant (sand) which is removed at surface.	
Waste Prevention and Minimisation	The quantity of proppant used is specific to each hydraulic fracture treatment. Flowback water from hydraulic fracture treatments will be filtered to remove any proppant. Whilst the use of new proppant for each hydraulic fracture increases the waste volumes of proppant, the reuse of the proppant would generate additional waste streams from the treatment and cleaning process of the filtration, treatment and storage equipment. The decision to use new proppant for each hydraulic fracture has also considered the amount of vehicle movements required and subsequent emissions from those movements. Emissions from the use of this additional processing equipment are also a consideration, including engine emissions and noise, which are negated if the proppant is not reused.	
Waste Treatment and Disposal	The proppant will be transported off site via licenced haulier to an Environment Agency permitted composting facility, where it is blended with compost after it has been sanitised. Such facilities are available in the UK and hold the relevant permits for taking this waste code. The physical treatment process consists of a dewatering prior to blending with compost. The physical treatment process (dewatering and composting) is identified within the waste facility's Environmental Permit.	
Waste Remaining in the Formation	Not Applicable.	
Monitoring	Tanks will be inspected prior to use to ensure they are suitable for holding proppant and subject to visual weekly inspections and annual thickness checks. Visual inspection to ensure no over loading occurs.	

Table 5.5: Extractive Waste – Proppant (Sand)

Milling of Packers (Metal)		
Waste Classification, Quantity and Storage	**Classification**	Non Hazardous
	EWC Code	20 01 40
	Estimated Quantity	200kg
	On Site Storage	1 x Open Top Builder's Skip
	Storage Duration	Maximum 7 Days
	Odour Potential	No Odour Anticipated
Operation / Activity	Coil tubing will be run into the borehole with a suitable drilling bit and will proceed to drill out each of the bridge plugs in turn, starting with the top plug. Fluid will be circulated down the coil tubing during the drilling operation and will circulate out the cuttings generated from the drilling action.	
Waste Prevention and Minimisation	Not possible to minimise debris from the casing perforating operation.	
Waste Treatment and Disposal	The cuttings will be separated from the fluid at surface using a conventional shale shaker and circulating tank. The shale shaker will capture any cuttings from the drilling and divert them to a cuttings skip for subsequent removal from site for offsite recycling and/or disposal at an Environment Agency permitted waste treatment facility, similar to the practices used during the drilling of the KM8 well where it is recycled metal. 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.	
Waste Remaining in the Formation	None.	
Monitoring	Skips will be inspected prior to use to ensure they are suitable for holding metal scrapings from the casing and subject to visual weekly inspections. Visual inspection to ensure no over loading occurs.	

Table 5.6: Extractive Waste – Milling of Packers (Metal)

Nitrogen		
Waste Classification, Quantity and Storage	**Classification**	Inert
	EWC Code	Not Applicable
	Estimated Quantity	Not Known at this Time
	On Site Storage	None – Comingled with the Natural Gas
	Storage Duration	Not Applicable
	Odour Potential	No Odour Anticipated
Operation / Activity	Nitrogen is injected into the well to aid the initial lifting of wellbore fluids, thus reducing the hydrostatic pressure and allowing natural gas to flow to surface.	
Waste 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 during the natural gas combustion process within the gas turbine at the Knapton Generating Station. To minimise the amount of nitrogen used, calculations will be used to determine the amount required to displace the fluids before gas reaches surface. The quantities of nitrogen required are small and a detailed measurement cannot be provided at this stage.	
Waste Treatment and Disposal	As an inert gas, nitrogen that has been extracted from the atmosphere will be comingled with the natural gas and flowed to the Knapton Generating Station for combustion within the gas turbine. For clarity, nitrogen is also a component of the natural gas composition, as detailed in Table 4.1. Unburnt nitrogen will be released to atmosphere during the natural gas combustion process.	
Waste 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 5.7: Extractive Waste – Nitrogen

5.3.2 Non-Extractive Waste

During the KM8 exploratory operations there may be non extractive wastes generated on site:

- Surface run-off water;
- Waste water and sewage;
- Waste engine, gear and lubricating oils;
- Waste hydraulic oils;
- Oil rags and absorbents;
- Waste oil filters;
- Paper and cardboard;
- Canteen waste;
- Wood; and
- Metal.

For clarity, the proposed development does not require nor does it propose the installation of a permanent connection to the existing sewerage. During the short duration pre-stimulation workover and hydraulic fracture stimulation/well test phases, when the number of personnel on site will be at its greatest, temporary welfare facilities will be provided on site, each facility having an independent under-unit sewage tank. During the production test phase and production phase, temporary welfare facilities are provided within the security cabin. During the site restoration phase, temporary welfare facilities are provided within the security cabin and/or 'Portaloo' type welfare facilities.

Sewage will be collected periodically throughout the short duration period when the wellsite is manned and removed by 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.

There will be no treatment or disposal of non extractive waste onsite and any storage will be limited to temporary storage, pending collection. No temporary storage of non extractive waste will exceed 12 months.

5.3.3 Waste Supervision and Carriers

A Site Supervisor will be appointed by Third Energy to oversee the KM8 hydraulic fracturing operation, including the management of wastes onsite. The management of waste on site will include:

- Management of waste in accordance with the waste hierarchy, as set out in the Waste (England and Wales) Regulations 2011 [Ref.19];

- Monitor all waste storage units such as skips and storage tanks;
- Liaise with third party waste advisors with respect to sampling and analysis of waste;
- Compiling all waste transfer notes; and
- Manage the collection and offsite disposal of all waste streams.

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

5.3.4 Wellsite Supervisor

Third Energy will appoint competent Wellsite Supervisor to oversee the KM8 hydraulic fracturing operation. They will be responsible for the Health and Safety of personnel, contractors and public and the implementation of any identified environmental requirements to ensure that operations do not have an adverse impact on the environment during wellsite operations including waste management. The onsite waste broker will report to the wellsite supervisor and provide advice where necessary to ensure that the management of waste has been undertaken in compliance with legislation and the waste hierarchy.

All Wellsite Supervisors will hold the relevant certificates and will be sufficiently experienced in accordance with the Third Energy's Business Management System, specifically the Contractor Selection and Management Guidance Document. The appointed Wellsite Supervisor will have:

- Minimum 5+ years' experience in wellsite supervision and in oil and gas drilling and production technologies;
- Current IWCF certification;
- Experience of well engineering, operation standards and applicable industry best practices;
- Experience in emergency response procedures;
- Understanding and application of applicable legislation, including but not limited to, the Offshore Installation and Wells (Design and Construction Etc.) Regulations 1996 [Ref.20], Borehole Sites and Operations Regulation 1995 [Ref.21] and be aligned with any revisions therewith.

6 ENVIRONMENTAL RISK ASSESSMENT

An Environmental Risk Assessment has been carried out in support of the permit application and is based upon the Horizontal Guidance Note H1 Environmental Risk Assessment for permits. (Version 2.1, December 2011) [Ref.22] and the EPR6 14: How to comply with your environmental permit: Additional guidance for: mining waste operations, Version 2, February 2011 [Ref.23].

The environmental risk assessment follows the following H1 structure:

- Identify the risk from the activity
- Assess risks and check they are acceptable
- Justify appropriate measures to control the risk (if needed)
- Present the risk assessment

Of the 10 (10) annexes that together form the Horizontal Guidance for the environmental risk assessment, the following annexes have been included. Annexes not referenced below are not relevant to the proposed KM8 hydraulic fracturing operation:

- Annex (a) Amenity and accident risks from installations and waste operations
- Annex (d) Discharges to Surface Water
- Annex (f) Air emissions
- Annex (g) Disposal and recovery of waste produced on site
- Annex (h) Global warming potential
- Annex (j) Groundwater

A copy of the environmental risk assessment, together with a supporting statement and conventional model is included within ‘KM8 Environmental Risk Assessment’ (TE-EPRA-KM8-HFS-ERA-07) provided in support of the environmental permit application.

7 MEASURES TO MINIMISE ENVIRONMENTAL IMPACT

Measures to minimise the environmental impact of the operation have been incorporated as part of the initial site selection process, site design and construction through to subsequent exploration operations. The measures to mitigate long term environmental impact are:

- Site located suitable distance from residential properties
- Site located away from any statutory designated areas
- Baseline monitoring of ecology, noise, water
- Hydrogeological risk assessment
- Site design to include impermeable membrane and containment ditches
- Wellbore lifecycle design to protect groundwater
- Hierarchy of waste management
- Operating procedures and inductions
- Waste handling, storage and disposal regime
- Continuous Training and development
- Environmental monitoring
- Restoration and aftercare

8 CONTROL AND MONITORING OF WASTE

The environmental risk assessment has identified the requirement to control and monitor waste generated from the KM8 hydraulic fracturing operation. A brief description of the control and monitoring of waste is provided below, with a separate Emission Monitoring Plan (TE-EPRA-KM8-HFS-9) provided in support of the environmental permit application.

8.1 RELEASES TO GROUNDWATER

The potential for a release to groundwater exists both at surface and within subsurface and has been assessed by way of a Hydrogeological Impact Assessment, which is included with the KMA Site Condition Report (TE-EPRA-KM8-HFS-SCR-06), submitted together with this Waste Management Plan in support of the KM8 hydraulic fracturing environmental permit application.

A baseline groundwater quality for the KMA wellsite has been established, which is described in detail within the KMA Site Condition Report (TE-EPRA-KM8-HFS-SCR-06).

8.1.1 Surface Release

Incorporated into the design of the Kirby Misperton 1 extension is an impermeable membrane constructed using fully welded 1mm HDPE, protected above and below by non-needle punch geotextile. The impermeable membrane prevents surface fluids (mainly rainwater) penetrating the underlying subsoils. Surface fluids migrate along the surface of the impermeable membrane to a perimeter ditch, where it is contained for subsequent reuse in the operation or removed via road tanker to an Environment Agency approved waste water treatment works for subsequent treatment and disposal.

The original wellsite is clay lined and the existing production equipment bunded. All equipment associated with the KM8 hydraulic fracturing, which is to be located within the Kirby Misperton 1 wellsite will be sited upon an impermeable membrane with bunded walls.

Daily inspections of the drainage ditch and bunds are undertaken to ensure the level does not exceed the maximum containment. If the level is close to reaching the maximum containment, the surface fluids are removed by road tanker for subsequent disposal at an approved waste facility.

A daily inspection of all tanks and other waste storage containers shall be undertaken to ensure they remain fit for purpose. The inspections will aid early identification of any potential release to site from equipment which deteriorates over time.

8.1.2 Subsurface Release

Risks are mitigated by adopting the best practice approach to wellsite construction, well construction and management of the hydraulic fracturing operation described in this planning application, Environmental Statement and Environmental Permit Application.

8.1.3 Groundwater Quality Monitoring

A scheme of groundwater quality monitoring, which has been discussed with the Environment Agency and their comments taken on board, provides for the monitoring of groundwater quality prior to, during and after the KM8 hydraulic fracturing operation. Results of the groundwater quality monitoring scheme will be made available for inspection by the Environment Agency and will form part of the monthly emissions submission as part of the environmental permit.

8.2 RELEASES TO AIR

Baseline air quality has been established for the KMA wellsite, which is described in detail within the KMA Site Condition Report (TE-EPRA-KM8-HFS-SCR-06).

The potential for a release to air has been assessed by way of an Air Quality Impact Assessment, which is included as Appendix 7 and submitted in support of the KM8 hydraulic fracturing environmental permit application. The Air Quality Impact Assessment considers all phases of the proposed development and assesses their impacts against Air UK Air Quality Standards (AQS) [Ref.24]. The proposed development does not contemplate flaring of natural gas and therefore the Air Quality Impact Assessment assesses the impacts from vehicle and equipment emissions and fugitive emissions. For clarity, whilst the Air Quality Impact Assessment takes into consideration all equipment and vehicles associated with the KM8 hydraulic fracturing, for the purpose of this Waste Management Plan, only emissions to air resulting from the management of extraction waste will be regulated by the Environment Agency.

The Air Quality Impact Assessment concludes that the well operations will not affect the attainment of air quality standards around the areas of permanent human habitation closest to the wellsite and will have negligible impact at local statutory designated conservation sites. Exceedances in short term air quality standards for some pollutants are likely on occasions around the site boundary during the hydraulic fracturing operation due to the equipment being operated on site.

A scheme of air quality monitoring will be undertaken during the KM8 hydraulic fracturing operation to monitor compliance with AQOs or relevant Limit Value. Results of the air quality monitoring scheme will be made available for inspection by the Environment Agency and will form part of the monthly emissions submission as part of the environmental permit.

8.3 NOISE

Baseline noise monitoring was undertaken over a two week period in February/ March 2015 to determine the background noise levels at the nearest sensitive receptors.

The potential for noise to be generated has been assessed by way of a Noise Impact Assessment, which has been submitted in support of the KM8 hydraulic fracturing planning application. The average sound power level of a typical workover rig, the highest noise generating hydraulic fracture equipment, pumps and blenders and production equipment was then modelled to give a predication of the noise levels to be anticipated during these operational phases at the nearest sensitive receptors.

For clarity, whilst the Noise Impact Assessment takes into consideration all equipment and vehicles associated with the KM8 hydraulic fracturing, for the purpose of this Waste Management Plan, only noise emissions resulting from the management of extraction waste will be regulated by the Environment Agency.

Nosie modelling indicates that the pre-stimulation workover and hydraulic fracture stimulation phases will be likely to generate the highest noise levels, however, these two operational phases have a short combined duration of eight (8) weeks. Additional mitigation during the pre-stimulation workover and hydraulic fracture stimulation phases will be provided. Noise modelling of the production test and subsequent production indicates noise levels will be extremely low and below the background noise levels at the nearest sensitive receptors.

The Noise Impact Assessment concludes that noise generated during the five (5) operational phases will fall within noise levels set within applicable planning practice guidance.

A scheme of noise monitoring will be undertaken during the KM8 hydraulic fracturing operation to monitor compliance with noise limit values. Results of the noise monitoring scheme will be made available for inspection by the Environment Agency.

The methodology covering noise monitoring is provided within the KM8 Emissions Monitoring Plan (TE-EPRA-KM8-HFS-EMP-09).

8.4 WELLSITE MONITORING

Throughout the KM8 hydraulic fracturing operation and subsequent production of natural gas, environmental monitoring will be undertaken at the KMA wellsite.

Environmental monitoring is undertaken by the Wellsite Supervisor and service personnel during operations to identify potential leaks and emissions from site equipment and materials stored within the site. This ensures that any action required to remediate leaks or emissions can be undertaken as soon as they are identified and prevent potential impact on the environment. Environmental monitoring includes inspection of site perimeter ditches, site surface, bunds, storage tanks, sewage facilities, site equipment and any materials stored within the wellsite.

A written record of monitoring (Environmental Checklist) is completed once per 12 hour shift by the Wellsite Supervisor and submitted at the end of shift. Copies of the Environmental Checklist are held on site and are made available for review by the Environment Agency.

On completion of the KM8 hydraulic fracturing operation, environmental monitoring will be undertaken by the production operators who visit the wellsites on a daily basis.

8.5 CONTRACTOR PERFORMANCE

Third Energy is ultimately responsible for any waste generated on site during the KM8 hydraulic fracturing operations. Third Energy 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 Third Energy's Contractor Selection and Management Guidance Document (TE_HSEMS_GD02) and, under that standard, are then subject to periodic monitoring of their performance.

8.6 SECURITY

Security of the wellsite is provided in the form of fencing and lockable gates. Additional fencing is provided around the wellhead when the site is unmanned. A CCTV camera is also active when the site is unmanned and a roaming security detail is provided, carrying out routine visits to the wellsite.

During well operations, 24 hours onsite security is provided. Security 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, in accordance with the Site Safety Document, a requirement of the Borehole Sites and Operations Regulations 1995.

8.7 COMPLAINTS

In the event that a complaint is received from stakeholders, including neighbours, the complaint shall be recorded and investigated in accordance with Third Energy's health, safety and environmental management system.

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 may require notification 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.

9 ENVIRONMENTAL INCIDENT MANAGEMENT

The potential for an environmental incident to occur during the operation is minimal. The source of such incident is contained within the wellbore and contained within the wellsite.

9.1 CONTAMINATION WITHIN THE WELLBORE

Well control equipment is deployed on the well in accordance with API RP53 'Recommended Practice for Blowout Prevention Equipment Systems for Drilling Wells' [Ref.26]. Well control equipment is considered secondary well control in the event that the primary well control, hydrostatic fluid weight, is compromised. Well control equipment is subject to a schedule of certification and testing, together with a requirement for those operating well control equipment to be certified competent.

9.2 WELLSITE CONTAINMENT

The proposed development is being undertaken within an existing wellsite. Incorporated into the design of the Kirby Misperton 1 extension is an impermeable membrane constructed using fully welded 1mm HDPE, protected above and below by non-needle punch geotextile. The impermeable membrane prevents surface fluids (mainly rainwater) penetrating the underlying subsoils. Surface fluids migrate along the surface of the impermeable membrane to a perimeter ditch, where it is contained for subsequent reuse in the operation or removed via road tanker to an Environment Agency approved waste water treatment works for subsequent treatment and disposal.

The original wellsite is clay lined and the existing production equipment bunded. All equipment associated with the KM8 hydraulic fracturing, which is to be located within the Kirby Misperton 1 wellsite will be sited upon an impermeable membrane with bunded walls.

In addition to general spill containment and clean up equipment provided on site, a substantial environmental incident response trailer is provided. The trailer contains equipment necessary to minimise and if possible contain an environmental incident in the unlikely event that the impermeable membrane or containment ditch is compromised. The equipment provides for damming of any nearby water course and subsequent clean up, including temporary bunding of spent clean-up equipment.

In the very unlikely event of an environmental incident occurring beyond the capabilities of the equipment or personnel on site then a specialist contractor, for example Veolia Environmental Services, will be called to assist Third Energy in dealing with the incident.

9.3 FIRE RESPONSE

Whilst a fire is associated more so with the health and safety of the personnel on site, 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 on site and should be used to keep the areas adjacent to the fire cool to avoid any damage being sustained to the impermeable membrane.

9.4 INCIDENT REPORTING AND INVESTIGATION

All incidents, no matter how minor, are reported in accordance with Third Energy's Reporting of Accidents, Environmental Incidents and Near Misses Standing Instruction (SI-08). The procedure provides for the investigation of all incidents to ensure lessons are captured and actions implemented to avoid reoccurrence.

In addition, the standard 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 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.

10 ALTERATIONS TO THE PLAN

Any required changes or deviations from this plan are to be referred to the Third Energy HSE Manager or to the site HSE Adviser in the first instance. No changes to or deviations from this plan are to be implemented until the required changes or deviations have been reviewed and approved by Third Energy 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 for the operator, Third Energy, 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.

11 PLAN FOR CLOSURE

The wellsite is currently being used for petroleum exploration and production activities.

In the event that the well(s) is deemed not capable of producing commercial quantities of petroleum a decision will be made to abandon the well in accordance with Oil & Gas UK Guidelines for the suspension and abandonment of wells [Ref.27] and restore the site. In such an event, a closure plan will be created in accordance with section 3.4 of the Environment Agency's guidance "How to comply with your environmental permit, additional guidance for: mining waste operations" as part of any application to surrender the environmental permit. Wellsite restoration will be the subject of a separate waste management plan.

Other regulations relevant to the closure plan include:

- The Borehole Sites and Operations Regulations 1995 [Ref.21],
- Offshore Installations and Wells (Design & Construction Regulations 1996 [Ref.20], and
- Petroleum Act 1998 (Petroleum Exploration and Development Licence) [Ref.28].

12 REFERENCES

Ref.1: Secretary of State

Ref.2: Department for Energy and Climate Change

Ref.3: Department of Energy and Climate Change *Petroleum Licensing system*

Ref.4: Town and Country Planning Act, 1990

Ref.5: Natural England *Agricultural Land Classification Maps, 2011*

Ref.6: Environment Agency *What's in your Backyard*

Ref.7: North Yorkshire County Council *Planning Application Decision Notice: C3/12/00989/CPO*

Ref.8: Environmental Permitting (England & Wales) Regulations 2016

Ref.9: Water Resources Act, 1991

Ref.10 Water Act, 2003

Ref.11: Directive 2006/21/EC of the European Parliament and of the Council, 15 March 2006: *on the management of waste from extractive industries and amending Directive 2004/35/EC*

Ref.12: Environment Agency *Guidance notes on part B5 – New bespoke mining waste operation permit*, 2013

Ref.13: European Commission *Council Directive 91/689/EEC on hazardous waste*

Ref.14: European Commission *Council Directive 67/548/EEC on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (Dangerous Substances Directive)*

Ref.15: European Commission *Council Directive 1999/45/EC concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations (Dangerous Preparations Directive)*

Ref.16: European Commission *Council Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (Industrial Emissions Directive)*

Ref.17: Consent to Discharge (NPSWQD001330), February 2010: *Discharge Trade Effluent comprising formation water and gas condensate from the gas extraction wells and Knapton Generating Station*

Ref.18: European Commission *Council Directive* 2000/60/EC *establishing a framework for Community action in the field of water policy (The EU Water Framework Directive - integrated river basin management for Europe)*

Ref.19: Waste (England and Wales) Regulations, 2011

Ref.20: Health and Safety Commission *Offshore Installation and Wells (Design and Construction etc.) Regulations, 1996*

Ref.21: Health and Safety Commission *Borehole Sites and Operation Regulations, 1995*

Ref.22: Environment Agency, Horizontal guidance note H1, 2011

Ref.23: Environment Agency *EPR 6.14 How to comply with your environmental permit. Additional guidance for: mining waste operations, 2011*

Ref.24: Department for Environment Food and Rural Affairs *Air UK Air Quality Standards*

Ref.25: Department of Communities and Local Government *Planning Practice Guidance, 2014*

Ref.26: American Petroleum Institute *Recommended Practices for Blowout Prevention Equipment Systems for Drilling Wells Standard*

Ref.27: Oil and Gas UK *Guidelines for the Suspension and Abandonment of Wells, 2012*

Ref.28: Petroleum Act, 1998 *(Petroleum Exploration and Development Licence)*

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APPENDIX 1 – THIRD ENERGY CORPORATE INFORMATION

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THIRD ENERGY CORPORATE INFORMATION

Registered Office

Third Energy UK Gas Limited
Knapton Generating Station
East Knapton
Malton
North Yorkshire
YO17 8JF
Company Registration No: 01421481

Principal Office

Third Energy UK Gas Limited
Portland House
Bressenden Place
Westminster
London
SW1E 5BH

Tel: 0207 042 0800
Web: www.third-energy.com

Operational Office

Third Energy UK Gas Limited
Knapton Generating Station
East Knapton
Malton
North Yorkshire
YO17 8JF

Tel: 01944 758 746

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APPENDIX 2 – THIRD ENERGY ENVIRONMENTAL RISK MANAGEMENT SYSTEM

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Third Energy Holdings Limited

Third Energy UK Gas Limited is a subsidiary of Third Energy Holdings Limited, an upstream development and production company with a focus on gas assets in the Southern Permian Gas Basin. The company was established in 2011 to exploit opportunities in the most efficient, environmentally responsible manner in undeveloped oil and gas fields. Third Energy Holdings Limited and its subsidiaries operate under an existing Business Management System, an overview of which is detailed below.

Third Energy Holdings Limited has an established Business Management System. .

Mission and Core Values

To become one of the leading and most respected of the small Operators working in the UK in both onshore and offshore operations.

To foster honesty, integrity and respect for both people and nature, underneath our company culture where all our employees have a positive "Can Do" attitude.

Third Energy's core values apply to all the companies within Third Energy Holdings Limited. These stipulate that Third Energy employees shall be:

Safe	The safety and well-being of our staff, the public and the environment are critical to our success.
Responsive to Stakeholders	Our stakeholders are vital – we listen to them and our people are dedicated to adding value to their business.
Ethical	Our relationships are characterised by trust and integrity. We deliver our promises. People want to work with us over the long run.
Innovative	We do things differently as well as emphasising teamwork, candour in our relationships, learning and continuous improvement. We believe good business is also fun.
Cost Conscious	Awareness of costs – both business and environmental - underpins our performance and results.

Third Energy Holdings Limited seeks excellence and continual improvement in every aspect of performance and endeavours to share this vision with like-minded external parties and positively influence our partners through being an exemplar organisation.

The risk evaluation and management process is central to the Business Management System and is applied extensively to all Third Energy activities that have the potential to:

- Cause harm to people or the environment;
- Damage company assets and / or property;
- Damage the company reputation;
- Disrupt business continuity through loss of financial, commercial or leadership control.

The risk evaluation and management process requires:

- Identification of the risk;
- Evaluation and assessment of the risks (against screening criteria);
- Control risks through prevention and mitigation;
- Recovery measures which limit escalation (in event of occurrence).

Different ways of applying the risk evaluation and management process are used appropriate to the business process level.

Third Energy has a mature, systematic and thorough approach to managing risk. Special focus is put on ensuring that all activities, including those of Contractors and Sub-Contractors, are conducted in an ethical, safe and prudent manner.

We maintain high standards of governance and aim to demonstrate accountability and transparency in our dealings with our stakeholders, including local communities, in respect of our activities and potential impact upon the environment.

Third Energy ensures roles and responsibilities of employees, contractors and sub-contractors who manage hazards are understood at all levels of the organisation. We strive to ensure competence through developed competency programmes.

Third Energy will only use recognised and proven tools and techniques for HSE Risk Management in accordance with the requirements of industry best practice.

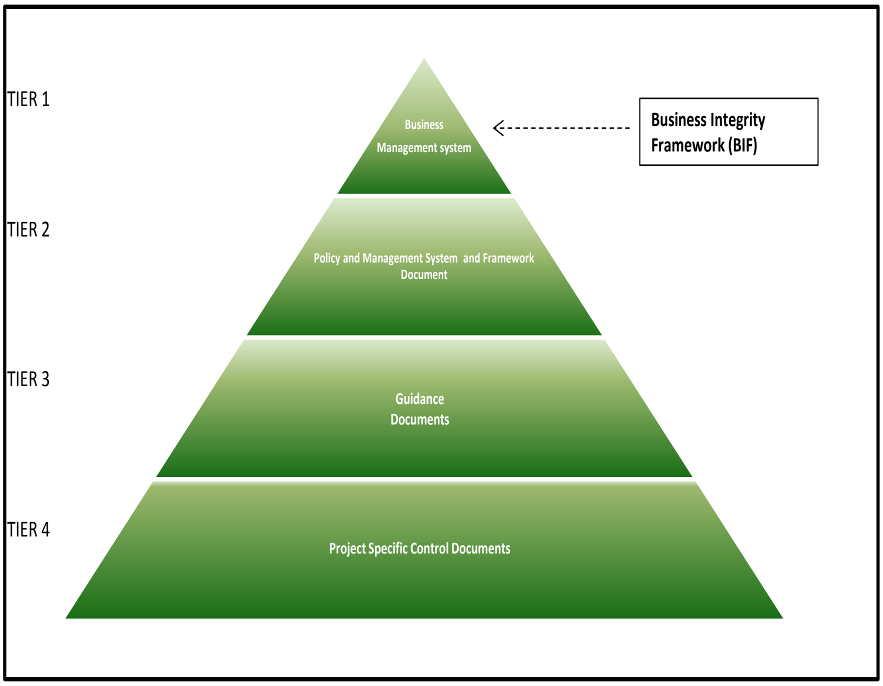
Third Energy sets objectives and targets that promote continual improvement in performance and continually monitors these indicators. These are set at all levels within the organisation - specifically and risk based. Site specific major accident risk indicators will be set for each installation or field, based on risk analysis with the intention of getting an early warning of any trends which could result in inability to meet risk acceptance criteria.

Third Energy has a systematic approach to ensure HSE risks in normal and abnormal operations including planned and unplanned changes are kept as low as reasonably practicable and within risk acceptance criteria.

Third Energy maintains systems and procedures for the design, construction, operation, maintenance and modification of facilities, which aim to prevent ill health, injury and pollution. Through these systems we ensure important barriers shall not be impaired or cease to function simultaneously as a con sequence of a single failure or single incident.

Third Energy communicates openly with employees and other people likely to be affected by our operations, to promote the practices and conditions that support our policy. In addition, we systematically identify, investigate and correct deficiencies in our HSEQ management systems. Third Energy emphasises reporting and investigation of actual or potential incidents. We regularly review the suitability and effectiveness of our policies, systems, objectives and targets to facilitate continual improvement.

The system structure is illustrated in the figure below. Tier 1 contains the BMS which is used to inform the subsequent MS documents. Tier 2 contains policies and framework (including HSE policy) that set strategic goals and document the commitment of the Company.



The BMS framework provides guidance on the implementation of policy requirements throughout the company. The TE guidance documents (and supporting documentation) are detailed in Tier 3 and provide additional information (and tools) for the Tier 2 policy and framework. The Guidance Documents must be acknowledged within Tier 4 documents, which contain detailed, specific and comprehensive controls for individual operations and activities.

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THIRD ENERGY UK GAS LIMITED

KNAPTON GENERATING STATION

ENVIRONMENTAL MANAGEMENT SYSTEM

ENVIRONMENTAL MANAGEMENT SYSTEM MANUAL

REVIEWED BY	ISSUE No	DATE
S.Zablocki OSM	06	11th September 2015

AUTHORISED BY	ISSUE No	DATE
M.Lea Station Manager	06	11th September 2015

1. INTRODUCTION

The purpose of this document is to provide guidance on the Environmental Management System (EMS) that is in operation in Knapton Generating Station and related well sites.

The scope of the Environmental Management System is all operations and activities related to Knapton Generating Station and related well sites.

It seeks to demonstrate the manner in which compliance with current legislation and regulations, as well as Company, Business and Station objectives and targets are achieved.

It identifies those persons with environmental responsibilities and signposts other station documentation where further information is available.

An Environmental Policy Statement, regular audits and reviews and the setting of an Annual Environmental Plan all contribute to the goal of continual improvement in environmental performance.

The Environmental Management System is based on the International Standard for Environmental Management Systems ISO 14001.

2. ENVIRONMENTAL POLICY STATEMENT

Knapton Generating Station has an environmental policy statement (incorporated into a combined Health, Safety and Environment Policy), a signed copy of which is always posted on the notice board.

Copies of this policy can be made available on request from the public, and is communicated internally to all staff and contractors working at Knapton Generating Station and related well sites.

The policy statement will be reviewed and if necessary updated annually.

3. ENVIRONMENTAL ASPECTS

The environmental aspects of operations, activities, products and services within Knapton Generating Station and related well sites are identified and their significance assessed.

Aspects that have a significant environmental impact are taken into account in establishing, implementing and maintaining the Environmental Management System.

The procedure for the assessment of environmental aspects and all assessed environmental aspects are kept on file.

4. LEGAL AND OTHER REQUIREMENTS

The procedure that will establish, implement and maintain the legal and other requirements related to the environmental aspects of Knapton Generating Station is Legal and Other Requirements.

5. ENVIRONMENTAL PLAN

Environmental targets and objectives are set annually to minimise the risk of significant environmental impacts of various activities as they are identified in the Register of Environmental Impacts.

The plan is developed by the Station Manager in consistency with the Environmental Policy to reflect improvements that can be made to reduce these impacts. Management objectives and planned improvements that relate to environmental issues and views of relevant interested parties are also considered and fed into the plan.

The Environmental Plan is endorsed at the Health, Safety & Environment Committee meeting and signed by the Station Manager. The contents of the Plan are communicated to those persons with responsibilities therein.

The Environmental Plan is audited monthly at the Committee meeting and progress assessed. Targets and dates are revised if necessary with reasons for changes documented in the relevant audit report.

A copy of the plan is in the control room and it can be available to staff and contractors.

6. STRUCTURE AND RESPONSIBILITIES

Specific responsibilities for the implementation of the Environmental Management System are as follows:

Station Manager

The Station Manager is responsible for the authorisation and implementation of the Environmental Policy at Knapton Generating Station. He will:

1. Prepare and maintain details for the organisation and arrangements for implementing the policy.

2. Set Environmental Objectives and Targets to ensure a continuous improvement in environmental performance.

3. Carry out an annual review of the Environmental Performance and implementation of Environmental Objectives and Targets.

4. Allocate responsibilities to the managers to establish, update and review, Operating Procedures, Standing Instructions and Environmental Management Procedures to ensure the implementation of the Environmental Policy and of Legal and Other Requirements.

5. Allocate resources under his control as necessary to provide and maintain conditions and places of work that are, so far as is reasonably practicable, safe and without risks to the environment.

6. Ensure that the plant is operated in order to minimise its impact on the environment.

7. Ensure that environmental arrangements are monitored on an active basis including Audits, Tours and workplace inspections are carried out and appropriate action initiated to secure continuing compliance in accordance with the policy.

8. Act as the Chairman of the Health, Safety and Environment Committee, ensure that the Environmental Management System is implemented, and encourage a proactive culture.

9. Ensure that all aspects of the plant PPC authorizations for Knapton Generating Station are fully complied with and all staff are familiar with the limits imposed by them.

10. The Station Manager will carry out the function of Waste Control Engineer.

O&M Supervisor

The O&M Supervisor is responsible for the implementation of the Company's Environmental Policy at Knapton Generating Station as it affects employees under his control. In particular, he will:

1. Ensure that all staff under his control are familiar with the policy and its implementation.

2. Overview the implementation of the annual Environmental Objectives and Targets for all employees under his control and carry out regular reviews to ensure a continuous improvement in environmental performance.

3. Implement and maintain a register of relevant Environmental Legislation in consultation with all information providers in accordance with the requirements of the Environmental Management System.

4. Ensure staff under his control are provided with training and refresher training where appropriate. The Administrator shall keep all records of training.

5. Ensure that all accidents, near misses and incidents are reported and investigated as per the Station Procedure and that remedial action is initiated to prevent a re-occurrence.
6. Monitor environmental arrangements on an active basis by carrying out regular audits, tours and inspections involving staff and employees to ensure continuing compliance in accordance with the policy and statutory requirements.
7. Monitor Emissions from the plant, which are to be reported under the requirements of the site PPC Permit, and prepare reports to satisfy those requirements as described in the Emissions Monitoring Procedure.
8. Participate in establishing, updating and reviewing, Operational Procedures, Standing Instructions and Environmental Management Procedures employed at Knapton Generating Station.
9. Ensure that environmental management system requirements are established, implemented, and maintained in accordance with ISO 14001.
10. Review of other plant documentation as required taking account of environmental issues.
11. Reporting on the performance of the environmental management system to management for review and as a basis for its improvement.
12. Ensure that the plant is operated to minimise its impact on the environment.
13. The O&M Supervisor will also carry out the functions of Environmental Co-ordinator and Waste Control Co-ordinator.

Lead Operators, Operators and Maintenance Staff

The Lead Operators, Operators and Maintenance Staff are responsible for the implementation of the Company's Environmental Policy at Knapton Generating Station. In particular, they will:

1. Ensure they are familiar with the policy and its implementation.
2. Implement environmental arrangements to ensure continuing compliance in accordance with the policy and statutory requirements.
3. Ensure that the plant is operated to minimise its impact on the environment. Monitor effluent discharge, plant chemistry, and ensure plant is operated within specified limits.

To help further in attaining high environmental standards employees can, for example:

- Ensure that any potential hazards are reported promptly to the appropriate supervisor.

- Report shortcomings in the Station's environmental arrangements.

- Assist where necessary in carrying out Environmental Risk Assessments.

Administration

The **Administrator** will:

- Manage all Monitoring and Training Records and ensure adequate notice is given to arrange all required refresher and statutory training.

7. TRAINING, AWARENESS AND COMPETENCE

All staff are trained in the specific environmental aspects and responsibilities of their jobs, in emergency procedures and the potential consequences of departing from the specific procedures. This also includes the Environmental Policy, the major impacts of the organisation’s activities and an introduction to the EMS. Where an activity has the potential to cause significant environmental impacts, care is taken that it is assigned to competent staff.

Training needs are identified, the training is provided and training records are held centrally at Administration. This is done with the help of the Environmental Training Matrix.

The Station Manager, in conjunction with station staff, will complete the Training Matrix by identifying those persons with environmental duties and identifying appropriate training that is required fulfilling those duties.

The Training Matrix will be reviewed at the HS&E committee.

Environmental training shall ensure that all employees are aware of:

- The importance of conformance with the Environmental Policy, procedures and the requirements of the Environmental Management System.
- The significant environmental impacts, actual or potential, of their work activities and the environmental benefits of improved personal performance.
- Their roles and responsibilities in achieving conformance with the environmental policy and procedures and with the requirements of the

environmental management system, including emergency preparedness and response requirements.
- The potential consequences of departure from specified operating procedures.

Employees whose responsibilities include areas covered by environmental procedures shall be trained in those procedures. Further training in the requirements of environmental procedures shall be performed when there is either a change in staff or a significant revision to the procedure.

Environmental awareness shall remain ongoing via a variety of initiatives, including toolbox talks and information on the Environmental Notice Board, co-ordinated by the Station Manager.

Care will be taken that contractors are made aware on site induction of the Environmental Policy and Plan, procedures and the environmental significance of their actions.

8. COMMUNICATION

Communication of Environmental Information either internally or externally will be done according to the procedures identified in the document: Communication of Environmental Information

9. DOCUMENTATION AND DOCUMENT CONTROL

All documents in Knapton Generating Station will be created, amended and withdrawn according to the procedure SI – 11: Document control.

10. OPERATIONAL CONTROL

Operations and activities in Knapton Generating Station and related well sites that are associated with the identified significant environmental aspects are identified and procedures are in place to control them.

These can be Standing Instructions, Operating Procedures or Environmental Management procedures. They will ensure compliance with the Environmental Policy, with Legal and other Requirements and the progress of the Environmental Plan.

11. EMERGENCY PREPAREDNESS AND RESPONSE

Emergency procedures are established in the event of a fault or malfunction in normal operating equipment, procedure or a situation that could result in:
- A threat to the health and safety of personnel either on or off site,
- Damage to plant or buildings either on or off site or,

- Polluting the environment.

A copy of the Emergency Procedures is always kept in the Control Room.

12. ENVIRONMENTAL SITE PLANS

Environmental site layout plans will be prepared for the Knapton Generating Station and related well sites. Environmental site layout plans shall be to scale and include the following environmental information:

- An accurate representation of the main features of the site;
- The activities carried out and any discharge points;
- Drainage plans, which identify both surface and foul drains (if applicable) and the final destination of any drain;
- The location of any waste activities, such as waste storage areas, whether full or empty;
- The location of any oil and chemical storage areas and/or facilities;
- The location of any important or sensitive receptors, including nearby surface water features, groundwaters or sensitive wildlife areas; and
- The location of any known or potentially contaminated land within the site.

In order to capture all the environmental information associated with the Knapton Generation Station or related well sites within accurate and scaled plans, it may be necessary to have more than one plan per site.

Environmental site layout plans shall be created, amended and withdrawn according to the procedure SI – 11: Document control. They shall be reviewed annually or in advance of process changes or non-routine works being undertaken at the site.

13. MONITORING AND MEASUREMENT

NOx and SOx emissions are measured continuously by the Control Room Distributed Control System (DCS) and the cumulative amount emitted is stored on file. The maximum concentration is set by the PPC Authorisation and compliance with the limit is demonstrated if 95% of the half hourly average readings for each rolling 24-hour period do not exceed the limit values, and the peak value does not exceed three times the limit value.

The calibration of the panel is done automatically each 24 hours and specialists will perform regular maintenance checks on the panel.

A limit of 50 mg/m^3 (30.7 ppm Vol. 1) of HCl emissions is set Third Energy and delivery is to cease and work order raised for scrubber repair. A measurement is taken by the Operator during the first acid delivery of the month and the result is recorded in the Environmental log book.

The Operator will also perform a pH analysis of the filtering water after the first delivery.

A record of these readings will be kept in the Environmental log-book.

14. EVALUATION OF COMPLIANCE

Compliance with all legal and other requirements will be evaluated periodically according to the procedure Evaluation of Compliance using the checklist attached.

15. NON-CONFORMANCE AND CORRECTIVE AND PREVENTIVE ACTION

Non – conformances and resulting corrective and preventive actions will be dealt with according to the procedures set out in SI – 08: Reporting of Accidents, Environmental Incidents and Near Misses

16. CONTROL OF RECORDS

Monitoring records are kept at the control room and the administration.

17. INTERNAL AUDITS

Internal audits are conducted periodically to ensure the effectiveness and adequacy of the Environmental Management System and compliance with relevant standards and regulations.

The procedure for this is Internal Audits.

18. EXTERNAL AUDITS

In addition to the Station's internal audits, one external audit will be carried out to ensure compliance with relevant standards and regulations and an independent analysis of the EMS. The findings will be discussed with the Station Manager and other interested parties. When the findings are accepted the same procedure for internal audit findings will be followed.

19. MANAGEMENT REVIEW

The Management Review will periodically assess various procedures of the EMS to ensure its adequacy and effectiveness. This will be done following the procedure Management Review.

20. SECURITY

Security Protocol

The Generating Station and its associated Wellsites are well established with the Lead Operator taking responsibility for maintaining an overview of the physical asset security to ensure the security and safety of Third Energy UK Gas Limited premises, workplaces, employees, contractors and their subcontractors and to persons not in the employment of Third Energy. Should necessity dictate, i.e. project works on a remote wellsite, then a specialist security provider will be contracted to facilitate this increased requirement.

Third Energy UK Gas Limited Standing Instruction 18 – Evaluation of Contractors would be utilised prior to awarding a contract to ensure the level of competence of security contractors working on behalf of Third Energy and that they have appropriate systems and processes in place to meet Third Energy standards and exceed these where possible.

Using a risk based approach an assessment will be made which will dictate the content of the contractor evaluation checklist. This will detail the level of the security procedures and measures required to ensure that Third Energy meets its legal requirement in ensuring that its operations do not have an adverse effect on the environment, employees, contractors and their subcontractors and to persons not in the employment of Third Energy.

Risk Management

As stated above a risk based approach is implemented at the Generation Station at Knapton and its associated operational wellsites. The security risk approach will inform security management on the control measures that are appropriate to reduce identified risks to an acceptable level.

For example, the Environmental Risk Assessment TE-EPRA-KM8-HFS-ERA-07 / Annex A ID 011 takes into consideration the risk of vandalism at the KM8 wellsite. Unauthorised access to the site by persons may cause fires, loss of containment from containers and damage to site equipment.

Prior to operations commencing at a wellsite, security assessment will be conducted which will be reviewed at least every three years to ensure the assessments and mitigation measures remain fit for purpose and appropriate. Site Security Assessments will be carried out and documented by a trained and experienced person using Third Energy’s Risk Assessment template.

Legislation

The Construction (Design and Management) Regulations 2015, which place specific requirements on the Client with respect to the design and management of construction projects.

The regulations provide provisions for the security of the construction site including that no contractor shall begin work on a construction site unless reasonable steps have been taken to prevent access by unauthorised persons to that site.

The Occupiers Liability Act 1984, sets out the duty of care you owe to people you have not invited or permitted to be on your land, such as trespassers.

Procedures

Security measures are well established at the Generating Station and its associated wellsites. Any new wellsites will be assessed as per Company protocol and subsequently communicated to site security personnel to cover unauthorised access, vandalism, protestors, theft and emergency response actions.

As stated in 'Security Protocol' the Lead Operator is responsible for maintaining an overview of site security place and monitors the status of the Intruder Detection Systems at in 'real time' via the Scada control system situated in the Generating Stations Control Room.

Where man guarding is utilised, clear documented roles and responsibilities, processes and procedures in to be in place and all staff are to have the appropriate qualifications, licenses and training to carry out their duties (as per SI 18 – Evaluation of Contractors).

Security measures

The Generation Station at Knapton and its associated operational wellsites all have security measures in place to ensure that the Operator can maintain environmental integrity. The security measures in place, applicable to all sites, are:

- Chain link fencing surrounding the periphery of each site, complete with locked double access gates and internally operated emergency exits.
- Appropriate signage for secure areas denoting authorized access only.
- Knapton Generating Station is covered by a full suite of CCTV cameras with appropriate CCTV signage when applicable.
- Security lighting in place where appropriate.
- Daily visits to each site by security/operations/maintenance on a 24 hour basis.
- Intruder alarms on each of the remote wellsites which are fibre optically linked to annunciate an alarm within the Knapton Control Room upon trigger.
- Fibre optic data transmittal allows the operations team at Knapton to monitor the process in 'real time' and immediately respond to any changes to, or the loss of containment within the operational infrastructure.

- Process ESD system will immediately fail safe in the event of an integrity loss.
- Upon trigger of any intruder alarm or substantial change to process integrity (verified as non-instrumentation fault) a member of the operations and maintenance staff will be dispatched to investigate.

Records

All substantiated issues will be raised and logged in the monthly Health, Safety, Security and Environmental meetings.

Records to be retained, unless otherwise agreed by the Environment Agency, for at least 6 years from the date the records were made.

Review

Reviews will be triggered when there are changes to the threat to site security and any changes to the site, for examples perimeter boundaries.

21. COMPLAINTS

Complaints will be dealt with as per Section 5.2.1 (Dealing with Complaints) within the 'Communication of Environmental Information' document with the EMS suite.

All Company sites have signs attached to the main gates which provide contact details which members of the public can use in the event of a complaint scenario.

Each of the markers along the Company's pipeline infrastructure have the main contact number for the Generating Station at Knapton denoted on it, which is manned on a 24/7 basis.

All complaints will be investigated and if verified the following actions will be implemented:

- The cause of the complaint identified, i.e the problem
- To minimise the impact of the activity causing the problem
- To investigate how and when the problem occurred
- To ensure that the problem will not be repeated.

All complaints will be responded to and all substantiated issues will be raised and logged in the monthly Health, Safety, Security and Environmental meetings.

Management systems will be revised to record changes to equipment or procedures so that future problems are avoided.

22. CLOSURE PROCESS

Upon decision to apply to surrender a permit, the Operator will provide evidence to the regulatory body that they will undertake all necessary measures to avoid any pollution risk as a result of their past/present/future activities and that the site will be returned to a satisfactory state.

The Operator will demonstrate efficiency of their environmental management system, and compliance history, via a comprehensive record system detailing all of the below:

- Site specific design, construction, monitoring and maintenance, inspection and failure records relating to pollution prevention.
- Relevant land and groundwater protection measures.
- Spills and incidents complete with remedial actions.
- Response and close out to notifications of non-conformances or failures issued by the regulatory bodies.
- Off-site impacts such as pollution incidents that caused, or are alleged to have caused, harm or health effects, which would enable the regulatory body to investigate any future cumulative effects of the Operators activities.

In addition to the above the Company will provide a closure plan to the regulatory body which, in conjunction with the site restoration and aftercare documents, will provide a risk-based strategy plan detailing:

- Appropriate pollution control measures to be identified and put in place upon closure.
- Specifications on how the facility will be managed and monitored during the aftercare phase.
- Completion criteria which would show the facility is in a satisfactory state for permit surrender.
- A schedule of periodic review in relation to the aftercare plan agreed with the regulatory body to ensure that the correct information is being collected and provoke refinement of the completion criteria if required.

All of the above will be reported in line with the Environment Agency’s H5 Site Condition Report Guidance and Templates in combination with the Regulatory Guidance Note RGN9: Surrender. In addition, pre permit surrender discussions will be held with the Environment Agency.

The Operator is committed to working with the regulatory body and achieving closure of the relevant environmental permit as agreed throughout the process(es) above.

APPENDIX 3 – ROLES AND RESPONSIBILITES

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Organisation	**Site Representative**	**Responsibilities**
Third Energy	Chief Executive Officer	Establish and maintain Environmental Policies, ensuring sufficient resources available for implementation. Attend and provide input at Annual Management reviews.
Third Energy	Operations Director	Establish clear leadership and promote a high degree of HSE awareness through communication of HSE Policies and responsibilities. Development and review of HSE objectives and targets in their respective area and develop the organisation and controls to meet the goals and achieve KPI indicators. Maintain, communicate and test emergency response procedures for effectiveness. Ensure legislative compliance through the provision of adequate competent resources. Provide support for the preparation and submission of consents and permits, including waste management plans. Ensure that monitoring and reporting relating to regulatory compliance is carried out. Encourage identification and reporting of non-conformances and track actions to close out. Review aspects register with cross section of asset team and make readily available. Developing and training staff so that they are capable of carrying out their work to the required standards. Contractor review and selection. Briefing all staff so that they fully understand their individual responsibilities for Health, Safety and Environment as part of the performance appraisal. Investigate all incidents, involving, or having the potential to cause, injury or harm to personnel, damage to infrastructure or the environment. Communicate performance and findings from audits, inspections and non-conformances. Hold a management review of SMS/EMS annually and track progress of actions identified to close out.
Third Energy	Station Manager	Registration of sites as a hazardous waste producer. Duty of care for waste produced from operations. Implementation of the Waste Management Plan. Training of those involved in the operation on site, including site induction and waste management.
Third Energy	Operations Support Manager	Provide HSE advice and support as the competent person in compliance with Regulation 7 of the Management at Work Regulations 1999. Provide HSE support to the Site Supervisor and contractors. Lead site investigations and audits to ensure that operations are conducted in accordance with SMS/EMS. Maintain and review legislative register. Liaise with government departments, non-government

		organisations, pressure groups, the public and media. Identify potential risks associated with emergency conditions. Inform Site Supervisor of potential risks to ensure they are incorporated into the Emergency Response Plan and Waste Management Plan. Review previous audits. Ensure reports are produced and communicated. Approving action close out and provide challenges where close out is insufficient. Site Waste Champion.
Third Energy	Operations Support Manager	Annual review of Aspects Register. Site specific environmental plan. EMS focal point for establishing, implementing and maintaining the EMS. Communicate environmental requirements and plan. Communicate environmental performance, significant findings and non-conformances. Communicate environmental statement. Key EMS structure and responsibilities to Site Supervisor. Ensure defined practices and processes are communicated to site/assets. Provide assistance and guidance in update and approval of Emergency Response Plans and Waste Management Plans. Ownership and maintenance of internal auditing schedule. Facilitation of internal and external audit teams and advise auditors of areas of focus. Ensure audit reports are documented and communicated. Analysing audit data and communicating system risks. Attend and support annual management review. Consolidate asset/site level management reviews for annual management review. Track progress from the management reviews. Keep records of management review for minimum 5 years.
Third Energy	Site Supervisor	Provide technical assistance for operations. Provide technical risk assessments. Ensure operational programmes are approved by an independent well examiner. Duty of care for waste produced from hydraulic fracture stimulation operations. Implementation of the Waste Management Plan. Segregation of waste on site. Training of those involved in the work on the plan.
Third Energy	Site Supervisor	Populate consents and permit register. Retain hard copy of consents/permits and provide electronic copies if required. Notify Operations Manager when expiration is due and seek assistance in timely manner. Issue consents/permits to ensure awareness of the

		conditions across the site Ensure appropriate level of training across the site is up to date. Manage non-conformances in their area of responsibility. Ensure sufficient priority is placed on undertaking audits. Attend annual management reviews. Monitor compliance with the Waste Management Plan.
Third Energy	Logistics Manager	Compliance with the Waste Management Plan. Provision of waste segregation and waste disposal, including skips and transport to and from the wellsite in accordance with the Waste Management Plan.
Third Energy	Wellsite Supervisor	Implementation of the environmental activities and mitigation in accordance with the Waste Management Plan. Monitoring the effectiveness of the Waste Management Plan. Test response plans on a regular basis and record learning's. Compile waste transfer notices.
Principal Contractor	Supervisor	Cooperation with the Operator. Assisting with training of sub-contractors. Monitoring the effectiveness of the Waste Management Plan.
Sub-Contractors	Supervisor	Compliance with the Waste Management Plan. Conduct operations responsibly and in compliance with work instructions, procedures and standards. Participate with line management and supervisors in the implementation of, compliance with, and improvement of the requirements of the SMS and EMS.
Principal Waste Contractor	Supervisor	Compliance with the Waste Management Plan. Issue waste transfer notices. Coordinate waste disposal notices. Conduct operations responsibly and in compliance with work instructions, procedures and standards. Participate with line management and supervisors in the implementation of, compliance with, and improvement of the requirements of the SMS and EMS. Notify the Operations Support Manager and Logistics Manager in the event of any changes or additional requirements associated with the recycling or disposal of waste at the various waste disposal facilities.

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APPENDIX 4 – CHEMICAL INVENTORY

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CHEMICAL INVENTORY - KM8 HYDRAULIC FRACTURE STIMULATION OPERATION

PRODUCT NAME	UNIT SIZE	QTY	TOTAL WEIGHT	MAX TONNES	UN NO	CLASSIFICATIONS	HAZARD	COMPOSITION	CLASS	USAGE	NOTES	JUSTIFICATION FOR CLASSIFICATION
COMPLETION FLUID ADDITIVES (RETAINED WITHIN THE WELL)												
Safe-Cide	KG	25	25	25	2810	Cat 6.1 T;R23. Xn;R20/21/22/23 R34.R36/37 R43	Toxic	Triazine(2H,4H,6H)-triethanol 50-100%. Glycine 1-5%	Haz	Biocide		H330
Safe-Core EN	Ltr	200	0.4	0.4	N/A	Xi;R36/38. R43. Xn;R22. R43,R52.	Irritant	Formaldehyde, Reaction products with Ethanolamine 10-30%	Haz	Corrosion inhibitor for completion brines		Contains a Teratogen
Safe-Scav NA	Ltr	25	0.025	0.025	N/A	Cat 6.1 T;R23. Xn;R20/21/22. R34.R36/37 R43.	Toxic	Ammonium Bisulphate 30-60%. Water 30-60%	Haz	Hydrogen scavenger		Suspected Carcinogen
FRACTURE FLUID ADDITIVES												
Acetic Acid	ltrs				2790	H314, H226	Corrosive, Flammable	Acetic Acid (30-60%)	Haz	pH-Buffer	Non-Hazardous to Groundwater. Has been assessed by the Environment Agency	
CLLAU301	1250 ltrs IBC	20.1876896	25234.61202	25.4869581	N/A	H315, H318, H290	Corrosive	Aluminum Sulfate (5-10%), Sulfuric Acid (1-5%)	Haz	Cross-Linker	Non-Hazardous to Groundwater. Has been assessed by the Environment Agency	
CLBEAU196	25 kg box	15.7684172	394.2104308	0.39421043	N/A	H334	Health	Hemicellulase Enzyme (1-5%)	Haz	Breaker	Non-Hazardous to Groundwater. Has been assessed by the Environment Agency	
CLBXTAU121	200 ltrs drum	12.123141	2424.628193	2.76407614	N/A	Not classified	None	No hazardous substances (60-100%)	NH	Breaker	Non-Hazardous to Groundwater. Has been assessed by the Environment Agency	Product not classified as hazardous
CLSAU352	200 ltrs drum	16.4519919	3290.398384	3.22459042	N/A	H302, H315, H318, H412	Corrosive, Health	Sodium Lauryl Sulfate (10-30%)	Haz	Surfactant	Non-Hazardous to Groundwater. Has been assessed by the Environment Agency	
CLWGAU421	25 kg sack	718.561088	17964.02721	17.9640272	N/A	Not classified	None	No hazardous substances (60-100%)	NH	Gelling Agent	Non-Hazardous to Groundwater. Has been assessed by the Environment Agency	Product not classified as hazardous
DCA-13002	25 kg box	8.29797732	207.4494331	0.20744943	1505	H302, H315, H319, H334, H317, H335, H272	Health, Oxidising	Sodium Persulfate (60-100%)	Haz	Breaker	Non-Hazardous to Groundwater. Has been assessed by the Environment Agency	
Sodium Chloride	25 kg sack	2634.08758	65852.18957	65.8521896	N/A	Not classified	None	Sodium chloride (60-100%)	NH	Brine	Not Hazardous to Groundwater. Has been assessed by the Environment Agency	Product not classified as hazardous
100 mesh Sand	25 kg Sack	191.36	4784	4.784	N/A	H350, H372	Health	Crystalline silica, quartz (60-100%)	NH	Proppant	Not Hazardous to Groundwater	Hazards only applicable for respirable crystalline silica, (< 5 micron fraction)
FRACTURE FLUID ADDITIVES (CONTINGENCY USE)												
CLLAU302	ltrs				N/A	Not classified	None	Sulfuric Acid (1-5%)	NH	Delayed Cross-Linker	Not Hazardous to Groundwater. Has been assessed by the Environment Agency	Product not classified as hazardous
CLLAU303	ltrs				N/A	H318	Health	Aluminum Sulfate Octadecahydrate	Haz	Delayed Cross-Linker	Not Hazardous to Groundwater (based on assessment for aluminium sulfate). Has been assessed by the Environment Agency	
DCA-14003	45 kg sack				N/A	Not classified	None	Sodium bicarbonate (60-100%)	NH	Buffer	Not Hazardous to Groundwater according to Balcombe HRA	Product not classified as hazardous
KCl (Potassium Chloride)	25 kg sack				N/A	Not classified	None	Potassium chloride (60-100%)	NH	Brine	Non-Hazardous to Groundwater. Has been assessed by the Environment Agency	Product not classified as hazardous
FUEL FOR HYDRAULIC FRACTURE EQUIPMENT (SURFACE USE ONLY)												
Diesel	ltrs	20000	20000	17.2	N/A	H304, H332, H315, H351, H373, H411	Health, Aquatic	Diesel (60-100%)	Haz	Fuel		
COIL TUBING (SURFACE USE ONLY)												
WG-11 GELLING AGENT	25 KG SACK	10	250 kg	1	N/A	Not classified	Not classified	no hazardous substances (60-100%)	NH	Gelling Agent		Product not classified as hazardous
BARO-LUBE NS	55 GAL DRUM	2	130GAL	1	N/A	Not classified	Not classified	no hazardous substances (60-100%)	NH	Friction Reducer (metal-metal)		Product not classified as hazardous
Diesel	ltrs	5000	5000	4.3	N/A	H304, H332, H315, H351, H373, H411	Health, Aquatic	Diesel (60-100%)	Haz	Fuel		
Nitrogen	2000 GAL tank	2	4000GAL	5.8	1067	H280	Compressed gas	CAS no 7727-37-9	NH	Stimulating flow in well and purging lines		Emitted to air - inert
WELL TESTING												
Nitrogen	16 x Bottle	1	1800 kg		1066	H280	Compressed gas	CAS no 7727-37-9	NH	Stimulating flow in well and purging lines		Emitted to air - inert
Methanol (Surface Use Only)	1000 litres	1	1,000 ltr	0.87	1230	H301, H311, H331, H370, H225	Flammable, Toxic, Health	CAS no 67-56-1	Haz	Inject into flow to remove Hydrate issues	Amounts determined during well planning	
Monoethylene Glycol (Surface Use Only)	1000 litres	1	1,000 ltr	0.87	N/A	H302, H373	Health	Ethylene glycol (60-100%)	Haz	Prevention of Hydrates during flowback	Amounts determined during well planning	

CHEMICAL INVENTORY - KM8 HYDRAULIC FRACTURE STIMULATION OPERATION

PRODUCT NAME	UNIT SIZE	QTY	TOTAL WEIGHT	MAX TONNES	UN NO	CLASSIFICATIONS	HAZARD	COMPOSITION	CLASS	USAGE	NOTES	JUSTIFICATION FOR CLASSIFICATION
COMPLETIONS												
Castrol Hyspin AWH M15	20ltr drum	5	100ltr	0.1	N/A	H304	Health	Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based (75-90%)	Haz			
CLEANSTREAM (SURFACE USE ONLY)												
Diesel	ltrs	5678	5678	4.9	N/A	H304, H332, H315, H351, H373, H411	Health, Aquatic	Diesel (60-100%)	Haz	Fuel		
MINIWAVE (SURFACE USE ONLY)												
22 Baume Hydrochloric Acid	ltrs	379	379	0.45	1789	H314. H318, H335, H290	Health, Corrosive	Hydrochloric acid (30-60%)	Haz	Adjusts PH		
Caustic Soda	13 kg Can	31	403kg	0.4	1823	H314, H318, H290	Corrosive	Sodium Hydroxide(60-100%)	Haz	Adjusts PH	Precautionary - may not hazardous as a component of the mud overall.	Health risks are related to concentration limits.
Diesel	ltrs	3000	3000	2.6	N/A	H304, H332, H315, H351, H373, H411	Health, Aquatic	Diesel (60-100%)	Haz	Fuel		
TUBING CONVEYED PERFORATING GUNS - ON SITE AD HOC												
Cord, detonating	0.0054	100	0.54	0.00054	0065	1.1D	Explosive	CAS no 220-260-0	Exp	TCP Explosives		
Articles, Explosive, N.O.S. (Booster)	0.0006	50	0.03	0.00003	0349	1.4S	Explosive	CAS no 220-260-0	Exp	TCP Explosives		
Components, Explosive Train, N.O.S. (Booster containing HMX)	0.0014	8	0.0112	0.0000112	0384	1.4S	Explosive	CAS no 2691-41-0	Exp	TCP Explosives		
Detonators, Non-Electric	0.001	8	0.008	0.000008	UN0455	1.4S	Explosive	CAS no 7631-86-9, 7440-32-6, 7778-74-7, 13424-46-9, 20062-22-0	Exp	TCP Explosives		
Detonators, Non-Electric	0.031	4	0.124	0.000124	UN0455	1.4S	Explosive	CAS no 1309-37-1, 2537-36-2, 7440-32-6, 7440-33-7, 7440-67-7, 7778-74-7, 9004-32-4, 9010-75-7, 13424-46-9, 20062-22-0, 61790-53-2	Exp	TCP Explosives		
Primers, Cap Type	0.000035	4	0.00014	0.00000014	UN0044	1.4S	Explosive	CAS no 7778-74-7, 7440-32-6, 7631-86-9	Exp	TCP Explosives		
Jet Perforating Guns, Charged	0.1135	101	11.4635	0.0114635	UN0124	1.1D	Explosive	Spacer guns with detonating cord and boosters	Exp	TCP Explosives		
Jet Perforating Guns, Charged	4.234	5	21.17	0.02117	UN0124	1.1D	Explosive	Perforating guns with detonating cord, boosters and shaped charges.	Exp	TCP Explosives		
WIRELINE (SURFACE USE ONLY)												
TELLUS S2V 15W HYD OIL	LTR	35	70	0.07	NA	Not classified	None	Highly refined mineral oils and additives	NH		MS19HP WELL CONTROL PANEL	Product not classified as hazardous
P79A HYD OIL	LTR	30	60	0.06	NA	Not classified	None	A blend of highly refined mineral oils with multifunctional additives	NH		MS19HP WELL CONTROL PANEL	Product not classified as hazardous
POLYBUTENE	LTR	60	360	0.36	NA	Not classified	None	Non-hazardous liquid	NH		MS14GP GREASE INJECTION PUMP	Product not classified as hazardous
P79A HYD OIL	LTR	20	40	0.04	NA	Not classified	None	A blend of highly refined mineral oils with multifunctional additives	NH		MS14GP GREASE INJECTION PUMP	Product not classified as hazardous
MILLMAX 32 HYD OIL	LTR	5	40	0.04	NA	Not classified	None	2-ethylhexyl zinc ditiophosphate (<1%)	NH		CR4501A WIRELINE VALVE	Product not classified as hazardous
MARTIN DECKER FLUID	LTR	2	4	0.004	NA	Not classified	None	Hydrocarbons, C11-17, solvent-extd. Light naphthenic, gasoil	NH		IN TRUCK	Product not classified as hazardous
COPASLIP	KG	1	3	0.003	1950	Not classified	None	No hazardous substances listed on SDS	NH		IN TRUCK	Product not classified as hazardous
FUCHS RENOLIT GREASE	KG	12	24	0.024	NA	Not classified	None	Highly refined mineral oil (50-100%)	NH		IN TRUCK	Product not classified as hazardous
WD40	LTR	5	15	0.015	3295	H226, H304, H336	Flammable, Health	Hydrocarbons, C9-C11, n-alkanes, isoalkanes, cyclics, <2% aromatics (06-80%)	Haz		IN TRUCK	
AUTO-MATIC TRANSMISSION FLUID UN	LTR	25	50	0.05	NA	Not classified	None	Highly refined mineral oil (C15-50)	NH		IN TRUCK GEARBOX	Product not classified as hazardous
MB228 ENGINE OIL 10/40W	LTR	30	90	0.09	NA	Not classified	None	No hazardous substances listed on SDS	NH		IN TRUCK ENGINE	
DIESEL	LTR	300	1,500	1.5	NA	H304, H332, H315, H351, H373, H411	Health, Aquatic	Diesel (60-100%)	Haz		IN TRUCK FUEL TANK	
Castrol Hyspin AWH M15	LTR	30	60	0.06	NA	H304	Health	Lubricating oils (petroleum), C20-50, hydrotreated neutral oil-based (75-90%)	Haz			

APPENDIX 5 – HYDRAULIC FRACTURE FLUID DISCLOSURE

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Hydraulic Fracturing Fluid Data

Water Volume (Cubic Metres)	3291.1
Max mass % of Total HF Fluid	88.4
Proppant (kilograms)	322317.3
Max mass % of Total HF Fluid	8.6
% of Water Volume - recycled/produced water	21.8
% of Water Volume - fresh water	78.2
Max (mass %) Water + Proppant =	97

HF Fluid Primary Products

Product Trade Names in Fracturing Fluid	Product Purpose in Well	Supplier
Acetic acid	pH buffer	Halliburton Energy Services
CLLAU301	Cross-linker	Halliburton Energy Services
CLBEAU196	Gel breaker	Halliburton Energy Services
CLBXTAU121	High temp. gel breaker	Halliburton Energy Services
CLSAU352	Surfactant	Halliburton Energy Services
CLWGAU421	Gelling agent	Halliburton Energy Services
DCA-13002	Gel breaker	Halliburton Energy Services
FRAC SAND	Proppant	Halliburton Energy Services
Sodium chloride	Salt	Halliburton Energy Services
Water	Base fluid	Halliburton Energy Services

HF Fluid Contingency Products

Product Trade Names in Fracturing Fluid	Product Purpose in Well	Supplier
CLLAU302	Delayed cross-linker	Halliburton Energy Services
CLLAU303	Delayed cross-linker	Halliburton Energy Services
DCA-14003	pH buffer	Halliburton Energy Services
KCl	Alternative salt	Halliburton Energy Services

HF Fluid Primary Constituents

Chemical Substance in Fracturing Fluid	Chemical Abstract Service Number (CAS Number)	Maximum Chemical substance Mass % in HF Fluid	Other common/household uses	Presumed Hazardous or Non- hazardous (EA/WFD)	Basis of Assessment
Acetic acid	64-19-7	0.0003	Vinegar	Non-hazardous	Environment Agency Guidance[#]
Aluminium sulfate	10043-01-3	0.0039	Food additive (acidity regulator)	Non-hazardous	Environment Agency Guidance[#]
Citric acid, triethyl ester	77-90-0	0.0078	Food additive (stabilizes foams)	Non-hazardous	Environment Agency Guidance#
Crystalline silica, quartz	14808-60-7	8.58	Sand	Non-hazardous	Balcombe HRA
Hemicellulase enzyme	9012-54-8	0.0001	Food additive (improves texture of low fat butter)	Non-hazardous	Environment Agency Guidance[#]
Maltodextrin	9050-36-6	0.0105	Food additive (sweetener)	Non-hazardous	Environment Agency Guidance#
Sodium chloride	7647-14-5	1.77	Food Grade Salt, Laundry Detergent, Aquarium Fish Medication, Ice Melting Product	Non-hazardous	Environment Agency Guidance[#]
Sodium carboxymethyl cellulose	9004-32-4	0.43	Food additive (coating)	Non-hazardous	Environment Agency Guidance#
Sodium lauryl sulfate	151-21-3	0.0011	Toothpaste, shampoo, bubble bath	Non-hazardous	Environment Agency Guidance[#]
Sodium persulfate	7775-27-1	0.0056	Detergent	Non-hazardous	Environment Agency Guidance[#]
Sorbitan, monododecanoate, poly (oxy-1,2-ethanediyl) derivs	9005-64-5	0.0020	Food additive (flavouring)	Non-hazardous	Environment Agency Guidance#
Sulfuric acid	7664-93-9	0.0010	Food additive (preservative)	Non-hazardous	Environment Agency Guidance[#]

HF Fluid Contingency Constituents

Chemical Substance in Fracturing Fluid	Chemical Abstract Service Number (CAS Number)	Maximum Chemical substance Mass % in HF Fluid	Other common/household uses	Presumed Hazardous or Non- hazardous (EA/WFD)	Basis of Assessment
Aluminium sulfate octahydrate	7784-31-8	0.0102	Water purification	Non-hazardous	Based on the assessment of aluminium sulfate.
Sodium bicarbonate	144-55-8	0.05	Food additive (leavening agent)	Non-hazardous	Balcombe HRA
Potassium chloride	7447-40-7	3.55	Detergent, Moisture Absorber, Ice Melting Product, Agricultural Fertilizer	Non-hazardous	Environment Agency Guidance[#]
Sodium gluconate	527-07-1	0.01	Food additive (preservative)	Non-hazardous	Environment Agency Guidance[#]
Sulfuric acid	7664-93-9	0.0004	Food additive (preservative)	Non-hazardous	Environment Agency Guidance[#]

[#] Assessed using Methodology for the determination of hazardous substances for the purposes of the Groundwater Daughter Directive (2006/118EC), issued by the Joint Agencies Groundwater Directive Advisory Group ("JAGDAG") comprising the Environment Agency, the Scottish Environment Protection Agency, and the Northern Ireland Environment Agency, the Department of Environment, Food & Rural Affairs, Welsh Assembly Government, the Environmental Protection Agency Ireland, Health Protection Agency and industry representatives.

Notes:
Water used may be any combination of recycled water, produced water or fresh water.
All chemical additive substance data is consistent with Safety Data Sheets.
Because maximum percentages are shown total of water, proppant and HF chemical substance components may be greater than 100%.

Substance assessment based on the Joint Agencies Groundwater Directive Advisory Group (JAGDAG) Methodology

Chemical Substance	CAS Number	Has the substance previously been considered by JAGDAG?	Classification under Groundwater Regulations 1998	Is significant new data or evidence available since original determination?	Is there sufficient information to undertake an assessment of the substance?	Is substance classed as a Radioactive Substance?	Does substance meet the test of being a Persistent, Bioaccumulative and Toxic (PBT) as defined in the REACH regulation and TGD?	Does the substance meet criteria for high B and high T under REACH / TGD and CLP; and additionally meet the test of high persistence in groundwater defined in Paragraph 2.1.2?;	Is substance classed as vPvB under REACH or paragraph 2.1.3?;	Is the substance classed as CMT under CLP?;	Is the substance very acutely toxic to aquatic biota?	Is the substance persistent and potentially very toxic to humans?	Conclusion	Are there any applicable hazardous breakdown products or intrinisic impurities?
Acetic acid	64-19-7	No	N/A	N/A	Yes	No	No. Biodegradability >95% in 28d^1. Log Pow -0.17^1. NOEC 3.058 mg/L (freshwater)^2	No	No	No	No - NOEC 3.058 mg/L (freshwater)^2	No	Non-hazardous	No
Aluminium sulfate	10043-01-3	Yes	List 2 (Non-hazardous pollutant)	No	Yes	No	PBT not applicable to inorganic substances.	N/A (inorganic)	N/A (inorganic)	No	No - NOEC 0.026 in Fry, 3.8 in Ceridaphnia^1 (figures based on dissolved Al).	No	Non-hazardous	No
Aluminium sulfate octahydrate	7784-31-8	No	N/A	N/A	Yes	No	PBT not applicable to inorganic substances.	N/A (inorganic)	N/A (inorganic)	No	No data	No	Non-hazardous (based on assessment for aluminium sulfate)	No
Hemicellulase enzyme	9012-54-8	No	N/A	N/A	Yes	No	No. Biogradability 129% in 28d^1. Log Pow -2.95^1. NOEC 45.5 (a.i.) mg/L in freshwater^2	No	No	No	No	No	Non-hazardous	No
Potassium chloride	7447-40-7	No	N/A	N/A	Yes	No	PBT not applicable to inorganic substances.	N/A (inorganic)	N/A (inorganic)	No	No - NOEC 500mg/L^2 in fathead minnows	No	Non-hazardous	No
Sodium chloride	7647-14-5	No	N/A	N/A	Yes	No	PBT not applicable to inorganic substances.	N/A (inorganic)	N/A (inorganic)	No	No - NOEC 252 mg/L fish, 292-584 mg/L microorganisms, 314 mg/L daphnia^1	No	Non-hazardous	No
Sodium lauryl sulfate	151-21-3	No	N/A	N/A	Yes	No	No. Biogradability 95% in 28d^1. Log Pow -2.03^1. NOEC 3.8 fish and 0.88 invertebrates^1	No	No	No	No	No	Non-hazardous	No
Sodium persulfate	7775-27-1	No	N/A	N/A	Yes	No	PBT not applicable to inorganic substances.	N/A (inorganic)	N/A (inorganic)	No	No - NOEC 91.7 fish freshwater^2	No	Non-hazardous	No
Sulfuric acid	7664-93-9	No	N/A	N/A	Yes	No	PBT not applicable to inorganic substances.	N/A (inorganic)	N/A (inorganic)	No	No - NOEC 0.31 (fish) NOEC 6.61 (microorganisms) NOEC 0.15 (invertebrates)^1	No	Non-hazardous	No

Note: This table sets out the groundwater hazard assessment for substances in the hydraulic fracturing fluid. It does not include substances which have been preivoulsy assessed as non-hazardous by the Enviornment Agency (e.g. crystalling silica, quartz and sodium bicarbonate). All chemical substance data is consistent wtih Safety Data Sheets.

^{1}Data from SDS

^{2}Data from REACH dossier

High persistence
Half-life in marine water is > 60 days
Half-life in fresh water is > 40 days
Half-life in marine sediments > 180 days
Half-life in fresh water sediments is > 120 days
Half-life in soil is > 120 days

High bioaccumulation
BCF > 2000
Log Pow > 4.5

High toxicity
NOEC for marine or freshwater species < 0.01 mg/L
Has hazard class Muta. 1A, Muta. 1B, Muta 2, Carc 1A, Carc 1B, Repr 1A or Repr 1B
Has hazard class Acute Tox 1, Actute Tox 2, Acute Tox 3, STOT SE 1 or STOT RE1

Description	Halliburton Trade Name	MSDS Available	Reach Compliant	EA approved	Commonly Found	Quantity required base don last designs	Unit	State
Salt	KCl	yes	yes	Yes	Detergent, Moisture Absorber, Ice Melting Product, Agricultural Fertilizer	145,204	lbs	solid
Gelling Agent	CLWGAU421	yes	yes	Yes	Food additive (thickener)	35,151	lbs	solid
Crosslinker	CLLAU301	yes	yes	Yes	Food additive (acidity regulator)	4,082	gal	liquid
Gel Breaker	CLBEAU196	yes	yes	Yes	Food additive (improves texture of low fat butter!)	869	gal	liquid
Gel Breaker	DCA13002	yes	yes	Yes	Detergent	457	lbs	solid
High Temp Gel Breaker	CLBXTAU121	yes	yes	Yes	Food additive (stabilizes foams)	641	gal	liquid
Surfactant	CLSAU352	yes	yes	Yes	Toothpaste, shampoo, bubble bath.	869	gal	liquid
Alternative Salt	NaCl	yes	yes	Yes	Food Grade Salt, Laundry Detergent, Aquarium Fish Medication, Ice Melting Product	0	gal	liquid
Delayed Crosslinker	CLLAU302	yes	yes	Yes	Food additive (preservative)	0	gal	liquid
Delayed Crosslinker	CLLAU303	yes	yes	Yes	Water purification	0	gal	liquid
pH Buffer	Acetic Acid	yes	yes	Yes	Vinegar	0	gal	liquid
pH Buffer	DCA-14003	yes	yes	Yes	Food additive (leavening agent)	0	lbs	solid
Low Temp Gel Breaker	CLBCREAU81	yes	yes	Yes	Food additive (stabilizer)	0	gal	liquid
Water	Water	yes	yes	Yes	Tap	869,488	gal	liquid
Frac Sand	100, 40/70, 30/50 or 20/40 mesh	yes	yes	Yes	Quarries in UK	709,950	lbs	solid

	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**	**Zone 5**	**Water Total (m3) for 5 zones**
CleanStim Linear Gel (m3)	88	89.8	100.2	101.8	1248.9	1,628.7
Cleanstim XL (m3)	336.9	352	374.7	598.8	0	1,662.4
Fluid per Stage (m3)	424.9	441.8	474.9	700.6	1248.9	3,291.1
# Frac Tanks (70m3)	7	7	8	11	19	
						Water Total (Mgal) for 5 zones
CleanStim Linear Gel (Mgal)	23.25	23.71	26.46	26.89	329.97	430.29
Cleanstim XL (Mgal)	89	93	99	158.2	0	439.20
Fluid per Stage (Mgal)	112.25	116.71	125.46	185.09	329.97	869.49
Proppants						Proppant Totals for 5 zones
100-mesh (1000 lbs)	1	1	1	1	8.05	12.05
FracSand 40/70 (1000 lbs)	70.5	76.5	80.6	126	93.8	447.4
FracSand 30/50 (1000 lbs)	20	20	24	40	75.5	179.5
FracSand 20/40 (1000 lbs)	15	15	15	26		71
Total Sand (1000 lbs)	106.5	112.5	120.6	193	177.4	709.95

	Chemicals						Chemical Totals for 5 zones
Salt	KCl / NaCl (lbs)	18,746	19,491	20,952	30,909	55,106	145,204
Gelling Agent	CLWGAU421 (lbs)	4,915	5,124	5,974	9,239	9,899	35,151
Crosslinker	CLLAU301 (gal)	801	837	941	1,503		4,082
Gel Breaker	CLBEAU196 (gal)	112	116	125	185	331	869
Gel Breaker	DCA13002 (lbs)	224	233				457
High Temp Gel Breaker	CLBXTAU121 (gal)			125	185	331	641
Surfactant	CLSAU352 (gal)	112	116	125	185	331	869

metric units				
66002	kg	Salt	2.01	% by wt of water
15978	kg	Gelling Agent	0.49	% by wt of water
15452	liter	Crosslinker	0.47	% by wt of water
3290	liter	Gel Breaker	0.10	% by wt of water
208	kg	Gel Breaker	0.01	% by wt of water
2426	liter	High Temp Gel	0.07	% by wt of water
3290	liter	Surfactant	0.10	% by wt of water
			3.24	% by wt of water

Chemicals based on present knowledge of available materials.

Tests are being done using NaCL as salt, and CLLAU302 and CLLAU302 as improved delayed crosslinker to reduce friction and horsepower requirements.

In addition we have acetic acid and DCA-14003 (pH Buffers) available on site.

	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**	**Zone 5**
Horsepower Requirements (HHP)	4358	4717	5543	5699	4694
Available HHP	8000	8000	8000	8000	8000
% planned over available	**54.5**	**59.0**	**69.3**	**71.2**	**58.7**

Breakdown/Stepdown/ Displ Minifrac

				Volume	
			per Mgal		Unit
			1	14.2	Mgal
167.0	lbs/Mgal	KCl	167.0	2378	lbs
20.0	lbs/Mgal	CLWGAU421	20.0	285	lbs
1.0	gal/Mgal	CLBEAU196	1.00	14	gal
2.0	lbs/Mgal	DCA13002	2.00	28	lbs
1.0	gal/Mgal	CLSAU352	1.00	14	gal

Pad/Carrier Mini/Mainfrac

				Volume	
			per Mgal		Unit
			1.0	89.0	Mgal
167	lbs/Mgal	KCl	167.0	14863	lbs
50.0	lbs/Mgal	CLWGAU421	50.0	4450	lbs
9.0	gal/Mgal	CLLAU301	9.0	801	gal
1.0	gal/Mgal	CLBEAU196	1.00	89	gal
2.0	lbs/Mgal	DCA13002	2.00	178	lbs
1.0	gal/Mgal	CLSAU352	1.00	89	gal

Displacement - Mini/Mainfrac

				Volume	
			per Mgal		Unit
			1	9.01	Mgal
167	lbs/Mgal	KCl	167.0	1505	lbs
20.0	lbs/Mgal	CLWGAU421	20.0	180	lbs
1.0	gal/Mgal	CLBEAU196	1.00	9	gal
2.0	lbs/Mgal	DCA13002	2.00	18	lbs
1.0	gal/Mgal	CLSAU352	1.00	9	gal

Breakdown/Stepdown/ Displ Minifrac

				Volume	
			per Mgal		Unit
			1	14.2	Mgal
167.0	lbs/Mgal	KCl / NaCl	167.0	2378	lbs
20.0	lbs/Mgal	CLWGAU421	20.0	285	lbs
1.0	gal/Mgal	CLBEAU196	1.00	14	gal
2.0	lbs/Mgal	DCA13002	2.00	28	lbs
1.0	gal/Mgal	CLSAU352	1.00	14	gal

Pad/Carrier Mini/Mainfrac

				Volume	
			per Mgal		Unit
			1.0	93.0	Mgal
167	lbs/Mgal	KCl / NaCl	167.0	15531	lbs
50.0	lbs/Mgal	CLWGAU421	50.0	4650	lbs
9.0	gal/Mgal	CLLAU301	9.0	837	gal
1.0	gal/Mgal	CLBEAU196	1.00	93	gal
2.0	lbs/Mgal	DCA13002	2.00	186	lbs
1.0	gal/Mgal	CLSAU352	1.00	93	gal

Displacement - Mini/Mainfrac

				Volume	
			per Mgal		Unit
			1	9.47	Mgal
167	lbs/Mgal	KCl / NaCl	167.0	1582	lbs
20.0	lbs/Mgal	CLWGAU421	20.0	189	lbs
1.0	gal/Mgal	CLBEAU196	1.00	9	gal
2.0	lbs/Mgal	DCA13002	2.00	19	lbs
1.0	gal/Mgal	CLSAU352	1.00	9	gal

Breakdown/Stepdown/ Displ Minifrac

			per Mgal	Volume	Unit
			1	15.2	Mgal
167.0	lbs/Mgal	KCl / NaCl	167.0	2545	lbs
20.0	lbs/Mgal	CLWGAU421	20.0	305	lbs
1.0	gal/Mgal	CLBEAU196	1.00	15	gal
1.0	gal/Mgal	CLBXTAU121	1.00	15	gal
1.0	gal/Mgal	CLSAU352	1.00	15	gal

Pad/Carrier Mini/Mainfrac

			per Mgal	Volume	Unit
			1.0	99.0	Mgal
167	lbs/Mgal	KCl / NaCl	167.0	16533	lbs
55.0	lbs/Mgal	CLWGAU421	55.0	5445	lbs
9.5	gal/Mgal	CLLAU301	9.5	941	gal
1.0	gal/Mgal	CLBEAU196	1.00	99	gal
1.0	gal/Mgal	CLBXTAU121	1.00	99	gal
1.0	gal/Mgal	CLSAU352	1.00	99	gal

Displacement - Mini/Mainfrac

			per Mgal	Volume	Unit
			1	11.22	Mgal
167	lbs/Mgal	KCl / NaCl	167.0	1874	lbs
20.0	lbs/Mgal	CLWGAU421	20.0	224	lbs
1.0	gal/Mgal	CLBEAU196	1.00	11	gal
1.0	gal/Mgal	CLBXTAU121	1.00	11	gal
1.0	gal/Mgal	CLSAU352	1.00	11	gal

Breakdown/Stepdown/ Displ Minifrac

				Volume	
			per Mgal		Unit
			1	15.2	Mgal
167.0	lbs/Mgal	KCl / NaCl	167.0	2545	lbs
20.0	lbs/Mgal	CLWGAU421	20.0	305	lbs
1.0	gal/Mgal	CLBEAU196	1.00	15	gal
1.0	gal/Mgal	CLBXTAU121	1.00	15	gal
1.0	gal/Mgal	CLSAU352	1.00	15	gal

Pad/Carrier Mini/Mainfrac

				Volume	
			per Mgal		Unit
			1.0	158.2	Mgal
167	lbs/Mgal	KCl / NaCl	167.0	26419	lbs
55.0	lbs/Mgal	CLWGAU421	55.0	8701	lbs
9.5	gal/Mgal	CLLAU301	9.5	1503	gal
1.0	gal/Mgal	CLBEAU196	1.00	158	gal
1.0	gal/Mgal	CLBXTAU121	1.00	158	gal
1.0	gal/Mgal	CLSAU352	1.00	158	gal

Displacement - Mini/Mainfrac

				Volume	
			per Mgal		Unit
			1	11.65	Mgal
167	lbs/Mgal	KCl / NaCl	167.0	1945	lbs
20.0	lbs/Mgal	CLWGAU421	20.0	233	lbs
1.0	gal/Mgal	CLBEAU196	1.00	12	gal
1.0	gal/Mgal	CLBXTAU121	1.00	12	gal
1.0	gal/Mgal	CLSAU352	1.00	12	gal

Breakdown/Stepdown/ Displ Minifrac

				Volume	
			per Mgal		Unit
			1	15.7	Mgal
167.0	lbs/Mgal	KCl / NaCl	167.0	2629	lbs
30.0	lbs/Mgal	CLWGAU421	30.0	472	lbs
1.0	gal/Mgal	CLBEAU196	1.00	16	gal
1.0	gal/Mgal	CLBXTAU121	1.00	16	gal
1.0	gal/Mgal	CLSAU352	1.00	16	gal

Pad/Carrier Mini/Mainfrac

				Volume	
			per Mgal		Unit
			1.0	301.5	Mgal
167	lbs/Mgal	KCl / NaCl	167.0	50351	lbs
30.0	lbs/Mgal	CLWGAU421	30.0	9045	lbs
1.0	gal/Mgal	CLBEAU196	1.00	302	gal
1.0	gal/Mgal	CLBXTAU121	1.00	302	gal
1.0	gal/Mgal	CLSAU352	1.00	302	gal

Displacement - Mini/Mainfrac

				Volume	
			per Mgal		Unit
			1	12.73	Mgal
167	lbs/Mgal	KCl / NaCl	167.0	2126	lbs
30.0	lbs/Mgal	CLWGAU421	30.0	382	lbs
1.0	gal/Mgal	CLBEAU196	1.00	13	gal
1.0	gal/Mgal	CLBXTAU121	1.00	13	gal
1.0	gal/Mgal	CLSAU352	1.00	13	gal

HALLIBURTON

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

CLLAU302

Revision Date: 05-Aug-2014 **Revision Number:** 2

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name	CLLAU302

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Crosslinker
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC4 - Use in batch and other process (synthesis) where opportunity for exposure arises

1.3. Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Not classified

Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Not Classified
Risk Phrases	None

2.2. Label Elements

Not classified

Hazard Pictograms

Signal Word **None**

Hazard Statements
Not Classified

Precautionary Statements - EU (§28, 1272/2008)
None

Contains

Substances	**CAS Number**
Sulfuric acid	7664-93-9

2.3. Other Hazards

None known

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Sulfuric acid	231-639-5	7664-93-9	1 - 5%	C; R35	Skin Corr. 1A (H314)	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Not applicable
3.2. Mixtures	Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	Immediately flush eyes with large amounts of water for at least 15 minutes. Get immediate medical attention.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.

4.2. Most Important symptoms and effects, both acute and delayed

No information available

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media
Water fog, carbon dioxide, foam, dry chemical.
Extinguishing media which must not be used for safety reasons
None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards
Decomposition in fire may produce toxic gases.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters
Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Contain spill with sand or other inert materials. Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Avoid breathing mist.

Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Store away from oxidizers. Store in a dry location.

7.3. Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	**CAS Number**	**EU**	**UK OEL**	**Netherlands**	**France OEL**
Sulfuric acid	7664-93-9	Not applicable	0.3 mg/m³	0.05 mg/m³	1 mg/m³

Substances	**CAS Number**	**Germany MAK/TRK**	**Spain**	**Portugal**	**Finland**
Sulfuric acid	7664-93-9	MAK: 0.1 mg/m³	3 mg/m³ VLA-EC VLA-ED: 1 mg/m³	TWA: 0.2 mg/m³	STEL: 1 mg/m³ TWA: 0.2 mg/m³

Substances	**CAS Number**	**Austria**	**Ireland**	**Switzerland**	**Norway**
Sulfuric acid	7664-93-9	Not applicable	Not applicable	Not applicable	STEL: 0.3 mg/m³ TWA: 0.1 mg/m³

Substances	**CAS Number**	**Italy**	**Poland**	**Hungary**	**Czech Republic**
Sulfuric acid	7664-93-9	Not applicable	NDSCh: 3 mg/m³ NDS: 1 mg/m³	TWA: 1 mg/m³ STEL: 1 mg/m³	TWA: 1 mg/m³

Substances	**CAS Number**	**Denmark**
Sulfuric acid	7664-93-9	TWA: 1 mg/m³

Derived No Effect Level (DNEL) No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC)	No information available.

8.2. Exposure controls

Engineering Controls	Use in a well ventilated area.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)
Hand Protection	Impervious rubber gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls	No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color:**	White to yellow
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	4.15
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.25
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity

Not applicable

10.2. Chemical Stability

Stable

10.3. Possibility of Hazardous Reactions

Will Not Occur

10.4. Conditions to Avoid

None anticipated

10.5. Incompatible Materials

Strong oxidizers.

10.6. Hazardous Decomposition Products

Carbon monoxide and carbon dioxide.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause respiratory irritation.
Eye Contact	May cause eye irritation
Skin Contact	May cause skin irritation.
Ingestion	None known

Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sulfuric acid	7664-93-9	2140 mg/kg (Rat)	No data available	347 ppm (Rat) 1 h 510 mg/m^3 (Rat) 2 h 295 mg/m^3 (Rat) 4h 375 mg/m^3 (Rat) 4h 160 mg/m^3 (Mouse) 4h 15 mg/m^3 (Guinea pig) 4h 9 mg/m^3 (Guinea pig) 4h

Substances	CAS Number	Skin corrosion/irritation
Sulfuric acid	7664-93-9	Corrosive to skin (rabbit)

Substances	CAS Number	Eye damage/irritation
Sulfuric acid	7664-93-9	Corrosive to eyes (rabbit)

Substances	CAS Number	Skin Sensitization
Sulfuric acid	7664-93-9	No information available

Substances	CAS Number	Respiratory Sensitization
Sulfuric acid	7664-93-9	No information available

Substances	CAS Number	Mutagenic Effects
Sulfuric acid	7664-93-9	Not regarded as mutagenic.

Substances	CAS Number	Carcinogenic Effects
Sulfuric acid	7664-93-9	Contains sulfuric acid, a potential carcinogen.

Substances	CAS Number	Reproductive toxicity
Sulfuric acid	7664-93-9	No significant toxicity observed in animal studies at concentration requiring classification. Did not show teratogenic effects in animal experiments.

Substances	CAS Number	STOT - single exposure
Sulfuric acid	7664-93-9	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Sulfuric acid	7664-93-9	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Sulfuric acid	7664-93-9	Not applicable

SECTION 12: Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Sulfuric acid	7664-93-9	EC50(72h): > 100 mg/L (growth rate) (Desmodesmus subspicatus)	LC50: >500 mg/l (Brachydanio rerio) LC50(96h) > 16 and < 28 mg/L (Lepomis macrochirus) NOEC(65d): 0.025 mg/L (fry growth) (Jordanella floridae) NOEC(chronic): 0.31 mg/L (larval development) (Salvelinus fontinalis)	NOEC(21d): 6.61 pH (total bacteria) NOEC(37d): ca. 26 g/L (activated sludge, respiration rate) (Similar substance)	EC50(48h): 29 mg/L (Daphnia magna) EC50(48h): > 100 mg/L (Daphnia magna) NOEL(chronic): 0.15 mg/L (mortality) (Tanytarsus dissimilis)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Sulfuric acid	7664-93-9	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Sulfuric acid	7664-93-9	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available.

Substances	PBT and vPvB assessment
Sulfuric acid	Not PBT/vPvB

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable

Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

ADR

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

14.1. UN Number: Not restricted.

14.2. UN Proper Shipping Name: Not restricted

14.3. Transport Hazard Class(es): Not applicable

14.4. Packing Group: Not applicable

14.5. Environmental Hazards: Not applicable

14.6. Special Precautions for User: None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 1: Low hazard to waters.

15.2. Chemical Safety Assessment

No information available

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3

R34 Causes burns.

Full text of H-Statements referred to under sections 2 and 3
H314 - Causes severe skin burns and eye damage

Key literature references and sources for data
www.ChemADVISOR.com/

Revision Date: 05-Aug-2014
Revision Note
Not applicable

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement

End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

CLLAU303

Revision Date: 05-Aug-2014 **Revision Number:** 2

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name CLLAU303

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Crosslinker
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC4 - Use in batch and other process (synthesis) where opportunity for exposure arises

1.3. Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Serious Eye Damage / Eye Irritation	Category 1 - (H318)

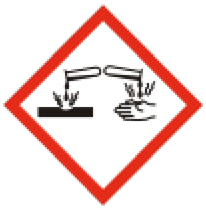
Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Xi - Irritant.
Risk Phrases	R41 Risk of serious damage to eyes. R37/38 Irritating to respiratory system and skin.

2.2. Label Elements

Hazard Pictograms



Signal Word **Danger**

Hazard Statements
H318 - Causes serious eye damage

Precautionary Statements - EU (§28, 1272/2008)
P280 - Wear protective gloves
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician

Contains

Substances	**CAS Number**
Aluminum sulfate octadecahydrate	7784-31-8

2.3. Other Hazards

None known

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Aluminum sulfate octadecahydrate	616-524-3	7784-31-8	30 - 60%	R37/38-41	Eye Dam. 1 (H318)	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Not applicable
3.2. Mixtures	Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	Immediately flush eyes with large amounts of water for at least 15 minutes. Get immediate medical attention.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

4.2. Most Important symptoms and effects, both acute and delayed

No information available

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media

All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards

Not applicable.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters

Not applicable.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Neutralize with lime slurry, limestone, or soda ash. Contain spill with sand or other inert materials. Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Avoid contact with eyes, skin, or clothing. Avoid breathing mist.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Store in a cool, dry location. Product has a shelf life of 24 months.

7.3. Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	**CAS Number**	**EU**	**UK OEL**	**Netherlands**	**France OEL**
Aluminum sulfate octadecahydrate	7784-31-8	Not applicable	STEL: 6 mg/m³ TWA: 2 mg/m³	Not applicable	Not applicable

Substances	**CAS Number**	**Germany MAK/TRK**	**Spain**	**Portugal**	**Finland**
Aluminum sulfate octadecahydrate	7784-31-8	Not applicable	VLA-ED: 2 mg/m³	TWA: 2 mg/m³	TWA: 1 mg/m³

Substances	**CAS Number**	**Austria**	**Ireland**	**Switzerland**	**Norway**
Aluminum sulfate octadecahydrate	7784-31-8	Not applicable	Not applicable	Not applicable	STEL: 4 mg/m³ TWA: 2 mg/m³

Substances	**CAS Number**	**Italy**	**Poland**	**Hungary**	**Czech Republic**
Aluminum sulfate octadecahydrate	7784-31-8	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Denmark**
Aluminum sulfate octadecahydrate	7784-31-8	TWA: 1 mg/m^3

Derived No Effect Level (DNEL) No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)
Hand Protection	Impervious rubber gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

Environmental Exposure Controls No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color:**	White
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	1.55
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.3
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity
Not applicable

10.2. Chemical Stability
Stable

10.3. Possibility of Hazardous Reactions
Will Not Occur

10.4. Conditions to Avoid
None anticipated

10.5. Incompatible Materials
Strong alkalis.

10.6. Hazardous Decomposition Products
Oxides of sulfur.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause respiratory irritation.
Eye Contact	May cause severe eye irritation.
Skin Contact	May cause skin irritation.
Ingestion	In large amounts: May cause abdominal pain, vomiting, nausea, and diarrhea.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Aluminum sulfate octadecahydrate	7784-31-8	1930 mg/kg (Rat) 370 mg/kg (Rat)	No data available	No data available

SECTION 12: Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Aluminum sulfate octadecahydrate	7784-31-8	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Aluminum sulfate octadecahydrate	7784-31-8	No information available

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Aluminum sulfate octadecahydrate	7784-31-8	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available.

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Disposal should be made in accordance with federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

ADR

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

14.1. UN Number:	Not restricted.
14.2. UN Proper Shipping Name:	Not restricted
14.3. Transport Hazard Class(es):	Not applicable
14.4. Packing Group:	Not applicable
14.5. Environmental Hazards:	Not applicable

14.6. Special Precautions for User: None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 1: Low hazard to waters.

15.2. Chemical Safety Assessment

No information available

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3

R37/38 Irritating to respiratory system and skin.
R41 Risk of serious damage to eyes.

Full text of H-Statements referred to under sections 2 and 3

H318 - Causes serious eye damage

Key literature references and sources for data

www.ChemADVISOR.com/

Revision Date: 05-Aug-2014

Revision Note

Not applicable

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

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End of Safety Data Sheet

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

DCA-14003

Revision Date: 05-Sep-2014 **Revision Number:** 7

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name	DCA-14003

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Buffer
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC14 - Metal surface treatment products, including galvanic and electroplating products
Process categories	PROC4 - Use in batch and other process (synthesis) where opportunity for exposure arises

1.3. Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Croatia	Centar za kontrolu otrovanja (CKO): (+385 1) 23-48-342 (Poison Control Center (PCC) - Institute for Medical Research and Occupational Health)
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Not classified

Classification according to EU Directives 67/548/EEC or 1999/45/EC
For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Not Classified
Risk Phrases	None

2.2. Label Elements

Not classified

Hazard Pictograms

Signal Word **None**

Hazard Statements
Not Classified

Precautionary Statements - EU (§28, 1272/2008)
None

Contains

Substances	**CAS Number**
Contains no hazardous substances	NA

2.3. Other Hazards

None known

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Contains no hazardous substances	Not applicable	NA	60 - 100%	Not applicable	Not applicable	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Substance
3.2. Mixtures	Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.

4.2. Most Important symptoms and effects, both acute and delayed

No significant hazards expected.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media
All standard fire fighting media
Extinguishing media which must not be used for safety reasons
None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards

Not applicable.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters

Not applicable.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust.
See Section 8 for additional information

6.2. Environmental precautions

None known.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Avoid creating or inhaling dust.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Store away from acids. Store in a dry location.

7.3. Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	**CAS Number**	**EU**	**UK OEL**	**Netherlands**	**France OEL**
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Germany MAK/TRK**	**Spain**	**Portugal**	**Finland**
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Austria**	**Ireland**	**Switzerland**	**Norway**
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Italy**	**Poland**	**Hungary**	**Czech Republic**
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Denmark**
Contains no hazardous substances	NA	Not applicable

Derived No Effect Level (DNEL) No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC)	No information available.

8.2. Exposure controls

Engineering Controls	A well ventilated area to control dust levels. Local exhaust ventilation should be used in areas without good cross ventilation.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

Environmental Exposure Controls	No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Solid	**Color:**	White
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	8
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.87
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity

Not applicable

10.2. Chemical Stability

Stable

10.3. Possibility of Hazardous Reactions

Will Not Occur

10.4. Conditions to Avoid

None anticipated

10.5. Incompatible Materials

Strong acids.

10.6. Hazardous Decomposition Products

Carbon monoxide and carbon dioxide.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause mild respiratory irritation.
Eye Contact	May cause mild eye irritation.
Skin Contact	May cause mild skin irritation.
Ingestion	None known
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.
LD50 Oral:	4220 mg/kg (rat)

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances	NA	No data available	No data available	No data available

SECTION 12: Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

The methods for determining biodegradability are not applicable to inorganic substances.

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances	NA	No information available

12.3. Bioaccumulative potential

Does not bioaccumulate

Substances	CAS Number	Log Pow
Contains no hazardous substances	NA	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available.

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

ADR

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

14.1. UN Number:	Not restricted.
14.2. UN Proper Shipping Name:	Not restricted
14.3. Transport Hazard Class(es):	Not applicable
14.4. Packing Group:	Not applicable
14.5. Environmental Hazards:	Not applicable
14.6. Special Precautions for User:	None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 1: Low hazard to waters.

15.2. Chemical Safety Assessment

No information available

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3
None

Key literature references and sources for data
www.ChemADVISOR.com/

Revision Date: 05-Sep-2014
Revision Note
Update to Format SECTION: 8

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

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End of Safety Data Sheet

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

KCL POTASSIUM CHLORIDE

Revision Date: 25-Jul-2014 **Revision Number:** 17

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name	KCL POTASSIUM CHLORIDE

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Brine
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC 26 - Handling of solid inorganic substances at ambient temperature PROC4 - Use in batch and other process (synthesis) where opportunity for exposure arises

1.3. Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008
Not classified

Classification according to EU Directives 67/548/EEC or 1999/45/EC
For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Not Classified
Risk Phrases	None

2.2. Label Elements

Not classified

Hazard Pictograms

Signal Word **None**

Hazard Statements
Not Classified

Precautionary Statements - EU (§28, 1272/2008)
Not Classified

Contains

Substances	**CAS Number**
Potassium chloride	7447-40-7

2.3. Other Hazards

None known

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Potassium chloride	231-211-8	7447-40-7	60 - 100%	Not applicable	Not applicable	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Substance
3.2. Mixtures	Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

4.2. Most Important symptoms and effects, both acute and delayed

May cause mild eye, skin, and respiratory irritation.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media
All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards

Not applicable.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Avoid breathing vapors.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Store in a cool, dry location. Product has a shelf life of 60 months.

7.3. Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	CAS Number	EU	UK OEL	Netherlands	France OEL
Potassium chloride	7447-40-7	Not applicable	10 mg/m³	Not applicable	Not applicable

Substances	CAS Number	Germany MAK/TRK	Spain	Portugal	Finland
Potassium chloride	7447-40-7	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Austria	Ireland	Switzerland	Norway
Potassium chloride	7447-40-7	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Italy	Poland	Hungary	Czech Republic
Potassium chloride	7447-40-7	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Denmark
Potassium chloride	7447-40-7	Not applicable

Derived No Effect Level (DNEL) No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC)	No information available.

8.2. Exposure controls

Engineering Controls	Use in a well ventilated area.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Dust proof goggles.
Other Precautions	Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls	No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Solid	**Color:**	White to gray
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	9.2
Freezing Point/Range	No data available
Melting Point/Range	771 °C
Boiling Point/Range	1413 °C
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.99
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

Molecular Weight	74.55
VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity

Not applicable

10.2. Chemical Stability

Stable

10.3. Possibility of Hazardous Reactions

Will Not Occur

10.4. Conditions to Avoid

None anticipated

10.5. Incompatible Materials

None known.

10.6. Hazardous Decomposition Products

None known.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause mild respiratory irritation.
Eye Contact	May cause mild eye irritation.
Skin Contact	May cause mild skin irritation.
Ingestion	May cause abdominal pain, vomiting, nausea, and diarrhea. Irritation of the mouth, throat, and stomach.
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.
LD50 Oral:	> 5000 mg/kg (rat)

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Potassium chloride	7447-40-7	2600 mg/kg (Rat) 2430 mg/kg (Rat) 3020 mg/kg (Rat) 383 mg/kg (Mouse) 1500 mg/kg (Mouse)	> 2000 mg/L (Rabbit) (similar substance)	No data available

Substances	CAS Number	Skin corrosion/irritation
Potassium chloride	7447-40-7	Non-irritating to the skin (rabbit) (similar substances)

Substances	CAS Number	Eye damage/irritation
Potassium chloride	7447-40-7	May cause mild eye irritation. (rabbit) (similar substances)

Substances	CAS Number	Skin Sensitization
Potassium chloride	7447-40-7	Did not cause sensitization on laboratory animals (mouse) (similar substances)

Substances	CAS Number	Respiratory Sensitization
Potassium chloride	7447-40-7	No information available

Substances	CAS Number	Mutagenic Effects
Potassium chloride	7447-40-7	In vitro tests did not show mutagenic effects

Substances	CAS Number	Carcinogenic Effects
Potassium chloride	7447-40-7	Did not show carcinogenic effects in animal experiments (similar substances)

Substances	CAS Number	Reproductive toxicity
Potassium chloride	7447-40-7	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments. (similar substances)

Substances	CAS Number	STOT - single exposure
Potassium chloride	7447-40-7	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Potassium chloride	7447-40-7	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)

Substances	CAS Number	Aspiration hazard
Potassium chloride	7447-40-7	Not applicable

SECTION 12: Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Potassium chloride	7447-40-7	EC50(72h): 2500 mg/l (Desmodesmus subspicatus) EC50(72h): > 100 mg/L (growth rate) (Desmodesmus subspicatus)	LC50: 1060 mg/L (Lepomis macrochirus); LC50: 750-1020 mg/L (Pimephales promelas)	EC50(3h): >1000 mg/L (activated sludge)	TLM96: 100-330 ppm (Crangon crangon) EC50(24h): >= 580 <=990 mg/L (Daphnia magna) EC50(48h): >=440 <= 880 mg/L (Daphnia magna)

12.2. Persistence and degradability

The methods for determining biodegradability are not applicable to inorganic substances.

Substances	CAS Number	Persistence and Degradability
Potassium chloride	7447-40-7	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Does not bioaccumulate

Substances	CAS Number	Log Pow
Potassium chloride	7447-40-7	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available.

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations. Substance should NOT be deposited into a sewage facility.
Contaminated Packaging	Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

ADR

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

14.1. UN Number: Not restricted.

14.2. UN Proper Shipping Name: Not restricted

14.3. Transport Hazard Class(es): Not applicable

14.4. Packing Group: Not applicable

14.5. Environmental Hazards: Not applicable

14.6. Special Precautions for User: None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 1: Low hazard to waters.

15.2. Chemical Safety Assessment

No information available

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3

None

Key literature references and sources for data
www.ChemADVISOR.com/
NZ CCID

Revision Date: 25-Jul-2014
Revision Note
Update to Format SECTION: 8

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement

End of Safety Data Sheet

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

ACETIC ACID

Revision Date: 25-Apr-2014 **Revision Number:** 21

1. Identification of the substance/mixture and of the company/undertaking

1.1 Product Identifier

Product Name	ACETIC ACID

1.2 Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Acid
Sector of use	Refer to the Annex for a listing of uses.

1.3 Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com
For further information, please contact
E-Mail address: fdunexchem@halliburton.com

1.4 Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

2. Hazards Identification

2.1 Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Skin Corrosion / irritation	Category 1 B - H314
Flammable liquids.	Category 3 - H226

Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	C - Corrosive.
Risk Phrases	R10 Flammable. R35 Causes severe burns.

2.2 Label Elements

Hazard Pictograms

Signal Word **Danger**

Hazard Statements
H314 - Causes severe skin burns and eye damage
H226 - Flammable liquid and vapor

Precautionary Statements - EU (§28, 1272/2008)
P370 + P378 - In case of fire: Use water spray for extinction
P301 + P330 + P331 - IF SWALLOWED: rinse mouth. Do NOT induce vomiting
P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
P363 - Wash contaminated clothing before reuse
P304 + P340 - IF INHALED: Remove to fresh air and keep at rest in a position comfortable for breathing
P310 - Immediately call a POISON CENTER or doctor/physician
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing

Contains

Substances	CAS Number
Acetic acid	64-19-7

2.3 Other Hazards

None known

3. Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Acetic acid	200-580-7	64-19-7	30 - 60%	R10 C; R35	Skin Corr. 1A (H314) Flam. Liq. 3 (H226)	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

4. First aid measures

4.1 Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes	In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.
Skin	In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes. Get medical attention. Remove contaminated clothing and launder before reuse.
Ingestion	Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

4.2 Most Important symptoms and effects, both acute and delayed

May cause eye, skin, and respiratory burns. May be harmful if swallowed.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

5. Firefighting Measures

5.1 Extinguishing media

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

5.2 Special hazards arising from the substance or mixture

Special Exposure Hazards

Use water spray to cool fire exposed surfaces. Decomposition in fire may produce toxic gases. Do not allow runoff to enter waterways.

5.3 Advice for firefighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment.
See Section 8 for additional information

6.2 Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3 Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Neutralize with lime slurry, limestone, or soda ash. Contain spill with sand or other inert materials. Scoop up and remove.

6.4 Reference to other sections

See Section 8 and 13 for additional information.

7. Handling and Storage

7.1 Precautions for Safe Handling

Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Wash hands after use. Launder contaminated clothing before reuse.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2 Conditions for safe storage, including any incompatibilities

Store away from alkalis. Store away from oxidizers. Store in a cool well ventilated area. Keep container closed when not in use.

7.3 Specific End Use(s)

Exposure Scenario	Please refer to the attached Annex for a listing of exposure scenarios.
Other Guidelines	No information available

8. Exposure Controls/Personal Protection

8.1 Control parameters

Exposure Limits

Substances	CAS Number	EU	UK OEL	Netherlands	France OEL
Acetic acid	64-19-7	10 ppm	Not applicable	Not applicable	10 ppm

Substances	CAS Number	Germany MAK/TRK	Spain	Portugal	Finland
Acetic acid	64-19-7	TWA: 10 ppm TWA: 25 mg/m^3 MAK: 10 ppm MAK: 25 mg/m^3	15 ppm VLA-EC; 37 mg/m^3 VLA-EC VLA-ED: 10 ppm VLA-ED: 25 mg/m^3	STEL: 15 ppm TWA: 10 ppm	STEL: 10 ppm STEL: 25 mg/m^3 TWA: 5 ppm TWA: 13 mg/m^3

Substances	CAS Number	Austria	Ireland	Switzerland	Norway
Acetic acid	64-19-7	Not applicable	Not applicable	Not applicable	STEL: 20 ppm STEL: 37.5 mg/m^3 TWA: 10 ppm TWA: 25 mg/m^3

Substances	CAS Number	Italy	Poland	Hungary	Czech Republic
Acetic acid	64-19-7	10 ppm	NDSCh: 30 mg/m^3 NDS: 15 mg/m^3	TWA: 25 mg/m^3 STEL: 25 mg/m^3	TWA: 25 mg/m^3

Substances	CAS Number	Denmark
Acetic acid	64-19-7	TWA: 10 ppm TWA: 25 mg/m^3

Derived No Effect Level (DNEL)

Worker

Substances	Long-term exposure - systemic effects, Inhalation	Acute / short term exposure - systemic effects, Inhalation	Long-term exposure - local effects, Inhalation	Acute / short term exposure - local effects, Inhalation	Long-term exposure - systemic effects, Dermal	Acute / short term exposure - systemic effects, Dermal	Long-term exposure - local effects, Dermal	Acute / short term exposure - local effects, Dermal	Hazards for the eyes - local effects
Acetic acid	Not available	Not available	25 mg/m^3	25 mg/m^3	Not available	Not available	Not available	Not available	Not available

General Population

Substances	Long-term exposure - systemic effects, Inhalation	Acute / short term exposure - systemic effects, Inhalation	Long-term exposure - local effects, Inhalation	Acute / short term exposure - local effects, Inhalation	Long-term exposure - systemic effects, Dermal	Acute / short term exposure - systemic effects, Dermal	Long-term exposure - local effects, Dermal	Acute / short term exposure - local effects, Dermal	Long-term exposure - systemic effects, Oral	Acute / short term exposure - local effects, Oral	Hazards for the eyes - local effects
Acetic acid	Not available	Not available	25 mg/m^3	25 mg/m^3	Not available	Not available	Not available	Not available	Not available	Not available	Not available

Predicted No Effect Concentration (PNEC)

Substances	Freshwater	Marine water	Intermittent release	Sewage treatment plant	Sediment (freshwater)	Sediment (marine water)	Air	Soil	Secondary poisoning
Acetic acid	3.06 mg/l	0.306 mg/l	30.58 mg/l	85 mg/l	11.4 mg/kg	1.14 mg/kg	Not available	0.478 mg/kg	Not available

8.2 Exposure controls

Engineering Controls	Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation.
Personal protective equipment	
Respiratory Protection	Organic vapor/acid gas respirator.
Hand Protection	Impervious rubber gloves. Neoprene gloves. Nitrile gloves. Butyl rubber gloves.
Skin Protection	Full protective chemical resistant clothing.
Eye Protection	Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions	Eyewash fountains and safety showers must be easily accessible.
Environmental Exposure Controls	No information available

9. Physical and Chemical Properties

9.1 Information on basic physical and chemical properties

Physical State:	Liquid	**Color:**	Clear
Odor:	Acrid	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	2.9
Freezing Point/Range	16 °C
Melting Point/Range	No data available
Boiling Point/Range	117 °C
Flash Point	42 °C PMCC
upper flammability limit	16
lower flammability limit	5.4
Evaporation rate	No data available
Vapor Pressure	11.7 mmHg
Vapor Density	No data available
Specific Gravity	1.05
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2 Other information

Molecular Weight	60.6
VOC Content (%)	No data available

10. Stability and Reactivity

10.1 Reactivity
Not applicable

10.2 Chemical Stability
Stable

10.3 Possibility of Hazardous Reactions
Will Not Occur

10.4 Conditions to Avoid
Keep away from heat, sparks and flame.

10.5 Incompatible Materials
Strong alkalis.

10.6 Hazardous Decomposition Products
Toxic fumes. Carbon monoxide and carbon dioxide.

11. Toxicological Information

11.1 Information on Toxicological Effects

Acute Toxicity

Inhalation	Causes severe respiratory irritation.
Eye Contact	May cause eye burns.
Skin Contact	Causes severe burns.
Ingestion	Causes burns of the mouth, throat and stomach.
Chronic Effects/Carcinogenicity	Prolonged, excessive exposure may cause erosion of the teeth.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Acetic acid	64-19-7	3310 mg/kg (Rat) 600 mg/kg (Rabbit) 4960 mg/kg (Mouse)	1060 mg/kg (Rabbit)	11.4 mg/L (Rat) 4 h

Substances	CAS Number	Skin corrosion/irritation
Acetic acid	64-19-7	Corrosive to skin

Substances	CAS Number	Eye damage/irritation
Acetic acid	64-19-7	Corrosive to eyes

Substances	CAS Number	Skin Sensitization
Acetic acid	64-19-7	No information available

Substances	CAS Number	Respiratory Sensitization
Acetic acid	64-19-7	No information available

Substances	CAS Number	Mutagenic Effects
Acetic acid	64-19-7	In vivo tests did not show mutagenic effects. In vitro tests did not show mutagenic effects

Substances	CAS Number	Carcinogenic Effects
Acetic acid	64-19-7	Did not show carcinogenic effects in animal experiments

Substances	CAS Number	Reproductive toxicity
Acetic acid	64-19-7	Did not show teratogenic effects in animal experiments.

Substances	CAS Number	STOT - single exposure
Acetic acid	64-19-7	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Acetic acid	64-19-7	No significant toxicity observed in animal studies at concentration requiring classification. Not applicable due to corrosivity of the substance.

Substances	CAS Number	Aspiration hazard
Acetic acid	64-19-7	Not applicable

12. Ecological Information

12.1 Toxicity
Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Acetic acid	64-19-7	EC50: 90 mg/L (Microcystis aeruginosa) EC50(72h): > 1000 mg/L (>300.82 mg/L – acetate ion) (Skeletonema costatum)	LC50: 79 mg/l (Pimephales promelas) LC50: 75 mg/l (Pimephales promelas) LC50(96h) > 1000 mg/L (>300.82 mg/L – acetate ion) (Oncorhynchus mykiss)	NOEC(16h): 1150 mg/L (Pseudomonas putida)	EC50: 47 mg/l (Daphnia magna) LC50: 32 mg/L (Artemia salina) EC50(48h) > 1000 mg/L (>300.82 mg/L – acetate ion) (Daphnia magna) NOEC(21d): 31.4 - 37.9 mg/L (Daphnia magna) (reproduction)

Effect concentrations in the aquatic environment are attributable to a change in pH value

12.2 Persistence and degradability
Readily biodegradable

Substances	CAS Number	Persistence and Degradability
Acetic acid	64-19-7	Readily biodegradable (>95%% @ 28d)

12.3 Bioaccumulative potential

Does not bioaccumulate

Substances	CAS Number	Log Pow
Acetic acid	64-19-7	-0.17 BCF 3.16 (Calculated)

12.4 Mobility in soil

No information available

12.5 Results of PBT and vPvB assessment

This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).

12.6 Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

13.1 Waste treatment methods

Disposal Method	Disposal should be made in accordance with federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

14. Transport Information

IMDG/IMO

UN Number:	UN2790
UN Proper Shipping Name:	Acetic Acid Solution
Transport Hazard Class(es):	8
Packing Group:	III
Environmental Hazards:	Not applicable
EMS:	EmS F-A, S-B

RID

UN Number:	UN2790
UN Proper Shipping Name:	Acetic Acid Solution
Transport Hazard Class(es):	8
Packing Group:	III
Environmental hazard:	Not applicable

ADR

UN Number:	UN2790
UN Proper Shipping Name:	Acetic Acid Solution
Transport Hazard Class(es):	8
Packing Group:	III
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	UN2790
UN Proper Shipping Name:	Acetic Acid Solution
Transport Hazard Class(es):	8
Packing Group:	III
Environmental hazard:	Not applicable

Special Precautions for User	None
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable

15. Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 1: Low hazard to waters.

15.2 Chemical Safety Assessment

Yes

16. Other Information

Full text of R-phrases referred to under Sections 2 and 3

R10 Flammable.
R35 Causes severe burns.

Key literature references and sources for data
www.ChemADVISOR.com/

Revision Date: 25-Apr-2014

Revision Note
Not applicable

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement
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End of Safety Data Sheet

Exposure Scenario

Chemical Name:	**Acetic acid**
CAS Number:	**64-19-7**
EC Number:	**200-580-7**
SDS Reference:	**HM001728 / CP1330**

Contents

Exposure Scenario 1: Formulation & (re)packing of substances and mixtures, Industrial use

1. List of use descriptors

Sector of uses SU	SU3: Industrial uses: Uses of substances as such or in preparations at industrial sites SU10: Formulation [mixing] of preparations and/or re-packaging (excluding alloys)
Process category [PROC]	PROC 1: Use in closed process, no likelihood of exposure; PROC 2: Use in closed, continuous process with occasional controlled exposure; PROC 3: Use in closed batch process (synthesis or formulation); PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises; PROC 5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities; and PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities. PROC 9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC 14: Production of preparations or articles by tabletting, compression, extrusion, pelletisation PROC 15: Use as laboratory reagent
Chemical product category [PC]	Not applicable
Article Categories [AC]	Not applicable
Environmental release categories [ERC]	ERC 2: Formulation of preparations
Specific Environmental Release Categories SPERC	Not applicable
Processes, tasks, activities covered	Formulation, packing and re-packing of the substance and its mixtures in batch or continuous operations, including storage, materials transfers, mixing, tabletting, compression, pelletisation, extrusion, large and small scale packing, sampling, maintenance and associated laboratory activities.

Section 2: Control of Exposure

Physical form of the product:	Liquid
Vapour pressure:	> 10 kPa
Process temperature:	25 °C
Remarks:	Not relevant
Concentration of the substance in a mixture:	Covers percentage substance in the product up to 100% (unless stated differently).

Section 2.1 Control of Human Exposure:

Other given operational conditions affecting workers exposure

Area of use	Room size:	Temperature:	Ventilation rate:	Remarks
Indoor/Outdoor use.	20 m^3	25 °C		

Frequency and duration of use	Duration	Frequency of use:	Remarks
Exposure time	8 hours	5 days/week	(unless stated differently)

Name of contributing exposure scenario	Risk management measures (RMM)
General exposures (closed systems):	Handle substance within a closed system. Wear suitable gloves tested to EN374.
General exposures (closed systems), with sample collection, With occasional controlled exposure:	Handle substance within a closed system. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
General exposures (closed systems), Use in contained batch processes:	Handle substance within a closed system. Provide extract ventilation to points where emissions occur. Wear suitable gloves tested to EN374.
General exposures (open systems), with sample collection, With potential for aerosol generation:	Provide extract ventilation to points where emissions occur. Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin.
Batch processes at elevated temperatures:	Avoid carrying out activities involving exposure for more than 1 hour. Ensure material transfers are under containment or extract ventilation. Wear suitable gloves tested to EN374.
Process sampling:	Sample via a closed loop or other system to avoid exposure. Avoid dip sampling. Wear suitable gloves tested to EN374.
Laboratory activities:	Handle in a fume cupboard or under extract ventilation. Wear suitable gloves tested to EN374.
Bulk transfers:	Clear spills immediately. Ensure material transfers are under containment or extract ventilation. Clear transfer lines prior to de-coupling. Return IBCs or tanks to supplier for re-use. Wear suitable gloves tested to EN374.
Mixing operations (open systems), With potential for aerosol generation.:	Provide extract ventilation to points where emissions occur. Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin.
Manual, Transfer from/pouring from containers:	Provide extract ventilation to points where emissions occur. Wear suitable gloves tested to EN374.
Drum/batch transfers:	Avoid spillage when withdrawing pump. Provide extract ventilation to points where emissions occur. Wear suitable gloves tested to EN374.
Production of preparations or articles by tabletting, compression, extrusion, pelettisation:	Provide extract ventilation to points where emissions occur. Wear suitable gloves tested to EN374.
Drum and small package filling:	Clear spills immediately. Ensure material transfers are under containment or extract ventilation. Put lids on containers immediately after use. Wear suitable gloves tested to EN374.
Equipment cleaning and maintenance:	Drain down and flush system prior to equipment break-in or maintenance. Transfer via enclosed lines. Retain drain downs in sealed storage pending disposal or for subsequent recycle. Wear suitable gloves tested to EN374.
Storage, With occasional controlled exposure:	Locate bulk storage outdoors., or, Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)., Avoid dip sampling. Wear suitable gloves tested to EN374.

Section 2.2 Control of environmental exposure	
Risk management measures (RMM)	Note: Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures.
Technical conditions and measures at process level (source) to prevent release	See Section 8 of the safety data sheet (Environmental exposure controls). See section 6 of the safety data sheet (Accidental release measures)
Organisational measures to prevent/limit release from site:	None
Environment factors not influenced by risk management	
Flow rate of receiving surface water (m^3/d):	Not relevant
Local freshwater dilution factor:	Not relevant
Local marine water dilution factor:	Not relevant

ERC2: Formulation of preparations (mixtures).

Section 3: Exposure Estimation	
Section 3.1 Health:	
Health:	*When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1.*

PROC1: Use in closed process, no likelihood of exposure General exposures (closed systems)

	Exposure level	RCR	Method	Remarks
Inhalation	0.01 ppm	0.00	Used ECETOC TRA model.	
Dermal	0.34 mg/kg/day	0.03	Used ECETOC TRA model.	
Various Routes		0.04	Used ECETOC TRA model.	

PROC 2: Use in closed, continuous process with occasional controlled exposure *General exposures (closed systems), with sample collection, With occasional controlled exposure.*

	Exposure level	RCR	Method	Remarks
Inhalation	7.00 ppm	0.70	Used ECETOC TRA model.	
Dermal	1.37 mg/kg/day	0.14	Used ECETOC TRA model.	
Various Routes		0.84	Used ECETOC TRA model.	

PROC3: Use in closed batch process (synthesis or formulation) *General exposures (closed systems), Use in contained batch processes*

	Exposure level	RCR	Method	Remarks
Inhalation	2.50 ppm	0.25	Used ECETOC TRA model.	
Dermal	0.34 mg/kg/day	0.03	Used ECETOC TRA model.	
Various Routes		0.28	Used ECETOC TRA model.	

PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises *General exposures (open systems), with sample collection, With potential for aerosol generation.*

	Exposure level	RCR	Method	Remarks
Inhalation	2.00 ppm	0.20	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.27	Used ECETOC TRA model.	

PROC3: Use in closed batch process (synthesis or formulation) *Batch processes at elevated temperatures*

	Exposure level	RCR	Method	Remarks
Inhalation	6.00 ppm	0.60	Used ECETOC TRA model.	
Dermal	0.03 mg/kg/day	0.00	Used ECETOC TRA model.	
Various Routes		0.60	Used ECETOC TRA model.	

PROC3: Use in closed batch process (synthesis or formulation) *Process sampling*

	Exposure level	RCR	Method	Remarks
Inhalation	2.50 ppm	0.25	Used ECETOC TRA model.	
Dermal	0.34 mg/kg/day	0.03	Used ECETOC TRA model.	
Various Routes		0.28	Used ECETOC TRA model.	

PROC15: Use as laboratory reagent *Laboratory activities*

	Exposure level	RCR	Method	Remarks
Inhalation	1.00 ppm	0.10	Used ECETOC TRA model.	
Dermal	0.03 mg/kg/day	0.00	Used ECETOC TRA model.	
Various Routes		0.10	Used ECETOC TRA model.	

PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities *Bulk transfers*

	Exposure level	RCR	Method	Remarks
Inhalation	1.50 ppm	0.15	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.22	Used ECETOC TRA model.	

PROC5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) *Mixing operations (open systems), With potential for aerosol generation.*

	Exposure level	RCR	Method	Remarks
Inhalation	6.00 ppm	0.50	Used ECETOC TRA model.	
Dermal	0.07 mg/kg/day	0.01	Used ECETOC TRA model.	
Various Routes		0.51	Used ECETOC TRA model.	

PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities *Manual, Transfer from/pouring*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	5.00 ppm	0.50	Used ECETOC TRA model.	
Dermal	0.14 mg/kg/day	0.01	Used ECETOC TRA model.	
Various Routes		0.51	Used ECETOC TRA model.	

PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities *Drum/batch transfers*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	1.50 ppm	0.15	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.22	Used ECETOC TRA model.	

PROC14: Production of preparations or articles by tabletting, compression, extrusion, pelettisation *Production of preparations or articles by tabletting, compression, extrusion, pelettisation*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	5.00 ppm	0.50	Used ECETOC TRA model.	
Dermal	0.34 mg/kg/day	0.03	Used ECETOC TRA model.	
Various Routes		0.53	Used ECETOC TRA model.	

PROC9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing) *Drum and small package filling*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	5.00 ppm	0.50	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.57	Used ECETOC TRA model.	

PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities *Equipment cleaning and maintenance*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	5.00 ppm	0.50	Used ECETOC TRA model.	
Dermal	2.74 mg/kg/day	0.27	Used ECETOC TRA model.	
Various Routes		0.77	Used ECETOC TRA model.	

PROC2: Use in closed, continuous process with occasional controlled exposure *Storage, With occasional controlled exposure.*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	7.00 ppm	0.70	Used ECETOC TRA model.	
Dermal	1.37 mg/kg/day	0.14	Used ECETOC TRA model.	
Various Routes		0.84	Used ECETOC TRA model.	

Section 3.2 Environment	
Environment	*Used EUSES model. When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposure are not expected to exceed the predicted PNECs and the resulting risk characterization ratios are expected to be less than 1.*

ERC 2: Formulation of preparations

Section 4: Guidance to check compliance with the exposure scenario	
Section 4.1 Health:	
Health	*Confirm that RMMs and OCs are as described or of equivalent efficiency.*
Section 4.2 Environment:	
Environment	*Further details on scaling and control technologies are provided in SpERC factsheet (http://cefic.org/en/reach-for-industries-libraries.html).ries-libraries.html).*
Scaling: The downstream user can check the compliance of his site by comparing site specific data with defaults used in the exposure assessment. The site specific quotient should be inferior or equal to the spERC quotient.	

$$\frac{m_{spERC} * (1 - E_{ER,spERC}) * F_{release,spERC}}{DF_{spERC}} \geq \frac{m_{site} * (1 - E_{ER,site}) * F_{release,site}}{DF_{site}}$$

mspERC: Substance use rate in spERC,
EER, spERC: Efficacy of RMM in spERC,
Frelease, spERC: Initial release fraction in spERC,
DFspERC: Dilution factor of STP effluent in river,
msite: Substance use rate at site,
EER, site: Efficacy of RMM at site,
Frelease, site: Initial release fraction at site, and
DFsite: Dilution factor of STP effluent in river.

Exposure Scenario 2: Use in Oil and Gas field drilling and production operations, Industrial use	
1. List of use descriptors	
Sector of uses SU	SU3: Industrial uses: Uses of substances as such or in preparations at industrial sites
Process category [PROC]	PROC1: Use in closed process, no likelihood of exposure; PROC2: Use in closed, continuous process with occasional controlled exposure; PROC3: Use in closed batch process (synthesis or formulation); PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises; PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities; and PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities.
Chemical product category [PC]	Not applicable
Article Categories [AC]	Not applicable
Environmental release categories [ERC]	ERC1: Manufacture of substances
Specific Environmental Release Categories SPERC	Not applicable
Processes, tasks, activities covered	Oil field well drilling and production operations (including drilling muds and well cleaning) including material transfers, on-site formulation, well head operations, shaker room activities and related maintenance.

Section 2: Control of Exposure	
Physical form of the product:	Liquid
Vapour pressure:	> 10 kPa
Process temperature:	25 °C
Remarks:	Not relevant
Concentration of the substance in a mixture:	Covers percentage substance in the product up to 100% (unless stated differently).

Section 2.1 Control of Human Exposure:				
Other given operational conditions affecting workers exposure				
Area of use	Room size:	Temperature:	Ventilation rate:	Remarks
Indoor/Outdoor use.	$20\ m^3$	25 °C	No data	No data

Frequency and duration of use	Duration	Frequency of use:	Remarks
Exposure time	8 hours	5 days/week	(unless stated differently)

Name of contributing exposure scenario	**Risk management measures (RMM)**
Bulk transfers:	Ensure material transfers are under containment or extract ventilation. Wear suitable gloves tested to EN374.
Filling/preparation of equipment from drums or containers:	Use drum pumps. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Drill floor operations (PROC3):	Avoid carrying out operation for more than 4 hours. Ensure operation is undertaken outdoors. Or, provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Drill floor operations (PROC4):	Limit the substance content in the product to 25%. Ensure operation is undertaken outdoors. Or provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Operation of solids filtering equipment – vapour exposures:	Ensure material transfers are under containment or extract ventilation. Wear suitable gloves tested to EN374.
Operation of solids filtering equipment – aerosol exposures:	Ensure material transfers are under containment or extract ventilation. Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin.
Operation of solids filtering equipment:	Ensure material transfers are under containment or extract ventilation. Wear suitable gloves tested to EN374.
Treatment and disposal of filtered solids:	Ensure material transfers are under containment or extract ventilation. Wear suitable gloves tested to EN374.
Process sampling:	Avoid carrying out activities involving exposure for more than 15 minutes. Use a sampling system designed to control exposure. Ensure operation is undertaken outdoors. Or, provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.

General exposure (closed systems):	Handle substance within a closed system. Wear suitable gloves tested to EN374.
Pouring from small containers:	Avoid carrying out activities involving exposure for more than 15 minutes. Ensure operation is undertaken outdoors. Or, provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
General exposure (open systems):	Avoid carrying out activities involving exposure for more than 4 hours. Ensure operation is undertaken outdoors. Or, provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Equipment cleaning and maintenance:	Avoid carrying out activities involving exposure for more than 1 hour. Ensure operation is undertaken outdoors. Or, provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Batch process:	Handle substance within closed system. Wear suitable gloves tested to EN374.
Batch process, Product sampling:	Handle substance within a closed system. Provide extract ventilation to points where emissions occur. Wear suitable gloves tested to EN374.

Section 2.2 Control of environmental exposure	
Risk management measures (RMM)	Note: Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures.
Technical conditions and measures at process level (source) to prevent release	See Section 8 of the safety data sheet (Environmental exposure controls). See section 6 of the safety data sheet (Accidental release measures)
Organisational measures to prevent/limit release from site:	None
Environment factors not influenced by risk management	
Flow rate of receiving surface water (m^3/d):	Not relevant
Local freshwater dilution factor:	Not relevant
Local marine water dilution factor:	Not relevant

ERC1: Manufacture of substances.

Section 3: Exposure Estimation

Section 3.1 Health:

Health:	*When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characaterisation ratios are expected to be less than 1.*

PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities. *Bulk transfers*

	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	1.50 ppm	0.15	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.22	Used ECETOC TRA model.	

PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities. *Filling/preparation of equipment drums or containers*

	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	7.00 ppm	0.70	Used ECETOC TRA model.	
Dermal	1.37 mg/kg/day	0.14	Used ECETOC TRA model.	
Various Routes		0.84	Used ECETOC TRA model.	

PROC3: Use in closed batch process (synthesis or formulation) *Drill floor operations*

	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	6.30 ppm	0.63	Used ECETOC TRA model.	
Dermal	0.34 mg/kg/day	0.03	Used ECETOC TRA model.	
Various Routes		0.66	Used ECETOC TRA model.	

PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises *Drill floor operations*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	8.40 ppm	0.84	Used ECETOC TRA model.	
Dermal	1.37 mg/kg/day	0.14	Used ECETOC TRA model.	
Various Routes		0.98	Used ECETOC TRA model.	

PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises *Operation of solids filtering equipment – vapour exposures*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	2.00 ppm	0.20	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.27	Used ECETOC TRA model.	

PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises *Operation of solids filtering equipment – aerosol exposures*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	2.00 ppm	0.20	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.27	Used ECETOC TRA model.	

PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities *Operation of solids filtering equipment*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	5.00 ppm	0.50	Used ECETOC TRA model.	
Dermal	0.14 mg/kg/day	0.01	Used ECETOC TRA model.	
Various Routes		0.51	Used ECETOC TRA model.	

PROC3: Use in closed batch process (synthesis or formulation) *Treatment and disposal of filtered solids*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	2.50 ppm	0.25	Used ECETOC TRA model.	
Dermal	0.03 mg/kg/day	0.00	Used ECETOC TRA model.	
Various Routes		0.25	Used ECETOC TRA model.	

PROC3: Use in closed batch process (synthesis or formulation) *Process sampling*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	3.50 ppm	0.35	Used ECETOC TRA model.	
Dermal	0.34 mg/kg/day	0.03	Used ECETOC TRA model.	
Various Routes		0.38	Used ECETOC TRA model.	

PROC1: Use in closed process, no likelihood of exposure *General exposures (closed systems)*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	0.01 ppm	0.00	Used ECETOC TRA model.	
Dermal	0.34 mg/kg/day	0.03	Used ECETOC TRA model.	
Various Routes		0.04	Used ECETOC TRA model.	

PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities *Pouring from small containers*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	3.50 ppm	0.35	Used ECETOC TRA model.	
Dermal	2.74 mg/kg/day	0.27	Used ECETOC TRA model.	
Various Routes		0.62	Used ECETOC TRA model.	

PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises *General exposures (open systems)*

	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	8.40 ppm	0.84	Used ECETOC TRA model.	
Dermal	1.37 mg/kg/day	0.14	Used ECETOC TRA model.	
Various Routes		0.98	Used ECETOC TRA model.	

PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities *Equipment cleaning and maintenance*

	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	7.00 ppm	0.70	Used ECETOC TRA model.	
Dermal	2.74 mg/kg/day	0.27	Used ECETOC TRA model.	
Various Routes		0.97	Used ECETOC TRA model.	

PROC1: Use in closed process, no likelihood of exposure *Batch process*

	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	0.01 ppm	0.00	Used ECETOC TRA model.	
Dermal	0.03 mg/kg/day	0.00	Used ECETOC TRA model.	
Various Routes		0.00	Used ECETOC TRA model.	

PROC2: Use in closed, continuous process with occasional controlled exposure *Batch process, Product sampling*

	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	2.50 ppm	0.25	Used ECETOC TRA model.	
Dermal	0.14 mg/kg/day	0.01	Used ECETOC TRA model.	
Various Routes		0.26	Used ECETOC TRA model.	

Section 3.2 Environment

Environment	*Used EUSES model. When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposure are not expected to exceed the predicted PNECs and the resulting risk characterization ratios are expected to be less than 1.*

ERC1: Manufacture of substances

Section 4: Guidance to check compliance with the exposure scenario

Section 4.1 Health:

Health	*Confirm that RMMs and OCs are as described or of equivalent efficiency.*

Section 4.2 Environment:

Environment	*Further details on scaling and control technologies are provided in SpERC factsheet (http://www.cefic.org/Industry-support/Implementing-reach/Libraries/)*

Scaling: The downstream user can check the compliance of his site by comparing site specific data with defaults used in the exposure assessment. The site specific quotient should be inferior or equal to the spERC quotient.

$$\frac{m_{spERC} * (1 - E_{ER,spERC}) * F_{release,spERC}}{DF_{spERC}} \geq \frac{m_{site} * (1 - E_{ER,site}) * F_{release,site}}{DF_{site}}$$

mspERC: Substance use rate in spERC,
EER, spERC: Efficacy of RMM in spERC,
Frelease, spERC: Initial release fraction in spERC,
DFspERC: Dilution factor of STP effluent in river,
msite: Substance use rate at site,
EER, site: Efficacy of RMM at site,
Frelease, site: Initial release fraction at site, and
DFsite: Dilution factor of STP effluent in river.

Exposure Scenario 3: Covers the use as a component of cleaning products within closed or contained systems including incidental exposures during transfer from storage, mixing/diluting in the preparatory phase and cleaning activities., Industrial use

1. List of use descriptors

Sector of uses SU	SU 3: Industrial uses: Uses of substances as such or in preparations at industrial sites SU 5: Manufacture of textiles, leather, fur SU 6b: Manufacture of pulp, paper and paper products
Process category [PROC]	PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 3: Use in closed batch process (synthesis or formulation) PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises PROC 7: Industrial spraying PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 10: Roller application or brushing PROC 13: Treatment of articles by dipping and pouring
Chemical product category [PC]	Not applicable
Article Categories [AC]	Not applicable
Environmental release categories [ERC]	ERC 4: Industrial use of processing aids in processes and products, not becoming part of articles
Specific Environmental Release Categories SPERC	Not applicable
Processes, tasks, activities covered	Covers the use as a component of cleaning products including transfer from storage, pouring/unloading from drums or containers. Exposures during mixing/diluting in the preparatory phase and cleaning activities (including spraying, brushing, dipping, wiping, automated and by hand), related equipment cleaning and maintenance.

Section 2: Control of Exposure

Physical form of the product:	Liquid
Vapour pressure:	> 10 kPa
Process temperature:	25 °C
Remarks:	Not relevant
Concentration of the substance in a mixture:	Covers percentage substance in the product up to 100% (unless stated differently).

Section 2.1 Control of Human Exposure:

Other given operational conditions affecting workers exposure

Area of use	Room size:	Temperature:	Ventilation rate:	Remarks
Indoor/Outdoor use.	20 m^3	25 °C	No data	No data

Frequency and duration of use	Duration	Frequency of use:	Remarks
Exposure time	8 hours	5 days/week	(unless stated differently)

Name of contributing exposure scenario	Risk management measures (RMM)
Bulk transfers:	Ensure material transfers are under containment or extract ventilation. Clear transfer lines prior to de-coupling. Wear suitable gloves tested to EN374.
Automated process with (semi) closed systems, Use in contained systems:	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Automated process with (semi) closed systems, Use in contained systems, Drum/batch transfers:	Avoid carrying out activities involving exposure for more than 1 hour. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Application of cleaning products in closed systems:	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Filling / preparation of equipment from drums or containers, Dedicated facility:	Ensure material transfers are under containment or extract ventilation. Clear transfer lines prior to de-coupling. Wear suitable gloves tested to EN374.
Use in contained batch processes, Treatment by heating:	Avoid carrying out activities involving exposure for more than 4 hours. Ensure material transfers are under containment or extract ventilation. Wear suitable gloves tested to EN374.
Degreasing small objects in cleaning station:	Clear spills immediately. Provide extract ventilation to points where emissions occur. Wear suitable gloves tested to EN374.
Cleaning with low-pressure washers:	Limit the substance content in the product to 5 %. Avoid carrying out activities involving exposure for more than 4 hours. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.

Cleaning with high pressure washers:	Limit the substance content in the product to 5 %. Avoid carrying out activities involving exposure for more than 1 hour. Ensure operation is undertaken outdoors, Or, Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Manual, Surfaces, cleaning, No spraying:	Limit the substance content in the product to 5 %. Avoid carrying out activities involving exposure for more than 4 hours. Ensure operation is undertaken outdoors, Or, Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Wear suitable gloves tested to EN374.
Equipment cleaning and maintenance:	Clear spills immediately. Drain down and flush system prior to equipment break-in or maintenance. Transfer via enclosed lines. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Retain drain downs in sealed storage pending disposal or for subsequent recycle. Wear suitable gloves tested to EN374.
Storage, With occasional controlled exposure:	Locate bulk storage outdoors, Or, Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Avoid dip sampling. Wear suitable gloves tested to EN374.

Section 2.2 Control of environmental exposure	
Risk management measures (RMM)	Note: Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures.
Technical conditions and measures at process level (source) to prevent release	See Section 8 of the safety data sheet (Environmental exposure controls). See section 6 of the safety data sheet (Accidental release measures)
Organisational measures to prevent/limit release from site:	None
Environment factors not influenced by risk management	
Flow rate of receiving surface water (m^3/d):	Not relevant
Local freshwater dilution factor:	Not relevant
Local marine water dilution factor:	Not relevant

ERC4: Industrial use of processing aids in processes and products, not becoming part of articles

Section 3: Exposure Estimation

Section 3.1 Health:

Health:	*When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1.*

PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities *Bulk transfers*

	Exposure level	RCR	Method	Remarks
Inhalation	5.00 ppm	0.50	Used ECETOC TRA model.	
Dermal	0.14 mg/kg/day	0.01	Used ECETOC TRA model.	
Various Routes		0.51	Used ECETOC TRA model.	

PROC2: Use in closed, continuous process with occasional controlled exposure *Automated process with (semi) closed systems, Use in contained systems*

	Exposure level	RCR	Method	Remarks
Inhalation	7.00 ppm	0.70	Used ECETOC TRA model.	
Dermal	1.37 mg/kg/day	0.14	Used ECETOC TRA model.	
Various Routes		0.84	Used ECETOC TRA model.	

PROC3: Use in closed batch process (synthesis or formulation) *Automated process with (semi) closed systems, Use in contained systems, Drum/batch transfers*

	Exposure level	RCR	Method	Remarks
Inhalation	3.50 ppm	0.35	Used ECETOC TRA model.	
Dermal	0.34 mg/kg/day	0.03	Used ECETOC TRA model.	
Various Routes		0.38	Used ECETOC TRA model.	

PROC2: Use in closed, continuous process with occasional controlled exposure *Application of cleaning products in closed systems*

	Exposure level	RCR	Method	Remarks
Inhalation	7.00 ppm	0.70	Used ECETOC TRA model.	
Dermal	1.37 mg/kg/day	0.14	Used ECETOC TRA model.	
Various Routes		0.84	Used ECETOC TRA model.	

PROC8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities *Filling / preparation of equipment from drums or containers, Dedicated facility*

	Exposure level	RCR	Method	Remarks
Inhalation	1.50 ppm	0.15	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.22	Used ECETOC TRA model.	

PROC4: Use in batch and other process (synthesis) where opportunity for exposure arises *Use in contained batch processes, Treatment by heating*

	Exposure level	RCR	Method	Remarks
Inhalation	6.00 ppm	0.60	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.67	Used ECETOC TRA model.	

PROC13: Treatment of articles by dipping and pouring *Degreasing small objects in cleaning station*

	Exposure level	RCR	Method	Remarks
Inhalation	5.00 ppm	0.50	Used ECETOC TRA model.	
Dermal	0.69 mg/kg/day	0.07	Used ECETOC TRA model.	
Various Routes		0.57	Used ECETOC TRA model.	

PROC10: Roller application or brushing *Cleaning with low-pressure washers*

	Exposure level	RCR	Method	Remarks
Inhalation	4.20 ppm	0.42	Used ECETOC TRA model.	
Dermal	5.49 mg/kg/day	0.55	Used ECETOC TRA model.	
Various Routes		0.97	Used ECETOC TRA model.	

PROC7: Industrial spraying *Cleaning with high pressure washers*

	Exposure level	RCR	Method	Remarks
Inhalation	7.00 ppm	0.7	Used ECETOC TRA model.	
Dermal	1.71 mg/kg/day	0.17	Used ECETOC TRA model.	
Various Routes		0.87	Used ECETOC TRA model.	

PROC10: Roller application or brushing *Manual, Surfaces, cleaning, No spraying*

	Exposure level	RCR	Method	Remarks
Inhalation	4.20 ppm	0.42	Used ECETOC TRA model.	
Dermal	5.49 mg/kg/day	0.55	Used ECETOC TRA model.	
Various Routes		0.97	Used ECETOC TRA model.	

PROC8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities *Equipment cleaning and maintenance*

	Exposure level	RCR	Method	Remarks
Inhalation	3.50 ppm	0.35	Used ECETOC TRA model.	
Dermal	2.74 mg/kg/day	0.27	Used ECETOC TRA model.	
Various Routes		0.62	Used ECETOC TRA model.	

PROC2: Use in closed, continuous process with occasional controlled exposure *Storage, With occasional controlled exposure.*

	Exposure level	RCR	Method	Remarks
Inhalation	7.00 ppm	0.70	Used ECETOC TRA model.	
Dermal	1.37 mg/kg/day	0.14	Used ECETOC TRA model.	
Various Routes		0.84	Used ECETOC TRA model.	

Section 3.2 Environment	
Environment	*Used EUSES model. When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposure are not expected to exceed the predicted PNECs and the resulting risk characterization ratios are expected to be less than 1.*

ERC 4: Industrial use of processing aids in processes and products, not becoming part of articles

Section 4: Guidance to check compliance with the exposure scenario

Section 4.1 Health:	
Health	*Confirm that RMMs and OCs are as described or of equivalent efficiency.*
Section 4.2 Environment:	
Environment	*Further details on scaling and control technologies are provided in SpERC factsheet (http://cefic.org/en/reach-for-industries-libraries.html).ries-libraries.html).*

Scaling: The downstream user can check the compliance of his site by comparing site specific data with defaults used in the exposure assessment. The site specific quotient should be inferior or equal to the spERC quotient.

$$\frac{m_{spERC} * (1 - E_{ER,spERC}) * F_{release,spERC}}{DF_{spERC}} \geq \frac{m_{site} * (1 - E_{ER,site}) * F_{release,site}}{DF_{site}}$$

mspERC: Substance use rate in spERC,
EER, spERC: Efficacy of RMM in spERC,
Frelease, spERC: Initial release fraction in spERC,
DFspERC: Dilution factor of STP effluent in river,
msite: Substance use rate at site,
EER, site: Efficacy of RMM at site,
Frelease, site: Initial release fraction at site, and
DFsite: Dilution factor of STP effluent in river.

Exposure Scenario 4: Use of the substance within laboratory settings within closed or contained systems including incidental exposures during material transfers and equipment cleaning, Industrial use	
1. List of use descriptors	
Sector of uses SU	SU3: Industrial uses: Uses of substances as such or in preparations at industrial sites
Process category [PROC]	PROC 10: Roller application or brushing PROC 15: Use as laboratory reagent
Chemical product category [PC]	Not applicable
Article Categories [AC]	Not applicable
Environmental release categories [ERC]	ERC 4: Industrial use of processing aids in processes and products, not becoming part of articles
Specific Environmental Release Categories SPERC	Not applicable
Processes, tasks, activities covered	Use of the substance within laboratory settings, including material transfers and equipment cleaning.

Section 2: Control of Exposure	
Physical form of the product:	Liquid
Vapour pressure:	> 10 kPa
Process temperature:	25 °C
Remarks:	Not relevant
Concentration of the substance in a mixture:	Covers percentage substance in the product up to 100% (unless stated differently).

Section 2.1 Control of Human Exposure:				
Other given operational conditions affecting workers exposure				
Area of use	Room size:	Temperature:	Ventilation rate:	Remarks
Indoor/Outdoor use.	20 m^3	25 °C		

Frequency and duration of use	Duration	Frequency of use:	Remarks
Exposure time	8 hours	5 days/week	(unless stated differently)

Name of contributing exposure scenario	**Risk management measures (RMM)**
Laboratory activities, small scale:	Handle in a fume cupboard or under extract ventilation. Wear suitable gloves tested to EN374.
Cleaning, Rolling, Brushing, Vessel and container cleaning:	Avoid carrying out activities involving exposure for more than 1 hour. Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Use long handled tools where possible. Wear suitable gloves tested to EN374.

Section 2.2 Control of environmental exposure	
Risk management measures (RMM)	Note: Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures.
Technical conditions and measures at process level (source) to prevent release	See Section 8 of the safety data sheet (Environmental exposure controls). See section 6 of the safety data sheet (Accidental release measures)
Organisational measures to prevent/limit release from site:	None
Environment factors not influenced by risk management	
Flow rate of receiving surface water (m^3/d):	Not relevant
Local freshwater dilution factor:	Not relevant
Local marine water dilution factor:	Not relevant

ERC 4: Industrial use of processing aids in processes and products, not becoming part of articles.

Section 3: Exposure Estimation	
Section 3.1 Health:	
Health:	*When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1.*

PROC15: Use as laboratory reagent *Laboratory activities, small scale*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	1.00 ppm	0.10	Used ECETOC TRA model.	
Dermal	0.03 mg/kg/day	0.00	Used ECETOC TRA model.	
Various Routes		0.10	Used ECETOC TRA model.	

PROC10: Roller application or brushing *Cleaning, Rolling, Brushing, Vessel and container cleaning*				
	Exposure level	**RCR**	**Method**	**Remarks**
Inhalation	3.00 ppm	0.30	Used ECETOC TRA model.	
Dermal	5.49 mg/kg/day	0.55	Used ECETOC TRA model.	
Various Routes		0.85	Used ECETOC TRA model.	

Section 3.2 Environment	
Environment	*Used EUSES model. When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposure are not expected to exceed the predicted PNECs and the resulting risk characterization ratios are expected to be less than 1.*

ERC4: Industrial use of processing aids in processes and products, not becoming part of articles

Section 4: Guidance to check compliance with the exposure scenario	
Section 4.1 Health:	
Health	*Confirm that RMMs and OCs are as described or of equivalent efficiency.*
Section 4.2 Environment:	
Environment	*Further details on scaling and control technologies are provided in SpERC factsheet (http://cefic.org/en/reach-for-industries-libraries.html).ries-libraries.html).*

Scaling: The downstream user can check the compliance of his site by comparing site specific data with defaults used in the exposure assessment. The site specific quotient should be inferior or equal to the spERC quotient.

$$\frac{m_{spERC} * (1 - E_{ER,spERC}) * F_{release,spERC}}{DF_{spERC}} \geq \frac{m_{site} * (1 - E_{ER,site}) * F_{release,site}}{DF_{site}}$$

mspERC: Substance use rate in spERC,
EER, spERC: Efficacy of RMM in spERC,
Frelease, spERC: Initial release fraction in spERC,
DFspERC: Dilution factor of STP effluent in river,
msite: Substance use rate at site,
EER, site: Efficacy of RMM at site,
Frelease, site: Initial release fraction at site, and
DFsite: Dilution factor of STP effluent in river.

DNELs and PNECs for Acetic acid (CAS# 64-19-7) - Workers	
DNELs	
Workers – Hazard via inhalation route	
Long-term exposure – systemic effects, Inhalation	No data available
Acute/short term exposure – systemic effects, Inhalation	No data available
Long-term exposure – local effects, Inhalation	25 mg/m3
Acute/short term exposure – local effects, Inhalation	25 mg/m3
Workers – Hazard via dermal route	
Long-term exposure – systemic effects, Dermal	No data available
Acute/short term exposure – systemic effects, Dermal	No data available
Long-term exposure – local effects, Dermal	No data available
Acute/short term exposure – local effects, Dermal	No data available
Hazard for the eyes – local effects	No data available

PNECs	
Freshwater	3.06 mg/L
Marine water	0.306 mg/L
Intermittent releases	30.58 mg/L
Sewage Treatment Plant (STP)	85 mg/L
Sediment (freshwater)	11.4 mg/kg (wet)
Sediment (marine water)	1.14 mg/kg (wet)
Air	No data available
Soil	0.478 mg/kg (wet)
Secondary poisoning	No data available

HALLIBURTON

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

CLLAU301

Revision Date: 25-Jul-2014 **Revision Number:** 6

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name	CLLAU301

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Crosslinker
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC4 - Use in batch and other process (synthesis) where opportunity for exposure arises

1.3. Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Skin Corrosion / irritation	Category 2 - H315
Serious Eye Damage / Eye Irritation	Category 1 - H318
Substances/mixtures corrosive to metal.	Category 1 - H290

Classification according to EU Directives 67/548/EEC or 1999/45/EC
For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Xi - Irritant.
Risk Phrases	R41 Risk of serious damage to eyes. R38 Irritating to skin.

2.2. Label Elements

Hazard Pictograms

Signal Word **Danger**

Hazard Statements
H318 - Causes serious eye damage
H315 - Causes skin irritation
H290 - May be corrosive to metals

Precautionary Statements - EU (§28, 1272/2008)
P280 - Wear protective gloves/eye protection/face protection
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician
P302 + P352 - IF ON SKIN: Wash with plenty of soap and water
P332 + P313 - If skin irritation occurs: Get medical advice/attention
P390 - Absorb spillage to prevent material damage

Contains

Substances	**CAS Number**
Aluminum sulfate	10043-01-3
Sulfuric acid	7664-93-9

2.3. Other Hazards

None known

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Aluminum sulfate	233-135-0	10043-01-3	5 - 10%	Xi; R41	Eye Irrit. 1 (H318) Met. Corr. 1 (H290)	No data available
Sulfuric acid	231-639-5	7664-93-9	1 - 5%	C; R35	Skin Corr. 1A (H314)	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Not applicable
3.2. Mixtures	Mixture

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes	Immediately flush eyes with large amounts of water for at least 15 minutes. Get immediate medical attention.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

4.2. Most Important symptoms and effects, both acute and delayed

May cause severe eye irritation. May cause skin irritation.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media

All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards

Not applicable.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters

Not applicable.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Neutralize with lime slurry, limestone, or soda ash. Contain spill with sand or other inert materials. Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Avoid contact with eyes, skin, or clothing. Avoid breathing mist.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Store in a cool, dry location. Product has a shelf life of 24 months.

7.3. Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	**CAS Number**	**EU**	**UK OEL**	**Netherlands**	**France OEL**
Aluminum sulfate	10043-01-3	Not applicable	2 mg/m³	2 mg/m³	Not applicable
Sulfuric acid	7664-93-9	Not applicable	0.3 mg/m³	0.05 mg/m³	1 mg/m³

Substances	**CAS Number**	**Germany MAK/TRK**	**Spain**	**Portugal**	**Finland**
Aluminum sulfate	10043-01-3	Not applicable	VLA-ED: 2 mg/m³	TWA: 2 mg/m³	TWA: 1 mg/m³
Sulfuric acid	7664-93-9	MAK: 0.1 mg/m³	3 mg/m³ VLA-EC VLA-ED: 1 mg/m³	TWA: 0.2 mg/m³	STEL: 1 mg/m³ TWA: 0.2 mg/m³

Substances	**CAS Number**	**Austria**	**Ireland**	**Switzerland**	**Norway**
Aluminum sulfate	10043-01-3	Not applicable	Not applicable	Not applicable	STEL: 4 mg/m³ TWA: 2 mg/m³
Sulfuric acid	7664-93-9	Not applicable	Not applicable	Not applicable	STEL: 0.3 mg/m³ TWA: 0.1 mg/m³

Substances	**CAS Number**	**Italy**	**Poland**	**Hungary**	**Czech Republic**
Aluminum sulfate	10043-01-3	Not applicable	Not applicable	Not applicable	Not applicable
Sulfuric acid	7664-93-9	Not applicable	NDSCh: 3 mg/m³ NDS: 1 mg/m³	TWA: 1 mg/m³ STEL: 1 mg/m³	TWA: 1 mg/m³

Substances	**CAS Number**	**Denmark**
Aluminum sulfate	10043-01-3	TWA: 1 mg/m³
Sulfuric acid	7664-93-9	TWA: 1 mg/m³

Derived No Effect Level (DNEL) No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Butyl rubber gloves. (>= 0.7 mm thickness) This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

Environmental Exposure Controls No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color:**	White
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	0.80
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.01
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity
Not applicable

10.2. Chemical Stability
Stable

10.3. Possibility of Hazardous Reactions
Will Not Occur

10.4. Conditions to Avoid
None anticipated

10.5. Incompatible Materials
Strong alkalis.

10.6. Hazardous Decomposition Products
Oxides of sulfur.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause respiratory irritation.
Eye Contact	May cause severe eye irritation.
Skin Contact	May cause skin irritation.
Ingestion	In large amounts: May cause abdominal pain, vomiting, nausea, and diarrhea.

Chronic Effects/Carcinogenicity	Contains sulfuric acid, a potential carcinogen.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Aluminum sulfate	10043-01-3	1930 mg/kg (Rat) > 2000 < 5000 mg/kg (Rat)	> 5000 mg/kg (Rabbit)	5 mg/L (Rat, aerosol) 4h (Similar substance)
Sulfuric acid	7664-93-9	2140 mg/kg (Rat)	No data available	347 ppm (Rat) 1 h 510 mg/m^3 (Rat) 2 h 295 mg/m^3 (Rat) 4h 375 mg/m^3 (Rat) 4h 160 mg/m^3 (Mouse) 4h 15 mg/m^3 (Guinea pig) 4h 9 mg/m^3 (Guinea pig) 4h

Substances	CAS Number	Skin corrosion/irritation

Aluminum sulfate	10043-01-3	Non-irritating to the skin (rabbit)
Sulfuric acid	7664-93-9	Corrosive to skin (rabbit)

Substances	**CAS Number**	**Eye damage/irritation**
Aluminum sulfate	10043-01-3	Causes severe eye irritation (rabbit)
Sulfuric acid	7664-93-9	Corrosive to eyes (rabbit)

Substances	**CAS Number**	**Skin Sensitization**
Aluminum sulfate	10043-01-3	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)
Sulfuric acid	7664-93-9	No information available

Substances	**CAS Number**	**Respiratory Sensitization**
Aluminum sulfate	10043-01-3	No information available
Sulfuric acid	7664-93-9	No information available

Substances	**CAS Number**	**Mutagenic Effects**
Aluminum sulfate	10043-01-3	Not regarded as mutagenic. In vitro tests did not show mutagenic effects
Sulfuric acid	7664-93-9	Not regarded as mutagenic.

Substances	**CAS Number**	**Carcinogenic Effects**
Aluminum sulfate	10043-01-3	Did not show carcinogenic effects in animal experiments
Sulfuric acid	7664-93-9	Contains sulfuric acid, a potential carcinogen.

Substances	**CAS Number**	**Reproductive toxicity**
Aluminum sulfate	10043-01-3	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments. (similar substances)
Sulfuric acid	7664-93-9	No significant toxicity observed in animal studies at concentration requiring classification. Did not show teratogenic effects in animal experiments.

Substances	**CAS Number**	**STOT - single exposure**
Aluminum sulfate	10043-01-3	No significant toxicity observed in animal studies at concentration requiring classification.
Sulfuric acid	7664-93-9	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	**CAS Number**	**STOT - repeated exposure**
Aluminum sulfate	10043-01-3	No significant toxicity observed in animal studies at concentration requiring classification.
Sulfuric acid	7664-93-9	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	**CAS Number**	**Aspiration hazard**
Aluminum sulfate	10043-01-3	Not applicable
Sulfuric acid	7664-93-9	Not applicable

SECTION 12: Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Substances	**CAS Number**	**Toxicity to Algae**	**Toxicity to Fish**	**Toxicity to Microorganisms**	**Toxicity to Invertebrates**

Aluminum sulfate	10043-01-3	EC50(72h): 14 mg/L (growth rate) (Pseudokirchnerella subcapitata)	LC50: 100 mg/L (Carassius auratus) LC50(96h): 186 mg/L (Danio rerio) LC50(42d): 15 ug/L (dissolved Aluminium) (Salmo trutta) NOEC(60d): 26 ug/L (mortality in Fry) (Salvelinus fontinalis)	EC50(180min): > 1000 mg/L (activated sludge)	EC50(48h): 136 mg/L (Daphnia magna) EC50(48h): > 200 mg/L (Daphnia magna) NOEC(8d): 3.8 mg/L (reproduction) (Ceriodaphnia dubia) (Similar substance)
Sulfuric acid	7664-93-9	EC50(72h): > 100 mg/L (growth rate) (Desmodesmus subspicatus)	LC50: >500 mg/l (Brachydanio rerio) LC50(96h) > 16 and < 28 mg/L (Lepomis macrochirus) NOEC(65d): 0.025 mg/L (fry growth) (Jordanella floridae) NOEC(chronic): 0.31 mg/L (larval development) (Salvelinus fontinalis)	NOEC(21d): 6.61 pH (total bacteria) NOEC(37d): ca. 26 g/L (activated sludge, respiration rate) (Similar substance)	EC50(48h): 29 mg/L (Daphnia magna) EC50(48h): > 100 mg/L (Daphnia magna) NOEL(chronic): 0.15 mg/L (mortality) (Tanytarsus dissimilis)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Aluminum sulfate	10043-01-3	The methods for determining biodegradability are not applicable to inorganic substances.
Sulfuric acid	7664-93-9	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Does not bioaccumulate

Substances	CAS Number	Log Pow
Aluminum sulfate	10043-01-3	No information available
Sulfuric acid	7664-93-9	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

Substances	PBT and vPvB assessment
Aluminum sulfate	Not PBT/vPvB
Sulfuric acid	Not PBT/vPvB

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Disposal should be made in accordance with federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number: Not restricted.
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental hazard: Not applicable

ADR

UN Number: Not restricted.
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental hazard: Not applicable

IATA/ICAO

UN Number: Not restricted.
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental hazard: Not applicable

14.1. UN Number: Not restricted.

14.2. UN Proper Shipping Name: Not restricted

14.3. Transport Hazard Class(es): Not applicable

14.4. Packing Group: Not applicable

14.5. Environmental Hazards: Not applicable

14.6. Special Precautions for User: None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 1: Low hazard to waters.

15.2. Chemical Safety Assessment

No information available

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3

R35 Causes severe burns.
R38 Irritating to skin.
R41 Risk of serious damage to eyes.

Key literature references and sources for data
www.ChemADVISOR.com/

Revision Date: 25-Jul-2014
Revision Note
Update to Format SECTION: 8

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement

End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

CLBEAU196

Revision Date: 25-Jul-2014 **Revision Number:** 6

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name CLBEAU196

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Breaker
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC4 - Use in batch and other process (synthesis) where opportunity for exposure arises

1.3. Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Respiratory Sensitization	Category 1 - (H334)

Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Xn - Harmful.
Risk Phrases	R42 May cause sensitization by inhalation.

2.2. Label Elements

Hazard Pictograms

Signal Word **Danger**

Hazard Statements
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled

Precautionary Statements - EU (§28, 1272/2008)
P261 - Avoid breathing dust/fume/gas/mist/vapors/spray
P285 - In case of inadequate ventilation wear respiratory protection
P304 + P341 - IF INHALED: If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing
P342 + P311 - If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician

Contains

Substances	**CAS Number**
Hemicellulase enzyme	9012-54-8

2.3. Other Hazards

Dust can form an explosive mixture in air

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Hemicellulase enzyme	232-734-4	9012-54-8	1 - 5%	Xn; R42	Resp. Sens. 1 (H334)	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Not applicable
3.2. Mixtures	Mixture

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.

4.2. Most Important symptoms and effects, both acute and delayed

May cause mild eye, skin, and respiratory irritation. May cause allergic respiratory reaction.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media

All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards

Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Avoid creating or inhaling dust. Slippery when wet.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Store away from oxidizers. Store in a cool, dry location. Product has a shelf life of 18 months.

7.3. Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	**CAS Number**	**EU**	**UK OEL**	**Netherlands**	**France OEL**
Hemicellulase enzyme	9012-54-8	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Germany MAK/TRK**	**Spain**	**Portugal**	**Finland**
Hemicellulase enzyme	9012-54-8	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Austria**	**Ireland**	**Switzerland**	**Norway**
Hemicellulase enzyme	9012-54-8	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Italy**	**Poland**	**Hungary**	**Czech Republic**
Hemicellulase enzyme	9012-54-8	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Denmark**
Hemicellulase enzyme	9012-54-8	Not applicable

Derived No Effect Level (DNEL)	No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC)	No information available.

8.2. Exposure controls

Engineering Controls	Use in a well ventilated area.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

Environmental Exposure Controls	No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Powder	**Color:**	White to Tan
Odor:	Characteristic	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	3.8-8 (1%)
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	No data available
Water Solubility	dispersible
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity

Not applicable

10.2. Chemical Stability

Stable

10.3. Possibility of Hazardous Reactions

Will Not Occur

10.4. Conditions to Avoid

None anticipated

10.5. Incompatible Materials

Strong oxidizers.

10.6. Hazardous Decomposition Products

Carbon monoxide and carbon dioxide.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause allergic respiratory reaction. May cause mild respiratory irritation.
Eye Contact	May cause mild eye irritation.
Skin Contact	None known.
Ingestion	None known
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Hemicellulase enzyme	9012-54-8	> 2000 mg/kg (Rat) (Similar substance) > 10000 mg/kg (Rat) > 8000 mg/kg (Mouse) > 2880 mg/kg (Rat)	No data available	> 3.5 mg/L (Rat) 4h > 4.86 mg/L (Rat) 4h

Substances	CAS Number	Skin corrosion/irritation
Hemicellulase enzyme	9012-54-8	Non-irritating to the skin (rabbit)

Substances	CAS Number	Eye damage/irritation
Hemicellulase enzyme	9012-54-8	Non-irritating to the eye (rabbit)

Substances	CAS Number	Skin Sensitization
Hemicellulase enzyme	9012-54-8	No information available

Substances	CAS Number	Respiratory Sensitization
Hemicellulase enzyme	9012-54-8	May cause sensitization by inhalation

Substances	CAS Number	Mutagenic Effects
Hemicellulase enzyme	9012-54-8	In vitro tests did not show mutagenic effects

Substances	CAS Number	Carcinogenic Effects
Hemicellulase enzyme	9012-54-8	No information available.

Substances	CAS Number	Reproductive toxicity
Hemicellulase enzyme	9012-54-8	No information available

Substances	CAS Number	STOT - single exposure
Hemicellulase enzyme	9012-54-8	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure

Hemicellulase enzyme	9012-54-8	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Hemicellulase enzyme	9012-54-8	Not applicable

SECTION 12: Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Hemicellulase enzyme	9012-54-8	EC50(72h) >/= 100 mg/L Total Organic Solids (Pseudokirchnerella subcapitata) EC50(72h): > 52.1 mg/L (Biomass) (Pseudokirchneriella subcapitata)	LC50(96h): >/= 100 mg/L Total Organic Solids (Oncorhynchus mykiss) LC50(96h): > 52.1 mg/L (Oncorhynchus mykiss)	No information available	EC50(48h): > 39.5 mg/L (Daphnia magna) EC50(48h): >/= 100 mg/L Total Organic Solids (Daphnia magna) EC50(48h): > 52.1 mg/L (mobility) (Daphnia magna)

12.2. Persistence and degradability

Readily biodegradable

Substances	CAS Number	Persistence and Degradability
Hemicellulase enzyme	9012-54-8	Readily biodegradable (129% @ 28d)

12.3. Bioaccumulative potential

Does not bioaccumulate

Substances	CAS Number	Log Pow
Hemicellulase enzyme	9012-54-8	-2.95 (Similar substance)

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available.

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted

Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental hazard: Not applicable

ADR

UN Number: Not restricted.
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental hazard: Not applicable

IATA/ICAO

UN Number: Not restricted.
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental hazard: Not applicable

14.1. UN Number: Not restricted.

14.2. UN Proper Shipping Name: Not restricted

14.3. Transport Hazard Class(es): Not applicable

14.4. Packing Group: Not applicable

14.5. Environmental Hazards: Not applicable

14.6. Special Precautions for User: None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK) WGK 1: Low hazard to waters.

15.2. Chemical Safety Assessment

No information available

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3

R42 May cause sensitization by inhalation.

Key literature references and sources for data

www.ChemADVISOR.com/

Revision Date: 25-Jul-2014

Revision Note

Update to Format SECTION: 8

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement

End of Safety Data Sheet

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

CLBXTAU121

Revision Date: 25-Jul-2014 **Revision Number:** 7

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name	CLBXTAU121

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Breaker
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC4 - Use in batch and other process (synthesis) where opportunity for exposure arises

1.3. Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Not classified

Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Not Classified
Risk Phrases	None

2.2. Label Elements

Not classified

Hazard Pictograms

Signal Word **None**

Hazard Statements

Not Classified

Precautionary Statements - EU (§28, 1272/2008)

Not Classified

Contains

Substances	**CAS Number**
Contains no hazardous substances	NA

2.3. Other Hazards

None known

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Contains no hazardous substances	Not applicable	NA	60 - 100%	Not applicable	Not applicable	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Substance
3.2. Mixtures	Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Get medical attention if irritation persists. Wash with soap and water.
Ingestion	Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

4.2. Most Important symptoms and effects, both acute and delayed

May cause mild eye, skin, and respiratory irritation.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards

Not applicable.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Slippery when wet.

See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Wash hands after use. Avoid contact with eyes, skin, or clothing. Avoid breathing mist. Avoid breathing vapors.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Keep from freezing. Store away from oxidizers. Keep container closed when not in use. Store in a well ventilated area. Product has a shelf life of 24 months.

7.3. Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	**CAS Number**	**EU**	**UK OEL**	**Netherlands**	**France OEL**
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Germany MAK/TRK**	**Spain**	**Portugal**	**Finland**
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Austria**	**Ireland**	**Switzerland**	**Norway**
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Italy**	**Poland**	**Hungary**	**Czech Republic**
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Denmark**
Contains no hazardous substances	NA	Not applicable

Derived No Effect Level (DNEL) No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions	None known.

Environmental Exposure Controls No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color:**	Light green
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	No data available
Freezing Point/Range	-45 °C
Melting Point/Range	No data available
Boiling Point/Range	294 °C
Flash Point	155 °C Closed cup
Evaporation rate	No data available
Vapor Pressure	< 1 mmHg
Vapor Density	9.54
Specific Gravity	1.14
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	0.33
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

Molecular Weight	276.28
VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity

Not applicable

10.2. Chemical Stability

Stable

10.3. Possibility of Hazardous Reactions

Will Not Occur

10.4. Conditions to Avoid

None anticipated

10.5. Incompatible Materials

None known.

10.6. Hazardous Decomposition Products

Carbon monoxide and carbon dioxide.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause mild respiratory irritation.
Eye Contact	May cause mild eye irritation.
Skin Contact	May cause mild skin irritation.
Ingestion	May cause abdominal pain, vomiting, nausea, and diarrhea.
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances	NA	No data available	No data available	No data available

SECTION 12: Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

Readily biodegradable

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances	NA	No information available

12.3. Bioaccumulative potential

Does not bioaccumulate

Substances	CAS Number	Log Pow
Contains no hazardous substances	NA	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Disposal should be made in accordance with federal, state, and local regulations.
Contaminated Packaging	Empty container completely. Transport with all closures in place. Return for reuse or dispose in a sanitary landfill according to national or local regulations.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

ADR

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

14.1. UN Number: Not restricted.

14.2. UN Proper Shipping Name: Not restricted

14.3. Transport Hazard Class(es): Not applicable

14.4. Packing Group: Not applicable

14.5. Environmental Hazards: Not applicable

14.6. Special Precautions for User: None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 1: Low hazard to waters.

15.2. Chemical Safety Assessment

No information available

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3

None

Key literature references and sources for data

www.ChemADVISOR.com/

Revision Date: 25-Jul-2014

Revision Note

Update to Format SECTION: 8

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET
according to Regulation (EC) No. 453/2010

CLSAU352

Revision Date: 25-Jul-2014 **Revision Number:** 6

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name	CLSAU352

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Surfactant
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC4 - Use in batch and other process (synthesis) where opportunity for exposure arises

1.3. Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Acute Oral Toxicity	Category 2 - H302
Skin Corrosion / irritation	Category 2 - H315
Serious Eye Damage / Eye Irritation	Category 1 - H318

Chronic Aquatic Toxicity	Chronic 3 - H412

Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Xi - Irritant.
Risk Phrases	R22 Harmful if swallowed. R41 Risk of serious damage to eyes. R38 Irritating to skin. R52/53 Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

2.2. Label Elements

Hazard Pictograms

Signal Word **Danger**

Hazard Statements
H302 - Harmful if swallowed
H315 - Causes skin irritation
H318 - Causes serious eye damage
H412 - Harmful to aquatic life with long lasting effects

Precautionary Statements - EU (§28, 1272/2008)
P280 - Wear protective gloves/eye protection/face protection
P301+ P312 - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
P330 - Rinse mouth
P302 + P352 - IF ON SKIN: Wash with plenty of soap and water
P332 + P313 - If skin irritation occurs: Get medical advice/attention
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTRE or doctor/physician

Contains

Substances	**CAS Number**
Sodium lauryl sulfate	151-21-3

2.3. Other Hazards

None known

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Sodium lauryl sulfate	205-788-1	151-21-3	10 - 30%	Xn; R22 Xi; 38-41 R52/53	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Dam. 1 (H318) Aquatic Chronic 3 (H412)	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Not applicable
3.2. Mixtures	Mixture

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	If swallowed, give at least 3-4 glasses of water, but do not induce vomiting. Do not give anything by mouth to an unconscious or convulsing person. Get medical attention.

4.2. Most Important symptoms and effects, both acute and delayed

May cause severe eye irritation. May cause skin irritation. May be harmful if swallowed.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards

Decomposition in fire may produce toxic gases.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Do NOT spread spilled product with water. Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Avoid breathing vapors. Wash hands after use. Launder contaminated clothing before reuse. Avoid breathing mist. Avoid contact with eyes, skin, or clothing.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Store away from oxidizers. Keep from freezing. Keep container closed when not in use. Product has a shelf life of 24 months.

7.3. Specific End Use(s)

Exposure Scenario	No information available

Other Guidelines No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	**CAS Number**	**EU**	**UK OEL**	**Netherlands**	**France OEL**
Sodium lauryl sulfate	151-21-3	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Germany MAK/TRK**	**Spain**	**Portugal**	**Finland**
Sodium lauryl sulfate	151-21-3	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Austria**	**Ireland**	**Switzerland**	**Norway**
Sodium lauryl sulfate	151-21-3	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Italy**	**Poland**	**Hungary**	**Czech Republic**
Sodium lauryl sulfate	151-21-3	Not applicable	Not applicable	Not applicable	Not applicable

Substances	**CAS Number**	**Denmark**
Sodium lauryl sulfate	151-21-3	Not applicable

Derived No Effect Level (DNEL) No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Engineering Controls Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Nitrile gloves. (>= 0.35 mm thickness) This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.
Skin Protection	Wear impervious protective clothing, including boots, gloves, lab coat, apron, rain jacket, pants or coverall, as appropriate, to prevent skin contact.
Eye Protection	Chemical goggles; also wear a face shield if splashing hazard exists.
Other Precautions	Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color:**	Off white
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	No data available
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	100 °C
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	0.98
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity

Not applicable

10.2. Chemical Stability

Stable

10.3. Possibility of Hazardous Reactions

Will Not Occur

10.4. Conditions to Avoid

None anticipated

10.5. Incompatible Materials

Strong oxidizers.

10.6. Hazardous Decomposition Products

Oxides of sulfur. Sodium oxides. Carbon monoxide and carbon dioxide.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause respiratory irritation. May cause allergic respiratory reaction.
Eye Contact	May cause severe eye irritation.
Skin Contact	May cause an allergic skin reaction. Prolonged or repeated contact may cause skin irritation.
Ingestion	Irritation of the mouth, throat, and stomach.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium lauryl sulfate	151-21-3	1288 mg/kg (Rat) 1200 mg/kg (Rat)	> 2000 mg/kg (Rabbit) (similar substance)	3900 mg/m^3 (Rat) 1 h

Substances	CAS Number	Skin corrosion/irritation
Sodium lauryl sulfate	151-21-3	Irritating to skin. (rabbit)

Substances	**CAS Number**	**Eye damage/irritation**
Sodium lauryl sulfate	151-21-3	Causes severe eye irritation (rabbit)

Substances	**CAS Number**	**Skin Sensitization**
Sodium lauryl sulfate	151-21-3	Did not cause sensitization on laboratory animals (guinea pig) (similar substances)

Substances	**CAS Number**	**Respiratory Sensitization**
Sodium lauryl sulfate	151-21-3	No information available

Substances	**CAS Number**	**Mutagenic Effects**
Sodium lauryl sulfate	151-21-3	In vitro tests did not show mutagenic effects In vivo tests did not show mutagenic effects. (similar substances)

Substances	**CAS Number**	**Carcinogenic Effects**
Sodium lauryl sulfate	151-21-3	Did not show carcinogenic effects in animal experiments (similar substances)

Substances	**CAS Number**	**Reproductive toxicity**
Sodium lauryl sulfate	151-21-3	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)

Substances	**CAS Number**	**STOT - single exposure**
Sodium lauryl sulfate	151-21-3	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	**CAS Number**	**STOT - repeated exposure**
Sodium lauryl sulfate	151-21-3	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	**CAS Number**	**Aspiration hazard**
Sodium lauryl sulfate	151-21-3	Not applicable

SECTION 12: Ecological Information

12.1. Toxicity
Ecotoxicity Effects

Substances	**CAS Number**	**Toxicity to Algae**	**Toxicity to Fish**	**Toxicity to Microorganisms**	**Toxicity to Invertebrates**
Sodium lauryl sulfate	151-21-3	EC50(72h): > 120 mg/L (growth rate) (Desmodesmus subspicatus)	LC50(96h): 29 mg/L (Pimephales promelas) LC50(96h): 4.5 mg/L (Lepomis macrochirus) NOEC(28d): < 3.8 mg/L (Pimephales promelas)	EC50(3h): 135 mg/L (activated sludge)	LC50(48h): 5.55 mg/L (Ceriodaphnia dubia) NOEC(7d): 0.88 mg/L (Ceriodaphnia dubia)

12.2. Persistence and degradability

Substances	**CAS Number**	**Persistence and Degradability**
Sodium lauryl sulfate	151-21-3	Readily biodegradable (95% @ 28d)

12.3. Bioaccumulative potential

Substances	**CAS Number**	**Log Pow**
Sodium lauryl sulfate	151-21-3	<= -2.03

12.4. Mobility in soil
No information available

12.5. Results of PBT and vPvB assessment

No information available.

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Disposal should be made in accordance with federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

ADR

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

14.1. UN Number:	Not restricted.
14.2. UN Proper Shipping Name:	Not restricted
14.3. Transport Hazard Class(es):	Not applicable
14.4. Packing Group:	Not applicable
14.5. Environmental Hazards:	Not applicable
14.6. Special Precautions for User:	None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 2: Hazard to waters.

15.2. Chemical Safety Assessment

No information available

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3

R22 Harmful if swallowed.
R38 Irritating to skin.
R41 Risk of serious damage to eyes.
R52/53 Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Key literature references and sources for data

www.ChemADVISOR.com/

Revision Date:	25-Jul-2014

Revision Note

Update to Format SECTION: 8

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement

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End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

CLWGAU421

Revision Date: 25-Jul-2014 **Revision Number:** 5

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name CLWGAU421

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Gelling Agent
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC4 - Use in batch and other process (synthesis) where opportunity for exposure arises

1.3. Details of the supplier of the safety data sheet

Halliburton Manufacturing Services, Ltd.
Halliburton House, Howemoss Crescent
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Not classified

Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Not Classified
Risk Phrases	None

2.2. Label Elements

Not classified

Hazard Pictograms

Signal Word **None**

Hazard Statements
Not Classified

Precautionary Statements - EU (§28, 1272/2008)
Not Classified

Contains

Substances	**CAS Number**
Contains no hazardous substances	NA

2.3. Other Hazards

Dust can form an explosive mixture in air

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Contains no hazardous substances	Not applicable	NA	60 - 100%	Not applicable	Not applicable	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Substance
3.2. Mixtures	Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

4.2. Most Important symptoms and effects, both acute and delayed

No significant hazards expected.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media
Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons
None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards

Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Avoid creating and breathing dust. Slippery when wet.
See Section 8 for additional information

6.2. Environmental precautions

None known.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Wash hands after use. Launder contaminated clothing before reuse. Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Avoid dust accumulations. Slippery when wet. Ground and bond containers when transferring from one container to another.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Store in a well ventilated area. Store away from oxidizers. Keep container closed when not in use. Store in a cool, dry location. Keep from heat, sparks, and open flames. Product has a shelf life of 24 months.

7.3. Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	CAS Number	EU	UK OEL	Netherlands	France OEL
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Germany MAK/TRK	Spain	Portugal	Finland
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Austria	Ireland	Switzerland	Norway
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Italy	Poland	Hungary	Czech Republic
Contains no hazardous substances	NA	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Denmark
Contains no hazardous substances	NA	Not applicable

Derived No Effect Level (DNEL)	No information available.
Worker	
General Population	
Predicted No Effect Concentration (PNEC)	No information available.

8.2. Exposure controls

Engineering Controls	A well ventilated area to control dust levels. Local exhaust ventilation should be used in areas without good cross ventilation.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	Eyewash fountains and safety showers must be easily accessible.
Environmental Exposure Controls	No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Powder	**Color:**	White to off white
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	6.5-8 (1%)
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.6
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity

Not applicable

10.2. Chemical Stability

Stable

10.3. Possibility of Hazardous Reactions

Will Not Occur

10.4. Conditions to Avoid

None anticipated

10.5. Incompatible Materials

Strong oxidizers.

10.6. Hazardous Decomposition Products

Carbon monoxide and carbon dioxide.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause mild respiratory irritation. In high air concentrations: May impede respiration.
Eye Contact	May cause mild eye irritation.
Skin Contact	Prolonged or repeated contact may cause skin irritation.
Ingestion	None known
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances	NA	No data available	No data available	No data available

SECTION 12: Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

Readily biodegradable

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances	NA	No information available

12.3. Bioaccumulative potential

Does not bioaccumulate

Substances	CAS Number	Log Pow
Contains no hazardous substances	NA	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available.

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

ADR

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

14.1. UN Number:	Not restricted.
14.2. UN Proper Shipping Name:	Not restricted
14.3. Transport Hazard Class(es):	Not applicable
14.4. Packing Group:	Not applicable
14.5. Environmental Hazards:	Not applicable
14.6. Special Precautions for User:	None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 1: Low hazard to waters.

15.2. Chemical Safety Assessment

No information available

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3
None

Key literature references and sources for data
www.ChemADVISOR.com/

Revision Date: 25-Jul-2014

Revision Note
Update to Format SECTION: 8

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement
This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

DCA-13002

Revision Date: 04-Aug-2014 **Revision Number:** 14

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product Name	DCA-13002

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Breaker
Sector of use	Refer to the Annex for a listing of uses.

1.3. Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4. Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

SECTION 2: Hazards Identification

2.1. Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Acute Oral Toxicity	Category 4 - (H302)
Skin Corrosion / irritation	Category 2 - (H315)
Serious Eye Damage / Eye Irritation	Category 2 - (H319)
Respiratory Sensitization	Category 1 - (H334)
Skin Sensitization	Category 1 - (H317)
Specific Target Organ Toxicity - (Single Exposure)	Category 3 - (H335)

Oxidizing solids.	Category 3 - (H272)

Classification according to EU Directives 67/548/EEC or 1999/45/EC
For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	O - Oxidizing. Xn - Harmful.
Risk Phrases	R8 Contact with combustible material may cause fire. R22 Harmful if swallowed. R36/37/38 Irritating to eyes, respiratory system and skin. R42/43 May cause sensitization by inhalation and skin contact.

2.2. Label Elements

Hazard Pictograms

Signal Word **Danger**

Hazard Statements
H302 - Harmful if swallowed
H315 - Causes skin irritation
H317 - May cause an allergic skin reaction
H319 - Causes serious eye irritation
H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled
H335 - May cause respiratory irritation

Precautionary Statements - EU (§28, 1272/2008)
P261 - Avoid breathing dust/fume/gas/mist/vapors/spray
P280 - Wear protective gloves/eye protection/face protection
P304 + P341 - IF INHALED: If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing
P342 + P311 - If experiencing respiratory symptoms: Call a POISON CENTER or doctor/physician
P302 + P352 - IF ON SKIN: Wash with plenty of soap and water
P332 + P313 - If skin irritation occurs: Get medical advice/attention
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337 + P313 - If eye irritation persists: Get medical advice/attention
P370 + P378 - In case of fire: Use water spray for extinction

Contains

Substances	**CAS Number**
Sodium persulfate	7775-27-1

2.3. Other Hazards

None known

SECTION 3: Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Sodium persulfate	231-892-1	7775-27-1	60 - 100%	O; R8 Xn; 22 Xi; 36/37/38 42/43	Acute Tox. 4 (H302) Skin Irrit. 2 (H315) Eye Irrit. 2 (H319) Skin Sens. 1 (H317) Resp. Sens. 1 (H334) STOT SE 3 (H335) Ox. Sol. 3 (H272)	01-2119495975-15

For the full text of the R-phrases mentioned in this Section, see Section 16

3.1. Substances	Substance
3.2. Mixtures	Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

4.2. Most Important symptoms and effects, both acute and delayed

May cause eye and skin irritation. May cause allergic skin and respiratory reaction.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

SECTION 5: Firefighting Measures

5.1. Extinguishing media

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

None known.

5.2. Special hazards arising from the substance or mixture

Special Exposure Hazards

Oxidizer. May ignite combustibles. Decomposition in fire may produce toxic gases.

5.3. Advice for firefighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

6.4. Reference to other sections

See Section 8 and 13 for additional information.

SECTION 7: Handling and Storage

7.1. Precautions for Safe Handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Avoid dust accumulations.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2. Conditions for safe storage, including any incompatibilities

Store away from combustibles. Store in a cool well ventilated area. Keep container closed when not in use. Product has a shelf life of 12 months.

7.3. Specific End Use(s)

Exposure Scenario	Please refer to the attached Annex for a listing of exposure scenarios.
Other Guidelines	No information available

SECTION 8: Exposure Controls/Personal Protection

8.1. Control parameters

Exposure Limits

Substances	CAS Number	EU	UK OEL	Netherlands	France OEL
Sodium persulfate	7775-27-1	Not applicable	2 mg/m^3	1 mg/m^3	Not applicable

Substances	CAS Number	Germany MAK/TRK	Spain	Portugal	Finland
Sodium persulfate	7775-27-1	Not applicable	VLA-ED: 0.1 mg/m^3	TWA: 0.1 mg/m^3	Not applicable

Substances	CAS Number	Austria	Ireland	Switzerland	Norway
Sodium persulfate	7775-27-1	Not applicable	Not applicable	Not applicable	STEL: 4 mg/m^3 TWA: 2 mg/m^3

Substances	CAS Number	Italy	Poland	Hungary	Czech Republic
Sodium persulfate	7775-27-1	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Denmark
Sodium persulfate	7775-27-1	TWA: 2 mg/m^3

Derived No Effect Level (DNEL) No information available.

Worker

Substances	Long-term exposure - systemic effects, Inhalation	Acute / short term exposure - systemic effects, Inhalation	Long-term exposure - local effects, Inhalation	Acute / short term exposure - local effects, Inhalation	Long-term exposure - systemic effects, Dermal	Acute / short term exposure - systemic effects, Dermal	Long-term exposure - local effects, Dermal	Acute / short term exposure - local effects, Dermal	Hazards for the eyes - local effects
Sodium persulfate	2.06 mg/m^3	590 mg/m^3	2.06 mg/m^3	Not available	18.2 mg/kg bw/day	400 mg/kg bw/day	0.102 mg/cm2	2.248 mg/cm2	Not available

General Population

Substances	Long-term exposure - systemic effects, Inhalation	Acute / short term exposure - systemic effects, Inhalation	Long-term exposure - local effects, Inhalation	Acute / short term exposure - local effects, Inhalation	Long-term exposure - systemic effects, Dermal	Acute / short term exposure - systemic effects, Dermal	Long-term exposure - local effects, Dermal	Acute / short term exposure - local effects, Dermal	Long-term exposure - systemic effects, Oral	Acute / short term exposure - local effects, Oral	Hazards for the eyes - local effects
Sodium persulfate	1.03 mg/m^3	295 mg/m^3	1.03 mg/m^3	295 mg/m^3	9.1 mg/kg bw/day	200 mg/kg bw/day	0.051 mg/cm2	1.124 mg/cm2	9.1 mg/kg bw/day	30 mg/kg bw/day	Not available

Predicted No Effect Concentration (PNEC) No information available.

Substances	Freshwater	Marine water	Intermittent release	Sewage treatment plant	Sediment (freshwater)	Sediment (marine water)	Air	Soil	Secondary poisoning
Sodium persulfate	0.0763 mg/L	0.011 mg/L	0.763 mg/L	3.6 mg/L	0.275 mg/kg sediment dw	0.0396 mg/kg sediment dw	Not available	0.015 mg/kg soil dw	No potential for bio-accumulation

8.2. Exposure controls

Engineering Controls	Use in a well ventilated area. Localized ventilation should be used to control dust levels.

Personal protective equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
Hand Protection	Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Butyl rubber gloves. (>= 0.7 mm thickness) This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.
Skin Protection	Rubber apron.
Eye Protection	Dust proof goggles.
Other Precautions	Eyewash fountains and safety showers must be easily accessible.

Environmental Exposure Controls No information available

SECTION 9: Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Solid	**Color:**	White
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	6
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	2.47
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

Molecular Weight	238.1
VOC Content (%)	No data available

SECTION 10: Stability and Reactivity

10.1. Reactivity

Not applicable

10.2. Chemical Stability

Stable

10.3. Possibility of Hazardous Reactions

Will Not Occur

10.4. Conditions to Avoid

Avoid contact with readily oxidizable materials.

10.5. Incompatible Materials

Avoid halogens. Contact with acids. Strong alkalis. Combustible materials.

10.6. Hazardous Decomposition Products

Oxides of sulfur. Oxygen. Sulfuric acid.

SECTION 11: Toxicological Information

11.1. Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause respiratory irritation. May cause allergic respiratory reaction.
Eye Contact	May cause eye irritation
Skin Contact	May cause skin irritation. May cause an allergic skin reaction.
Ingestion	Irritation of the mouth, throat, and stomach.
Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.
LD50 Oral:	895 mg/kg (rat)
LD50 Dermal:	> 10000 mg/kg (rat)

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium persulfate	7775-27-1	895 mg/kg (Rat) 1200 mg/kg 930 mg/kg 1000 mg/kg 920 mg/kg	> 10000 mg/kg (Rat)	19.0 mg/L (Rat, 4h) > 5.1 mg/L (Rat)

Substances	CAS Number	Skin corrosion/irritation
Sodium persulfate	7775-27-1	Causes skin irritation (rabbit)

Substances	CAS Number	Eye damage/irritation
Sodium persulfate	7775-27-1	Causes severe eye irritation (rabbit)

Substances	CAS Number	Skin Sensitization
Sodium persulfate	7775-27-1	Skin sensitizer in guinea pig.

Substances	CAS Number	Respiratory Sensitization
Sodium persulfate	7775-27-1	May cause sensitization by inhalation

Substances	CAS Number	Mutagenic Effects
Sodium persulfate	7775-27-1	In vitro tests did not show mutagenic effects In vivo tests did not show mutagenic effects.

Substances	CAS Number	Carcinogenic Effects
Sodium persulfate	7775-27-1	Did not show carcinogenic effects in animal experiments (similar substances)

Substances	CAS Number	Reproductive toxicity
Sodium persulfate	7775-27-1	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments. (similar substances)

Substances	CAS Number	STOT - single exposure
Sodium persulfate	7775-27-1	May cause respiratory irritation.

Substances	CAS Number	STOT - repeated exposure

Sodium persulfate	7775-27-1	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	**CAS Number**	**Aspiration hazard**
Sodium persulfate	7775-27-1	Not applicable

SECTION 12: Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Substances	**CAS Number**	**Toxicity to Algae**	**Toxicity to Fish**	**Toxicity to Microorganisms**	**Toxicity to Invertebrates**
Sodium persulfate	7775-27-1	EC50(72h): 116 mg/L (biomass) (Pseudokirchnerella subcapitata)	LC50(96h): 163 mg/L (Oncorhynchus mykiss)	EC10(18h): 36 mg/L (Pseudomonas putida)	EC50(48h): 133 mg/L (mobility) (Daphnia magna)

12.2. Persistence and degradability

The methods for determining biodegradability are not applicable to inorganic substances.

Substances	**CAS Number**	**Persistence and Degradability**
Sodium persulfate	7775-27-1	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Bioaccumulation is unlikely

Substances	**CAS Number**	**Log Pow**
Sodium persulfate	7775-27-1	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available.

12.6. Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

SECTION 13: Disposal Considerations

13.1. Waste treatment methods

Disposal Method	Disposal should be made in accordance with federal, state, and local regulations.
Contaminated Packaging	This bag may contain residue of a hazardous material. Some authorities may regulate such containers as hazardous waste. Dispose of container according to national or local regulations.

SECTION 14: Transport Information

IMDG/IMO

UN Number:	UN1505
UN Proper Shipping Name:	Sodium Persulfate
Transport Hazard Class(es):	5.1
Packing Group:	III
Environmental Hazards:	Not applicable
EMS:	EmS F-A, S-Q

RID

UN Number:	UN1505

UN Proper Shipping Name:	Sodium Persulfate
Transport Hazard Class(es):	5.1
Packing Group:	III
Environmental hazard:	Not applicable

ADR

UN Number:	UN1505
UN Proper Shipping Name:	Sodium Persulfate
Transport Hazard Class(es):	5.1
Packing Group:	III
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	UN1505
UN Proper Shipping Name:	Sodium Persulfate
Transport Hazard Class(es):	5.1
Packing Group:	III
Environmental hazard:	Not applicable

14.1. UN Number:	UN1505
14.2. UN Proper Shipping Name:	Sodium Persulfate
14.3. Transport Hazard Class(es):	5.1
14.4. Packing Group:	III
14.5. Environmental Hazards:	Not applicable
14.6. Special Precautions for User:	None

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

SECTION 15: Regulatory Information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 1: Low hazard to waters.

15.2. Chemical Safety Assessment

Yes

SECTION 16: Other Information

Full text of R-phrases referred to under Sections 2 and 3

R8 Contact with combustible material may cause fire.
R22 Harmful if swallowed.
R36/37/38 Irritating to eyes, respiratory system and skin.
R42/43 May cause sensitization by inhalation and skin contact.

Key literature references and sources for data
www.ChemADVISOR.com/

Revision Date: 04-Aug-2014
Revision Note
Update to Format SECTION: 8

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement

End of Safety Data Sheet

Exposure Scenario

Chemical Name: **Sodium persulfate**
CAS Number: **7775-27-1**
EC Number: **231-892-1**
SDS Reference: **HM007647 / CP1508**

Contents

Exposure Scenario 1: Industrial Use

1. List of use descriptors

Sector of uses SU	SU 3 Industrial uses: Uses of substances as such or in preparations at industrial sites.
Process category [PROC]	PROC1 Use in closed process, no likelihood of exposure PROC2 Use in closed, continuous process with occasional controlled exposure (e.g. sampling) PROC3 Use in closed batch process (synthesis or formulation) PROC4 Use in batch and other process (synthesis) where opportunity for exposure arises PROC7 Industrial spraying PROC8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC8b Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC9 Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC 10 Roller application PROC13 Treatment of articles by dipping and pouring PROC14 Production of preparations or articles by tabletting, compression, extrusion, pelettisation PROC 15 Use as laboratory reagent PROC 22 Potentially closed processing operations with minerals/metals at elevated temperature PROC 23 Open processing and transfer operations with minerals/metals at elevated temperature
Chemical product category [PC]	Not Applicable
Article Categories [AC]	Not Applicable
Environmental release categories [ERC]	ERC 6a Industrial use resulting in manufacture of another substance (use of intermediates) – Use of intermediates in primarily the chemical industry using continuous processes or batch processes applying dedicated or multi-purpose equipment, either technically controlled or operated by manual interventions, for the synthesis of other substances. ERC 6b Industrial use of reactive processing aids – Industrial use of reactive processing aids in continuous processes or batch processes applying dedicated or multi-purpose equipment, either technically controlled or operated by manual interventions. ERC 6d Industrial use of process regulators for polymerisation processes in production of resins, rubbers, polymers – Industrial use of chemicals (cross-linking agents, curing agents) in the production of thermosets and rubbers, polymer processing.
Specific Environmental Release Categories SPERC	Not Applicable
Processes, tasks, activities covered	End uses of substances in preparations at industrial sites
Number of sites:	10 % rule applies
Assessment Method	ECETOC TRA/EUSES

2. Operational conditions and risk management measures

2.1 Control of workers exposure

Product characteristics

Physical state:	solid
Concentration:	up to 100 %
Powder:	dustiness max. 13 % of particles below 10 µm
Packaging:	moisture-resistant, dust-tight packaging: 25 and 50 kg polyethylene bags, 1 t big bag (polypropylene coated textile)
Physical state:	liquid

Concentration:	max. 25 % (tier I concentrations up to 100 %)

Amounts used

Not Applicable

Frequency and duration of use/exposure

Duration [for one worker]: 8 hours/day

Frequency [for one worker]: max. 300 days/year

Human factors not influenced by risk management

Respiration volume under conditions of use: 10 m^3/8h-day (light activity)

Area of potential skin contact under conditions of use: two hands and face (480 cm^2)

Body weight: 70 kg (worker)

Other given operational conditions affecting workers exposure

Wearing of protective clothing/personal protective equipment is mandatory.

Technical conditions and measures at process level (source) to prevent release

Local exhaust ventilation is installed, with exhaust air scrubbers/filters (min. 90 % removal efficiency).

Technical conditions and measures to control dispersion from source towards the worker

Keep container tightly closed in a cool and dry place. Storage away from foodstuffs, reducing agents, heavy-metal compounds, acids and alkalis, protected from humidity and water. Protect from sources of heat. Store not together with inflammable substances.

Organisational measures to prevent /limit releases, dispersion and exposure

All personnel are trained.

Conditions and measures related to personal protection, hygiene and health evaluation

General protective and hygienic measures: Keep away from foodstuffs, beverages and food. Take off immediately all contaminated clothing. Clean skin thoroughly immediately after handling the product. Ensure that washing facilities are available in the work place. Avoid contact with the eyes and skin. Do not breathe dust.

- Breathing equipment (according to EN 143): use breathing filter apparatus (half mask P2 APF 10, or P3 APF 20).
- Protection of hands (according to EN 374),: material: rubber or PVC or other plastic material gloves, glove thickness: 0.5 mm, break through time: >=8h
- Eye protection (according to EN 166): tightly sealed safety goggles, face protection
- Skin and body protection: Light weight protective clothing, rubber or neoprene footwear

2.2 Control of environmental exposure

Product characteristics

Physical state:	solid
Concentration:	up to 100 %
Powder:	dustiness max. 13 % of particles below 10 µm
Packaging:	moisture-resistant, dust-tight packaging: 25 and 50 kg polyethylene bags, 1 t big bag (polypropylene coated textile)
Physical state:	liquid
Concentration:	max. 25 % (tier I concentrations up to 100 %)

Amounts used

Number of sites:	10 % rule applies
Annual amount:	40000 t/year
Emission days per site:	max. 300 days/year

Frequency and duration of use/exposure

Continuous release; 300 days/year

Environment factors not influenced by risk management

Dilution factor: rivers = 10 (default), coastal zones = 100 (default)

Other given operational conditions affecting environmental exposure

Substance release to the environment can be practically excluded. The substance is complete consumed in the reaction. No unreacted substance is present in the final product.

Technical conditions and measures at process level (source) to prevent release

Local exhaust ventilation is installed, with

ERC 6a min. 99 % emission reduction

ERC 6b min. 90 % emission reduction

ERC 6d min. 99.9 % emission reduction

The substance is completely consumed during use and therefore there is practically no release to wastewater and soil.

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Substance release can be practically excluded. The substance is completely consumed during chemical reaction. No unreacted substance remains in the final product.

Organizational measures to prevent/limit release from site

All personnel are trained.

Conditions and measures related to municipal sewage treatment plant
2000 m^3/day (default)
Conditions and measures related to external treatment of waste for disposal
Normally there is no waste. No unreacted persulfate remains.
Conditions and measures related to external recovery of waste
None.

3. Exposure estimation and reference to its source

Acute/Short term exposure

No acute/short term exposure was considered. All exposure periods considered were long term, covering a repeated 8 h/day work shifts.

Long term exposure

The following table shows worst-case long term exposure concentrations to workers (> 4 h/day exposure, full shift), listing exposures for relevant PROCs. Exposure concentrations were calculated using ECETOC TRA (2009). Solid and liquid preparations (preparation concentrations of up to 100 %, TRA > 25 %) were included, as well as indoor and outdoor use (if applicable). Risk minimisation methods include local exhaust ventilation (LEV), respiratory protection (half mask P2 APF 10, 90 % protection) and gloves (90 % protection).

Long term exposure concentrations to workers (Industrial use)

Routes of exposure	Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
	value	unit	value	unit	
Dermal exposure					
PROC 1 (solid)	0.0343	mg/kg/day	--	--	ECETOC TRA
PROC 1 (liquid)	0.0343	mg/kg/day	--	--	ECETOC TRA
PROC 2 (solid)	0.0137	mg/kg/day	--	--	ECETOC TRA
PROC 2 (liquid)	0.0137	mg/kg/day	--	--	ECETOC TRA
PROC 3 (solid)	0.0034	mg/kg/day	--	--	ECETOC TRA
PROC 3 (liquid)	0.0034	mg/kg/day	--	--	ECETOC TRA
PROC 4 (solid)	0.0685	mg/kg/day	--	--	ECETOC TRA
PROC 4 (liquid)	0.0685	mg/kg/day	--	--	ECETOC TRA
PROC 4 (outdoors, solid)	0.4799	mg/kg/day	--	--	ECETOC TRA
PROC 4 (outdoors, liquid)	0.4799	mg/kg/day	--	--	ECETOC TRA
PROC 5 (solid)	0.1371	mg/kg/day	--	--	ECETOC TRA
PROC 5 (liquid)	0.1371	mg/kg/day	--	--	ECETOC TRA
PROC 5 (outdoors, solid)	0.9599	mg/kg/day	--	--	ECETOC TRA
PROC 5 (outdoors, liquid)	0.9599	mg/kg/day	--	--	ECETOC TRA
PROC 8a (solid)	0.1371	mg/kg/day	--	--	ECETOC TRA
PROC 8a (liquid)	0.1371	mg/kg/day	--	--	ECETOC TRA
PROC 8a (outdoors, solid)	0.1371	mg/kg/day	--	--	ECETOC TRA
PROC 8a (outdoors, liquid)	0.9600	mg/kg/day	--	--	ECETOC TRA
PROC 8b (solid)	0.0342	mg/kg/day	--	--	ECETOC TRA
PROC 8b (liquid)	0.0205	mg/kg/day	--	--	ECETOC TRA
PROC 9 (solid)	0.0685	mg/kg/day	--	--	ECETOC TRA
PROC 9 (liquid)	0.0685	mg/kg/day	--	--	ECETOC TRA
PROC 9 (outdoors, solid)	0.4800	mg/kg/day	--	--	ECETOC TRA
PROC 9 (outdoors, liquid)	0.4800	mg/kg/day	--	--	ECETOC TRA
PROC 10 (liquid)	0.2742	mg/kg/day			ECETOC TRA
PROC 10 (outdoors, liquid)	1.9200	mg/kg/day			ECETOC TRA
PROC 13 (solid)	0.1371	mg/kg/day	--	--	ECETOC TRA
PROC 13 (liquid)	0.1371	mg/kg/day	--	--	ECETOC TRA
PROC 13 (outdoors, solid)	0.9600	mg/kg/day	--	--	ECETOC TRA
PROC 13 (outdoors, liquid)	0.9600	mg/kg/day	--	--	ECETOC TRA
PROC 14 (solid)	0.0342	mg/kg/day	--	--	ECETOC TRA
PROC 14 (liquid)	0.0342	mg/kg/day	--	--	ECETOC TRA
PROC 22 (solid)	0.0282	mg/kg/day	--	--	ECETOC TRA
PROC 23 (solid)	0.0141	mg/kg/day	--	--	ECETOC TRA
PROC 23 (outdoors, solid)	0.0990	mg/kg/day			ECETOC TRA
Inhalation exposure					

PROC 1 (solid)	0.0010	mg/m^3	--	--	ECETOC TRA
PROC 1 (liquid)	0.0100	mg/m^3	--	--	ECETOC TRA
PROC 2 (solid)	0.0050	mg/m^3	--	--	ECETOC TRA
PROC 2 (liquid)	0.0102	mg/m^3	--	--	ECETOC TRA
PROC 3 (solid)	0.0100	mg/m^3	--	--	ECETOC TRA
PROC 3 (liquid)	0.0102	mg/m^3	--	--	ECETOC TRA
PROC 4 (solid)	0.0500	mg/m^3	--	--	ECETOC TRA
PROC 4 (liquid)	0.0102	mg/m^3	--	--	ECETOC TRA
PROC 4 (outdoors, solid)	0.3500	mg/m^3	--	--	ECETOC TRA
PROC 4 (outdoors, liquid)	0.0716	mg/m^3	--	--	ECETOC TRA
PROC 5 (solid)	0.0500	mg/m^3	--	--	ECETOC TRA
PROC 5 (liquid)	0.0102	mg/m^3	--	--	ECETOC TRA
PROC 5 (outdoors, solid)	0.3500	mg/m^3	--	--	ECETOC TRA
PROC 5 (outdoors, liquid)	0.0716	mg/m^3	--	--	ECETOC TRA
PROC 8a (solid)	0.0500	mg/m^3	--	--	ECETOC TRA
PROC 8a (liquid)	0.0102	mg/m^3	--	--	ECETOC TRA
PROC 8a (outdoors, solid)	0.5000	mg/m^3	--	--	ECETOC TRA
PROC 8a (outdoors, liquid)	0.0716	mg/m^3	--	--	ECETOC TRA
PROC 8b (solid)	0.0250	mg/m^3	--	--	ECETOC TRA
PROC 8b (liquid)	0.0030	mg/m^3	--	--	ECETOC TRA
PROC 9 (solid)	0.0500	mg/m^3	--	--	ECETOC TRA
PROC 9 (liquid)	0.0102	mg/m^3	--	--	ECETOC TRA
PROC 9 (outdoors, solid)	0.3500	mg/m^3	--	--	ECETOC TRA
PROC 9 (outdoors, liquid)	0.0716	mg/m^3	--	--	ECETOC TRA
PROC 10 (liquid)	0.0051	mg/m^3	--	--	ECETOC TRA
PROC 10 (outdoors, liquid)	0.0358	mg/m^3	--	--	ECETOC TRA
PROC 13 (solid)	0.0100	mg/m^3	--	--	ECETOC TRA
PROC 13 (liquid)	0.0100	mg/m^3	--	--	ECETOC TRA
PROC 13 (outdoors, solid)	0.0700	mg/m^3	--	--	ECETOC TRA
PROC 13 (outdoors, liquid)	0.0716	mg/m^3	--	--	ECETOC TRA
PROC 14 (solid)	0.0100	mg/m^3	--	--	ECETOC TRA
PROC 14 (liquid)	0.0100	mg/m^3	--	--	ECETOC TRA
PROC 22 (solid)	0.0300	mg/kg/day	--	--	ECETOC TRA
PROC 23 (solid)	0.0300	mg/kg/day	--	--	ECETOC TRA
PROC 23 (outdoors, solid)	0.2100	mg/kg/day	--	--	ECETOC TRA
Combined exposure			--	--	ECETOC TRA
PROC 1 (solid)	0.0344	mg/kg/day	--	--	ECETOC TRA
PROC 1 (liquid)	0.0357	mg/kg/day	--	--	ECETOC TRA
PROC 2 (solid)	0.0144	mg/kg/day	--	--	ECETOC TRA
PROC 2 (liquid)	0.0151	mg/kg/day	--	--	ECETOC TRA
PROC 3 (solid)	0.0048	mg/kg/day	--	--	ECETOC TRA
PROC 3 (liquid)	0.0048	mg/kg/day	--	--	ECETOC TRA
PROC 4 (solid)	0.0757	mg/kg/day	--	--	ECETOC TRA
PROC 4 (liquid)	0.0700	mg/kg/day	--	--	ECETOC TRA
PROC 4 (outdoors, solid)	0.5299	mg/kg/day	--	--	ECETOC TRA
PROC 4 (outdoors, liquid)	0.4902	mg/kg/day	--	--	ECETOC TRA
PROC 5 (solid)	0.1442	mg/kg/day	--	--	ECETOC TRA
PROC 5 (liquid)	0.1386	mg/kg/day	--	--	ECETOC TRA
PROC 5 (outdoors, solid)	1.0099	mg/kg/day	--	--	ECETOC TRA
PROC 5 (outdoors, liquid)	0.9702	mg/kg/day	--	--	ECETOC TRA
PROC 8a (solid)	0.1442	mg/kg/day	--	--	ECETOC TRA
PROC 8a (liquid)	0.1386	mg/kg/day	--	--	ECETOC TRA
PROC 8a (outdoors, solid)	0.2085	mg/kg/day	--	--	ECETOC TRA
PROC 8a (outdoors, liquid)	0.9702	mg/kg/day	--	--	ECETOC TRA
PROC 8b (solid)	0.0378	mg/kg/day	--	--	ECETOC TRA
PROC 8b (liquid)	0.0210	mg/kg/day	--	--	ECETOC TRA

PROC 9 (solid)	0.0757	mg/kg/day	--	--	ECETOC TRA
PROC 9 (liquid)	0.0700	mg/kg/day	--	--	ECETOC TRA
PROC 9 (outdoors, solid)	0.5300	mg/kg/day	--	--	ECETOC TRA
PROC 9 (outdoors, liquid)	0.4902	mg/kg/day	--	--	ECETOC TRA
PROC 10 (liquid)	0.2750	mg/kg/day	--	--	ECETOC TRA
PROC 10 (outdoors, liquid)	1.9251	mg/kg/day	--	--	ECETOC TRA
PROC 13 (solid)	0.1385	mg/kg/day	--	--	ECETOC TRA
PROC 13 (liquid)	0.1386	mg/kg/day	--	--	ECETOC TRA
PROC 13 (outdoors, solid)	0.9700	mg/kg/day	--	--	ECETOC TRA
PROC 13 (outdoors, liquid)	0.9702	mg/kg/day	--	--	ECETOC TRA
PROC 14 (solid)	0.0357	mg/kg/day	--	--	ECETOC TRA
PROC 14 (liquid)	0.0357	mg/kg/day	--	--	ECETOC TRA
PROC 22 (solid)	0.0325	mg/kg/day	--	--	ECETOC TRA
PROC 23 (solid)	0.0184	mg/kg/day	--	--	ECETOC TRA
PROC 23 (outdoors, solid)	0.1290	mg/kg/day	--	--	ECETOC TRA

Exposure concentrations were estimated for each of the relevant PROCs, with personal protective equipment applied as outlined above and in section 9.2.4. PROC 5 (outside) when the substance is used in its solid form revealed highest concentrations for overall exposure with 1.9251 mg/kg bw/day.

Summary of the long term exposure values:

The following table summarizes worst-case long term exposure concentrations to workers for each exposure route calculated by ECETOC TRA. ECETOC TRA calculations for inhalation exposure assumed using a local exhaust ventilation system (LEV, 90 % protection) and wearing a respiratory protective mask (half mask P2 APF 10, 90 % protection or P3 APF 20, 95 % protection). ECETOC TRA calculations for dermal exposures assumed wearing gloves, with a reduction of exposures by 90 % (TNsG, 2007) and the use of a LEV system. The worst-case dermal systemic exposure concentration (mg/kg bw/day) was converted to a local exposure concentration ($mg/cm^2/day$), assuming exposure of two hands and face (480 cm^2) for a 70 kg worker (ECHA CSA R14, 2008): 1.920 mg/kg bw/day * 70 kg / 480 cm^2 = 0.28 $mg/cm^2/day$.

Summary of ECETOC TRA long term exposure concentration to workers (Industrial use)

Routes of exposure	Concentrations	Justification
Dermal local exposure (in $mg/cm^2 day$)	0.2800	Calculation
Dermal systemic exposure (in mg/kg bw/day)	1.9200	ECETOC TRA
Inhalation exposure (in mg/m^3/8h work day)	0.5000	ECETOC TRA
Combined systemic exposure (in mg/kg bw/day)	1.9251	ECETOC TRA

For Industrial use highest exposure concentrations to workers were 1.92 mg/kg bw/day for systemic dermal exposure, corresponding to 0.28 mg/cm^2 dermal local exposure and 0.50 $mg/m^3/day$ for inhalation exposure. Highest combined exposure was 1.9251 mg/kg bw/day. All estimated exposure concentrations were considered worst-case.

Exposure for industrial spraying application (PROC 7) was assessed in a tier II analysis. Tier II assessments were calculated using ConsExpo (v4.1, RIVM, 2005). The scenario was selected from the “painting products” product database including product category “spray painting – pneumatic spraying”. Default parameters were taken from RIVM ConsExpo Paint Products Fact Sheet (2007) and adjusted for industrial applications. All calculations reflect a worst-case tier II approach.

For the PROC 7 tier II scenario parameters were adjusted for industrial, including setting the exposure frequency to 300 days a year, increasing the body weight to 70 kg (worker), increasing the inhalation rate to light exercise and extending spray and exposure duration to full shift, i.e. 360 min. spraying and 480 min. exposure (following ECB Data Base on Human Exposure for PT 7 and PT10, 2007). The weight fraction of the compound was set to 0.25. Uptake fractions were set to 0.1, reflecting the worst-case scenario with appropriate risk minimisation methods applied. Workers dermal exposure area was set to 1500 cm^2 for forearms and hands (ECETOC TRA Targeted Risk Assessment, Technical Report no. 93). Defaults and adjusted parameters for industrial spraying are shown in the following:

General Exposure Data:

exposure frequency:	300 1/year
body weight:	70 kilogram

Inhalation model: Exposure to spray

weight fraction compound	0.25 fraction
exposure duration	480 minute
room volume	34 m^3
ventilation rate	1.5 1/hr
mass generation rate	0.5 g/sec
spray duration	360 minute
airborn fraction	0.2 fraction
weight fraction non-volatile	0.5 fraction
density non-volatile	1.5 g/cm^3
room height	2.25 meter
inhalation cut-off diameter	15 micrometer
non-respirable uptake fraction	0 fraction

Spraying away from exposed person	
Uptake model: Fraction	
uptake fraction	0.1 fraction
inhalation rate	36.4 m^3/day
Dermal model: Direct dermal contact with product : constant rate	
weight fraction compound	0.25 fraction
exposed area	1.5E3 cm^2
contact rate	110 mg/min
release duration	798 second
Uptake model: fraction	
uptake fraction	0.1 fraction
Output	
Inhalation (point estimates)	
inhalation mean event concentration	2.54 mg/m^3
inhalation mean concentration on day of exposure	0.845 mg/m^3
inhalation air concentration year average	0.694 mg/m^3/day
inhalation acute (internal) dose	0.0439 mg/kg
inhalation chronic (internal) dose	0.0361 mg/kg/day
Dermal : point estimates	
dermal load	0.244 mg/cm^2
dermal external dose	5.23 mg/kg
dermal acute (internal) dose	0.523 mg/kg
dermal chronic (internal) dose	0.429 mg/kg/day
Oral non-respirable: point estimates	
oral external dose	0 mg/kg
oral acute (internal) dose	0 mg/kg
oral chronic (internal) dose	0 mg/kg
Integrated (point estimates)	
total external dose	8.63 mg/kg
total acute dose (internal)	0.566 mg/kg
total chronic dose (internal)	0.465 mg/kg/day

For industrial spraying (PROC 7) calculated by ConsExpo the relevant long term exposure concentrations for dermal exposure, inhalation exposure and combined systemic exposure were 0.429 mg/kg/day, 0.694 mg/m³/day and 0.465 mg/kg/day, respectively.

The following table summarizes worst-case long term exposure concentrations to workers for each exposure routes, as calculated for each of the relevant applications using ECETOC TRA and ConsExpo.

Summary of overall long term exposure concentration to workers (Industrial use)

Routes of exposure	**Concentrations**	**Justification**
Dermal local exposure (in mg/cm²/day)	0.5190	Calculation
Dermal systemic exposure (in mg/kg bw/day)	3.5600	ConsExpo
Inhalation exposure (in mg/m³/8h work day)	0.6940	ECETOC TRA
Combined systemic exposure (in mg/kg bw/day)	1.9251	ConsExpo

For Industrial use highest exposure values are for dermal local exposure 0.5190 mg/cm²/day, for dermal systemic exposure 3.5600 mg/kg bw/day, for inhalation exposure 0.6940 mg/m³/day and for combined systemic exposure 1.9251 mg/kg bw/day.

Consumer use

Not relevant for this substance life cycle step.

Indirect exposure of humans via the environment (oral)

The following table shows environmental release categories (ERCs; tier I and tier II), according to ECHA CSA R12 (2009). Tier I calculations were performed using ECETOC TRA. Tier II calculations were performed using EUSES (v2.1). Specific ERC release values were installed in the EUSES model. Risk minimisation methods leading to emission reduction from of 99.0 % (ERC 6a), 90.0 % (ERC 6b) and 99.9 % (ERC 6d) in air were included. As the substance is completely consumed during use, there is practically no release to wastewater and soil. There is practically no waste, as no unreacted substance remains after use. The following table shows the specific ERC used.

ECETOC TRA scenario (Industrial use)

Environmental Release Category (ERC)	**Description**
ERC 6a	Industrial use resulting in manufacture of another substance (use of intermediates)
ERC 6b	Industrial use of reactive processing aids
ERC 6d	Industrial use of process regulators for polymerization processes in production of resins, rubbers, polymers

The following table shows the indirect exposure of humans via the environment.

Concentration for oral exposure of humans via the environment

ERC		Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
		value	unit	value	unit	
6a	Wet fish	2.41E-05	mg/kg/day	--	--	EUSES (v2.1)
6a	Drinking water	1.69E-03	mg/L/day	--	--	EUSES (v2.1)
6a	Meat	2.96E-08	mg/kg/day	--	--	EUSES (v2.1)
6a	Leafy crops	1.17E-03	mg/kg/day	--	--	EUSES (v2.1)
6a	Root crops	3.02E-04	mg/kg/day	--	--	EUSES (v2.1)
6a	Milk	5.53E-07	mg/kg/day	--	--	EUSES (v2.1)
6a	Air	1.52E-03	mg/m3	--	--	EUSES (v2.1)
6a	Total dose	3.62E-03	mg/kg/day	--	--	EUSES (v2.1)
6a	Wet fish	2.41E-05	mg/kg/day	--	--	EUSES (v2.1)
6a	Drinking water	4.31E-04	mg/L/day	--	--	EUSES (v2.1)
6a	Meat	6.92E-09	mg/kg/day	--	--	EUSES (v2.1)
6a	Leafy crops	2.61E-04	mg/kg/day	--	--	EUSES (v2.1)
6a	Root crops	7.7E-05	mg/kg/day	--	--	EUSES (v2.1)
6a	Milk	1.29E-07	mg/kg/day	--	--	EUSES (v2.1)
6a	Air	3.05E-04	mg/m3	--	--	EUSES (v2.1)
6a	Total dose	8.81E-04	mg/kg/day	--	--	EUSES (v2.1)
6a	Wet fish	2.41E-05	mg/kg/day	--	--	EUSES (v2.1)
6a	Drinking water	1.22E-03	mg/L/day	--	--	EUSES (v2.1)
6a	Meat	2.11E-08	mg/kg/day	--	--	EUSES (v2.1)
6a	Leafy crops	8.27E-04	mg/kg/day	--	--	EUSES (v2.1)
6a	Root crops	2.17E-04	mg/kg/day	--	--	EUSES (v2.1)
6a	Milk	3.94E-07	mg/kg/day	--	--	EUSES (v2.1)
6a	Air	1.07E-03	mg/m3	--	--	EUSES (v2.1)
6a	Total dose	2.59E-03	mg/kg/day	--	--	EUSES (v2.1)

For Industrial use ERC 6a, ERC 6c and ERC 6d calculated total daily concentrations for indirect exposure of humans via the environment were 3.62E-03 mg/kg/day, 8.81E-04 mg/kg/day, and 2.59E-03 mg/kg/day, respectively.

The following table shows total daily doses for oral exposure of humans via the environment.

Total daily dose for oral exposure of humans via the environment

	Total daily dose for oral exposure via the environment (mg/kg bw/d)		Justification
ERC	Exposed via local concentration	Exposed via local and regional concentration	
6a	3.62E-03	3.98E-03	EUSES (v2.1)
6b	8.81E-04	1.24E-03	EUSES (v2.1)
6d	2.59E-03	2.95E-03	EUSES (v2.1)

For Industrial use ERC 6a, ERC 6b and ERC 6d the total daily doses for oral exposure of humans via the environment were 3.62E-03 mg/kg/day, 8.81E-04 mg/kg/day and 2.59E-03 mg/kg/day, respectively. The regional total daily concentration was 3.61E 04 mg/kg/day.

Environmental exposure (Industrial use)

The following table shows environmental release categories (ERCs; tier I and tier II), according to ECHA CSA R12 (2009). Tier I calculations were performed using ECETOC TRA. Tier II calculations were performed using EUSES (v2.1. Specific ERC release values were installed in the EUSES model. Risk minimisation methods leading to emission reduction from of 99.0 % (ERC 6a), 90.0 % (ERC 6b) and 99.9 % (ERC 6d) in air were included. As the substance is completely consumed during use, there is practically no release to wastewater and soil. There is practically no waste, as no unreacted substance remains after use. The following table shows the specific ERC used.

ECETOC TRA scenario (Industrial use)

Environmental Release Category (ERC)	Description
ERC 6a	Industrial use resulting in manufacture of another substance (use of intermediates)
ERC 6b	Industrial use of reactive processing aids
ERC 6d	Industrial use of process regulators for polymerization processes in production of resins, rubbers, polymers

The section below shows tier II exposure assessment results.

Environmental releases

The following table shows estimated releases to relevant compartments of the environment. No measured data was available. Data was calculated by EUSES (v2.1).

Releases to the environment (local)

ERC	Compartments	Predicted releases	Measured release (kg/d)	Explanation / source of measured data
6a	Air	6.67 kg/day	--	EUSES (v2.1)
6a	Waste water	0 kg/day	--	EUSES (v2.1)
6a	Surface water	--	--	EUSES (v2.1)

6a	Industrial soil	--	--	EUSES (v2.1)
6a	Agricultural soil	--	--	EUSES (v2.1)
6a	Air	1.33 kg/day	--	EUSES (v2.1)
6a	Waste water	0 kg/day	--	EUSES (v2.1)
6a	Surface water	--	--	EUSES (v2.1)
6a	Industrial soil	--	--	EUSES (v2.1)
6a	Agricultural soil	--	--	EUSES (v2.1)
6a	Air	4.67 kg/day	--	EUSES (v2.1)
6a	Waste water	0 kg/day	--	EUSES (v2.1)
6a	Surface water	--	--	EUSES (v2.1)
6a	Industrial soil	--	--	EUSES (v2.1)
6a	Agricultural soil	--	--	EUSES (v2.1)

For Industrial use ERC 6a, ERC 6b and ERC 6d estimated maximal released amounts to air were 6.67 kg/day, 1.33 kg/day and 4.67 kg/day, respectively. There was no release to water and soil.

The following table shows estimated point source releases and estimated total releases for regional exposures. All relevant compartments were taken into account for exposure estimations.

Summary of the releases to the environment

ERC	Compartments	Release from point source (local exposure estimation)	Total release for regional exposure estimation	Justification
6a	Air	6.67 kg/day	54.8 day	EUSES (v2.1)
6a	Waste water	0 kg/day	0 kg/day	EUSES (v2.1)
6a	Surface water	--	0 kg/day	EUSES (v2.1)
6a	Industrial soil	--	0 kg/day	EUSES (v2.1)
6a	Air	1.33 kg/day	11 day	EUSES (v2.1)
6a	Waste water	0 kg/day	0 kg/day	EUSES (v2.1)
6a	Surface water	--	0 kg/day	EUSES (v2.1)
6a	Industrial soil	--	0 kg/day	EUSES (v2.1)
6a	Air	4.67 kg/day	38.4 kg/day	EUSES (v2.1)
6a	Waste water	0 kg/day	0 kg/day	EUSES (v2.1)
6a	Surface water	--	0 kg/day	EUSES (v2.1)
6a	Industrial soil	--	0 kg/day	EUSES (v2.1)

For Industrial use local release values for ERC 6a, ERC 6b and ERC 6d were 6.67 kg/day, 1.33 kg/day and 4.67 kg/day to air for local releases, respectively. Total regional releases were 54.8 kg/day, 11 kg/day and 38.4 kg/day, respectively Release values were used for calculation of environmental compartment predicted environmental concentrations.

Exposure concentration in sewage treatment plants (STP)

The following table shows estimated concentrations in waste water. Only estimated data calculated by EUSES 2.1 was available. No monitoring data was available. During use the product is completely consumed and therefore there is practically no release to wastewater and soil.

Concentrations in sewage (Industrial use)

ERC		Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
		value	unit	value	unit	
6a	Sewage (STP effluent)	0	mg/L	--	--	EUSES (v2.1)
6a	Sewage sludge	0	mg/kg	--	--	EUSES (v2.1)
6b	Sewage (STP effluent)	0	mg/L	--	--	EUSES (v2.1)
6b	Sewage sludge	0	mg/kg	--	--	EUSES (v2.1)
6d	Sewage (STP effluent)	0	mg/L	--	--	EUSES (v2.1)
6d	Sewage sludge	0	mg/kg	--	--	EUSES (v2.1)

For Industrial use ERC 6a, ERC 6b and ERC 6d concentrations in sewage effluent and sewage sludge were zero (0).

The following table summarises exposure concentrations in sewage treatment plants.

Predicted Exposure Concentrations (PEC) in sewage (Industrial use)

ERC		Value	Justification
6a	Concentration in sewage (PECSTP; mg/L)	0	EUSES (v2.1)
6a	Concentration in sewage sludge (mg/kg dw)	0	EUSES (v2.1)
6b	Concentration in sewage (PECSTP; mg/L)	0	EUSES (v2.1)
6b	Concentration in sewage sludge (mg/kg dw)	0	EUSES (v2.1)
6d	Concentration in sewage (PECSTP; mg/L)	0	EUSES (v2.1)
6d	Concentration in sewage sludge (mg/kg dw)	0	EUSES (v2.1)

For Industrial use no release to STP was expected, as the product is completely consumed during use and therefore there is practically no release to wastewater and soil.

Exposure concentration in aquatic pelagic compartment

The exposure in aquatic pelagic compartment was calculated by EUSES 2.1. The following table shows estimated concentrations for freshwater and marine compartments. No monitoring data was available.

Local concentrations in water (Industrial use)

ERC		Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
		value	unit	value	unit	
6a	Freshwater	0	mg/L	--	--	Estimated local exposure concentration based on EUSES calculation.
		0.0104	mg/L	--	--	Regional concentration
		0.0104	mg/L	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6a	Marine water	0	mg/L	--	--	Estimated local exposure concentration based on EUSES calculation.
		9.66E-04	mg/L	--	--	Regional concentration
		9.66E-04	mg/L	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6a	Intermittent releases to water	--	--	--	--	No intermittent releases to water
6b	Freshwater	0	mg/L	--	--	Estimated local exposure concentration based on EUSES calculation.
		0.0104	mg/L	--	--	Regional concentration
		0.0104	mg/L	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6b	Marine water	0	mg/L	--	--	Estimated local exposure concentration based on EUSES calculation.
		9.66E-04	mg/L	--	--	Regional concentration
		9.66E-04	mg/L	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6b	Intermittent releases to water	--	--	--	--	No intermittent releases to water
6d	Freshwater	0	mg/L	--	--	Estimated local exposure concentration based on EUSES calculation.
		0.0104	mg/L	--	--	Regional concentration
		0.0104	mg/L	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6d	Marine water	0	mg/L	--	--	Estimated local exposure concentration based on EUSES calculation.
		9.66E-04	mg/L	--	--	Regional concentration
		9.66E-04	mg/L	--	--	Estimated predicted exposure

						concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6d	Intermittent releases to water	--	--	--	--	No intermittent releases to water

For Industrial use ERC 6a, ERC 6b and ERC 6d local and regional estimated predicted exposure concentrations in freshwater and marine water were 0.0104 mg/L and 9.66E- 04 mg/L, respectively.

The following table shows summarized PEC-values for aquatic compartments.

Predicted Exposure Concentrations (PEC) in aquatic compartment (Industrial use)

ERC	Compartments	Local concentration	PEC aquatic (local+regional)	Justification
6a	Freshwater (in mg/L)	0	0.0104	EUSES (v2.1)
6a	Marine water (in mg/L)	0	9.66E-04	EUSES (v2.1)
6a	Intermittent releases to water (in mg/L)	--	--	No intermittent releases to water
6b	Freshwater (in mg/L)	0	0.0104	EUSES (v2.1)
6b	Marine water (in mg/L)	0	9.66E-04	EUSES (v2.1)
6b	Intermittent releases to water (in mg/L)	--	--	No intermittent releases to water
6d	Freshwater (in mg/L)	0	0.0104	EUSES (v2.1)
6d	Marine water (in mg/L)	0	9.66E-04	EUSES (v2.1)
6d	Intermittent releases to water (in mg/L)	--	--	No intermittent releases to water

For Industrial use all PEC-values in freshwater and marine water were 0.0104 mg/L and 9.66E-04 mg/L, respectively. PEC-values were used for risk characterisation.

Exposure concentration in sediments

The following table shows estimated exposure concentrations for sediments calculated by EUSES 2.1. No monitoring data was available.

Local concentrations in sediment (Industrial use)

ERC	Compartments	Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
		value	unit	value	unit	
6a	Freshwater sediments	--	--	--	--	No local exposure concentration calculated by EUSES.
		7.09E-03	mg/kg wwt	--	--	Regional concentration
		8.82E-03	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6a	Marine water sediments	--	--	--	--	No local exposure concentration calculated by EUSES.
		6.69E-04	mg/kg wwt	--	--	Regional concentration
		8.22E-04	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6b	Freshwater sediments	--	--	--	--	No local exposure concentration calculated by EUSES.
		7.09E-03	mg/kg wwt	--	--	Regional concentration
		8.82E-03	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6b	Marine water sediments	--	--	--	--	No local exposure concentration calculated by EUSES.
		6.69E-04	mg/kg wwt			Regional concentration
		8.22E-04	mg/kg wwt			Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration

		--	--	--	--	No monitoring data available
6d	Freshwater sediments	--	--	--	--	No local exposure concentration calculated by EUSES.
		7.09E-03	mg/kg wwt	--	--	Regional concentration
		8.82E-03	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6d	Marine water sediments	--	--	--	--	No local exposure concentration calculated by EUSES.
		6.69E-04	mg/kg wwt			Regional concentration
		8.22E-04	mg/kg wwt			Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available

For Industrial use ERC 6a, ERC 6b and ERC 6d PEC-values were 8.82E-03 mg/kg wwt for freshwater sediments and 8.22E-04 mg/kg wwt for marine water sediments, respectively.

The following table shows PEC-values for freshwater and marine sediments. Summarized exposure concentrations in aquatic sediments were taken into account for risk characterisation

Predicted Exposure Concentrations (PEC) in sediments (Industrial use

ERC	Compartments	Local concentration	PEC sediment (local+regional)	Justification
6a	Freshwater sediments (in mg/kg wwt)	--	8.82E-03	EUSES (v2.1)
6a	Marine water sediments (in mg/kg wwt)	--	8.22E-04	EUSES (v2.1
6b	Freshwater sediments (in mg/kg wwt)	--	8.82E-03	EUSES (v2.1
6b	Marine water sediments (in mg/kg wwt)	--	8.22E-04	EUSES (v2.1
6d	Freshwater sediments (in mg/kg wwt)	--	8.82E-03	EUSES (v2.1
6d	Marine water sediments (in mg/kg wwt)	--	8.22E-04	EUSES (v2.1

For Industrial use ERC 6a, ERC 6b and ERC 6d calculated PEC-values in sediments were 8.82E -03 mg/kg wwt for freshwater sediments and 8.22E-04 mg/kg wwt for marine water sediments, respectively. PEC-values were used for risk characterisation.

Exposure concentrations in soil and groundwater

The following table shows estimated local concentrations in soil and groundwater calculated by EUSES. No monitoring data was available.

Local concentrations in soil (Industrial use)

ERC	Compartments	Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
		value	unit	value	unit	
6a	Agricultural soil averaged	9.55E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculation for average 30 days.
		5.26E-04	mg/kg wwt	--	--	Regional concentration
		0.0103	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration (30 days) + regional concentration.
		9.55E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculation for average 180 days.
		5.26E-04	mg/kg wwt	--	--	Regional concentration
		0.0103	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration (180 days) + regional concentration.
6a	Grassland averaged	0.0128	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculation.

6a	Groundwater	--	--	--	--	No local exposure concentration was calculated by EUSES.
6b	Agricultural soil averaged	1.91E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculation for average 30 days.
		5.26E-04	mg/kg wwt	--	--	Regional concentration
		2.62E-03	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration (30 days) + regional concentration.
		1.91E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculation for average 180 days.
		5.26E-04	mg/kg wwt	--	--	Regional concentration
		2.62E-03	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration (180 days) + regional concentration
6b	Grassland averaged	2.57E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculation.
6b	Groundwater	--	--	--	--	No local exposure concentration was calculated by EUSES.
6d	Agricultural soil averaged	6.68E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculation for average 30 days.
		5.26E-04	mg/kg wwt	--	--	Regional concentration
		7.39E-03	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration (30 days) + regional concentration.
		6.68E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculation for average 180 days.
		5.26E-04	mg/kg wwt	--	--	Regional concentration
		7.39E-03	mg/kg wwt	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration (180 days) + regional concentration.
6d	Grassland averaged	8.99E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculation.
6d	Groundwater	--	--	--	--	No local exposure concentration was calculated by EUSES.

For Industrial use ERC 6a estimated concentrations were 9.55E-03 mg/kg wwt for agricultural soil averaged over 30 days and 180 days and 0.0128 mg/kg wwt for grassland. For ERC 6b concentrations were 1.91E-03 mg/kg wwt for agricultural soil (averaged over 30 and 180 days) and 2.57E-03 mg/kg wwt for grassland, respectively. For ERC 6d concentrations were 6.68E-03 mg/kg wwt for agricultural soil (averaged 30 and 180 days) and 8.99E-03 mg/kg for grassland.

The following table shows PEC-values for soil and groundwater.

Predicted Exposure Concentrations (PEC) in soil and groundwater (Industrial use)

ERC			Local concentration	PEC soil/groundwater (local + regional)	Justification
6a	Agricultural soil averaged (mg/kg wwt)	30 days	9.55E-03	0.0103	EUSES (v2.1)
		180 days	9.55E-03	0.0103	EUSES (v2.1)

6a	Grassland averaged (mg/kg wwt)		0.0128	0.0135	EUSES (v2.1)
6a	Groundwater (mg/L)		--	0.0591	EUSES (v2.1)
6b	Agricultural soil averaged (mg/kg wwt)	30 days	1.91E-03	2.62E-03	EUSES (v2.1)
		180 days	1.91E-03	2.62E-03	EUSES (v2.1)
6b	Grassland averaged (mg/kg wwt)		2.57E-03	3.28E-03	EUSES (v2.1)
6b	Groundwater (mg/L)		--	0.0151	EUSES (v2.1)
6d	Agricultural soil averaged (mg/kg wwt)	30 days	6.68E-03	7.39E-03	EUSES (v2.1)
		180 days	6.68E-03	7.39E-03	EUSES (v2.1)
6d	Grassland averaged (mg/kg wwt)		8.99E-03	9.7E-03	EUSES (v2.1)
6d	Groundwater (mg/L)		--	0.0426	EUSES (v2.1)

For Industrial use ERC 6a calculated PEC-values were 0.0103 mg/kg wwt for agricultural soil averaged over 30 days and 180 days, 0.0135 mg/kg wwt for grassland and 0.0591 mg/L for groundwater, respectively. For ERC 6b calculated PEC-values were 2.62E-03 mg/kg wwt for agricultural soil averaged over 30 days and 180 days, 3.28E-03 mg/kg wwt for grassland and 0.0151 mg/L for groundwater, respectively. For ERC 6d calculated PEC-values were 7.39E-03 mg/kg wwt agricultural soil (averaged over 30 and 180 days), 9.7E-03 for grassland and 0.0426 mg/L for groundwater. PEC-values were used for risk characterisation.

Atmospheric compartment

The following table shows estimated local concentrations in air calculated by EUSES (v2.1).

Local concentrations in air (Industrial use)

ERC	Compartments	Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
		value	unit	value	unit	
6a	During emission	1.85E-03	mg/m^3	--	--	Estimated local exposure concentration based on EUSES calculation.
		--	--	--	--	No estimated predicted exposure concentration (PEC) was calculated by EUSES
		--	--	--	--	No monitoring data available
6a	Annual average	1.52E-03	mg/m^3	--	--	Estimated local exposure concentration based on EUSES calculation.
		3.67E-11	mg/m^3	--	--	Regional concentrations
		1.52E-03	mg/m^3	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6a	Annual total deposition	0.546	mg/m^2/ day	--	--	Estimated local exposure concentration based on EUSES calculation.
6b	During emission	3.71E-04	mg/m^3	--	--	Estimated local exposure concentration based on EUSES calculation.
		--	--	--	--	No estimated predicted exposure concentration (PEC) was calculated by EUSES
		--	--	--	--	No monitoring data available
6b	Annual average	3.05E-03	mg/m^3	--	--	Estimated local exposure concentration based on EUSES calculation.
		3.67E-11	mg/m^3	--	--	Regional concentrations
		3.05E-04	mg/m^3	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6b	Annual total deposition	0.0109	mg/m^2/ day	--	--	Estimated local exposure concentration based on EUSES calculation.
6d	During emission	1.3E-03	mg/m^3	--	--	Estimated local exposure concentration based on EUSES calculation.

		--	--	--	--	No estimated predicted exposure concentration (PEC) was calculated by EUSES
		--	--	--	--	No monitoring data available
6b	Annual average	1.07E-03	mg/m^3	--	--	Estimated local exposure concentration based on EUSES calculation.
		3.67E-11	mg/m^3	--	--	Regional concentrations
		1.07E-03	mg/m^3	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	No monitoring data available
6d	Annual total deposition	0.0382	mg/m^2/ day	--	--	Estimated local exposure concentration based on EUSES calculation.

For Industrial use ERC 6a estimated total emission to the atmospheric compartment was 1.85E-03 mg/m3, the annual average was 1.52E-03 mg/m3 with an annual deposition of 0.546 mg/m2/day. For ERC 6b estimated total emission to the atmospheric compartment was 3.71E-04 mg/m3, the annual average was 3.05E-03 mg/m3 with an annual deposition of 0.0109 mg/m2/day. For ERC 6d estimated total emission to the atmospheric compartment was 1.3E-03 mg/m3, the annual average was 1.07E-03 mg/m3 with an annual deposition of 0.0382 mg/m2/day. The following table shows PEC-values for the atmospheric compartment.

Predicted Exposure Concentration (PEC) in air (Industrial use)

ERC		Local concentration	PEC air (local + regional)	Justification
6a	During emission (mg/m^3)	1.85E-03	--	EUSES (v2.1)
6a	Annual average (mg/m^3)	1.52E-03	1.52E-03	EUSES (v2.1
6a	Annual deposition(mg/m^2/day)	0.546	--	EUSES (v2.1
6b	During emission (mg/m^3)	3.71E-04	--	EUSES (v2.1
6b	Annual average (mg/m^3)	3.05E-03	3.05E-04	EUSES (v2.1
6b	Annual deposition(mg/m^2/day)	0.0109	--	EUSES (v2.1
6d	During emission (mg/m^3)	1.3E-03	--	EUSES (v2.1
6d	Annual average (mg/m^3)	1.07E-03	1.07E-03	EUSES (v2.1
6d	Annual deposition(mg/m^2/day)	0.0382	--	EUSES (v2.1

For Industrial use ERC 6a, 6b and 6d calculated PEC-values for annual average were 1.52E-03 mg/m3, 3.05E-04 mg/m3, 4.83E-03 mg/m3 and 1.07E-03 mg/m3. PEC-values were used for risk characterisation.

Exposure concentration relevant for the food chain (Secondary poisoning)

The following table shows exposure concentrations relevant for the food chain (secondary poisoning) calculated by EUSES (v2.1). No monitoring data was available.

Local concentration relevant for secondary poisoning (Industrial use)

ERC		Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
		value	unit	value	unit	
6a	Concentration in food of fish eating predator	0.0146	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculations
		0.0104	mg/L	--	--	Regional concentration (surface water)
		--	--	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	Measured concentrations
6a	Concentration in food of fish eating top-predator (marine)	1.36E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculations
		9.66E-04	mg/L	--	--	Regional concentration (surface water)
		--	--	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	Measured concentrations
6a	Concentration in earthworm	0.024	mg/kg	--	--	Concentration from agricultural soil

6b	Concentration in food of fish eating predator	0.0146	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculations
		0.0104	mg/L	--	--	Regional concentration (surface water)
		--	--	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	Measured concentrations
6b	Concentration in food of fish eating top-predator (marine)	1.36E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculations
		9.66E-04	mg/L	--	--	Regional concentration (surface water)
		--	--	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	Measured concentrations
6b	Concentration in earthworm	7.01E-03	mg/kg	--	--	Concentration from agricultural soil
6d	Concentration in food of fish eating predator	0.0146	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculations
		0.0104	mg/L	--	--	Regional concentration (surface water)
		--	--	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	Measured concentrations
6d	Concentration in food of fish eating top-predator (marine)	1.36E-03	mg/kg wwt	--	--	Estimated local exposure concentration based on EUSES calculations
		9.66E-04	mg/L	--	--	Regional concentration (surface water)
		--	--	--	--	Estimated predicted exposure concentration (PEC) = estimated local exposure concentration + regional concentration
		--	--	--	--	Measured concentrations
6d	Concentration in earthworm	0.0177	mg/kg	--	--	Concentration from agricultural soil

For Industrial use all concentrations in food of fish eating top predators were 0.0146 mg/kg wwt in freshwater and 1.36E-03 mg/kg wwt in marine environments, respectively. Concentrations in earthworms were 0.024 mg/kg for ERC 6a, 7.01E-03 mg/kg for ERC 6b and 0.0177 mg/kg for ERC 6d.

The following table shows PEC-values for secondary poisoning.

Predicted Exposure Concentration in food (PECoral) for secondary poisoning (Industrial use)

ERC		Local concentration	PEC oral (local + regional)	Justification
6a	PECoral predator (in mg/kg wwt)	0.0146	0.025	EUSES (v2.1) calculations
6a	PECoral top predator (in mg/kg wwt)	1.36E-03	2.33E-03	EUSES (v2.1) calculations
6a	Concentration in earthworm (in mg/kg wwt)	0.024	2.45E-02	EUSES (v2.1) calculations
6b	PECoral predator (in mg/kg wwt)	0.0146	0.025	EUSES (v2.1) calculations
6b	PECoral top predator (in mg/kg wwt)	1.36E-03	2.33E-03	EUSES (v2.1) calculations
6b	Concentration in earthworm (in mg/kg wwt)	7.01E-03	7.54E-03	EUSES (v2.1) calculations
6d	PECoral predator (in mg/kg wwt)	0.0146	0.025	EUSES (v2.1) calculations

6d	PECoral top predator (in mg/kg wwt)	1.36E-03	2.33E-03	EUSES (v2.1) calculations
6d	Concentration in earthworm (in mg/kg wwt)	0.0177	1.82E-02	EUSES (v2.1) calculations
For Industrial use all PECoral-values for top predators were 0.025 mg/kg wwt in freshwater and 2.33E-03 mg/kg wwt in marine environments. Concentrations in earthworms were 2.45E 02 mg/kg for ERC 6a, 7.54E-03 mg/kg for ERC 6b and 1.82E-02 mg/kg for ERC 6d. PEC-values were used for risk characterisation.				

DNELs and PNECs for Sodium persulfate (CAS# 7775-27-1) - Workers	
DNELs	
Workers – Hazard via inhalation route	
Long-term exposure – systemic effects, Inhalation	2.06 mg/m^3
Acute/short term exposure – systemic effects, Inhalation	590 mg/m^3
Long-term exposure – local effects, Inhalation	2.06 mg/m^3
Acute/short term exposure – local effects, Inhalation	No data available
Workers – Hazard via dermal route	
Long-term exposure – systemic effects, Dermal	18.2 mg/kg bw/day
Acute/short term exposure – systemic effects, Dermal	400 mg/kg bw/day
Long-term exposure – local effects, Dermal	0.102 mg/cm^2
Acute/short term exposure – local effects, Dermal	2.248 mg/cm^2
Hazard for the eyes – local effects	No data available

PNECs	
Freshwater	0.0763 mg/L
Marine water	0.011 mg/L
Intermittent releases	0.763 mg/L
Sewage Treatment Plant (STP)	3.6 mg/L
Sediment (freshwater)	0.275 mg/kg sediment dw
Sediment (marine water)	0.0396 mg/kg sediment dw
Air	No data available
Soil	0.015 mg/kg soil dw
Secondary poisoning	No potential for bioaccumulation

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

FRAC SAND

Revision Date: 17-Feb-2014 **Revision Number:** 11

1. Identification of the substance/mixture and of the company/undertaking

1.1 Product Identifier

Product Name	FRAC SAND

1.2 Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Proppant
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC 26 - Handling of solid inorganic substances at ambient temperature

1.3 Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4 Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

2. Hazards Identification

2.1 Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Carcinogenicity	Category 1A - (H350)
Specific Target Organ Toxicity - (Repeated Exposure)	Category 1 - (H372)

Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	T - Toxic.
Risk Phrases	R49 May cause cancer by inhalation. R48/20 Harmful: danger of serious damage to health by prolonged exposure through inhalation.

2.2 Label Elements

Hazard Pictograms

Signal Word **Danger**

Hazard Statements
H350i - May cause cancer by inhalation
H372 - Causes damage to organs through prolonged or repeated exposure

Precautionary Statements - EU (§28, 1272/2008)
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P281 - Use personal protective equipment as required
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P308 + P313 - IF exposed or concerned: Get medical advice/attention
P314 - Get medical attention/advice if you feel unwell

Contains

Substances	**CAS Number**
Crystalline silica, quartz	14808-60-7

2.3 Other Hazards

None known

3. Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Crystalline silica, quartz	238-878-4	14808-60-7	60 - 100%	T; R49 Xn; R48/20	Carc. 1A (H350i) STOT RE 1 (H372)	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

4. First aid measures

4.1 Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water.
Ingestion	Under normal conditions, first aid procedures are not required.

4.2 Most Important symptoms and effects, both acute and delayed

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

5. Firefighting Measures

5.1 Extinguishing media

Suitable Extinguishing Media

None - does not burn.

Extinguishing media which must not be used for safety reasons

None known.

5.2 Special hazards arising from the substance or mixture

Special Exposure Hazards

Not applicable.

5.3 Advice for firefighters

Special Protective Equipment for Fire-Fighters

Not applicable.

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust.
See Section 8 for additional information

6.2 Environmental precautions

None known.

6.3 Methods and material for containment and cleaning up

Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

6.4 Reference to other sections

See Section 8 and 13 for additional information.

7. Handling and Storage

7.1 Precautions for Safe Handling

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice

7.2 Conditions for safe storage, including any incompatibilities

Store in a cool, dry location. Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Product has a shelf life of 36 months.

7.3 Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

8. Exposure Controls/Personal Protection

8.1 Control parameters

Exposure Limits

Substances	**CAS Number**	**EU**	**UK OEL**	**Netherlands**	**France OEL**
Crystalline silica, quartz	14808-60-7	Not applicable	STEL: 0.3 mg/m³ TWA: 0.3 mg/m³	TWA: 0.075 mg/m³	0.1 mg/m³

Substances	**CAS Number**	Germany MAK/TRK	**Spain**	**Portugal**	**Finland**

Crystalline silica, quartz	14808-60-7	0,15 mg/m^3	VLA-ED: 0.1 mg/m^3	TWA: 0.025 mg/m^3	TWA: 0.05 mg/m^3 TWA: 0.2 mg/m^3

Substances	**CAS Number**	Austria	Ireland	**Switzerland**	**Norway**
Crystalline silica, quartz	14808-60-7	Not applicable	Not applicable	Not applicable	STEL: 0.9 mg/m^3 STEL: 0.3 mg/m^3 TWA: 0.3 mg/m^3 TWA: 0.1 mg/m^3

Substances	**CAS Number**	**Italy**	**Poland**	**Hungary**	**Czech Republic**
Crystalline silica, quartz	14808-60-7	Not applicable	NDS: 2 mg/m^3 NDS: 0.3 mg/m^3 NDS: 4.0 mg/m^3 NDS: 1.0 mg/m^3	TWA: 0.15 mg/m^3	Not applicable

Substances	**CAS Number**	**Denmark**
Crystalline silica, quartz	14808-60-7	TWA: 0.3 mg/m^3 TWA: 0.1 mg/m^3

Derived No Effect Level (DNEL) No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC) No information available.

8.2 Exposure controls

Engineering Controls Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

Personal protective equipment

Respiratory Protection Wear a NIOSH certified, European Standard EN 149 (FFP2/FFP3), or equivalent respirator when using this product.

Hand Protection Normal work gloves.

Skin Protection Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

Eye Protection Wear safety glasses or goggles to protect against exposure.

Other Precautions None known.

Environmental Exposure Controls No information available

9. Physical and Chemical Properties

9.1 Information on basic physical and chemical properties

Physical State:	Solid	**Color:**	Tan
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	No data available
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	2.65
Water Solubility	Insoluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2 Other information

VOC Content (%)	No data available

10. Stability and Reactivity

10.1 Reactivity
Not applicable

10.2 Chemical Stability
Stable

10.3 Possibility of Hazardous Reactions
Will Not Occur

10.4 Conditions to Avoid
None anticipated

10.5 Incompatible Materials
Hydrofluoric acid.

10.6 Hazardous Decomposition Products
Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).

11. Toxicological Information

11.1 Information on Toxicological Effects

Acute Toxicity

Inhalation	Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A). Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).
Eye Contact	May cause mechanical irritation to eye.
Skin Contact	None known.
Ingestion	None known
Chronic Effects/Carcinogenicity	Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis. Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2). There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Crystalline silica, quartz	14808-60-7	500 mg/kg (Rat)	No data available	No data available

Substances	CAS Number	Skin corrosion/irritation
Crystalline silica, quartz	14808-60-7	Non-irritating to the skin

Substances	CAS Number	Eye damage/irritation
Crystalline silica, quartz	14808-60-7	Mechanical irritation of the eyes is possible.

Substances	CAS Number	Skin Sensitization
Crystalline silica, quartz	14808-60-7	Did not cause sensitization on laboratory animals

Substances	CAS Number	Respiratory Sensitization
Crystalline silica, quartz	14808-60-7	No information available

Substances	CAS Number	Mutagenic Effects
Crystalline silica, quartz	14808-60-7	Not regarded as mutagenic

Substances	CAS Number	Carcinogenic Effects
Crystalline silica, quartz	14808-60-7	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure.

Substances	CAS Number	Reproductive Toxicity
Crystalline silica, quartz	14808-60-7	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - single exposure
Crystalline silica, quartz	14808-60-7	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Crystalline silica, quartz	14808-60-7	Causes damage to organs through prolonged or repeated exposure if inhaled Lungs

Substances	CAS Number	Aspiration hazard
Crystalline silica, quartz	14808-60-7	Not applicable

12. Ecological Information

12.1 Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity for Invertebrates
Crystalline silica, quartz	14808-60-7	EC50(72h): 89 mg/L (biomass) (Scenedesmus subspicatus) (similar substance)	LC50(96h): 508 mg/L (Danio rerio) (similar substance)	No information available	LC50(48h): 731 mg/L (Daphnia magna) (similar substance) LC50(48h): 33.5 mg/L (Ceriodaphnia dubia) (similar substance)

12.2 Persistence and degradability

Substances	Persistence and Degradability

Crystalline silica, quartz	The methods for determining biodegradability are not applicable to inorganic substances.

12.3 Bioaccumulative potential
Does not bioaccumulate

12.4 Mobility in soil
No information available

12.5 Results of PBT and vPvB assessment
No information available.

12.6 Other adverse effects
Endocrine Disruptor Information
This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

13.1 Waste treatment methods

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations.

14. Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

ADR

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

Special Precautions for User	None
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable

15. Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

All of the components in the product are on the following Inventory lists: All of the components in the product are on the following Inventory lists:.

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 0: Generally not water endangering.

15.2 Chemical Safety Assessment

No information available

16. Other Information

Full text of R-phrases referred to under Sections 2 and 3

R49 May cause cancer by inhalation.
R48/20 Harmful: danger of serious damage to health by prolonged exposure through inhalation.

Key literature references and sources for data
www.ChemADVISOR.com/

Revision Date: 17-Feb-2014
Revision Note
Not applicable

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement
This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

HALLIBURTON

SAFETY DATA SHEET

according to Regulation (EC) No. 453/2010

SODIUM CHLORIDE

Revision Date: 27-Mar-2014 **Revision Number:** 12

1. Identification of the substance/mixture and of the company/undertaking

1.1 Product Identifier

Product Name	SODIUM CHLORIDE

1.2 Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Additive
Sector of use	SU2 - Mining, (including offshore industries)
Product category	PC20 - Products such as pH-regulators, flocculants, precipitants, neutralization agents, other unspecific
Process categories	PROC 26 - Handling of solid inorganic substances at ambient temperature

1.3 Details of the supplier of the safety data sheet

Halliburton Energy Services
Halliburton House, Howemoss Place
Kirkhill Industrial Estate
Dyce
Aberdeen, AB21 0GN
United Kingdom

Emergency Phone Number: +44 1224 795277 or +1 281 575 5000

www.halliburton.com

For further information, please contact

E-Mail address: fdunexchem@halliburton.com

1.4 Emergency telephone number

+44 1224 795277 or +1 281 575 5000

Emergency telephone - §45 - (EC)1272/2008	
Europe	**112**
Denmark	Poison Control Hotline (DK): +45 82 12 12 12
France	ORFILA (FR): + 01 45 42 59 59
Germany	Poison Center Berlin (DE): +49 030 30686 790
Italy	Poison Center, Milan (IT): +39 02 6610 1029
Netherlands	National Poisons Information Center (NL): +31 30 274 88 88 (NB: this service is only available to health professionals)
Norway	Poisons Information (NO):+ 47 22 591300
Poland	Poison Control and Information Centre, Warsaw (PL): +48 22 619 66 54; +48 22 619 08 97
Spain	Poison Information Service (ES): +34 91 562 04 20
United Kingdom	NHS Direct (UK): +44 0845 46 47

2. Hazards Identification

2.1 Classification of the substance or mixture

REGULATION (EC) No 1272/2008

Not classified

Classification according to EU Directives 67/548/EEC or 1999/45/EC

For the full text of the R-phrases mentioned in this Section, see Section 16

Classification	Not Classified
Risk Phrases	None

2.2 Label Elements

Not classified

Hazard Pictograms

Signal Word **None**

Hazard Statements

Not Classified

Precautionary Statements - EU (§28, 1272/2008)

Not Classified

Contains

Substances	**CAS Number**
Sodium chloride	7647-14-5

2.3 Other Hazards

None known

3. Composition/information on Ingredients

Substances	EINECS	CAS Number	PERCENT (w/w)	EEC Classification	EU - CLP Substance Classification	REACH No.
Sodium chloride	231-598-3	7647-14-5	60 - 100%	Not applicable	Not applicable	No data available

For the full text of the R-phrases mentioned in this Section, see Section 16

4. First aid measures

4.1 Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.

4.2 Most Important symptoms and effects, both acute and delayed

May cause eye irritation

4.3 Indication of any immediate medical attention and special treatment needed

Notes to Physician	Treat symptomatically

5. Firefighting Measures

5.1 Extinguishing media

Suitable Extinguishing Media

All standard fire fighting media

Extinguishing media which must not be used for safety reasons

None known.

5.2 Special hazards arising from the substance or mixture

Special Exposure Hazards

Not applicable.

5.3 Advice for firefighters

Special Protective Equipment for Fire-Fighters
Not applicable.

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust.
See Section 8 for additional information

6.2 Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3 Methods and material for containment and cleaning up

Scoop up and remove.

6.4 Reference to other sections

See Section 8 and 13 for additional information.

7. Handling and Storage

7.1 Precautions for Safe Handling

Avoid creating or inhaling dust.

Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice

7.2 Conditions for safe storage, including any incompatibilities

Store in a cool, dry location.

7.3 Specific End Use(s)

Exposure Scenario	No information available
Other Guidelines	No information available

8. Exposure Controls/Personal Protection

8.1 Control parameters

Exposure Limits

Substances	CAS Number	EU	UK OEL	Netherlands	France OEL
Sodium chloride	7647-14-5	Not applicable	10 mg/m³	Not applicable	Not applicable

Substances	CAS Number	Germany MAK/TRK	Spain	Portugal	Finland
Sodium chloride	7647-14-5	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Austria	Ireland	Switzerland	Norway
Sodium chloride	7647-14-5	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Italy	Poland	Hungary	Czech Republic
Sodium chloride	7647-14-5	Not applicable	Not applicable	Not applicable	Not applicable

Substances	CAS Number	Denmark
Sodium chloride	7647-14-5	Not applicable

Derived No Effect Level (DNEL) No information available.

Worker

General Population

Predicted No Effect Concentration (PNEC) No information available.

8.2 Exposure controls

Engineering Controls Use in a well ventilated area.

Personal protective equipment

Respiratory Protection	Dust/mist respirator. (N95, P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.

Other Precautions	None known.
Environmental Exposure Controls	No information available

9. Physical and Chemical Properties

9.1 Information on basic physical and chemical properties

Physical State:	Solid	**Color:**	White
Odor:	Odorless	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	No data available
Freezing Point/Range	No data available
Melting Point/Range	801 °C
Boiling Point/Range	No data available
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	2.16
Water Solubility	Very soluble
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2 Other information

VOC Content (%)	No data available

10. Stability and Reactivity

10.1 Reactivity

Not applicable

10.2 Chemical Stability

Stable

10.3 Possibility of Hazardous Reactions

Will Not Occur

10.4 Conditions to Avoid

None anticipated

10.5 Incompatible Materials

None known.

10.6 Hazardous Decomposition Products

None known.

11. Toxicological Information

11.1 Information on Toxicological Effects

Acute Toxicity

Inhalation	May cause respiratory irritation.
Eye Contact	May cause eye irritation
Skin Contact	May cause skin irritation.
Ingestion	None known

Chronic Effects/Carcinogenicity	No data available to indicate product or components present at greater than 1% are chronic health hazards.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium chloride	7647-14-5	3 g/kg (Rat)	10 g/kg (Rabbit)	42 g/m^3 (Rat) 1 h

Substances	CAS Number	Skin corrosion/irritation
Sodium chloride	7647-14-5	Non-irritating to the skin (rabbit)

Substances	CAS Number	Eye damage/irritation
Sodium chloride	7647-14-5	May cause mild eye irritation. (rabbit)

Substances	CAS Number	Skin Sensitization
Sodium chloride	7647-14-5	No information available

Substances	CAS Number	Respiratory Sensitization
Sodium chloride	7647-14-5	No information available

Substances	CAS Number	Mutagenic Effects
Sodium chloride	7647-14-5	Not regarded as mutagenic

Substances	CAS Number	Carcinogenic Effects
Sodium chloride	7647-14-5	Did not show carcinogenic effects in animal experiments

Substances	CAS Number	Reproductive Toxicity
Sodium chloride	7647-14-5	Not a confirmed reproductive toxicant.

Substances	CAS Number	STOT - single exposure
Sodium chloride	7647-14-5	No information available

Substances	CAS Number	STOT - repeated exposure
Sodium chloride	7647-14-5	Not classified

Substances	CAS Number	Aspiration hazard
Sodium chloride	7647-14-5	Not applicable

12. Ecological Information

12.1 Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Sodium chloride	7647-14-5	EC50(120h): 2430 mg/L (cell number) (Nitzschia sp.)	TLM96: > 1000 mg/l (Oncorhynchus mykiss) LC50(96h): 5840 mg/L (Lepomis macrochirus) NOEC(33d): 252 mg/L (Pimephales promelas)	EC10 </= 35000 mg/L; NOEC 5000 – 8000 mg/L (activated sludge) NOEC 292-584 mg/L (Escherichia coli)	TLM96: > 1,000,000 ppm (Mysidopsis bahia) LC50(48h): 874 - 4136mg/L (Daphnia magna) NOEC(21d): 314 mg/L (Daphnia pulex)

12.2 Persistence and degradability

The methods for determining biodegradability are not applicable to inorganic substances.

Substances	CAS Number	Persistence and Degradability
Sodium chloride	7647-14-5	No information available

12.3 Bioaccumulative potential

Does not bioaccumulate

Substances	CAS Number	Log Pow

Sodium chloride	7647-14-5	No information available

12.4 Mobility in soil

No information available

12.5 Results of PBT and vPvB assessment

No information available.

12.6 Other adverse effects

Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

13. Disposal Considerations

13.1 Waste treatment methods

Disposal Method	Bury in a licensed landfill according to federal, state, and local regulations.
Contaminated Packaging	Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

14. Transport Information

IMDG/IMO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

RID

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

ADR

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

IATA/ICAO

UN Number:	Not restricted.
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental hazard:	Not applicable

Special Precautions for User	None
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not applicable

15. Regulatory Information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories

All of the components in the product are on the following Inventory lists: All of the components in the product are on the following Inventory lists:.

EINECS Inventory	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian DSL Inventory	All components listed on inventory or are exempt.

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

Germany, Water Endangering Classes (WGK)	WGK 0: Generally not water endangering.

15.2 Chemical Safety Assessment

No information available

16. Other Information

Full text of R-phrases referred to under Sections 2 and 3

Key literature references and sources for data

www.ChemADVISOR.com/
NZ CCID

Revision Date:	27-Mar-2014

Revision Note

Not applicable

This safety data sheet complies with the requirements of Regulation (EC) No. 453/2010

Disclaimer Statement

End of Safety Data Sheet

APPENDIX 6 – MANAGEMENT OF RADIOACTIVE WASTE

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Technical Report

BAT STATEMENT RELATED TO THE DISPOSAL OF RADIOACTIVE WASTE FROM THIRD ENERGY UK GAS LTD'S KIRBY MISPERTON A WELLSITE

Studsvik Contract Reference:	P0744
Studsvik Report Reference:	P0744/TR/001
Revision:	C
Date:	14/05/15
Client Ref:	KM8-UNC-0021

Prepared By: ……………………………………………… Date: 14/05/15
Nick Chambers
Radiation Protection Adviser/Radioactive Waste Adviser

Checked By: V Lilley
……………………………………………… Date: 14/05/15
Radiation Protection Adviser/Senior Waste Management Consultant

Checking Level: Two

Approved By: ……………………………………………… Date: 14/05/15
Andrew Laker
Consultancy Services Manager – Waste Management

Studsvik UK Limited
Unit 14
Princes Park
4th Avenue
Team Valley Trading Estate
Gateshead
Tyne & Wear. NE11 0NF

REVISION SHEET

Rev.	Description	Revised By	Checked By	Approved By
A	First Issue	N Chambers	R Strange	A Laker
B	Second Issue – amendment after one round of customer comments	N Chambers	R Strange	A Laker
C	Third Issue – amendment following revision of flowback volumes & options	N Chambers	V Lilley	A Laker

LIMITATIONS

This report has been prepared by Studsvik UK Limited in their professional capacity as Consultants, with all reasonable skill, care and diligence within the terms of the Contract with the Client. The advice and opinions in this report are based upon the information made available at the date of this report and on current UK standards, codes and legislation. The contents of this report do not, in any way, purport to include any manner of legal advice or opinion. This report has been produced in accordance with the terms and conditions detailed within client Purchase Order number POR005047.

Should the Client release this report to a Third Party, that Third Party does not acquire any rights, contractual or otherwise, whatsoever against Studsvik UK Limited and accordingly, Studsvik UK Limited assumes no duties, liabilities or obligations to that Third Party

EXECUTIVE SUMMARY

This Best Available Techniques (BAT) document has been prepared on behalf of Third Energy UK Gas Ltd as part of an application to the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2010 to allow for the accumulation and disposal of Naturally-Occurring Radioactive Material (NORM).

The potential presence of NORM in aqueous waste on the Kirby Misperton A (KMA) wellsite is related to the potential dissolution of radionuclides within the targeted formations and their subsequent transport to the surface during operations performed in relation to well KM8. Elements such as uranium, radium and radon are potentially dissolved in relatively low concentrations during reactions between the water and rock matrix. The dissolved radionuclides within the formations may be transported to the surface within the ‘flowback water’ of the KM8 hydraulic fracturing operations. Additionally, precipitates may be formed as a result of subsequent chemico-physical changes occurring within the water, however, these volumes are expected to be negligible.

There is a potential for the contamination of solid components/materials during the phase separation of material and the treatment of flowback water on the surface. However, due to the relatively low NORM concentrations anticipated, and the relatively short duration of the proposed operations, the works are not expected to give rise to any significant contamination issues.

With regard to minimising the arisings of aqueous radioactive waste, a BAT is considered to be the on-site treatment of the flowback (in this case using a process of electrocoagulation), to allow for its re-use during subsequent hydraulic stimulations; however, the potential for this approach will be dependent upon the physical and chemical make-up of the flowback water, the determination of which will only be possible once site operations commence. Assuming on-site treatment is feasible, a final waste water volume (which will be accumulated at the surface at close of the fifth phase of hydraulic fracturing) of approximately 675 m^3 (comprising final flowback waste water and accumulated treatment waste waters) has been estimated for the KM8 hydraulic fracturing operation. Should on-site treatment be unfeasible, a total flowback water volume of approximately 1,646 m^3 has been estimated.

Aqueous waste will be transported off-site to a bespoke, permitted industrial waste water treatment facility. This is the preferred option for treatment, as identified by this BAT study and will ensure that the aqueous waste will be managed effectively in accordance with current regulations and minimise any environmental impact associated with the waste. It has been demonstrated within this report that the treatment process will not give rise to any significant radiological exposure to members of the public or the environment, and is considered to be the best practicable environmental option.

The degree to which generation of solid waste occurs during the KM8 hydraulic fracturing operation is uncertain, however, disposal options have been considered for (what is anticipated as being) a relatively insignificant waste stream.

A summary of the waste management arrangements is also provided, outlining the necessary requirements for compliance with both the conditions of the Environmental Permitting (England and Wales) Regulations 2010 (EPR10) permit, and the applicable requirements of the Ionising Radiations Regulations 1999 (IRR99).

GLOSSARY

BAT	Best Available Technique
EA	Environment Agency
EMMP	Environmental Management and Monitoring Plan
EPR10	Environmental Permitting Regulations 2010 (as amended)
IRR99	Ionising Radiations Regulations 1999
KMA	Kirby Misperton A Wellsite
KM8	Kirby Misperton 8 hydrocarbon well
LAIP	Letter of Agreement in Principle
LLW	Low Level Waste
NORM	Naturally-Occurring Radioactive Material
OSPAR	Oslo Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
RIA	Radiological Impact Assessment
RPA	Radiation Protection Adviser
RPS	Radiation Protection Supervisor
RSCR	Radiological Site Condition Report
RSR	Radioactive Substances Regulation
RWA	Radioactive Waste Adviser
TSS	Total Suspended Solids
WwTW	Wastewater Treatment Works

CONTENTS

1 INTRODUCTION

1.1 Background

The following Best Available Techniques (BAT) Statement has been prepared as part of an application for a Permit to perform a Radioactive Substances Regulation (RSR) activity, in accordance with the Environmental Permitting (England and Wales) Regulations 2010 (as amended) [1]. The practice relates to on-shore oil and gas exploratory operations to be performed by Third Energy UK Gas Ltd on the Kirby Misperton A wellsite, and relates primarily to hydraulic fracturing to be performed from the KM8 well. The requirement for an RSR permit is related to the potential generation of radioactive waste during site operations as a result of the inadvertent extraction of naturally-occurring radioactive material (NORM) from the target formations.

1.2 Site details

The KM8 hydraulic fracturing operation and subsequent production testing will be undertaken at the following location:

Kirby Misperton A Wellsite
Off Habton Road
Kirby Misperton
North Yorkshire
YO17 6XS
England

National Grid Ref: SE 771789
Site Area: 1.465 ha

1.3 BAT definition and requirements

Within the Environment Agency EPR guidance [2] BAT is defined as:

"The use of the best available techniques will emphasise the use of non-waste technology, if available."

The term "best available techniques" means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste. In determining whether a set of processes, facilities and methods of operation constitute the best available techniques in general or individual cases, special consideration will be given to:

- *comparable processes, facilities or methods of operation which have recently been successfully tried out;*
- *technological advances and changes in scientific knowledge and understanding;*
- *the economic feasibility of such techniques;*
- *time limits for installation in both new and existing plants;*
- *the nature and volume of the discharges and emissions concerned.*

It therefore follows that what is "best available techniques" for a particular process will change with time in the light of technological advances, economic and social factors, as well as changes in scientific knowledge and understanding.

If the reduction of discharges and emissions resulting from the use of best available techniques does not lead to environmentally acceptable results, additional measures have to be applied.

"Techniques" include both the technology used and the way in which the installation is designed, built, maintained, operated and dismantled."

The definition notes that consideration should be given to the nature and volumes of the discharges under question.

The aim of the concept of BAT is to optimise, and thus minimise, the activity of radioactivity handled, the amount of contamination generated, and the activity of waste requiring disposal, so minimising the activity which is ultimately discharged to the environment.

Part of the concept of BAT is that users should consider the work procedures and the resulting radioactive waste generated before work commences, to ensure the minimisation of waste at all stages. BAT is an on-going process with reviews both periodically and whenever there is a substantive change in circumstances. The Environment Agency (EA) requires that the BAT approach is adopted in an appropriate manner at a level which is proportionate to the environmental risk. There is no *de minimis* level below which BAT does not apply, proportionality being a key principle.

Key elements include justifying the use of radioactive material (not applicable to the Permit application in question; see Section 2), performing tasks efficiently without creating unnecessary waste and decay-storing solid waste where practicable. All waste minimisation procedures need to take account of such factors as,

- practicality
- operator safety
- monetary cost, and
- benefits to the environment of reduced discharges and disposals.

Permits granted under EPR10 require operators to use BAT to minimise the activity of radioactive waste produced that will require disposal under the permit.

The application of BAT requires operators to use best available techniques in the design and operational management of their facilities, to minimise discharges and disposals of radioactive waste. The focus is to ensure a high standard of protection for the public and the environment.

BAT is applied to such aspects as minimising waste creation, abating discharges, and the monitoring of plant, discharges and the environment for radioactivity. It takes account of such factors as the availability and cost of relevant measures, operator safety and the benefits of reduced discharges and disposals in relation to doses to workers, the public and non-human biota.

Third Energy UK Gas Ltd has appointed Studsvik UK Limited as Radiation Protection Adviser (RPA) and Radioactive Waste Adviser (RWA), to provide advice on the management of radioactive waste, and to support Third Energy with regard to RSR permit compliance associated with KMA wellsite operations.

This BAT statement has been drafted in support of the application for an EPR Permit to allow for the potential accumulation (and subsequent disposal) of NORM arising from hydraulic stimulation operations on a pre-drilled hydrocarbon exploration site. The following sections address the various requirements in considering whether BAT are being applied to the practice and associated waste streams.

2 JUSTIFICATION OF PRACTICES

A preliminary consideration with regard to radiological protection is whether the operations which will generate the radioactive waste, and which could increase the exposure of individuals, are justified, in accordance with the Justification of Practices Involving Ionising Radiation Regulations 2004 [3]. However, the operations are not considered to be a 'practice', as defined within the EC Basic Safety Standard Directive [4], given that the natural radiation sources in question are not being used for their radioactive, fissile or fertile properties. Therefore, further consideration of the Justification regulations is not required.

3 DESCRIPTION OF WASTE STREAMS

The potential presence of NORM in aqueous waste, due to the dissolution of radionuclides within the rock formations (by naturally present, or injected, water), is an unavoidable consequence of hydrocarbon exploration, including the process of hydraulic fracturing.

Contamination may arise as a result of dissolution of radionuclides within the formation, and their subsequent transport to the surface, either within 'produced water' naturally released from the formation(s), or within 'flowback' water which may return to the surface following injection during well preparation or hydraulic stimulation (fracturing) operations. There is also the potential for the contamination of solid materials (for example, phase-separator components), and/or build-up of sludges or insoluble scales/coatings within pipework/components.

The potential for (EPR10) in-scope radioactive substances on the KMA site relates purely to radioactive *waste*, which may be inadvertently generated during the proposed site operations. No *use* of radioactive *material* is to occur on the site (i.e. radionuclides are not to be used for their radioactive, fertile or fissile properties), and the requirements of the EPR10 extend only insofar as the regulations apply to radioactive waste. The only waste-related procedures which require consideration are the storage and transfer/disposal of aqueous radioactive waste, and the potential generation of solid radioactive waste through contamination of equipment/PPE which will also require appropriate treatment/disposal. Given the relatively low concentrations of NORM anticipated, operations are not expected to give rise to any significant contamination issues.

With regard to the potential generation of aqueous waste two scenarios are considered, which are discussed in further detail in sections 3.1 and 3.2; firstly (section 3.1), it is assumed that for technical reasons the recycling and re-use of flowback water is not possible, and all flowback water is simply accumulated on-site prior to consignment to an off-site treatment facility. Secondly (section 3.2), it is assumed that treatment of the flowback water is technically feasible, allowing for its re-use during subsequent stages.

3.1 Untreated & un-recycled flowback water

The anticipated aqueous waste is flowback water, hydraulic fracture treatment fluid which will be released from the target formations immediately following each of the five proposed zonal, fracture stages. Relatively small volumes of flowback water may also be released gradually during subsequent phases of the operation, specifically well testing and production testing. It is anticipated that the return fraction [*including contribution of any produced water*] of injected fluid volume will likely be 30 %; however, it has been pessimistically assumed that 50 % of the injected fluid volume will return to the surface. A total fluid injection volume of 3,291 m^3 is proposed, potentially giving rise to a flowback waste water volume of 1,646 m^3. The total estimated volume of waste flowback water is considered to be a conservative (over-estimate) of the volume likely to be produced from the site. There is significant uncertainty associated with the potential return rate, and it's pertinent to note that less pessimistic calculations estimated waste water volumes as low as 450 m^3.

The elevated concentrations of NORM present within the flowback waters relate predominantly to radioisotopes of radium (and associated progeny), which find their way into the water due to their chemical solubility. Elevated concentrations of radon progeny may also be present, due to dissolved Rn-222 (radon) and, to a lesser extent, Rn-220 (thoron) gas. The waste flowback water may also contain significant quantities of dissolved solids, and also relatively small volumes of suspended solids.

Based on the maximum anticipated uranium and thorium concentrations within the formation in question, and based on knowledge of radium dissolution within other formations (and assuming a similar extent of dissolution within the KM8 target formations), it has been estimated (worst-case) that the flowback water generated during each proposed stage of hydraulic stimulation could contain Ra-226 at a maximum specific activity concentration of 140 Bq L^{-1}. Similarly, it has been estimated (worst-case) that the produced waters could contain Ra-228 at a maximum specific activity concentration of 14 Bq L^{-1}.

Based on the maximum estimated volume of approximately 1,646 m^3, this equates to approximately 230 and 23 MBq of Ra-226 and Ra-228, respectively, within the waste flowback water.

3.2 Flowback water treatment

In order to minimise waste arisings, the re-use of the flowback fluid in subsequent injections is the preferred option. However, treatment of the flowback water (for reasons associated with the non-radioactive characteristics of the water) will be necessary, prior to any such recycling/re-use. Subject to the physical and chemical make-up of the flowback water (to be determined once operations have commenced), a decision will be taken on the potential for treatment using Haliburton's Multi-Chem® CleanWave® technology. Similarly, the waste flowback water which may arise following the fifth and final stimulation may be treated, prior to any transfer/disposal.

The treatment process utilises the technique of electrocoagulation, with the primary aim of removing Total Suspended Solids (TSS), by up to 99 %. The process is also claimed to effect the partial removal of Group II metals (i.e. Ra^{2+}) and heavy metals. As such, there is the potential for the waste streams produced as a result of the proposed electrocoagulation process to be contaminated with NORM.

The electrocoagulation process generates a sludge waste, which in terms of volume is expected to be approximately 5-10 % of the flowback water volume undergoing treatment. The sludge is expected to comprise 85 % liquid (water) and 15 % solids (removed TSS, and any additional precipitate generated during the treatment process), and for the purpose of the EPR10 permit application is considered a liquid.

Although the treatment process is an established, proprietary technique, there is uncertainty as to the likely efficiency of radium removal, which will be dependent on several local factors (including the chemistry of both the feed water and the flowback water). Based on the estimated fluid injection profile, and a produced ‘sludge’ volume of between 5 and 10 % of the treated water volume, it has been estimated that the treatment process will generate a total sludge waste volume of between 82-165 m^3. For the purpose of this assessment, it has been conservatively assumed that the technique will be 100 % efficient in the removal of radium from the flowback water, and the potential electrocoagulation sludge waste will contain maxima of approximately 230 and 23 MBq of Ra-226 and Ra-228, respectively.

The proposed waste water treatment will also involve exposure to ultra-violet light, in order to minimise the potential for biological activity within the hydraulic stimulation fluids. However, this treatment stage is not expected to produce any potentially NORM-contaminated aqueous waste.

3.3 Assumed radioactive waste inventory

For the purpose of the remainder of this document, and also in the determination of suitable activities to be included within the EPR10 RSR application, the maximum amount of radioactivity that could be generated via either of the processes outlined in Sections 3.1 and 3.2 will be used (i.e. 230 and 23 MBq of Ra-226 and Ra-228, respectively). It is considered good practice to also allow for a degree of headroom in the activities; therefore, the activity limits used for the RSR permit application and this BAT statement for Ra-226 and Ra-228 within accumulated aqueous waste are 300 and 30 MBq, respectively*.

3.4 Waste water storage

Waste water accumulated on site will be stored in closed, steel storage tanks. The maximum storage capacity of the tanks is in excess of 1,000 m^3 and is therefore suitable for the expected rate of generation of flowback water resulting from the hydraulic fracturing processes on the KMA wellsite. Given the significant waste storage capacity available on site, it is extremely unlikely that the maximum storage capacity will be approached. Nevertheless, should that be the case then the well shall be shut-in until the accumulated waste flowback water can be taken off-site for treatment and disposal, creating further storage capacity.

3.5 Waste water characterisation

Any flowback waste water produced during the hydraulic stimulations (or any flowback/produced water generated at a later stage of site operations), and any electrocoagulation waste water produced as a result of potential waste water treatment, will be characterised prior to any transfer/disposal from site, as detailed in Section 7.4.

3.6 Miscellaneous solid waste

Given the potential for the formation of NORM-contaminated scales/coatings within pipework and associated apparatus, and/or the NORM contamination of phase separator and potential treatment module equipment/material, allowance has also been made for the generation of a relatively small quantity of solid radioactive waste. Accumulation and disposal of a nominal

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* Although the waste activity calculations estimate potential Ra-226 and Ra-228 activities of approximately 230 and 23 MBq, a degree of head-room will be requested within the RSR application, given the uncertainties associated with the specific activities of the potential flowback water.

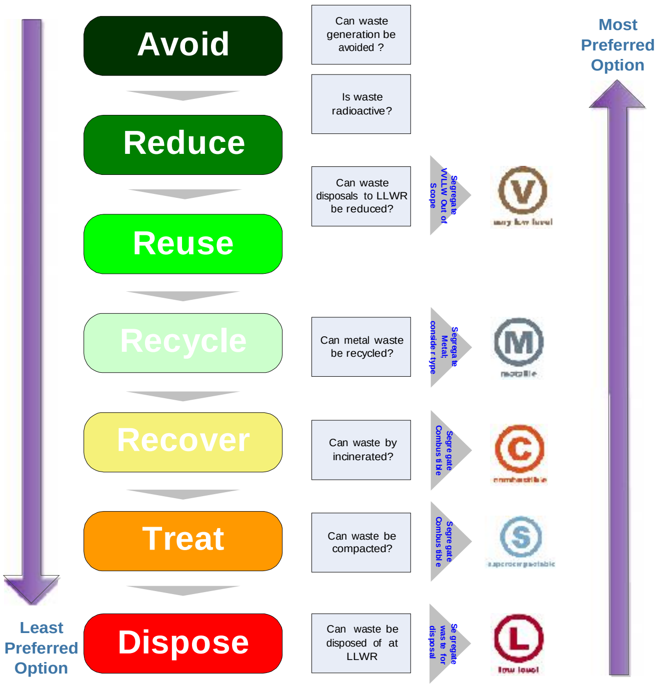
10 MBq each of Ra-226, Pb-210, and Po-210, and 4 MBq each of Ra-228 and Th-228 will be requested within the permit application.

4 WASTE MANAGEMENT OPTIONS ASSESSMENT

The application of the Waste Hierarchy[†] is fundamental to the management of radioactive waste in the UK. UK Low Level Waste (LLW) Policy [5] requires the application of the waste hierarchy to the management of Low Level Waste. The waste hierarchy (Figure 1.1 – *including details of the UK LLW Repository's segregated waste categories*) describes an ordering of preferences for the management of waste:

- Not create waste where practicable
- To reduce waste arisings
- To minimise the quantity of waste requiring final disposal; through application of the remaining options of the waste hierarchy (e.g. recycle, recover)

Figure 1.1 The Waste Hierarchy



Disposal is always considered the least preferred option, and use should always be justified through application of BAT (to minimise environmental impacts).

Options for each waste stream have been identified and assessed in Section 5, the aim being to identify a waste route that can be considered BAT.

[†] The Waste Hierarchy has been transposed into UK law through the Waste (England and Wales) Regulations 2011. The aim of these Regulations is to minimise waste disposal and to utilise other treatment and prevention methods first.

5 DISPOSAL OPTIONS ASSESSMENT

Given that the potential waste arisings are simply the bi-product of a NORM industrial activity, and there are currently no proprietary techniques which would prevent the dissolution of radium from the formation(s), there is no scope for the prevention of primary waste generation. Therefore this BAT assessment simply relates to the disposal of the potential arisings (this section), and the measures to be adopted to minimise the environmental impact of potential contamination associated with the handling and storage of NORM-contaminated waste (Section 7). Unless determined as being technically unfeasible, the treatment and recycling/re-use of waste water will be performed wherever possible, to minimise the volume of waste arisings.

5.1 Waste route selection for aqueous waste

5.1.1 Direct discharge from site into a watercourse

Direct discharge from site into a watercourse is not considered a viable option, given that there's currently no infrastructure in place to potentially allow for such a discharge. Additionally, the environmental impact of such a discharge is likely to be significant, given the relatively low flow-rate of the nearest water course‡.

Given the relatively small volume of waste water anticipated, and the fact that no proven, commercially-available, proprietary treatment technology is currently available, any necessary on-site pre-treatment to remove radium prior to discharge is not considered as being economically viable.

5.1.2 Direct discharge from site into the public sewer

Direct discharge from site is not considered to be a viable option, given that there's currently no installed sewer connection on the site, and installation of such is not considered as being economically viable given the relatively low volume of waste anticipated.

5.1.3 Transfer to WwTW

Given the difficulties associated with potential waste acceptance encountered elsewhere by the industry in the UK, transfer to a Wastewater Treatment Works (WwTW) is not considered a viable option. If this route were to be made available, the associated environmental impact is not expected to be significant, being principally associated with the transportation of the waste.

5.1.4 Transfer to a bespoke RSR Permitted waste treatment facility

With regard to the waste hierarchy, off-site transfer of waste for treatment is clearly the preferred option, given that the process of treatment should minimise any environmental impact associated with the waste, and is clearly the preferred option for the KMA wellsite operation. A Letter of Agreement in Principle (LAIP) has been obtained for the treatment of the aqueous waste at an

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‡ An assessment has been performed using the environmental regulators' Initial Radiological Assessment Methodology. Given that no data is available for the nearest watercourse [*numerous small streams and land drains appear to be shown on Ordnance Survey Maps in the area surrounding the site*], a watercourse flow-rate of 0.1 m^3 s^{-1} was initially assumed, and the proposed discharge was estimated to lead to a potential *Angling Family* exposure of approximately 480 microSv y^{-1}. Assuming discharge was made possible into the Pickering Beck @ Ings Bridge (Nearest Gauging Station; No. 27056; flow data 1974-2013; mean flow-rate 0.866 m^3 s^{-1}; source National River Flow Archive @ www.ceh.ac.uk), the proposed discharge would lead to an *Angling Family* exposure of approximately 67 microSv y^{-1}. Potential environmental impacts associated with non-radiological components of the waste would also require consideration, and could be a limiting a factor.

EPR10-permitted facility. If this route were to be chosen, the associated environmental impact is not expected to be significant (see Section 6), being principally associated with the transportation of the waste.

5.1.5 Transfer to incinerator

Given the relatively low volume of waste which will potentially be generated, transfer to an incinerator facility is considered a viable option, dependant on the concentrations of non-radiological contaminants within the waste. If this route were to be taken, the associated environmental impact is not expected to be significant, being principally associated with the transportation of the waste.

5.2 Waste route selection for solid waste

The generation of solid waste is not anticipated during the exploratory phase of operations. As such, detailed consideration of disposal options is not considered necessary. However, the following options would be considered, being dependent upon the specific activity concentrations of the waste.

5.2.1 Disposal to landfill disposal facility

Conditionally-exempt Type 1 NORM waste (having a *NORM waste concentration* of ≤5 Bq g^{-1}) could be disposed of to a licenced landfill, subject to consideration of the potential non-radiological contaminants.

5.2.2 Disposal to LLW disposal facility

Low-level waste (LLW) having a total activity concentration (of EPR10 radionuclides) of ≤200 Bq g^{-1} could be disposed of to one of two UK landfill facilities, subject to consideration of the potential non-radiological contaminants.

5.2.3 Transfer to treatment facility

Where separation of radiological contamination was considered possible (for example by high-pressure water-jetting), and economically viable, transfer of the waste to a suitable treatment facility would be considered (and would be the preferred approach from the perspective of the waste hierarchy). It is pertinent to note that generation of such waste is only likely to occur after daily production for several years, and in any event, when the equipment reaches end-of-life and becomes waste. The generation of such waste on the KMA wellsite is therefore highly improbable, however the raising of an LAIP for the treatment of contaminated equipment has however been sought as a precautionary measure.

5.3 Summary & BAT justification

5.3.1 Aqueous waste

Wherever technically possible, flowback will be recycled and reused during subsequent stages of hydraulic stimulation, thereby minimising the volume of waste water which will ultimately require treatment and/or disposal.

Incineration is potentially a BAT, however this route is simply a disposal, and does not involve treatment of the waste. Disposal is the least preferred option within the waste hierarchy and the transfer of aqueous waste to a licenced waste treatment facility is identified as the preferred option. Transfer to a bespoke treatment facility, involving pre-treatment prior to any disposal, immobilises the NORM in a solid filter cake suitable for disposal to landfill and ensures that potential environmental impacts are minimised. This option therefore also aligns with the concept of the waste hierarchy.

5.3.2 Solid waste

Given that generation of solid LLW is not anticipated during the proposed KMA wellsite operations, treatment and disposal options will only be considered in detail (following waste characterisation) should any solid waste actually be generated. In summary, the solid waste would be characterised and sent to a permitted waste disposal facility (if considered to be non-exempt Low-level Waste), or to a licenced landfill facility (if considered as being either Out-of-Scope of the requirements of the EPR10, or as conditionally-exempt Type 1 NORM waste).

6 ENVIRONMENTAL IMPACT ASSESSMENTS

Although no liquid discharges from the site are proposed, in order to demonstrate that the potential transfer of aqueous waste to a treatment facility is indeed a BAT, confirmation of the potential radiological environmental impacts are presented below.

The potential EPR10-permitted treatment site which can receive aqueous waste from the exploration sites utilises an acid/alkali treatment process to treat the waste waters, and produces an inert, non-hazardous solid filter-cake residue. The process removes approximately 90 and 42 % of the radium and lead, respectively. The phase conversion results in the production of solid material which is estimated to contain NORM at activity concentrations which will render the material Out-of-Scope of the requirements of the EPR10.

The site has been permitted for a number of years to accumulate, treat and dispose of NORM waste. As such, a Radiological Impact Assessment (RIA) is in place to cover the site's existing Permit limits (*which allows for receipt of significantly higher activities, relative to those detailed within this BAT statement*). However, to confirm that the treatment of the aqueous waste detailed within this BAT statement will result in minimal environmental impact, an RIA has been performed, based on the anticipated waste activities. It is estimated that aqueous waste disposal from site (following waste treatment) will potentially result in an effective dose of approximately 0.8 μSv y^{-1} to the most exposed group (Farming Family).

The estimated dose represents approximately 0.26 % of the 300 μSv y^{-1} currently recommended by Public Health England as the dose constraint applicable to public exposure from a single new source [7]. The fatality risk (associated with one year's exposure) is calculated to be 3.9E-08 (approximately 1 in 26,000,000) based on a fatality risk factor of 5 % per Sv.

It is therefore considered that the method of disposal involving transportation to a waste treatment facility and removal of the majority of the NORM within a solid filter-cake residue (suitable for landfilling) is considered to be the best practicable environmental option.

7 GENERAL WASTE MANAGEMENT CONSIDERATIONS

7.1 Minimisation of accumulating waste activities and volumes

Waste volumes accumulated on the sites are dictated by the rate at which aqueous material is transported to the site surface, and the rate at which items of equipment become contaminated with solid NORM residues (if at all).

Removal of aqueous waste to an EPR10-permitted waste treatment facility (within road tankers) will occur as soon as is reasonably practicable.

As soon as practicable, after identification and characterisation, low-level solid waste will be transferred to a suitable EPR10-permitted treatment or disposal facility. Waste which is Out-of-Scope of the EPR10, or which is considered to be conditionally-exempt Type 1 NORM waste, will be consigned to a licenced landfill facility, or considered for recycling/re-use, as appropriate.

7.2 Contamination monitoring

A number of baseline samples of environmental media will be taken prior to commencement of works on the sites, to determine background concentrations of radionuclides in the local area. A background contamination survey will also be performed (using a suitable alpha/beta contamination monitor). A contamination monitoring programme will be devised, to ensure that any significant (albeit improbable) environmental contamination is promptly identified. This will include alpha/beta contamination monitoring of key areas/surfaces, including:

- Well-head (and immediately surrounding site surface);
- Separator equipment (external surfaces, and any internal surfaces accessible for maintenance/access (and immediately surrounding site surface));
- Storage tanks (internal surfaces where practicable, external valves and immediately surrounding site surface);
- Electrocoagulation treatment module.

Consignments of waste flowback water and electrocoagulation waste water (‘sludge’) will also be monitored externally for contamination, prior to leaving site. At close of works, all potentially-contaminated equipment will be monitored prior to leaving site.

The frequency, actions and responsibilities associated with monitoring shall be documented in a Radiological Management System, to be produced following issue of the RSR Permit, and which will ensure compliance with the Permit conditions.

7.3 Storage arrangements

Aqueous waste will be stored in steel tanks, on an area of site underlain by an impermeable membrane/bund to minimise the probability of environmental contamination.

Solid waste will be stored within a secure container, or within a secure lay-down area, as appropriate. Pipework/components will be capped to prevent release of contamination.

The operations will be performed on a secure, fenced site protected by 24 hour security.

7.4 Waste characterisation

Waste characterisation will involve representative sampling and radiochemical analysis within a laboratory holding the appropriate UKAS accreditations, where appropriate. A sample of waste flowback water or electrocoagulation waste water (‘sludge’) will be taken from a suitable sampling point (to be detailed within the Radiological Management System Document). Analysis will include the determinands listed in the OSPAR-related *Revised Reporting Procedures for Discharges of Radioactive Substances from Non-nuclear Sectors Ref. 2005-7 2009 update* (i.e. Ra-226, Ra-228 and Pb-210). Analysis for Po-210 will also be undertaken.

Given the relatively low-level concentrations of radionuclides anticipated within the waste water, assay via portable and commercially-available analytical equipment (prior to transportation) will be unable to accurately determine the specific activities within the water, and there will be a necessary reliance on the results of subsequent quantitative laboratory analyses of samples taken on site. However, a qualitative check of sampled water will be performed as aqueous waste accumulates (and in any event, prior to any off-site transportation of waste water), to confirm the absence of any unexpected (albeit unlikely) gross contamination. It will be assumed, until proven otherwise by quantitative laboratory analysis, that the water contains Ra-226 and Ra-228 at approximately 140 and 14 Bq L^{-1}, respectively.

Sampling and analysis of solid waste will be considered further should any such material be identified during the proposed, routine contamination monitoring. Analyses will include the determinands listed above.

7.5 SQEP & training

Third Energy will appoint a suitable, and appropriately trained, Radiation Protection Supervisor (RPS) for the KMA site, who will have responsibility for ensuring compliance with the conditions of the site Permit. Support will be provided by a formally appointed Radiation Protection Adviser (RPA) and Radioactive Waste Advisor (RWA). Site operatives with direct responsibilities associated with radioactive waste will also receive training, as appropriate.

7.6 Maintenance and audit of facilities

A routine maintenance and audit program will be implemented prior to commencement of operations. The program will ensure quality control in the function and application of the facilities. A baseline Radiological Site Condition Report (RSCR) will be produced prior to commencement of operations, and will include details of background concentrations of NORM at the site location (involving a combination of sampling and laboratory analyses and contamination monitoring); the report can subsequently be used to confirm the absence of any radiologically-significant contamination at time of Permit surrender.

During site operations, routine contamination monitoring of items/equipment will be performed wherever contamination is a possibility, or in the unlikely event of a spill. Site-specific maintenance and audit procedures during well testing shall be available on site.

7.7 Management of radiation work

The management arrangements will be documented in the Radiological Management System document, and support the BAT Statement.

Third Energy UK Gas Ltd have formally appointed Studsvik UK as Radiation Protection Adviser (RPA) and Radioactive Waste Adviser (RWA).

7.8 Working arrangements

Prior to the start of works, a radiological risk assessment and (if appropriate) Local Rules document (*as required by the Ionising Radiations Regulations 1999 (IRR99), detailing the safe management of the material on site, including contingency plans*) will be prepared by the RPA.

8 CONCLUSIONS

This report details the results of a BAT assessment for two potential waste streams associated with the proposed operations on the KMA well-site, namely aqueous flowback water, and solid waste in the form of contamination within pipework, vessels etc. With regard to minimising the arisings of aqueous radioactive waste, a best available technique is considered to be the on-site treatment of the flowback water, to allow for its re-use during subsequent hydraulic stimulations. However, the potential for this approach will be dependent upon the physical and chemical make-up of the flowback, the determination of which will only be possible once site operations commence. In terms of the aqueous waste ultimately produced (flowback water and potentially electrocoagulation treatment waste) the best available technique has been identified and justified, being the off-site transfer of waste to a suitable waste treatment facility at which liquid waste will effectively be converted to EPR10 Out-of-Scope solid material. The generation of solid waste is considered unlikely during the proposed exploratory operations; however a monitoring regime will be in place to ensure that the potential for solid waste is continually assessed.

For the levels of radioactivity to be encountered, the proposed procedures and facilities are considered adequate.

Given the timescales associated with the proposed works, a review date for this BAT statement is not considered necessary. However, this will be re-assessed should there be significant delays, or fundamental alterations to the scope of works.

9 REFERENCES

1. Environmental Permitting (England and Wales) Regulations 2010 (SI: 675) (as amended).
2. The Regulation of Radioactive Substances Activities – Non-nuclear Operators, Regulatory Guidance Series RSR 3, v.1, April 2011 (Environment Agency).
3. Justification of Practices Involving Ionising Radiation Regulations 2004 (SI: 1769).
4. Council Directive 96/29/Euratom, Official Journal of the European Communities L159/1 (1996).
5. Policy for the Long Term Management of Solid Low Level Radioactive Waste in the United Kingdom (2007).
6. Waste (England and Wales) Regulations 2011 (SI:988)
7. Board Statement on the 1990 Recommendations of the ICRP. Doc NRPB 4(1) (1993).

Studsvik

External Memo

P0744/RPA/001 v4 RevD

To:	**Sean Smart (PSSL)** **Jonathan Foster (PSSL)**	**Location**	**RE: Third Energy Gas UK KMA Wellsite**
From:	**Nick Chambers (RPA/RWA)**	**Location:**	**Studsvik UK Ltd**
Copies:	**Project File**	**Date:**	**13.05.15**
Subject:	**Wellsite & Radiological Impact Assessment (Rn-222+)**		

This memo formally confirms our advice with regard to well site operations, and the potential for exposure to radon gas following its discharge to atmosphere via fugitive release from equipment.

A. Background

A specific request has been made for information on the effect of potential discharge of radon gas (Rn-222) as part of the KMA EPR RSR application process. This memo aims to address the potential exposure issue.

Radon gas (Rn-222), being the progeny of radium-226 (Ra-226) which is present in the returned waters at elevated activity concentrations, could potentially de-gas and be removed from the produced waters within the phase separation equipment or storage tanks, and be discharged from the site.

It has been estimated that the KMA wellsite operation may require the accumulation of aqueous waste containing a maximum activity of 300 MBq Ra-226. It is assumed that 100 % (i.e. 300 MBq) of the Rn-222 produced via the decay of this Ra-226 inventory is discharged from site as an aerial release.

Additionally, it is assumed that a relatively small volume of gas is released in the form of fugitive emissions from miscellaneous process equipment on site. It is estimated[*] that a total of 8.02 tonnes of natural gas may be released, equivalent to approximately 1.18E+04 m^3. Assuming a radon concentration within natural gas of 200 Bq m^{-3}, this equates to a potential release inventory of 2.36 MBq.

A total release inventory of 302.4 MBq has therefore been assumed for the purpose of the assessment.

B. Dose Assessment

A radiological impact assessment has been performed which follows the Environment Agency's *Initial radiological assessment methodology – part 1 user*

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[*] Assuming 1 Te natural gas (as CH_4) is equivalent to approximately 1471 m^3 natural gas (as CH_4); source: http://www.epa.gov/cmop/resources/converter.html.

report [Reference 1] *& part 2 methods and input data* [Reference 2]. The assessment considers potential exposure of the *Local resident family*, living in a dwelling at a distance of 100 m from the site and consuming foodstuffs grown at a distance of 500 m from the site.

It is considered that the potential dose due to Rn-222 to the *Local resident family* exposure group does not include all progeny for the relevant pathways. In order to ensure that the assessment is robust, and suitably worst-case, it has been assumed that equivalent activities (i.e. 302.4 MBq) of both lead-210 (Pb-210) and polonium-210 (Po-210) are discharged annually from the site, along with the Rn-222.

Based on a 3 m release height, the assessment estimates that a member of the *Local resident family* exposure group could potentially receive an effective dose of 23 microSv/y as a result of the hypothetical discharge (summary in Appendix 1).

C. Conclusion

The estimated exposure is considered suitably worst-case, and falls significantly within both the dose constraint of 300 microSv/y for a single source [Reference 3], and the statutory public dose limit of 1000 microSv/y. For context, the estimated dose can be directly compared to that routinely received due to Rn-222 exposure in the home and workplace in the UK, being (on average) 1300 microSv/y [Reference 4].

D. References

1. Initial radiological assessment methodology – part 1 user report. Science Report: SC030162/SR1 (Environment Agency, 2006).
2. Initial radiological assessment methodology – part 2 methods and input data. Science Report: SC030162/SR2 (Environment Agency, 2006).
3. Board Statement on the 1990 Recommendations of the ICRP. Doc NRPB 4(1) (1993).
4. S J Watson et al. Ionising Radiation Exposure of the UK Population: 2005 Review. Chilton, HPA-RPD-001 (2005).

Yours sincerely
On behalf of Studsvik UK Limited

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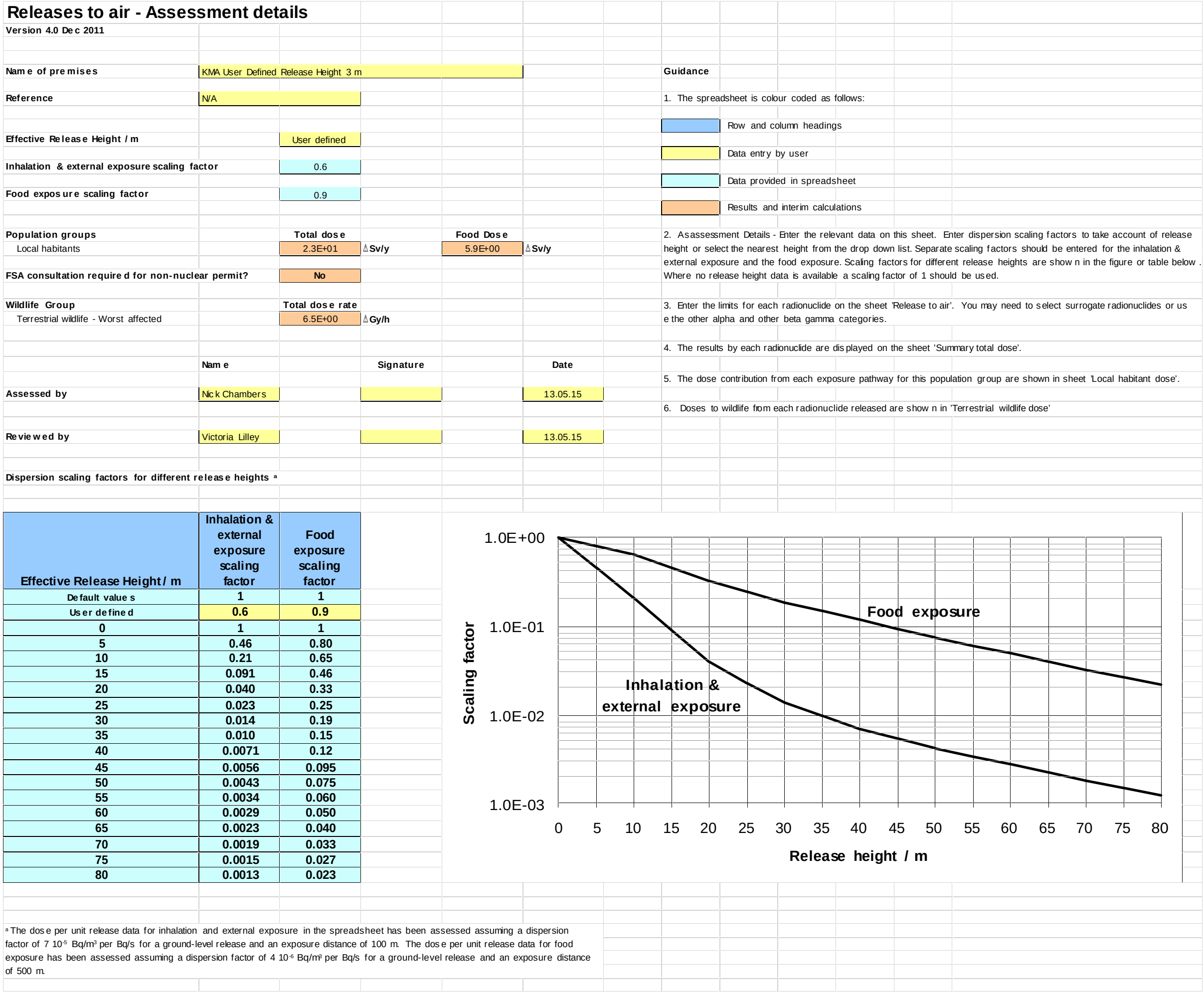
Appendix 1 Summary of Radiological Impact Assessment



Releases to air - Assessment details

Version 4.0 Dec 2011

Name of premises	KMA User Defined Release Height 3 m			
Reference	N/A			
Effective Release Height / m		User defined		
Inhalation & external exposure scaling factor		0.6		
Food exposure scaling factor		0.9		
Population groups		**Total dose**		**Food Dose**
Local habitants		2.3E+01	ΔSv/y	5.9E+00 ΔSv/y
FSA consultation required for non-nuclear permit?		**No**		
Wildlife Group		**Total dose rate**		
Terrestrial wildlife - Worst affected		6.5E+00	ΔGy/h	

	Name	**Signature**	**Date**
Assessed by	Nick Chambers		13.05.15
Reviewed by	Victoria Lilley		13.05.15

Guidance

1. The spreadsheet is colour coded as follows:

🟦	Row and column headings
🟨	Data entry by user
▭	Data provided in spreadsheet
🟧	Results and interim calculations

2. Asassessment Details - Enter the relevant data on this sheet. Enter dispersion scaling factors to take account of release height or select the nearest height from the drop down list. Separate scaling factors should be entered for the inhalation & external exposure and the food exposure. Scaling factors for different release heights are shown in the figure or table below. Where no release height data is available a scaling factor of 1 should be used.

3. Enter the limits for each radionuclide on the sheet 'Release to air'. You may need to select surrogate radionuclides or use the other alpha and other beta gamma categories.

4. The results by each radionuclide are displayed on the sheet 'Summary total dose'.

5. The dose contribution from each exposure pathway for this population group are shown in sheet 'Local habitant dose'.

6. Doses to wildlife from each radionuclide released are shown in 'Terrestrial wildlife dose'

Dispersion scaling factors for different release heights [a]

Effective Release Height / m	Inhalation & external exposure scaling factor	Food exposure scaling factor
Default values	1	1
User defined	0.6	0.9
0	1	1
5	0.46	0.80
10	0.21	0.65
15	0.091	0.46
20	0.040	0.33
25	0.023	0.25
30	0.014	0.19
35	0.010	0.15
40	0.0071	0.12
45	0.0056	0.095
50	0.0043	0.075
55	0.0034	0.060
60	0.0029	0.050
65	0.0023	0.040
70	0.0019	0.033
75	0.0015	0.027
80	0.0013	0.023

[a] The dose per unit release data for inhalation and external exposure in the spreadsheet has been assessed assuming a dispersion factor of 7 10^{-5} Bq/m^3 per Bq/s for a ground-level release and an exposure distance of 100 m. The dose per unit release data for food exposure has been assessed assuming a dispersion factor of 4 10^{-6} Bq/m^3 per Bq/s for a ground-level release and an exposure distance of 500 m.

Radionuclide	**Surrogate radionuclide**		**Discharge at Limits**
	Human assessment	**Wildlife assessment**	**Bq/y**
Lead-210	-	Caesium-137	3.02E+08
Polonium-210	-	Radium-226	3.02E+08
Radon-222	-	Radium-226	3.02E+08

APPENDIX 7 – AIR QUALITY IMPACT ASSESSMENT

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Third Energy UK Gas Limited

Air quality impact assessment of operations at the Kirby Misperton A wellsite

Report	150332
Date	17 September 2015
Revision	10

AIR QUALITY IMPACT ASSESSMENT OF OPERATIONS AT THE KIRBY MISPERTON A WELLSITE

THIRD ENERGY UK GAS LIMITED

Report prepared for

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Knapton Generating station
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17 September 2015

ISSUE HISTORY

Revision	Date	Approved	
150332,0	2 April 2015	N Ford	N Ford
First issue			
150332,1	7 April 2015	N Ford	N Ford
Minor amendments to text following client review.			
150332,2	10 April 2015	N Ford	N Ford
Minor amendments to text following further client review.			
150332,3	17 April 2015	N Ford	N Ford
Addition of releases from site vehicle movements to air quality impact and greenhouse gas release inventory (section 4). Addition of recent results of baseline air quality monitoring (section 2.4).			
150332,4	7 May 2015	N Ford	N Ford
Amendements to vehicle movement schedule.			
150332,5	15 May 2015	N Ford	N Ford
Clarification of comments on the air quality impact of nitrogen dioxide at residential locations on pages 23 and 24.			
150332,6	12 June 2015	N Ford	N Ford
Amendments to account for the expansion of the Caravan Park and the addition of specific comments considering air quality impact at the Caravan site and the Flamingo Land Theme Park locations (sections 3 and 4, Annex A).			
150332,7	29 June 2015	N Ford	N Ford
Amendments to the vehicle movement schedule and duration of operating phases (Section 3) with corresponding revisions to the air quality assessment and greenhouse gas inventory (Section 4).			
150332,8	30 June 2015	N Ford	N Ford
Amendments to the vehicle movement schedule and extension of production phase from 1 to 9 years (Section 3) with corresponding revisions to the air quality assessment and greenhouse gas inventory (Section 4).			
150332,9	29 July 2015	N Ford	N Ford
Amendments following issue of Schedule 5 notice. Table 3.10 revised and inclusion of consideration of benzene in assessment of fugitive releases (sections 3.6 and 4.4).			
150332,10	17 September 2015	N Ford	N Ford
Amendments to section 2.4 to update details of recent baseline air quality monitoring.			

CONTENTS

Page No.

0 SUMMARY

A dispersion modelling assessment using the ADMS 5 model was employed to predict the impact on local air quality of discharges of important pollutants from well operations at the Kirby Misperton A (KMA) wellsite. All operating phases associated with the well workover, fracturing, subsequent clean up and demobilisation prior to production were considered with emphasis on releases from temporary operations equipment, largely stationary diesel engines, and fugitive emissions from the natural gas transmission system. The greenhouse gas inventory for the operation was also assessed.

Process contributions from engine releases to ground level concentrations of nitrogen dioxide and PM_{10} are expected to exceed short term air quality standards at the site boundary based on model predictions, although the extent of any exceedence is not clear due to the influence of temporary structures on the dispersion of low level engine exhaust releases.

At the nearest locations of permanent human habitation process contributions to ground level concentrations of carbon monoxide, sulphur dioxide, volatile organic compounds and PM_{10} are not considered to be likely to have any significant impact on air quality. Process contributions of nitrogen dioxide are more significant, although it is concluded that these are unlikely to pose a substantial threat to the continued attainment of air quality standards.

At the closest statutory designated nature conservation sites process contributions to ground level concentrations of sulphur dioxide and nitrogen dioxide are mostly below the level of significance and do not pose any substantial risk to attainment of the critical levels. Nutrient nitrogen and acid deposition associated with the process contributions at these locations are not considered to be significant in relation to corresponding critical loads.

Natural gas produced from the KMA wellsite is transported via pipeline to the nearby Knapton Generating Station. Fugitive releases of natural gas are expected from the on site gas transmission system. Based on leakage rates assessed by Third Energy the impact on local air quality of fugitive natural gas releases was assessed. The maximum process contribution to ground level concentrations of methane, ethane , propane and higher hydrocarbons (expressed as benzene) was predicted to be equivalent to no more than 8% of the estimated long term environmental benchmark at the site boundary falling to below 1% of these levels at the nearest residential locations. The long term process contribution to ground level concentrations of these compounds during both pre production and production phases of well operations is not considered to be significant based on Environment Agency assessment criteria.

The modelling assessment methodology and necessary assumptions provide a very conservative assessment of impact on air quality, particularly for nitrogen dioxide. The overall results and conclusions reached therefore incorporate a reasonable margin of comfort in spite of the inevitable uncertainty of such modelling studies.

It is concluded that the well operations will not affect the attainment of air quality standards around the areas of permanent human habitation closest to the wellsite and will have negligible impact at local statutory designated conservation sites. Exceedences in short term air quality standards for some pollutants are likely on occasions around the site boundary. No exceedence in air quality standards is indicated for the locations of temporary habitation in the Caravan Park and nearby Flamingo Land Theme Park.

Release of greenhouse gases during well operations are estimated to be around 1680 t CO_2 equivalent, based on the expected duration of the defined operational phases. Due to the inherent uncertainty of this type of project the duration of some phases may exceed initial expectations and as such an estimate of 2602 tCO_2 equivalent is provided as a maximum for the overall project.

1 INTRODUCTION

Third Energy UK Gas Limited (Third Energy) placed a contract with Environmental Scientifics Group Limited (ESG) to undertake an assessment of the impact on local air quality of discharges of important pollutants from proposed operations at the Kirby Misperton A (KMA) wellsite, North Yorkshire.

1.1 Scope of study

The purpose of this study is to assess the impact of releases from the proposed operations at the KMA wellsite on local air quality in the context of applicable air quality standards and accepted environmental benchmarks. It is necessary, as part of the application for a permit to operate, to demonstrate that the proposed development will not have a significant adverse impact on the ambient concentrations of important pollutants.

The main issues to be addressed within this assessment are:

- The impact on local air quality of releases of pollutants, both point source and fugitive, on local air quality
- The estimated release of greenhouse gases during the period of operation

1.2 General approach

The approach taken in this assessment comprised the following main stages:

- Determine a suitable modelling tool for the assessment.
- Collate available process design data for input to the model.
- Determine pertinent point source release conditions over various phases of wellsite operation
- Determine pertinent fugitive releases over the various phases of wellsite operation
- Establish the influence of any proposed site buildings or structures on the dispersion of releases
- Obtain information on local background concentrations of important pollutants.
- Obtain 5 years' recent meteorological data from a measurement station appropriate to the location.
- Model the dispersion of releases of important pollutants from the wellsite operations to determine the process contribution to ambient concentrations over the local area with particular attention to locations of human exposure and statutory designated areas.
- Assess the predicted process contributions and established background concentrations with reference to applicable air quality standards and environmental benchmarks to determine compliance.
- Comment on the predicted impact of discharges of important pollutants on local air quality
- Establish an inventory of greenhouse gas releases for the wellsite operations

Further details of the approach taken and model input information are provided in the following sections.

1.3 Structure of the report

This report provides an assessment of the impact of discharges from the proposed operations at the KMA wellsite on air quality in the vicinity and on releases of greenhouse gases. The approach to the assessment has been described above. The following sections provide a detailed commentary on the assessment and conclusions:

Section 2	Air quality standards and assessment criteria
Section 3	The model methodology employed and important input data
Section 4	The results of the assessment
Section 5	Conclusions of the assessment

2 POLICY CONTEXT AND ASSESSMENT CRITERIA

The Kirby Misperton A wellsite is located 750m south west of Kirby Misperton village and around 1 km south east of the village of Little Barugh in the Ryedale District of North Yorkshire (see Figure 3.1).

Kirby Misperton A is an existing wellsite and the Kirby Misperton 8 (KM8) well was most recently drilled by Third Energy in 2013 as part of an appraisal of gas reserves followed by subsequent production. This appraisal concluded that there is a resource of sandstone and shale in the deep Bowland section. The current operations proposed by Third Energy are for the hydraulic fracturing of five zones within the well and, if successful, flowing of the natural gas produced, by pipeline, to the Knapton Generating Station. This is intended to enable the appraisal of the potential of the reserve.

2.1 Context of assessment

This operation will be under the control of both the minerals planning authority and the Environment Agency and will require planning permission and an environmental permit to operate. As part of the planning and permitting applications it is necessary to demonstrate the likely impact of operations on local ambient concentrations of important pollutants. It is in this context that the proposed operations are being examined to determine their additional contribution to the existing concentrations of important pollutants and therefore determine compliance with applicable air quality limit values and environmental benchmarks.

Local Authorities are required to assess compliance with applicable air quality objectives. Where the objectives are unlikely to be met the Local Authority is required to declare an Air Quality Management Area (AQMA) and prepare proposals for remedial action to achieve the required objective. There are no declared AQMAs in the vicinity of the wellsite, in addition, there is no knowledge of any other intended developments locally that will significantly impact on existing air quality.

2.2 Pollutants from well operations

The operations at Kirby Misperton do not involve any on site flaring of natural gas as the gas produced will be piped to the local Knapton Generating Station. There will however be releases of pollutants from two main sources:

- Releases from the mobile plant used for the wellsite operations during the initial preparation, fracturing and well testing operations and subsequent site restoration.
- Fugitive releases of natural gas from the initial fracturing process and during the subsequent production phase.

Substantial mobile plant is required for the intended operations. These will be predominately powered using stationary diesel engines. The main pollutants from the combustion of diesel fuel, are oxides of nitrogen (NO_x), carbon monoxide (CO) and volatile organic compounds (VOCs). Oxides of nitrogen are generally considered to comprise of nitrogen monoxide (NO) and nitrogen dioxide (NO_2). Emissions from combustion primarily consist of nitrogen monoxide, although reaction in the atmosphere results in conversion to nitrogen dioxide, which is the primary nitrogen oxide of interest with respect to ambient pollution. Carbon monoxide and volatile organic compounds are generally formed from incomplete combustion of fuel and their presence will therefore be related to efficiency of combustion.

It is assumed that the diesel fuel used will meet current regulations and as such will have a sulphur content of 0.1% by mass or less. A worst case is assumed in this assessment with consideration of discharges of sulphur dioxide (SO_2) consistent with the maximum allowable fuel sulphur content. Diesel combustion may also give rise to the release of fine particulate matter. In this assessment PM_{10} (particulate matter with an aerodynamic diameter below 10 µm) releases from the combustion of diesel have been considered.

Air quality standards for England consider limit values for nitrogen dioxide, carbon monoxide, sulphur dioxide and PM_{10}. The standards specified are in the form of concentrations and are determined to be levels below which effects are unlikely even in sensitive population groups or below which the risk to public health would be very small. There are no applicable standards for the general group of volatile organic compounds, although guidance[1] recommends comparison with the air quality standards for benzene as a means of determining significance.

2.3 Air Quality Standards

The UK's air quality strategy is based on meeting obligations within the European Union (EU) Ambient Air Quality Directive (2008/50/EC, 21 May 2008)[2] and the Fourth Daughter Directive (relating to metals and hydrocarbons). Table 2.1 summarises the applicable limit values for the pollutants considered in this assessment as at 2015.

It may be seen that standards are generally provided on the basis of short term and long term means. The limit values are considered to apply where members of the public are likely to be regularly exposed over the monitoring period. For the longer averaging periods the standards are considered to apply around the frontage of premises such as residential properties, schools and hospitals. The shorter term limit value (1 hour or 1 day means) applies at these locations and other areas where exposure is likely to be of one hour or more on a regular basis.

In some cases air quality standards (AQS) discuss standards (concentrations recorded over a specified time period which are considered to be acceptable in terms of current knowledge of the impact on health and the environment), objectives (target date by which the standard is expected to be met) and limit values (a legally binding time averaged limit which must not be exceeded). In the case of pollutants considered above the values specified are limit values which the UK is obliged to meet.

In addition, the Environment Agency guidance (H1, Annex F[1]) provides environmental assessment levels (EALs) for the protection of human health which may also be employed to assess the significance of ambient pollutant concentrations. These are also summarised in Table 2.1. Where an AQS or EAL is not available, workplace exposure limits have been employed, together with the methodology in H1, Annex F[1], to provide a benchmark for this assessment.

Table 2.1 UK Air Quality Standards and Environmental Assessment Levels

Pollutant	Basis	Concentration
Air quality standards		
Carbon monoxide (CO)	running 8 hour mean	10 mg/m^3
Nitrogen dioxide (NO_2)	1 hour mean (99.79 percentile – 18 exceedences per year)	200 µg/m^3
	annual mean	40 µg/m^3
Sulphur dioxide (SO_2)	15 minute mean (99.9 percentile – 35 exceedences per year)	266 µg/m^3
	1 hour mean (99.72 percentile – 24 exceedences per year)	350 µg/m^3
	24 hour mean – 99.18 percentile – 3 exceedences per year)	125 µg/m^3
PM_{10}	24 hour mean (90.41 percentile- 35 exceedences per year)	50 µg/m^3
	annual mean	40 µg/m^3
Benzene	annual mean	5 µg/m^3
Environmental assessment levels		
Carbon monoxide (CO)	Short term	30000 µg/m^3
Environmental assessment levels determined from workplace exposure limits		
Methane	Long term	7140 µg/m^3
Ethane	Long term	13420 µg/m^3
Propane	Long term	19680 µg/m^3

Long term and short term EALs are assumed to apply to annual and hourly values respectively.

Values determined from workplace exposure limits use the methodology specified in H1, Annex F[1] and the workplace exposure values provided in the HSE's EH40/2005[3] and OSHA's PEL[4].

In addition to the standards associated with human health above, critical levels are specified[1] for sulphur dioxide and nitrogen dioxide in relation to the protection of vegetation and ecosystems as shown in Table 2.2.

Table 2.2 Critical levels for the protection of vegetation and ecosystems

Pollutant	**Basis**	**Concentration**
Nitrogen dioxide (NO_2)	annual mean	30 µg/m^3
	daily mean	75 µg/m^3
Sulphur dioxide (SO_2)	annual mean[1]	10 µg/m^3

1. refers to the lower limit for sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity.

2.4 Background air quality in Kirby Misperton

In considering the overall impact of an operation, such as this herein, on local air quality and compliance with limit values, it is necessary not only to consider the contribution from the source of interest, but also the existing levels of pollutants of interest. Background air quality data for the Kirby Misperton area are available from DEFRA's air quality archive (http://uk-air.defra.gov.uk/data/pcm-data). The archive provides estimated background concentrations of important pollutants for 1km^2 areas for the UK. The latest background levels of pollutants of interest for the area considered (477500 478500) were used for this assessment. Table 2.3 summarises the estimated background concentration for NO_2, CO, PM_{10}, SO_2 and benzene as obtained from the air quality archive and which have been employed in this study. The DEFRA archive does not extend to the monitoring of total volatile organic compounds.

Table 2.3 Background concentrations for Kirby Misperton

Pollutant	**Basis**	**Concentration (µg/m^3)**
Nitrogen dioxide (2012)	annual mean	6.1
Carbon monoxide (2010)	maximum 8 hour running mean	1431
Benzene (2012)	annual mean	0.24
Sulphur dioxide (2012)	annual mean	2.3
PM_{10} (2012)	annual mean	13.6

As part of the environmental assessment of the KM8 operation air quality monitoring around the vicinity of the site has been undertaken to establish baseline conditions. This is reported elsewhere within the accompanying supporting documentation for the associated Environmental Impact Assessment. Subsequent air quality monitoring will be undertaken during the operations. The results of the complete baseline monitoring exercise are presented in Table 2.4.

Table 2.4 Baseline air quality measurements for the KMA wellsite

Parameter	**Concentration**
Methane	0.0008%
Carbon dioxide	0.0389%
Volatile organic compounds	9.89 µg/m^3
Benzene	6.92 µg/m^3
Toluene	30.07 µg/m^3
Ethylbenzene	6.52 µg/m^3
m & p xylene	11.63 µg/m^3
o xylene	6.12 µg/m^3
Nitrogen dioxide	22.19 µg/m^3
Nitrogen monoxide	6.48 µg/m^3
Nitrogen oxides	14.29 µg/m^3
Sulphur hexafluoride	<0.15 µg/m^3
Hydrogen sulphide	1.12 µg/m^3
Particulate matter	52 mg/m^2 day

a. methane and carbon dioxide reported measurements are the mean of 3 grab samples respectively together with all other reported measurements which are individual measurements from continuous sampling over the 25 February to 10 April 2015.

The concentration of methane of 0.0008% is consistent with the monitoring point located offsite, suggesting that the area in general is higher than the UK general background. However it should also be noted that maintenance on the existing production plant within the KM1 wellsite was being undertaken during periods of monitoring which could attribute to slightly elevated methane levels.

A total of three (3) sampling rounds were undertaken to establish a baseline figure for ambient air quality. These were taken every two (2) weeks between the 25 February 2015 and 10 April 2015. Once collected, the samples were analysed by ESG within a couple of days.

Four monitoring locations were selected in order to give a wide coverage of the main site. A 'clean' sample point was chosen and a monitoring stand positioned outside the South West corner of the KMA wellsite, 20m south along the access track. The position was chosen to give a baseline for all of the required parameters. Three (3) further monitoring locations identified around KMA wellsite. The first location, in the North East corner of the wellsite, was chosen, taking into account prevailing wind direct, site elevation and future positioning of equipment. The second location, in the North West corner of the wellsite, was chosen following the considerations as the first. The third monitoring location, in the South East corner of the wellsite, was chosen to provide a full perimeter monitoring suite and the prevailing wind direction. The 'clean sample' placed outside the South West corner of the wellsite would give the make of any particles coming onto the wellsite. This would then be deducted from other samples to give a true sample of particulates generated from the works being carried out within the wellsite. For clarity, any parameters that will be monitored by grab sampling techniques will be done so at the four (4) monitoring locations to ensure consistency amongst all of the monitoring rounds. It is important to state that the locations proposed are the same locations that have been used to establish the baseline condition.

An additional grab sample will also be taken by the ESG engineers for methane whilst attending site. The additional monitoring location shall be variable and will be determined on the day by the wind speed and direction. A minimum distance from the methane emission sources will be 5m on a still/calm day, with a maximum of 20 meters on a windy day. The location will also be dependent on any ATEX zones that are established at the KMA wellsite.

Although proposed monitoring plan would only provide for one (1) clear downwind sampling location (with the addition of the variable methane sampling), Third Energy have been advised by ESG that the proposed locations are sufficient.

When considering the combination of estimated process contributions and background concentrations it should be noted that background concentrations are generally available as annual mean values and as such simple addition when considering short term air quality standards may not be appropriate. Guidance from the Environment Agency[5] suggests a simplified method for combining estimated process contributions and background concentrations. For comparison with long term standards the overall concentration is the sum of the process contribution (annual mean) and background concentration (annual mean). For comparison with short term standards the Environment Agency suggest the sum of the process contribution (hourly or daily mean) and twice the background concentration (annual mean). This methodology has been employed in this assessment.

The Environment Agency's guidance note H1[1] provides a methodology for assessing the impact and determining the acceptability of emissions to atmosphere on ambient air quality. The contribution of the process (PC) to the ambient concentration of a given pollutant is considered insignificant if:

- the long term PC is less than 1% of the long term environmental standard
- the short term PC is less than 10% of the short term environmental standard

If the long term PC is greater than 1% of the environmental standard then the corresponding predicted environmental concentration (PEC, PC + background concentration) should be assessed. The ambient concentration of the pollutant is unlikely to have a significant effect if:

- The long term PEC is less than 70% of the relevant long-term environmental standard

3 MODELLING METHODOLOGY

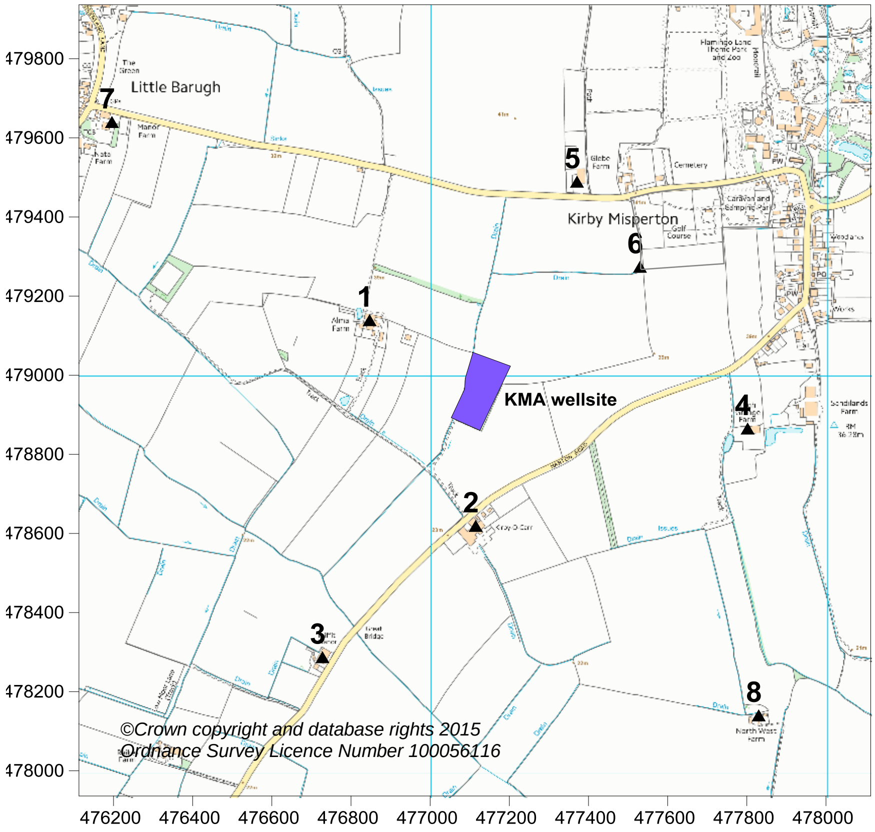
The contributions to ambient concentrations of selected pollutants from the proposed operations at the KMA wellsite have been modelled using the Atmospheric Dispersion Modelling System (ADMS) version 5. The use of this modelling tool is widely accepted by the Environment Agency and UK Local Authorities.

ADMS 5 requires a range of information in order to perform the modelling. The primary information used to perform the modelling is discussed below.

3.1 Assessment area

The area over which the assessment was undertaken is a 2000m x 2000m area with the wellsite (477113 478936) located approximately at the centre (see Figure 3.1).

Figure 3.1 Assessment area for modelling



A general grid with receptors spaced at 40 m intervals (i.e. 2601 points for a 51 x 51 grid) was used to assess the process contribution to ground level concentrations over the area. The grid was considered at ground level (i.e. 0m).

Some special receptors, as identified in Figure 3.1, were considered at the locations of human habitation closest to the wellsite including transient populations at the Caravan site and Flamingo Land Park. In addition a number of receptors located at the edge of the statutory designated sites in the vicinity of the wellsite have also been included.

The coordinates of the special receptors located at the nearest residential locations and statutory designated sites are summarised in Tables 3.1 and 3.2 respectively. All special receptors are considered at an elevation of 1.5 m above ground level.

Table 3.1 Locations of residential receptors

Location (see Figure 3.1)		**Easting**	**Northing**
1	Alma Farm	476847	479139
2	Kirby-O-Carr	477115	478619
3	Tuiffit Manor	476728	478287
4	High Grange Farm	477802	478865
5	Glebe Farm	477371	479489
6	Caravan Park	477530	479274
7	Manor Farm	476196	479640
8	North west Farm	477830	478140

Table 3.2 Locations of statutory designated sites

Site	**Designation**[a]	**Position**[b]	**Easting**	**Northing**
Howardian Hills	AONB	6.0 km S	476862	473113
Newbridge Quarry	SSSI	7.2 km NE	479904	485282
River Derwent	SSSI, SAC	6.4 km SE	482433	475800
Green Lane Pit	SSSI	6.2 km NW	473227	483663
Cropton Bank	SSSI	8.9 km NW	474491	487179
The Ings	SSSI	4.0 km SW	475834	475286
Haugh & Gundale Slacks	SSSI	9.5 km NE	479746	487712
Golden Hill Pit	SSSI	5.9 km NW	472555	482596
Ellerburn Bank	SSSI	10 km NE	485001	484690

a. SSSI (Site of special scientific interest), AONB (Area of outstanding natural beauty), SAC (Special area of conservation).
b. Position is the edge of the site closest to the wellsite.

3.2 Buildings

The presence of buildings close to a release point can have a significant impact on the dispersion of releases. The most significant impact can be the downwash of a plume around a building causing increased concentrations in the immediate area around the building. Buildings can also disturb the wind flow causing turbulent wake downwind which can also affect dispersion. It is normally considered that buildings within 5 times the height of release should be considered in any modelling.

The temporary structures and buildings intended for the site are generally at a relatively low level of around 3-4 m, however the exhausts from the engines are generally of similar height and as such it is considered necessary to include some consideration of temporary structures within the modelling. A sound barrier consisting of ISO containers to a height of 8.7 m will be located close to the site boundary on the north, east and west side.

ADMS 5 models buildings as either rectangular or circular structure. As shown in Figure 3.2 the structures which are considered to be significant in relation to dispersion from the various engine exhausts are estimated as rectangular blocks based on the site plan provided by Third Energy[6].This is a necessary approximation given the number of individual blocks and their varying height. Subsequent sensitivity analyses undertaken indicated that the main impact of on-site buildings is on the dispersion and subsequent ground level concentrations around the site boundary. Consideration of buildings has insignificant impact on the predicted ground level pollutant concentrations beyond around 200 m of the site and no impact at the nearest locations of human habitation as summarised in Table 3.1.

3.3 Meteorology

For this modelling assessment hourly sequential meteorological data from the nearest suitable meteorological station to the Kirby Misperton site was obtained. The data, provided by the UK Met Office, was from the Leconfield station and covered the 5-year period 2008 to 2012.

Other closer stations (High Mowthorpe, Fylingdales and Scarborough) did not have the capability to provide the entire data set necessary for the modelling. In this case Leconfield, which is around 20 miles to the south east of Kirby Misperton is considered to be the most suitable complete data source available.

The data included, among other parameters, hourly measurements of wind speed and direction. A typical annual windrose (2008) for the Leconfield station is shown in Figure 3.3. The prevailing wind is from the south west and west.

Figure 3.2 Wellsite with buildings and pollutant release locations

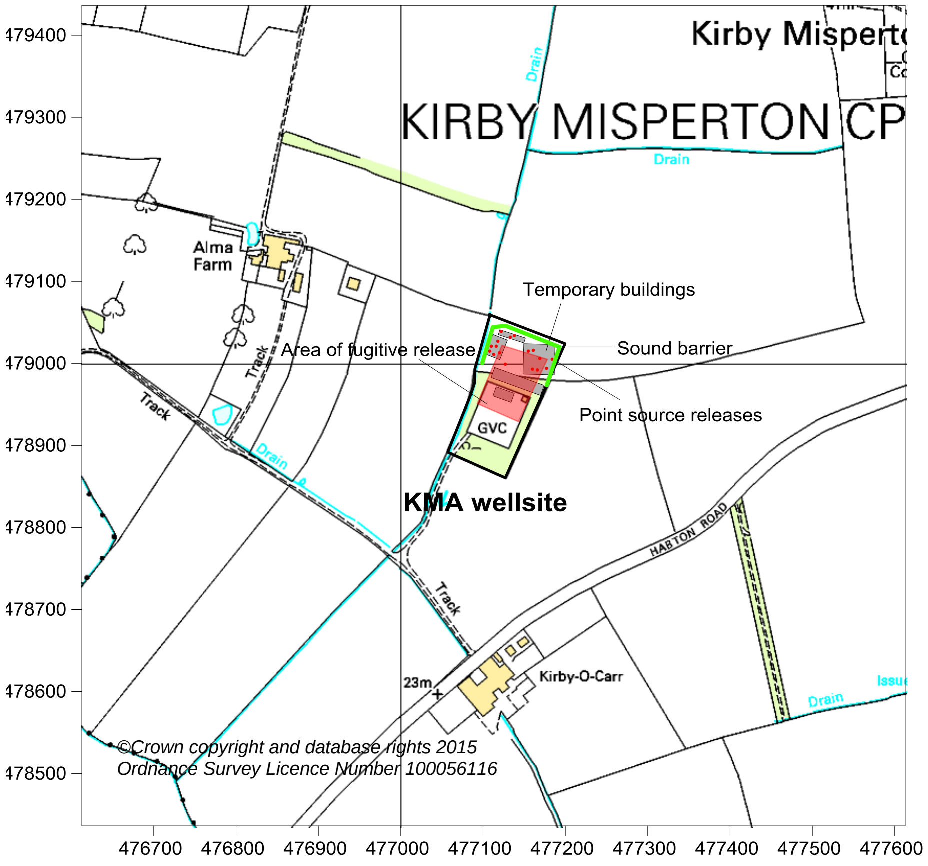


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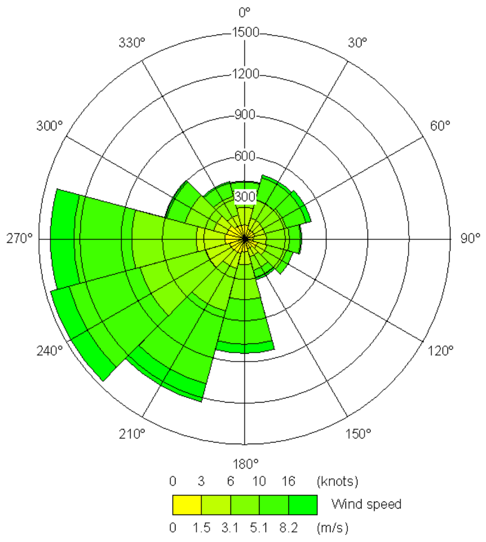
Figure 3.3 Windrose for Leconfield (2008)



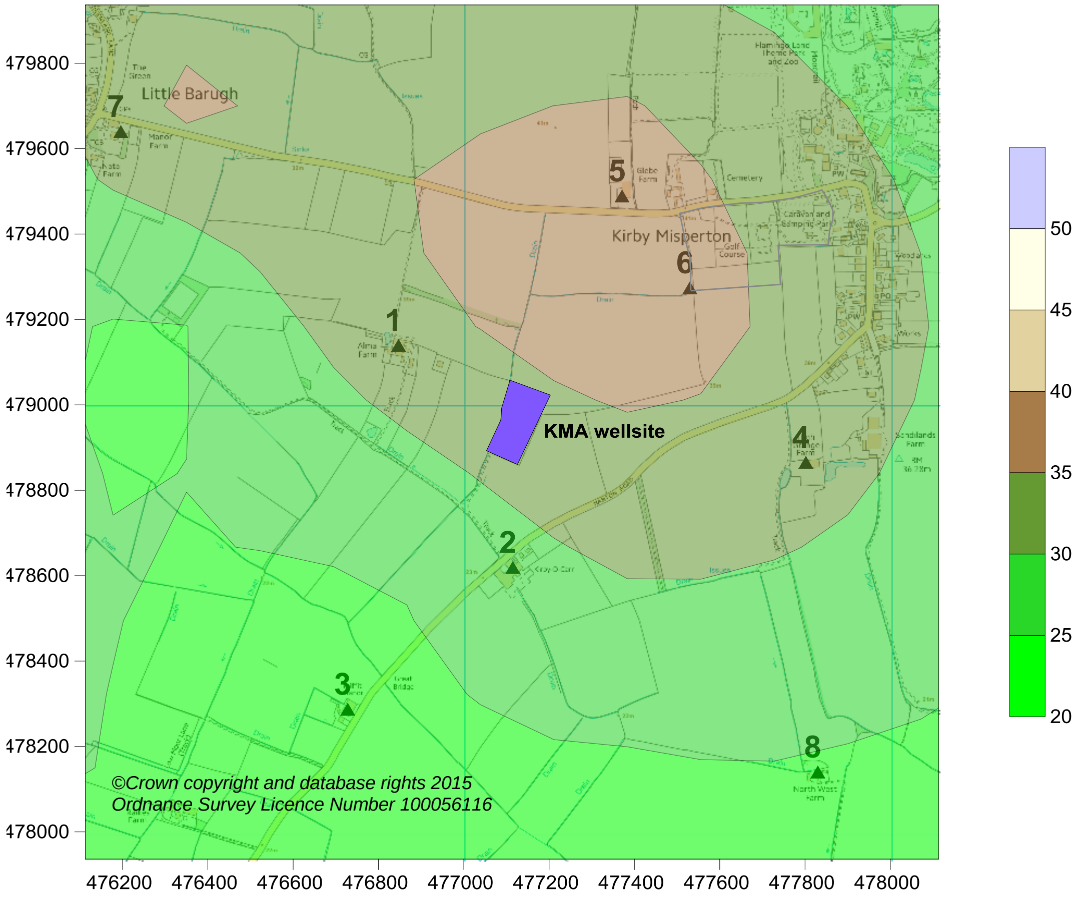
3.4 Terrain

The area of the assessment around the Kirby Misperton A wellsite is relatively flat. The wellsite is around 210 m from the nearest residence and around 700 m from the village of Kirby Misperton to the north east and around 1.1 km from Little Barugh to the north west.

The general area is considered to fall into the category of an agricultural area and as such a surface roughness of 0.2, as defined in ADMS 5, has been assigned. A sensitivity analysis indicated no significant change in predicted contributions to ground level concentrations of nitrogen dioxide between surface roughness values of 0.1(root crops) to 1.0 (woodland).

Terrain data was obtained for the assessment area from the Ordnance Survey Land-form Panorama DTM data base. The ground elevation is illustrated in Figure 3.4 and indicates a slight elevation from the south west to the north east. Sensitivity analyses indicated that terrain had a negligible impact on predicted process contributions and dispersion and as such was not considered in the general modelling assessment.

Figure 3.4 Ground elevation within the assessment area



3.5 Pollutant releases from point sources

The significant point source pollutant releases from the site during the proposed operation result from the use of diesel fuel in various engines. Third Energy[7] have provided details of the engines used during each phase of the operations and their maximum fuel consumption. Table 3.3 summarises the operational details of all equipment which have significant exhaust pollutant release.

Based on site information provided by Third Energy[6], the individual point source have been located as shown in Figure 3.2 (red dots).

Table 3.3 Operating details of major equipment and other sources of pollutant release

Ref.	**Unit**	**Fuel consumption l/h[a]**	**Exhaust diameter m**	**Exhaust height m**	**Exhaust velocity[b] m/s**
a	ICH truck (MB Actros 2641l)	71.2	0.12	3.8	30.8
b	Zone II 1600cfm (150psig) diesel driven air compressor	85	0.2	2.35	13.2
c	Zone II 6.0mBTU/hr (150psig) steam generator	150	0.4	2.96	7.4
d	Power Pack Zone 2 HES 60/80/85/100K	106	0.3	3.21	43.6
e	Batchmixer & HT-400 pump - (Annulus pump)	131	2 off 0.2	4.05	10.4
f	Water Pump Unit - SK 36 PE Pump Trailer	95	0.12	3.8	44.1
g	Nitrogen unit (John Deere engine)	105	0.20	2.51	16.3
h	CleanStream unit, with diesel generator	57.5	0.20	3.0	9.0
i	MiniWave water treatment unit	61.1		2.0	9.5
j, k, l	HQ-2000 Grizzly pumps (3 off)	187	0.3	4.09	14.8
m	HQ-2000 Grizzly Stand by	155	0.3	4.09	12.3
n	50 bpm Blender	100.25	2 off 0.2	3.0	7.8
o	Dry gel Blender	39.25	0.2	4.0	8.2
p	Generator (2 off)	20.25	0.1	1.5	6.3
q	Centrifugal pumps (2 off)	25.5	0.1	1.2	7.9
r	Articulated flatbed HGV[c]	3.5	0.12	3.8	1.5
s	Earth mover	25	0.12	3.8	10.8
t	Fugitive emissions from gas transfer system leaks	-	-	-	-

a. fuel consumption is based on average operation at 88% full load.
b. based on an assumed exhaust gas temperature of 100^{o}C and an exhaust gas volume of 15.8 Nm^3/kg fuel.
c. estimated fuel consumption at engine idle[12].

Third Energy have identified several distinct phases of the operation where different groups of equipment will be employed. Table 3.4 summarises the main phases of the operation at the KMA wellsite. There is some uncertainty as to the duration of some of the above phases as the work to be undertaken will depend largely on the results of the fracture, however it is anticipated that the main phases will be of the following durations:

Workover	2 weeks
Hydraulic fracture stimulation and well test	6 weeks
Production test	90 days
Production	9 years
Restoration	6 weeks (Monday to Saturday)

Table 3.4 Operational phases

Phase		**Equipment used**[a]	**Duration**
Workover	Well logging	a	2 operations each of around 5 hours
	Setting upper completions	a	2 operations each of around 4 hours
	Operating frack sleeves	d	9 operations each of around 24 hours
	Site vehicle movements	r	186 HGV movements in the phase with a scheduled maximum of 25 movements/day 6 LGV/passenger car movements/day
Hydraulic Fracture Stimulation and Well Test	Performing fracture	j,k,l,m,e,n,o,p,q,h	5 operations each of around 5 hours
	Well clean up (between zone fractures)	d,e,b,c,i	4 operations each of between 1 and 3 days
	Setting bridge plugs	d	5 operations each of around 24 hours
	Final well clean up	d,e,b,c,i	4 operations each of between 1 and 3 days
	Lifting the well	d,g,b,c,i	1 operation of around 24 hours
	Flowback well	b,c,i	1 operation of around 24 hours
	Site vehicle movements	r	434 HGV movements in the phase with a scheduled maximum of 49 movements/day 10 LGV/passenger car movements/day
Production test	Production test	-	1 HGV movement every 2-3 days 4 LGV/passenger car movements/day
Production	Production	-	4 LGV/passenger car movements/day
Restoration	Restoration	r,s	1240 HGV movements over the 6 week phase with an average of 36 movements/day. 6 LGV/passenger car movements/day 4 earth movers each operated for a maximum of 6 hours per day over the 6 week phase

a. equipment refers to the references in Table 3.3.

Table 3.5 Emission factors for stationary diesel engines

Pollutant	**Emission factor**	
	lb/MMBtu	**g/MJ**[a]
Nitrogen oxides (as NO_2)	1.9[c]	0.82
Carbon monoxide	0.85	0.37
Carbon dioxide	165	71.0
Particulate (PM_{10})	0.1	0.043
Volatile organic compounds (as C)	0.09	0.039
Sulphur dioxide[b]	-	0.045
Nitrous oxide[d]	0.0013	0.0006

a. based on a higher heating value of 44.8 MJ/kg
b. based on a maximum fuel sulphur content of 0.1 % by weight.

c. the lower end of the range provided is assumed as this is more consistent with vendor information[7] than the upper end of the range.
d. emission factor derived from US EPA 2014 Emission factors for greenhouse gas inventories, April 2014.

The fuel used by the above equipment will be diesel. In order to determine the likely pollutant releases from the above operations emissions factors and the estimated fuel usage have been employed. The emission factors used for this application are based on the United States Environmental Protection Agency (US EPA) AP-42[8] compilation and refer to diesel combustion in stationary engines. These factors are widely accepted and are seen as being reasonably representative in this case. Table 3.5 summarises the emission factors employed herein for releases from stationary diesel engines.

For the vehicles involved in the operation the following emission factors in Table 3.6 are assumed.

Table 3.6 Emission factors for diesel vehicles

Pollutant	**Emission factor (g/h)**	
	Articulated flatbed[a]	**Earth mover**
Nitrogen oxides (as NO_2)	57	669
Nitrous oxide	0.9	2.8
Carbon monoxide	95	219
Carbon dioxide	9100	64432
Particulate (PM_{10})	2.6	43
Volatile organic compounds (as C)	13	69
Sulphur dioxide[b]	5.7	41

a. assumes a diesel heavy duty vehicle operating at idle[13]. For each vehicle movement it is assumed that the incoming vehicle remains at the site operating at idle for a period of 1 hour before leaving. Releases during movement to and from the wellsite are not considered to have a significant impact on local air quality in comparison to on site vehicle releases.
b.based on a construction land based mobile machine (1.A.2.fii)[14] and fuel consumption for a moderate load for a Caterpillar D6N bulldozer. Each earth mover is assumed to operate for 6 hours per day and 6 days per week.

LGV and passenger car movements are primarily for the movement of staff to and from the site. It is therefore considered that pollutant releases from these vehicles within the site boundary will be negligible in relation to the releases from HGVs and stationary engines and are therefore not considered further in the assessment of local air quality Impact.

The hourly pollutant release rates for each of the operational phases in Table 3.4 is summarised in Table 3.7 based on the emission factors in Table 3.5 and the corresponding fuel consumption in Table 3.3.

Table 3.7 Pollutant releases during well operations

Phase		**Pollutant release rate (g/s)**					
		NO_x	**CO**	**CO_2**	**PM_{10}**	**VOC**	**SO_2**
Workover	Well logging	**0.593**	**0.267**	**51.3**	**0.031**	**0.028**	**0.032**
	a	0.593	0.267	51.3	0.031	0.028	0.032
	Setting upper completions	**0.593**	**0.267**	**51.3**	**0.031**	**0.028**	**0.032**
	a	0.593	0.267	51.3	0.031	0.028	0.032
	Operating frack sleeves	**0.882**	**0.398**	**76.4**	**0.046**	**0.042**	**0.048**
	d	0.882	0.398	76.4	0.046	0.042	0.048
	Site vehicle movements	**0.016**	**0.027**	**2.6**	**0.001**	**0.004**	**0.002**
	r	0.016	0.027	2.6	0.001	0.004	0.002

Table 3.7 Pollutant releases during well operations (continued)

Phase		**Pollutant release rate (g/s)**					
		NO_x	**CO**	**CO_2**	**PM_{10}**	**VOC**	**SO_2**
Hydraulic fracture stimulation and well test	Performing fracture	**8.562**	**3.863**	**741**	**0.449**	**0.407**	**0.466**
	j	1.560	0.704	135	0.082	0.074	0.085
	k	1.560	0.704	135	0.082	0.074	0.085
	l	1.560	0.704	135	0.082	0.074	0.085
	m	1.290	0.582	112	0.068	0.061	0.070
	e	0.572	0.258	49.5	0.030	0.027	0.031
	n	0.834	0.376	72.2	0.044	0.040	0.045
	o	0.327	0.147	28.3	0.017	0.016	0.018
	p	0.169	0.076	14.6	0.009	0.008	0.009
	q	0.212	0.096	18.4	0.011	0.010	0.012
	h	0.479	0.216	41.4	0.025	0.023	0.026
	Well clean up	**4.137**	**1.867**	**358**	**0.217**	**0.197**	**0.225**
	d	0.882	0.398	76.4	0.046	0.042	0.048
	e	0.791	0.357	68.5	0.041	0.038	0.043
	b	0.707	0.319	61.3	0.037	0.034	0.039
	c	1.248	0.563	108	0.065	0.059	0.068
	i	0.509	0.229	44.0	0.027	0.024	0.028
	Setting bridge plugs	**0.882**	**0.398**	**76.4**	**0.046**	**0.042**	**0.048**
	d	0.882	0.398	76.4	0.046	0.042	0.048
	Final well clean up	**4.137**	**1.867**	**358**	**0.217**	**0.197**	**0.225**
	d	0.882	0.398	76.4	0.046	0.042	0.048
	e	0.791	0.357	68.5	0.041	0.038	0.043
	b	0.707	0.319	61.3	0.037	0.034	0.039
	c	1.248	0.563	108	0.065	0.059	0.068
	i	0.509	0.229	44.0	0.027	0.024	0.028
	Lifting the well	**4.220**	**1.904**	**365**	**0.221**	**0.201**	**0.230**
	d	0.882	0.398	76.4	0.046	0.042	0.048
	g	0.874	0.394	75.7	0.046	0.042	0.048
	b	0.707	0.319	61.3	0.037	0.034	0.039
	c	1.248	0.563	108	0.065	0.059	0.068
	i	0.509	0.229	44.0	0.027	0.024	0.028
	Flowback well	**2.464**	**1.112**	**213**	**0.129**	**0.296**	**0.134**
	b	0.707	0.319	61.3	0.037	0.034	0.039
	c	1.248	0.563	108	0.065	0.059	0.068
	i	0.509	0.229	44.0	0.027	0.024	0.028
	t	-	-	-	-	0.179	-
	Site vehicle movements	**0.032**	**0.054**	**5.2**	**0.001**	**0.007**	**0.003**
	r	0.032	0.054	5.2	0.001	0.007	0.003

Table 3.7 Pollutant releases during well operations (continued)

Phase		**Pollutant release rate (g/s)**					
		NO_x	**CO**	**CO_2**	**PM_{10}**	**VOC**	**SO_2**
Production test	Production test	-	-	-	-	**0.179**	-
	t	-	-	-	-	0.179	-
	Site vehicle movements	**0.016**	**0.026**	**2.5**	**0.001**	**0.004**	**0.002**
	r	0.016	0.026	2.5	0.001	0.004	0.002
Production	Production	**-**	**-**	**-**	**-**	**0.179**	**-**
	t	-	-	-	-	0.179	-
Restoration	Restoration	**0.984**	**0.280**	**75.2**	**0.052**	**0.080**	**0.048**
	r	0.240	0.036	3.6	0.004	0.004	0.004
	s	0.744	0.244	71.6	0.048	0.076	0.044

a. Emissions from vehicles (r) in the workover, fracture and restoration phases are assumed to be evenly spread over a 24 hour period. The release rate is based on the maximum expected daily movement of vehicles during the phase of operations (Table 3.4) For the production test phase vehicle movements are assessed at a maximum of one movement per day. During restoration total hourly emissions from earth movers (s) are based on all four movers operating at their maximum hourly release in Table 3.6.
b.In the modelling of flowback well and production test the contribution of fugitive emissions to total volatile organic compounds is omitted since the majority of this release is methane. For the purposes of the assessment VOCs from other sources are assumed to be present as benzene for comparison with the corresponding air quality standard. Fugitive releases are considered separately in section 4.4.

The above discharge rates have been employed in the modelling of each operational phase.

The majority of oxides of nitrogen at the engine exhausts will be in the form of nitrogen monoxide. Whilst conversion to nitrogen dioxide will occur in the atmosphere it is unlikely that all of the nitrogen oxides in the exhaust release will be in the form of nitrogen dioxide at ground level. It may be noted that for this type of assessment the Environment Agency recommend[1] that conversion rates of 35% and 70% be considered for short and long term air quality impacts respectively. These are generally considered to be quite conservative estimates. In this case the conversion rates recommended are employed, although it is considered that this will result in a significant over estimate of the process contribution to ground level concentrations of nitrogen dioxide. Conversion rates at over the relatively short distances considered in this assessment are likely to be substantially lower than those assumed herein. Estimates based on the Janssen equation[9] indicate conversion rates of less than half of those employed in this assessment, indicating a likely overestimate of the impact significance of process releases. This will be a particularly significant consideration at the site boundary where the distance to the release point, and hence transit time, will be relatively short.

3.6 Pollutant releases from fugitive sources

Fugitive releases are considered to comprise the leakage of natural gas from the associated production equipment at the site which transfers the gas from the well to the Knapton Generating Station. It is assumed that there is the potential for leakage of natural gas following the fracture during flow back of fracture fluids and then during flowing. It is assumed for the purposes of this assessment that the fugitive emissions are released over the area identified in Figure 3.2 (i.e. an area of 1932 m^2).

Third Energy have provided the following expected composition of natural gas.

Table 3.8 Expected composition of natural gas

Gas Component	Composition[a] mole %
Hydrocarbons	
Methane (CH_4)	91.13
Ethane (C_2H_6)	3.30
Propane (C_3H_8)	0.57
Butane (C_4H_{10})	<0.01
Pentane (C_5H_{12})	<0.01
Hexane (C_6H_{14})	<0.01
Non-Hydrocarbons	
Carbon Dioxide (CO_2)	0.88
Carbon Monoxide (CO)	0.00
Hydrogen Sulphide (H_2S)	0.00
Nitrogen (N_2)	4.13
Oxygen (O_2)	0.00

a. mean of 6 samples

Third Energy[6] have provided their assessment of the likely leakage rates of the various components of the natural gas transmission system as indicated in Table 3.9.

Table 3.9 Transmission system leakage rates

Component	Number of components	Estimated emissions[a] (tonnes per year)
Connections	379	0.86
Flanges	117	0.43
Open Ended Lines	0	0.00
Pumps	0	0.00
Valves	151	4.94
Others	92	1.79
Total	739	8.02

a. leakage rate is based on 8424 operating hours per year.

On the basis of the total leakage rate in Table 3.9 and the natural gas composition in Table 3.8 the fugitive emission rates in Table 3.10 were determined.

Table 3.10 Fugitive emission rates

Component	Emissions rate	
	g/s	$g/m^2/s$[a]
Methane	0.218	1.1×10^{-4}
Ethane	0.015	7.7×10^{-6}
Propane	0.004	2.1×10^{-7}
Benzene	0.00012	6.2×10^{-8}

The above emission rates have been employed in the modelling of the impact of fugitive emissions. It is assumed that the C_{6+} fraction of hydrocarbons is present as benzene at the detection limit for hexane (in Table 3.8). This provides a worse case assessment for potential fugitive releases of benzene.

3.7 Nitrogen and acid deposition

Critical loads are set for the deposition of various substances to sensitive ecosystems. It is necessary to predict process contributions to acid deposition and nitrogen deposition in order to determine their significance with respect to the relevant critical load range for the habitat types associated with each designated site (see Table 3.2). The UK Air Pollution Information System (APIS – www.apis.ac.uk) provides acidity and nitrogen deposition critical loads for designated features within every SAC, SPA or A/SSSI in the UK.

In this case deposition rates for nitrogen and sulphur were calculated using methods recommended by the Environment Agency (AQTAG06)[11]. The dry deposition flux was determined as recommended using the relationship:

Dry deposition flux (μg/m^2/s) = ground level concentration (μg/m^3) x deposition velocity (m/s)

and the deposition velocities summarised in Table 3.11 which are applicable to grassland.

Table 3.11 Deposition velocities

Pollutant	Deposition velocity (m/s)
Nitrogen dioxide	0.0015
Sulphur dioxide	0.012

The calculated contributions of the process were then assessed against published critical load information to determine significance.

3.8 Modelling scenarios

ADMS 5 has been employed to estimate process contributions to ambient concentrations of selected pollutants based on the general conditions specified above.

Each phase of the operation as described in Table 3.4 has been modelled by assuming that the site is operated at the condition 24 hours per day all year round. The assessment considered a five year meteorological period (2008 to 2012). It should be recognised that each pre production phase will be performed for a relatively short period (some of a few hours, others of two to three days). It is expected that that initial workover will last around 14 days with the fracturing, clean up, flowing and demobilisation taking a further 42 days. The main ambient impact will therefore be of a short term nature. The aim of the modelling was to assess the maximum likely impact over a period of an hour or up to a day to enable comparison with relevant short term air quality standards.

The impact of emission from vehicles, in particular HGVs, is considered as separately to the releases in each of the phases from stationary engines. The maximum release from HGVs is considered to arise from the anticipated 49 vehicle movements during one day of the hydraulic fracturing phase. Vehicle movements at other times during this phase and in all other phases will be lower and in most cases significantly lower. In Tables 4.2 to 4.11 the air quality impact of this maximum daily vehicle movement is summarised.

Fugitive emissions from the production test and production phases were also considered to be continuous and were assessed over each of five years (2008 to 2012). It is more appropriate to consider these releases over a longer term in view of their expected duration.

4 MODELLING RESULTS

ADMS 5 has been run for the operating scenarios described in Section 3.8. The results of the modelling are discussed below.

4.1 Impact of releases around the site boundary

Figures A.1 to A.6 illustrate the dispersion of pollutants on the basis of the short term, and where applicable, long term air quality standards when operating in the well clean up mode. The well clean up operating mode is reasonably representative of the use of high intensity equipment over a period of 24 hours or more and has similar pollutant discharge rates as well lifting and flowback operations.

The dispersion pattern shows significant process contributions to ground level concentrations around the site boundary which is indicative of the relatively low level release height of the engine exhausts in comparison to the temporary structures around the site. The peak off site process contribution is significantly dependent on the assumptions made regarding exhaust height and adjacent structures. The ADMS model is not sufficient to adequately model the impact on dispersion of a large number of structures on multiple low level exhausts over a relatively short distance. It is therefore difficult to provide an absolute determination of peak process contribution in this area with any certainty. The impact of on-site structures beyond a distance of 200 m is less significant and at the nearest locations of permanent human habitation the assumptions made regarding site structures and exhaust release height have negligible impact.

The modelling described herein has represented buildings as number of blocks (see 3.2) and assumes that the engine exhaust release height is 0.2 m above the height of the tallest building (4.3 m). Other assumptions around this general arrangement make a significant difference to the site boundary pollutant concentrations. However, there is negligible impact at the locations of permanent human habitation. The predicted maximum concentrations around the site boundary are summarised in Table 4.1.

Table 4.1 Predicted maximum process contributions

Pollutant	Averaging basis	Maximum process contribution to ground level concentration (%AQS)
NO_2	hourly mean (99.79 %)	468
SO_2	hourly mean (99.72%)	77
CO	8 hours	9
PM_{10}	daily mean	144

The maximum process contribution is based on the well clean up operating mode. An assessment based on the fracturing phase would show considerably higher peak process contributions due to the higher pollutant discharges associated with the equipment used, although this process occurs for a considerably shorter period than other operating modes and is unlikely therefore to be representative. Conversely consideration of the well logging or fracture preparation phase would exhibit considerably lower process contributions.

In general the operating mode considered is typical of the higher intensity part of the overall operation. During these periods it can be expected that for both nitrogen dioxide and PM_{10}, short term air quality standards around the site boundary will be exceeded on occasions. It is noted that this will be an area where air quality monitoring will be undertaken both before and during wellsite operations.

4.2 Impact of releases at the nearest residential locations

As discussed in 4.1 the assumptions regarding the influence of site structures on pollutant dispersion and hence process contribution to ground level concentrations is largely insignificant at the nearest locations of human habitation.

Process contributions on a short term averaging basis have been considered for each pollutant during each operating phase at these locations.

Table 4.2 summarises the process contribution at the nearest locations of permanent human habitation for carbon monoxide.

Table 4.2 Predicted maximum process contributions of CO at residential locations

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum process contribution – maximum 8 hour rolling mean (%AQS)**							
Alma Farm	0.2	0.1	2.3	1.4	1.4	1.0	0.2	0.4
Kirby-O-Carr	0.2	0.1	2.3	0.9	0.9	0.8	0.1	0.4
Tuiffit Manor	<0.1	0.0	0.8	0.4	0.4	0.3	0.1	0.1
High Grange Farm	0.1	0.0	1.2	0.6	0.6	0.4	0.2	0.3
Glebe Farm	0.1	0.1	1.2	0.7	0.6	0.5	0.1	0.3
Caravan Park	0.1	0.1	1.3	0.7	0.7	0.6	0.1	0.3
Manor Farm	0.0	<0.1	0.9	0.5	0.5	0.4	<0.1	0.1
North West Farm	0.1	<0.1	0.9	0.4	0.4	0.3	<0.1	0.1

It may be seen that the maximum process contribution of carbon monoxide is below the level of significance (10% of AQS) and as such it is not considered that process contributions of carbon monoxide resulting from any operating mode will have any significant impact at the nearest residential locations to the wellsite.

Tables 4.3 and 4.4 summarise the process contribution at the nearest locations of permanent human habitation for sulphur dioxide on the 1 and 24 hour averaging bases.

Table 4.3 Predicted maximum process contributions of SO_2 at residential locations

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum process contribution - hourly mean (%AQS)**							
Alma Farm	0.5	0.3	7.3	3.8	4.1	2.9	0.4	2.5
Kirby-O-Carr	0.5	0.3	8.1	3.6	3.5	2.8	0.3	2.6
Tuiffit Manor	0.1	0.1	2.6	1.3	1.3	1.0	0.1	1.1
High Grange Farm	0.3	0.2	5.6	3.2	3.2	2.6	0.2	1.8
Glebe Farm	0.4	0.2	6.3	2.7	2.7	1.9	0.2	2.2
Caravan Park	<0.1	0.2	7.2	4.1	3.7	3.1	0.3	2.3
Manor Farm	0.1	0.1	2.2	1.2	1.2	1.0	0.1	0.9
North West Farm	0.2	0.1	2.6	1.2	1.2	1.0	0.1	0.9

Table 4.4 Predicted maximum process contributions of SO_2 at residential locations

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum process contribution - daily mean (%AQS)**							
Alma Farm	0.7	0.5	8.1	4.3	4.3	3.1	0.2	1.3
Kirby-O-Carr	0.5	0.3	9.3	3.1	3.2	2.3	0.2	0.9
Tuiffit Manor	0.2	0.2	2.4	1.2	1.2	0.8	<0.1	0.4
High Grange Farm	0.3	0.2	4.3	1.8	1.9	1.4	0.1	0.9
Glebe Farm	0.3	0.3	4.7	2.3	2.3	1.6	0.1	0.9
Caravan Park	0.3	0.3	4.8	2.2	2.3	1.7	0.2	1.4
Manor Farm	0.1	0.1	1.6	0.8	0.8	0.6	<0.1	0.3
North West Farm	0.2	0.1	2.2	1.1	1.1	0.7	<0.1	0.5

It may be seen that the maximum process contribution of sulphur dioxide on both of the short term averaging bases is below the Environment Agency's criteria for significance[1]. As such it is not considered that process contributions of sulphur dioxide resulting from any operating mode will have any significant impact at the nearest residential locations to the wellsite.

Table 4.5 summarises the process contribution at the nearest locations of permanent human habitation for PM_{10} on the short term averaging basis.

Table 4.5 Predicted maximum process contributions of PM_{10} at residential locations

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum process contribution - daily mean (%AQS)**							
Alma Farm	1.3	0.9	33.6	8.7	8.7	6.1	0.1	2.6
Kirby-O-Carr	0.8	0.5	33.8	5.1	5.3	4.1	<0.1	2.2
Tuiffit Manor	0.3	0.3	11.5	2.2	2.3	1.5	<0.1	0.9
High Grange Farm	0.4	0.4	16.5	3.5	3.6	2.7	<0.1	2.1
Glebe Farm	0.7	0.6	22.5	4.7	4.8	3.1	<0.1	2.2
Caravan Park	0.9	0.8	24.4	5.1	5.1	3.5	0.1	2.8
Manor Farm	0.2	0.2	7.6	1.6	1.6	1.1	<0.1	0.6
North West Farm	0.2	0.2	8.7	1.9	2.0	1.3	<0.1	0.9

For all operating modes, with the exception of the fracture, the process contribution of PM_{10} is below the Environment Agency's guideline for significance. As the fracturing operation is performed for a short period (5 hours) on only 5 occasions during the overall operation, it is not considered that the process contribution from this operation will pose a significant threat to attainment of the air quality standard over the 24 hour averaging period.

There is no short term air quality standard for benzene. As such the annual mean process contribution of volatile organic compounds at each residential location for each operating phase has been compared with the long term air quality standard for benzene in Table 4.6.

Table 4.6 Predicted maximum process contributions of VOCs at residential locations

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum process contribution - annual mean (%AQS)**							
Alma Farm	1.0	0.7	12.2	7.6	7.7	5.3	0.9	4.6
Kirby-O-Carr	0.9	0.5	13.6	6.3	6.5	4.5	0.8	4.1
Tuiffit Manor	0.3	0.3	4.5	2.4	2.5	1.6	0.3	1.6
High Grange Farm	0.8	0.6	11.8	5.8	5.9	4.0	0.7	4.2
Glebe Farm	1.2	1.0	15.7	8.5	8.5	5.6	0.9	6.1
Caravan Park	1.6	1.2	21.2	10.6	10.8	6.9	1.2	8.0
Manor Farm	0.2	0.1	2.6	1.5	1.5	1.1	0.2	1.0
North West Farm	0.3	0.2	4.6	2.4	2.5	1.7	0.2	1.2

In most cases the process contribution exceeds the Environment Agency's significance level on a long term basis. The background concentration of benzene (Table 2.3) is equivalent to around 5% of the air quality standard. The maximum predicted environmental concentration at each location (process contribution and background concentration) is around 21 % of the air quality standard. This is well below the level at which the Environment Agency consider a process contribution might have a significant impact on air quality. On this basis it is considered that the process contribution of volatile organic compounds is unlikely to have any significant impact on local air quality.

Table 4.7 summarises the process contribution at the nearest locations of permanent human habitation for nitrogen dioxide on the short term averaging basis.

Table 4.7 Predicted maximum process contributions of NO_2 at residential locations

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum process contribution - hourly mean (%AQS)**							
Alma Farm	6.8	3.9	98.3	47.2	47.0	33.8	2.4	34.3
Kirby-O-Carr	6.3	3.0	94.9	41.9	43.3	35.1	2.1	35.4
Tuiffit Manor	2.4	1.4	34.6	16.3	17.2	13.3	0.9	15.1
High Grange Farm	3.7	2.1	67.1	37.2	37.3	29.4	1.4	24.1
Glebe Farm	4.8	2.6	79.8	52.8	47.0	41.5	1.5	29.0
Caravan Park	5.6	2.6	85.0	51.6	51.8	42.0	1.7	25.3
Manor Farm	2.0	1.1	26.4	15.0	15.0	12.0	0.6	12.6
North West Farm	2.0	1.5	36.1	15.4	15.5	12.0	0.7	12.9

It may be seen for the main high intensity operational phases the process contributions of nitrogen dioxide at all residential locations exceed the Environment Agency's guideline level of significance. The background concentration of nitrogen dioxide on a short term basis is equivalent to around 6% of the air quality standard. The predicted process contributions at the two locations closest to the wellsite therefore indicate an exceedence of the air quality standard during fracturing operations. However, these operations are of a short term duration (5 hours with a maximum total duration of 25 hours) whereas the assessment considers the maximum process contribution for full time operation over a period of one year for each of five years' meteorological conditions. On this basis it is considered unlikely that all periods of fracturing will coincide with the meteorological conditions necessary to result in the maximum process contributions in Table 4.7.

Compliance with this air quality standard is more likely to be influenced by operation at the other high intensity operating modes which are of a longer duration and which all show predicted environmental concentrations below the air quality standard.

It is considered that for most pollutants during most operating phases the process contributions to ground level pollutant concentrations at the nearest residential locations are unlikely to have a significant air quality impact. The air quality impact of HGV movements, even at the maximum anticipated daily activity, is almost entirely below the level of significance at the nearest locations of frequent human habitation.

The assessment indicates that nitrogen dioxide is the predominant pollutant in relation to air quality, although it is not considered that this will lead to a failure in the short term air quality standard in practice. A long term assessment of the predicted environmental concentration of nitrogen dioxide, shown in Table 4.8, assuming full time running at each operational mode, indicates concentrations well below the air quality standard and at levels which the Environment Agency assessment criteria suggest will not significantly impact on air quality.

Table 4.8 Predicted maximum process contributions of NO_2 at residential locations

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum predicted environmental concentrations - annual mean (%AQS)**							
Alma Farm	17.1	16.5	41.2	29.2	29.4	25.0	15.6	20.4
Kirby-O-Carr	16.9	16.2	43.4	26.8	27.2	23.5	15.6	19.9
Tuiffit Manor	15.9	15.8	24.8	19.7	19.9	18.3	15.4	17.0
High Grange Farm	16.7	16.4	40.0	25.9	26.2	22.7	15.5	19.9
Glebe Farm	17.5	17.1	47.9	30.8	30.8	25.6	15.6	22.1
Caravan Park	18.2	17.4	59.2	34.9	35.1	28.8	15.7	22.6
Manor Farm	15.6	15.5	20.8	18.0	18.1	17.2	15.3	16.4
North West Farm	15.8	15.7	24.9	19.7	19.8	18.4	15.3	16.6

It should also be considered that the assumptions made for the purposes of the modelling tend to give a pessimistic view of maximum pollutant concentrations, in particular for nitrogen dioxide (see 3.5).

The Caravan site is around 420 m from the site boundary at its closest to the north west in the general direction of the prevailing wind. No exceedence in air quality standards for any of the pollutants considered is indicated within this assessment. The Flamingo Land Park is a further 500 m to the north east. The impact of pollutant releases from the wellsite at this location is significantly less than at the Caravan Park as indicated in Figures A.1 to A.7.

4.3 Impact of process releases at sensitive nature conservation sites

Several sensitive conservation sites have been identified within the locality of the KMA wellsite as detailed in Table 3.2. The maximum process contributions to ground level concentrations of nitrogen dioxide and sulphur dioxide at these sites have been determined for each of the operating modes. The results are summarised in Table 4.9 to 4.11 where the process contribution is compared with the relevant critical levels for protection of vegetation and ecosystems (see Table 2.2).

Table 4.9 Predicted maximum process contributions at nature conservation sites Nitrogen dioxide – daily mean

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum process contribution (% standard for ecosystems and vegetation)**							
Howardian Hills	0.3	0.1	4.3	1.8	1.9	1.4	<0.1	0.2
Newbridge Quarry	0.2	0.1	3.1	1.5	1.6	1.2	<0.1	0.2
River Derwent	0.4	0.1	5.7	2.7	2.8	2.1	<0.1	0.2
Green Lane Pit	0.2	0.1	2.9	1.4	1.4	1.0	<0.1	0.2
Cropton Bank	0.2	0.1	3.3	1.6	1.6	1.2	<0.1	0.1
The Ings	0.4	0.2	5.8	2.8	2.9	2.2	<0.1	0.4
Haugh & Gundale Slacks	0.2	0.1	3.3	1.6	1.6	1.2	<0.1	1.3
Golden Hill Pit	0.2	0.1	3.3	1.6	1.6	1.2	<0.1	0.2
Ellerburn Bank	0.2	0.1	2.4	1.1	1.1	0.8	<0.1	0.1

Table 4.10 Predicted maximum process contributions at nature conservation sites Nitrogen dioxide – annual mean

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum process contribution (% standard for ecosystems and vegetation)**							
Howardian Hills	0.1	<0.1	1.2	0.6	0.6	0.4	<0.1	0.6
Newbridge Quarry	0.1	0.1	1.6	0.8	0.8	0.5	<0.1	0.9
River Derwent	0.1	0.1	1.8	0.8	0.9	0.6	<0.1	0.9
Green Lane Pit	0.1	<0.1	1.1	0.5	0.5	0.4	<0.1	0.6
Cropton Bank	0.1	<0.1	1.2	0.6	0.6	0.4	<0.1	0.3
The Ings	0.1	0.1	1.8	0.9	0.9	0.6	<0.1	1.0
Haugh & Gundale Slacks	0.1	0.1	1.8	0.8	0.9	0.6	<0.1	2.8
Golden Hill Pit	0.1	<0.1	1.2	0.6	0.6	0.4	<0.1	0.7
Ellerburn Bank	0.1	<0.1	1.2	0.5	0.5	0.4	<0.1	0.5

Table 4.11 Predicted maximum process contributions at nature conservation sites Sulphur dioxide – annual mean

Operational phase	**Well logging Setting upper completions**	**Sealing bridge plugs Operating frack sleeves**	**Performing fracture**	**Well clean up Final well clean up**	**Lifting the well**	**Flowback well**	**Vehicle movements**	**Restoration**
Location	**Maximum process contribution (% standard for ecosystems and vegetation)**							
Howardian Hills	<0.1	<0.1	0.3	0.1	0.1	0.1	<0.1	<0.1
Newbridge Quarry	<0.1	<0.1	0.4	0.2	0.2	0.1	<0.1	<0.1
River Derwent	<0.1	<0.1	0.4	0.2	0.2	0.1	<0.1	<0.1
Green Lane Pit	<0.1	<0.1	0.3	0.1	0.1	0.1	<0.1	<0.1
Cropton Bank	<0.1	<0.1	0.3	0.1	0.1	0.1	<0.1	<0.1
The Ings	<0.1	<0.1	0.4	0.2	0.2	0.1	<0.1	<0.1
Haugh & Gundale Slacks	<0.1	<0.1	0.3	0.1	0.1	0.1	<0.1	0.1
Golden Hill Pit	<0.1	<0.1	0.3	0.1	0.1	0.1	<0.1	<0.1
Ellerburn Bank	<0.1	<0.1	0.3	0.1	0.1	0.1	<0.1	<0.1

At all sites the process contribution is relatively low and generally below the level of significance on a short term and long term basis.

APIS provides information on critical loads for nature conservation sites in respect of nutrient nitrogen and acid deposition. Table 4.12 summarises the determination of the impact of nutrient nitrogen and acid deposition at applicable sites for the well cleaning operating mode, which is considered representative of the high intensity operating phases. Some of the sites originally identified are geological sites or sites not sensitive to acid deposition and have been omitted from the subsequent assessment.

Table 4.12 Nutrient nitrogen and acid deposition

Site	**Nitrogen deposition**		**Sulphur deposition**	**Total acid deposition**	
	kgN/ha y	**% critical load**	**kgS/ha y**	**Keq/ha y**	**% critical load**
Cropton Bank	0.099	0.6	0.251	0.023	6.3
The Ings	0.151	1.5	0.382	0.035	7.9
Haugh & Gundale Slacks	0.099	0.6	0.251	0.023	2.7
Ellerburn Bank	0.085	0.6	0.237	0.021	2.1

a. Conversion factor for $\mu gNO_2/m^2/s$ *to kgN/ha y is 96. Conversion factor for kgN/ha y to Keq/ha y is 0.0714.*
b. Conversion factor for $\mu gSO_2/m^2/s$ *to kgS/ha y is 157.7. Conversion factor for kgS/ha y to Keq/ha y is 0.0625.*

H1 Annex B[10] indicates that process contributions for nitrogen deposition exceeding 20% of the critical load may not be acceptable for the most sensitive sites (e.g. SPA, RAMSAR). On this basis it is considered that the process contribution to nitrogen and acid deposition at local sensitive sites is not significant. It should also be noted that these above calculations are based on annual mean process contributions. The total operation is expected to be of a duration of around 8 weeks and as such annual mean process contributions can be expected to be significantly lower than reported in Tables 4.10 and 4.11 with commensurate reductions in nitrogen and acid deposition.

4.4 Impact of fugitive releases

The fugitive releases determined in Table 3.10 have been modelled to determine their impact on local air quality around the KMA wellsite. Figure A.7 illustrates the predicted dispersion of fugitive releases of methane which provides the highest contributions to ground level concentrations. In this case it is considered that modelling over an extended period of one year is suitable since these releases are considered to be typical of those during the production test and production phases when the well is flowing.

It may be seen that the maximum impact is confined to the wellsite with concentrations at the site boundary equivalent to around 8% of the calculated environmental assessment level for methane and 6% of the air quality standard for benzene. Table 4.13 summarises the impact of process contributions of methane, ethane, propane and benzene at the nearest locations of permanent human habitation and temporary accommodation at the Caravan Park.

Table 4.13 Process contributions from fugitive releases at residential lcoations

Location	**Maximum process contribution (annual mean)**			
	% environmental assessment level			**% AQS**
	Methane	**Ethane**	**Propane**	**Benzene**
Alma Farm	0.1	<0.1	<0.1	0.09
Kirby-O-Carr	0.1	<0.1	<0.1	0.09
Tuiffit Manor	<0.1	<0.1	<0.1	0.02
High Grange Farm	0.1	<0.1	<0.1	0.05
Glebe Farm	0.1	<0.1	<0.1	0.06
Caravan Park	<0.1	<0.1	<0.1	0.08
Manor Farm	<0.1	<0.1	<0.1	0.01
North West Farm	<0.1	<0.1	<0.1	0.01

It may be seen that all process contributions for methane, ethane, propane and C_{6+} higher hydrocarbons (expressed as benzene) are below the Environment Agency's long term criteria for significance. It is therefore considered that fugitive releases do not have any significant impact on air quality in the vicinity of the wellsite. It is anticipated that the production phase will be of 9 years duration. No year on year cumulative effects are indicated for fugitive releases.

4.5 Releases of greenhouse gases

Greenhouse gas releases from the KM8 operations are primarily associated with three sources:

- Carbon dioxide, nitrous oxide and volatile organic compounds released from stationary engines during pre production well operations.
- Carbon dioxide, nitrous oxide and volatile organic compounds from mobile sources deployed at various stages of the workover, site clearance during the production test period and the site restoration.
- Methane releases from the natural gas transmission system during flow back and production.

Greenhouse gas (GHG) release rates from wellsite operations are estimated in Table 4.14 and the total greenhouse gas inventory for each phase is summarised in Table 4.15.

Releases from the stationary engines are based on the release rates in Table 3.7 and the expected duration of each operational phase described in section 3.4. Releases from mobile sources are based on the release rates in Table 3.7 and maximum daily vehicle movements described in Table 3.4. Fugitive emissions of methane are assumed to be at the rates determined in Table 3.10 and to persist for the period of well flowback, production test and production.

The determination of greenhouse gas emissions is confined to consideration of releases of carbon dioxide, methane and nitrous oxide. Other gases with significantly higher global warming potentials (e.g. sulphur hexafluoride (SF_6), hydroflurocarbons (HFCs) and perfluorocarbons (PFCs)) are not generally considered to be generated in significant concentrations from diesel combustion and emission factors for these gases are not readily available.

Table 4.14 Greenhouse gas releases

Phase		**Release rate (kg/h)**[a]		
		CO_2	**CH_4**	**N_2O**
Workover	Well logging	185	0.10	0.030
	Setting upper completions	185	0.10	0.030
	Operating frack sleeves	275	0.15	0.049
	Vehicle movements	9.4	0.01	0.001
Hydraulic fracture stimulation and well test	Performing fracture	2668	1.47	0.480
	Well clean up	1289	0.71	0.230
	Setting bridge plugs	275	0.15	0.050
	Final well clean up	1289	0.71	0.230
	Lifting well	1314	0.72	0.240
	Flowback well	767	1.06	0.140
	Vehicle movements	18.4	0.03	0.002
Production test	Production test	0	0.64	0
	Vehicle movements	0.38	0.0005	0.00004
Production	Production	0	0.64	0
Restoration	Restoration	78	0.09	0.004

a. release rate is the mean release rate per hour for the expected duration of the operational phase.

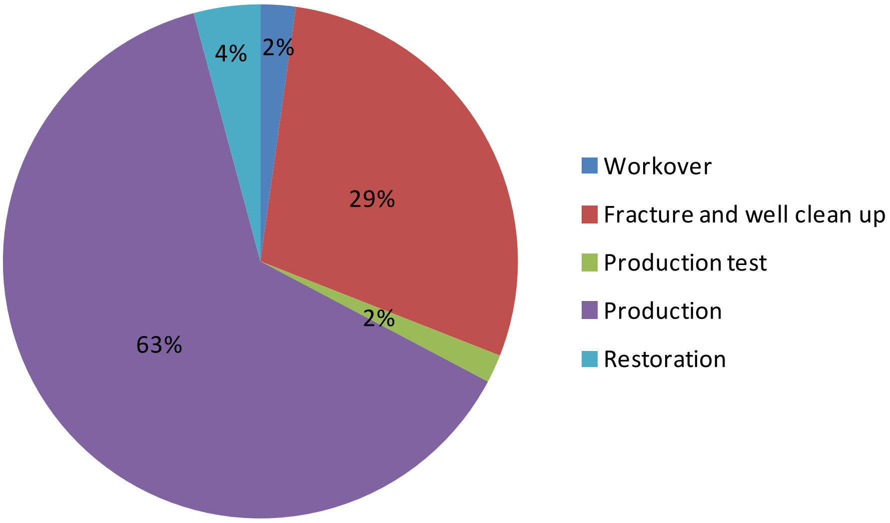
Table 4.15 Greenhouse gas inventory

Phase		**GHG release rate**[a] **$kgCO_2eq^{100}/h$**	**Phase duration h**	**Total GHG release t**	
Workover	Well logging	196.4	10	2.0	**37.0**
	Setting upper completions	196.4	8	1.6	
	Operating frack sleeves	293.3	108	31.7	
	Vehicle movements	9.9	88	1.8	
Hydraulic fracture stimulation and well test	Performing fracture	2847.7	20	57.0	**483.3**
	Well clean up	1375.2	192	264.0	
	Setting bridge plugs	293.7	120	35.2	
	Final well clean up	1375.2	48	66.0	
	Lifting well	1403.5	24	33.7	
	Flowback well	832.7	24	20.0	
	Vehicle movements	19.7	374	7.4	
Production test	Production test	13.4	2160	29.0	**29.9**
	Vehicle movements	0.4	2160	0.9	
Production	Production	13.4	78840	1059.6	**1059.6**
Restoration	Restoration	72.6	864	70.2	**70.2**
Wellsite operations				**1679.9**	

a. Methane and nitrous oxide are expressed as a CO_2 equivalent based on a 100 year time horizon (IPPC, 2007 – 1 kg CH_4 is equivalent to 21 kg CO_2 and 310 kg N_2O).

This assessment indicates a total greenhouse gas release over the period of wellsite operations of 1680 t CO_2 equivalent. The estimated greenhouse gas release during each phase is illustrated in Figure 4.1.

Figure 4.1 Greenhouse gas releases during wellsite operation



It is emphasised that due to the exploratory nature of the operations, the duration of each phase may well depart from that expected. A worst case estimate of greenhouse gas releases has been made based on:

- 14 days at a continuous GHG release rate consistent with the average release rate of the workover (i.e. 229 $kgCO_{2eq}/h$), excluding vehicle movements
- 42 days at a continuous GHG release rate consistent with the average release rate associated with fracturing and stimulation phase (i.e. 1355 $kgCO_{2eq}/h$) excluding vehicle movements
- 90 days at a continuous GHG release rate consistent with the average release rate associated with the production test phase (i.e. 14 $kgCO_{2eq}/h$)
- 3285 days at a continuous GHG release rate consistent with the average release rate associated with the production phase (i.e. 13 $kgCO_{2eq}/h$)
- 36 days at a continuous GHG release rate consistent with the average release rate associated with the restoration phase (i.e. 81 $kgCO_{2eq}/h$)

Vehicle movements are excluded from the determination of the average releases over the workover and fracture and stimulation phases as inclusion unrepresentatively reduces the calculated average.

This equates to a maximum release of 2602 tCO_2 equivalent.

It is therefore expected that the releases of greenhouse gases during all operations at the KMA wellsite including a subsequent 9 years' production will be around 1680 t CO_2 equivalent with a maximum upper estimate of 2602 tCO_2 equivalent.

5 CONCLUSIONS

A dispersion modelling assessment using the ADMS 5 model was employed to predict the impact on local air quality of discharges of important pollutants from well operations at the Kirby Misperton A (KMA) wellsite. All operating phases associated with the well workover, fracturing, subsequent clean up and demobilisation prior to production were considered with emphasis on releases from temporary operations equipment, largely stationary diesel engines, and fugitive emissions from the natural gas transmission system. The greenhouse gas inventory for the operation was also assessed.

Process contributions from engine releases to ground level concentrations of nitrogen dioxide and PM_{10} are expected to exceed short term air quality standards at the site boundary based on model predictions, although the extent of any exceedence is not clear due to the influence of temporary structures on the dispersion of low level engine exhaust releases.

At the nearest locations of permanent human habitation process contributions to ground level concentrations of carbon monoxide, sulphur dioxide, volatile organic compounds and PM_{10} are not considered to be likely to have any significant impact on air quality. Process contributions of nitrogen dioxide are more significant, although it is concluded that these are unlikely to pose a substantial threat to the continued attainment of air quality standards.

At the closest statutory designated nature conservation sites process contributions to ground level concentrations of sulphur dioxide and nitrogen dioxide are mostly below the level of significance and do not pose any substantial risk to attainment of the critical levels. Nutrient nitrogen and acid deposition associated with the process contributions at these locations are not considered to be significant in relation to corresponding critical loads.

Natural gas produced from the KMA wellsite is transported via pipeline to the nearby Knapton Generating Station. Fugitive releases of natural gas are expected from the on site gas transmission system. Based on leakage rates assessed by Third Energy the impact on local air quality of fugitive natural gas releases was assessed. The maximum process contribution to ground level concentrations of methane, ethane , propane and higher hydrocarbons (expressed as benzene) was predicted to be equivalent to no more than 8% of the estimated long term environmental benchmark at the site boundary falling to below 1% of these levels at the nearest residential locations. The long term process contribution to ground level concentrations of these compounds during both pre production and production phases of well operations is not considered to be significant based on Environment Agency assessment criteria.

The modelling assessment methodology and necessary assumptions provide a very conservative assessment of impact on air quality, particularly for nitrogen dioxide. The overall results and conclusions reached therefore incorporate a reasonable margin of comfort in spite of the inevitable uncertainty of such modelling studies.

It is concluded that the well operations will not affect the attainment of air quality standards around the areas of permanent human habitation closest to the wellsite and will have negligible impact at local statutory designated conservation sites. Exceedences in short term air quality standards for some pollutants are likely on occasions around the site boundary. No exceedence in air quality standards is indicated for the locations of temporary habitation in the Caravan Park and nearby Flamingo Land Theme Park.

Release of greenhouse gases during well operations are estimated to be around 1680 t CO_2 equivalent, based on the expected duration of the defined operational phases. Due to the inherent uncertainty of this type of project the duration of some phases may exceed initial expectations and as such an estimate of 2602 tCO_2 equivalent is provided as a maximum for the overall project.

6 REFERENCES

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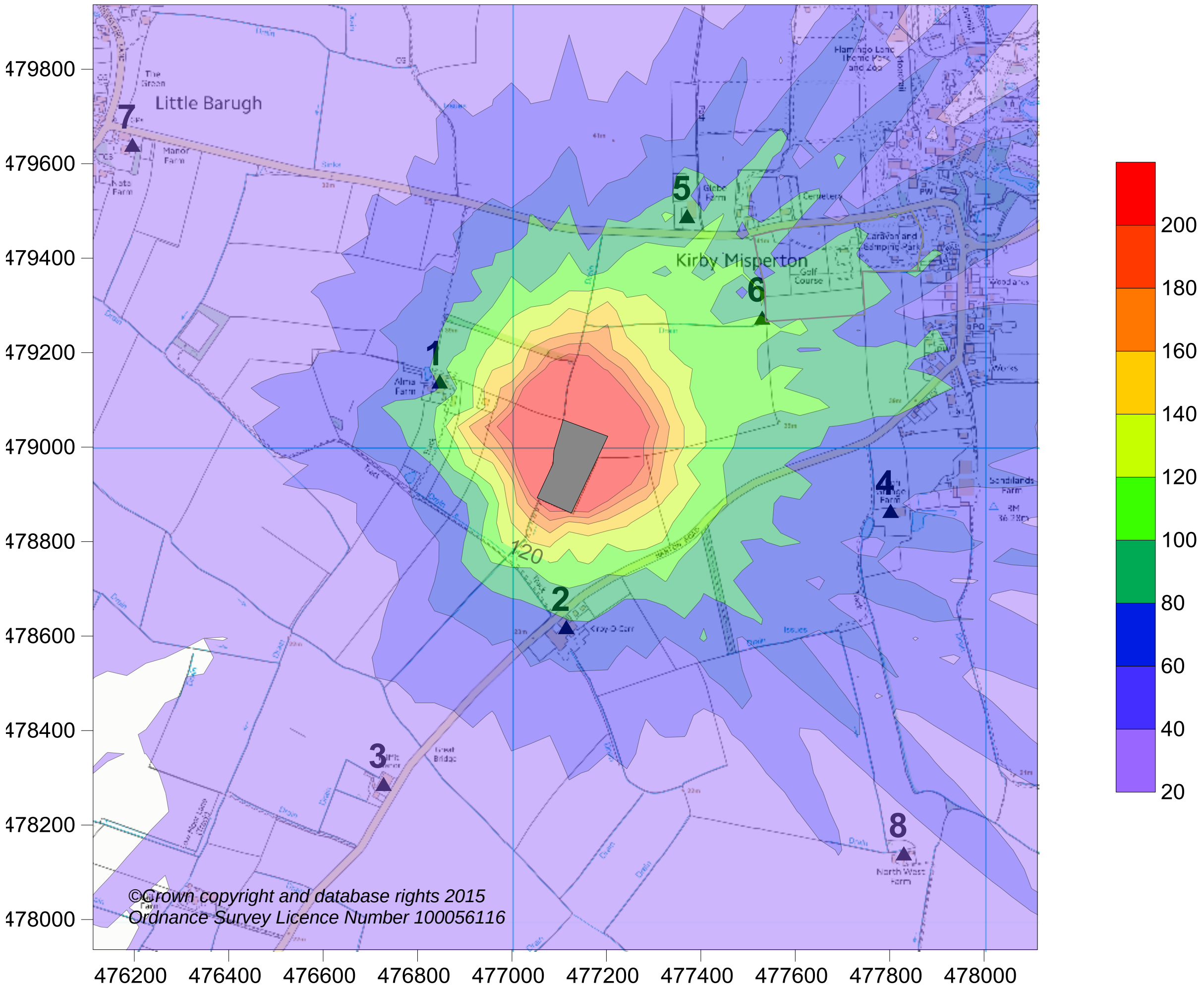
Annex A Dispersion model contour plots

The results of the modelling of the impact of the well operations on local ambient concentrations of important pollutants are presented in tabular form in Section 4. In Annex A these results are presented as contour plots of the process contribution to ambient concentrations. All results are presented as the maximum contribution of the process operation (excluding existing background concentrations) in µg/m^3, with the exception of carbon monoxide which is expressed as mg/m^3.

The following figures are presented:

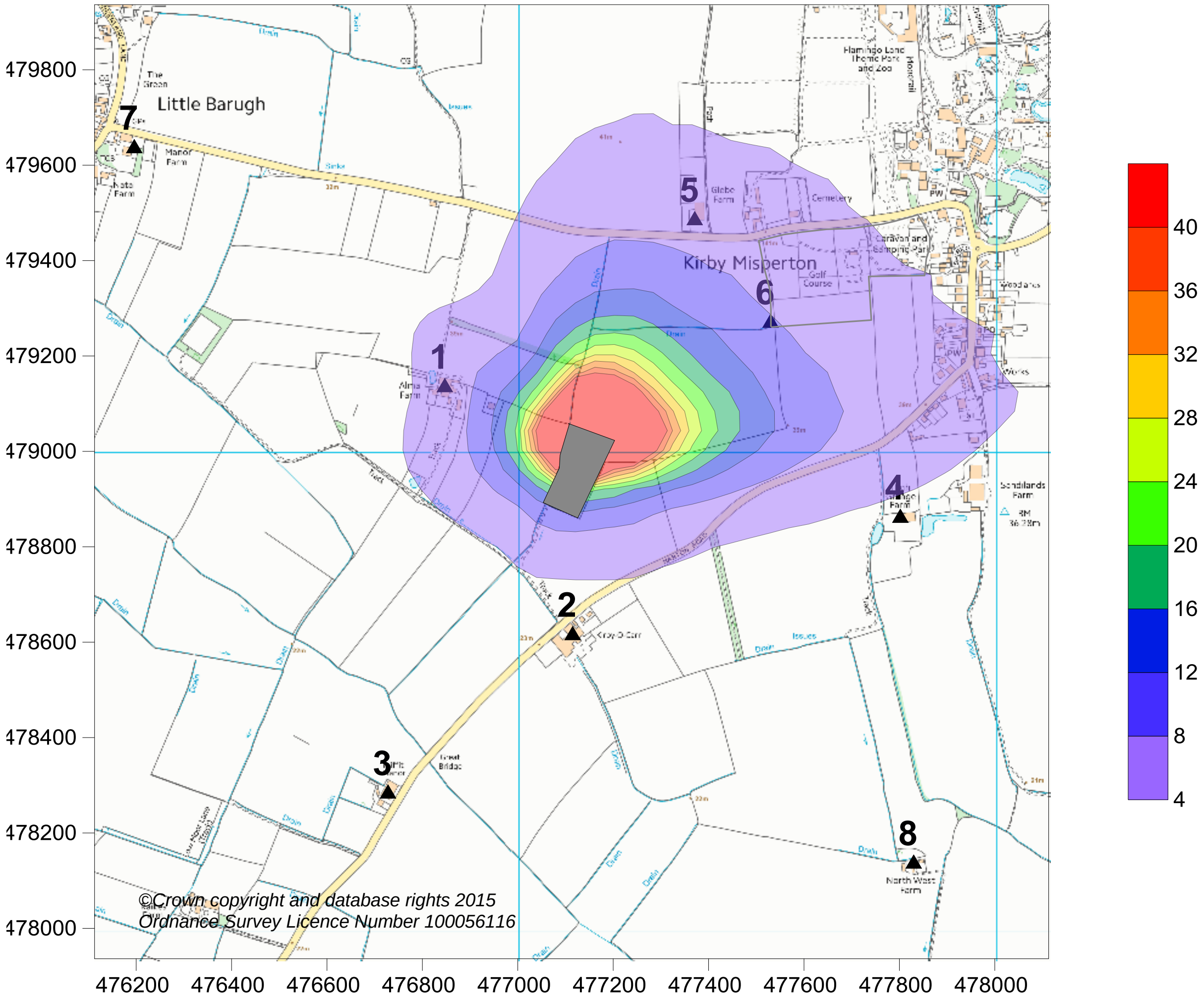
Figure 1	Predicted concentrations of nitrogen dioxide (99.8 percentile of 1 hour means) from stationary engine releases during well clean up operations
Figure 2	Predicted concentrations of nitrogen dioxide (annual mean) from stationary engine releases during well clean up operations
Figure 3	Predicted concentrations of carbon monoxide (maximum 8 hour rolling average) from stationary engine releases during well clean up operations
Figure 4	Predicted concentrations of PM_{10} (90.41 percentile of daily means) from stationary engine releases during well clean up operations
Figure 5	Predicted concentrations of sulphur dioxide (99.72 percentile of hourly means) from stationary engine releases during well clean up operations
Figure 6	Predicted concentrations of volatile organic compounds (annual mean) from stationary engine releases during well clean up operations
Figure 7	Predicted concentrations of methane from fugitive emissions (annual mean)

Figure A.1 Predicted concentrations of nitrogen dioxide (99.8 percentile of 1 hour means) from stationary engine releases during well clean up operations



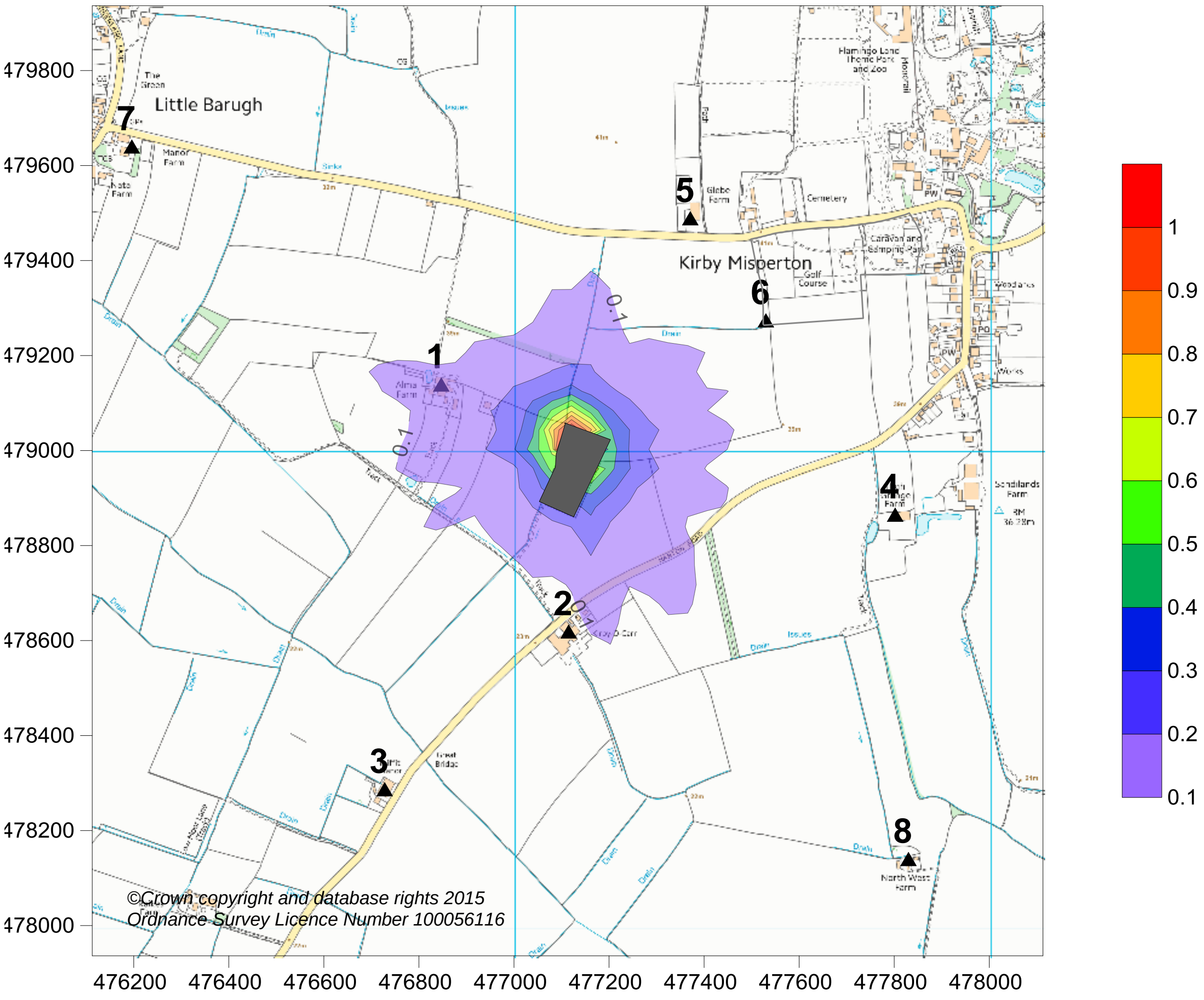
20 µg/m^3 is equivalent to 10% of the nitrogen dioxide short term air quality standard

Figure A.2 **Predicted concentrations of nitrogen dioxide (annual mean) from stationary engine releases during well clean up operations**



4 µg/m^3 is equivalent to 10% of the nitrogen dioxide long term air quality standard

Figure A.3 **Predicted concentrations of carbon monoxide (maximum 8 hour rolling average) from stationary engine releases during well clean up operations**



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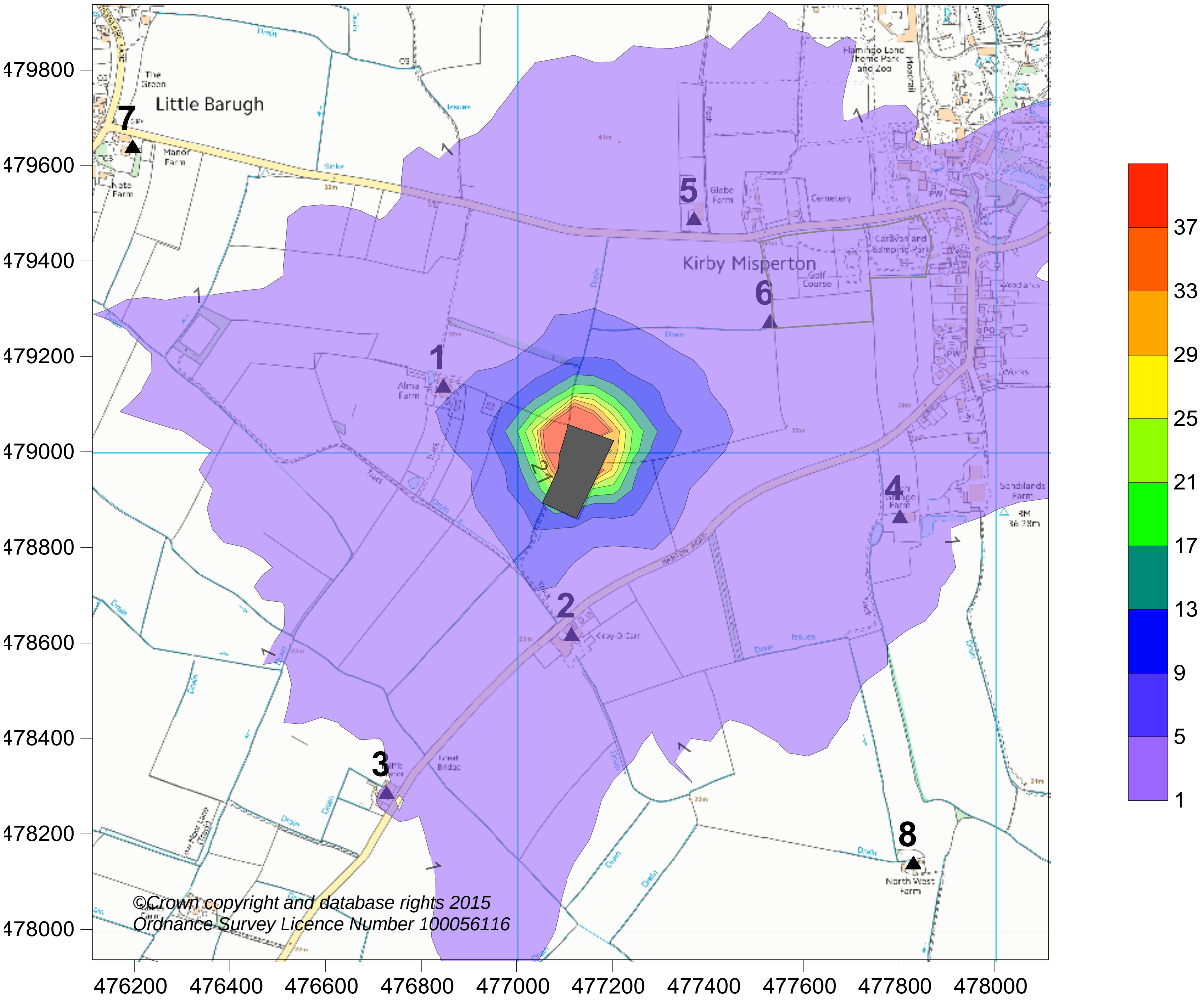
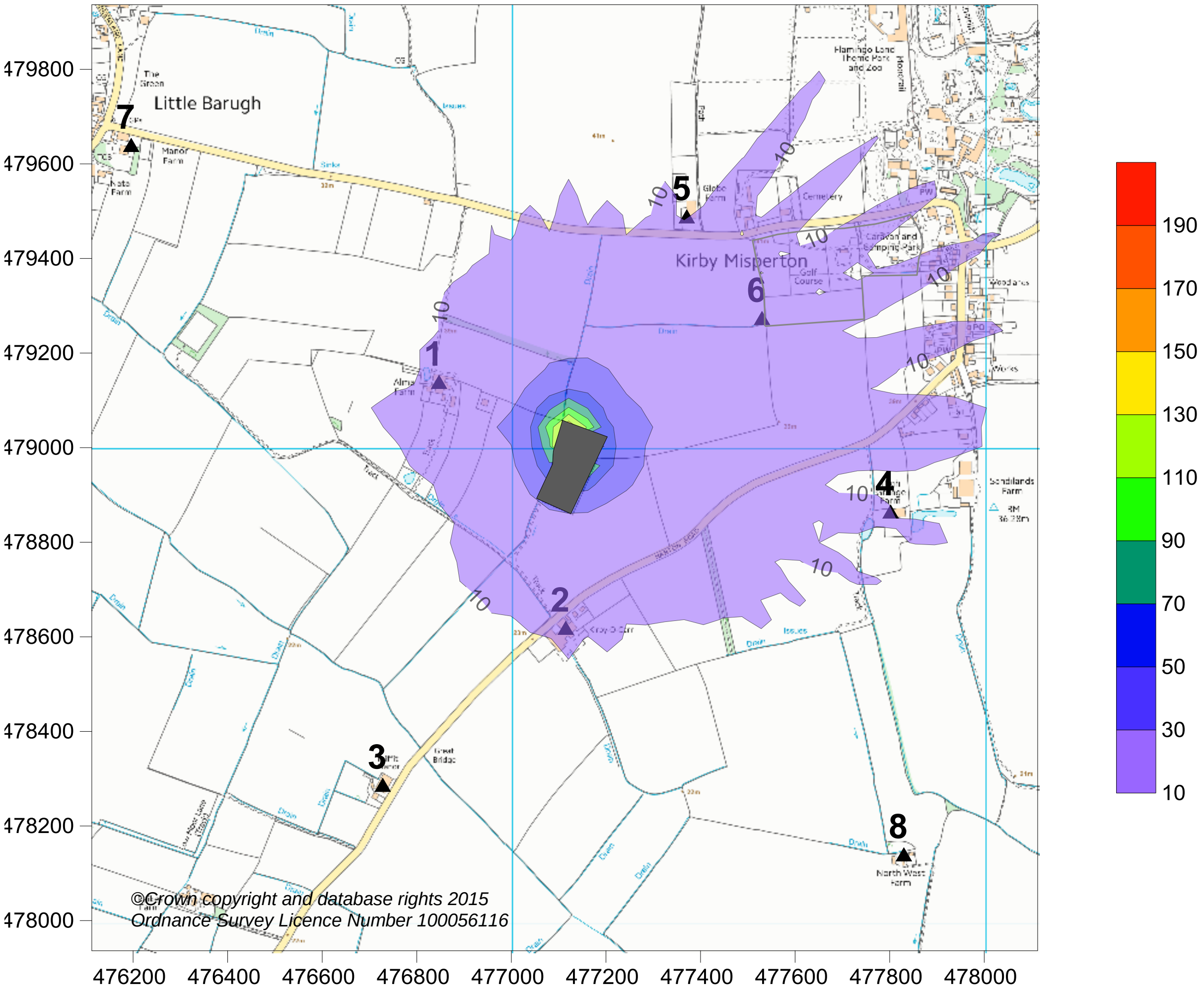
0.1 mg/m^3 is equivalent to 1% of the carbon monoxide short term air quality standard

Figure A.4 Predicted concentrations of PM_{10} (90.41 percentile of daily means) from stationary engine releases during well clean up operations



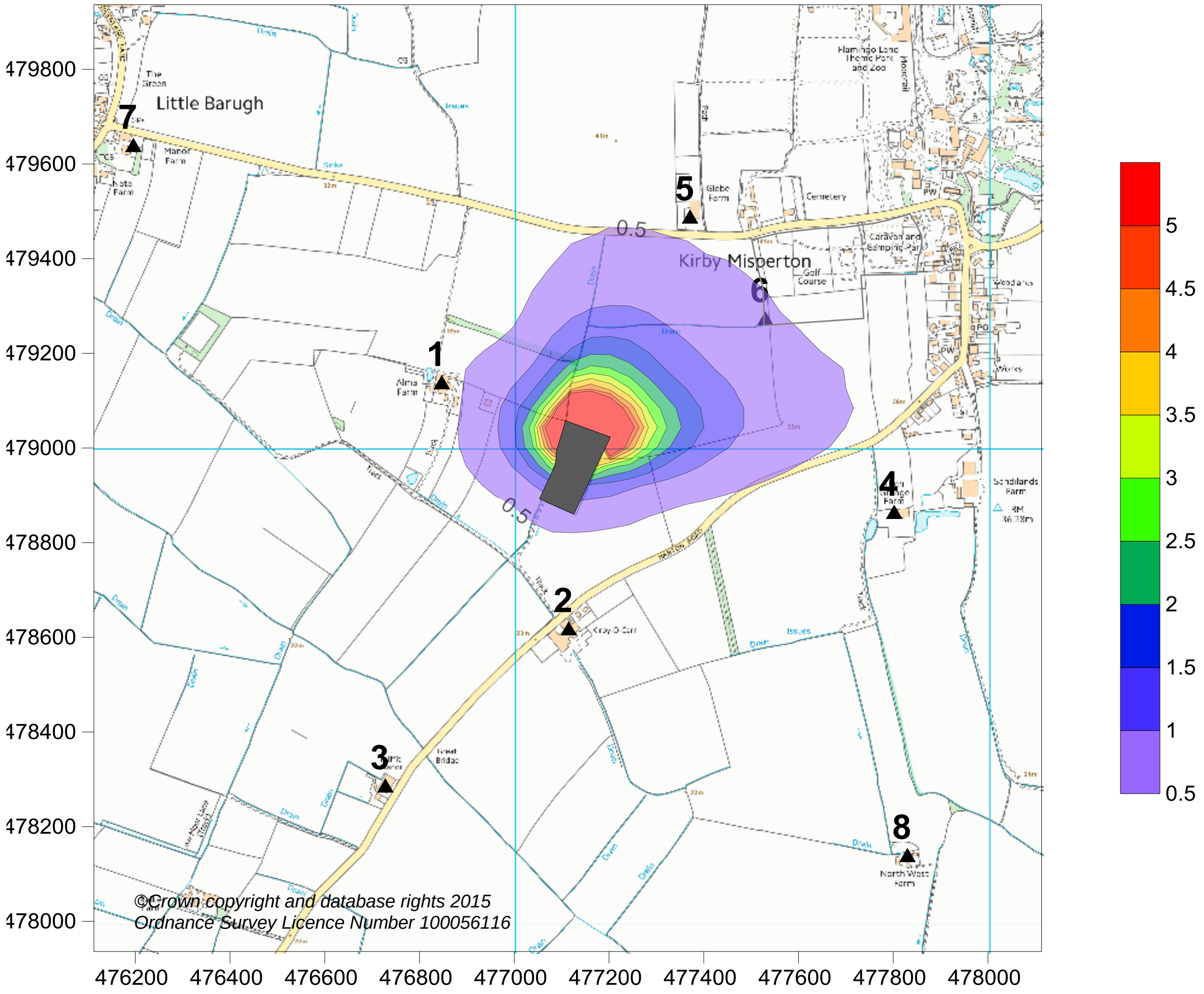
1 µg/m^3 is equivalent to 2% of the PM_{10} short term air quality standard

Figure A.5 **Predicted concentrations of sulphur dioxide (99.72 percentile of hourly means) from stationary engine releases during well clean up operations**



10 µg/m^3 is equivalent to around 3% of the sulphur dioxide hourly air quality standard

Figure A.6 **Predicted concentrations of volatile organic compounds (annual mean) from stationary engine releases during well clean up operations**



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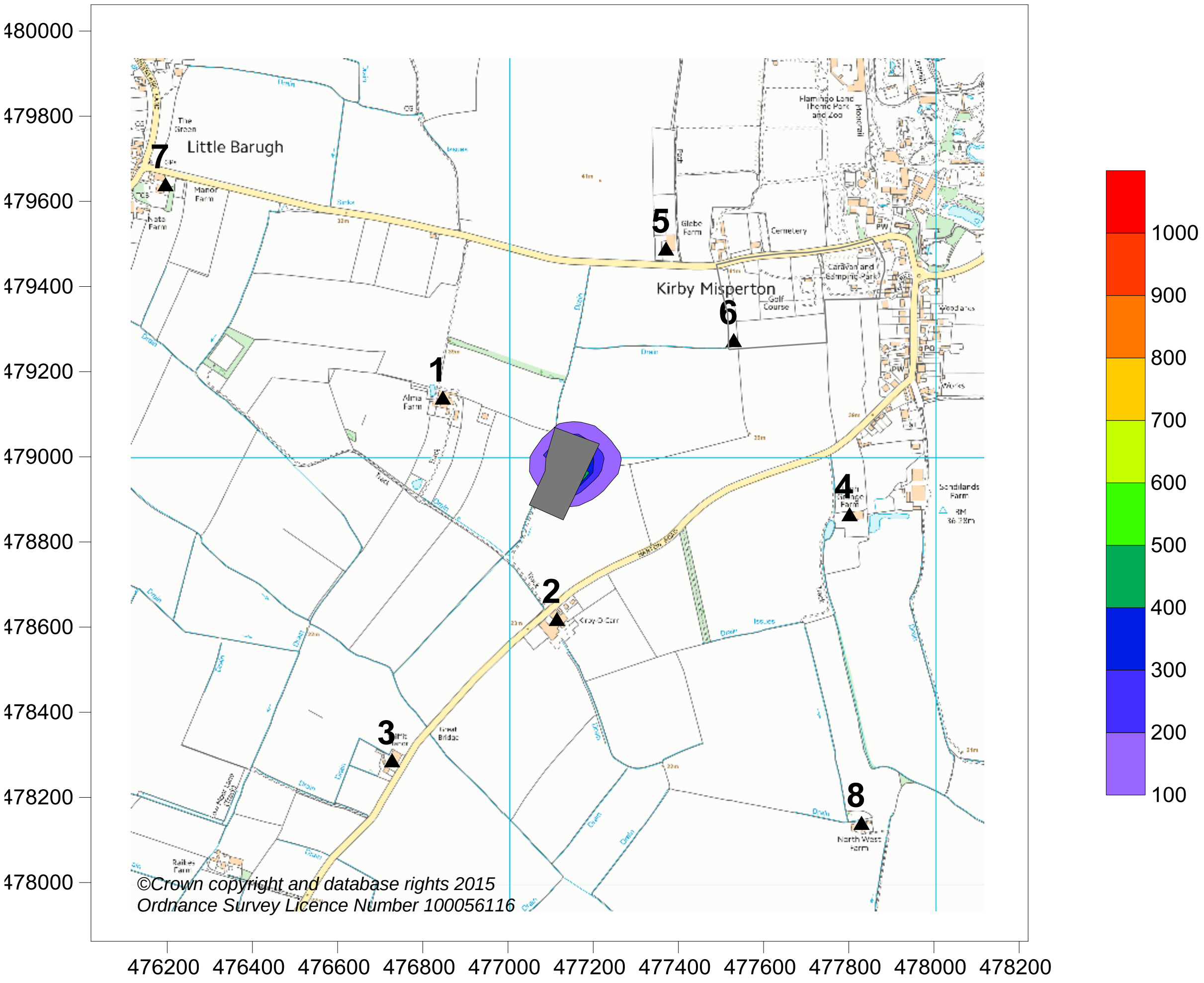
0.5 µg/m^3 is equivalent to around 10% of the benzene long term air quality standard

Figure A.7 **Predicted concentrations of methane (annual mean)**
Fugitive releases



100 µg/m^3 is equivalent to 1.4% of the long term environmental assessment level for methane

ANNEX B Modelling files

The ADMS modelling files detailing the model input for the runs providing maximum hourly mean concentrations have been provided under separate cover and are summarised below:

Operating phase	**Year**	**File Name**
Well logging	2012	KM8 WL 2012.APL
Setting upper completions		Same as well logging
Operating frack sleeves		KM8 OFS 2012.APL
Vehicle movements		KM8 VM 2012.APL
Performing fracture		KM8 PF 2012.APL
Well clean up (between zone fractures)		KM8 WCU 2012.APL
Setting bridge plugs		Same as operating frack sleeves
Final well clean up		Same as well clean up
Lifting the well		KM8 LTW 2012.APL
Flowback well		KM8 FBW 2012
Restoration		KM8 SR 2012.APL
Fugitive releases		KM8 FUG 2012.APL

END OF REPORT

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APPENDIX 8 – SITE LAYOUT PLAN

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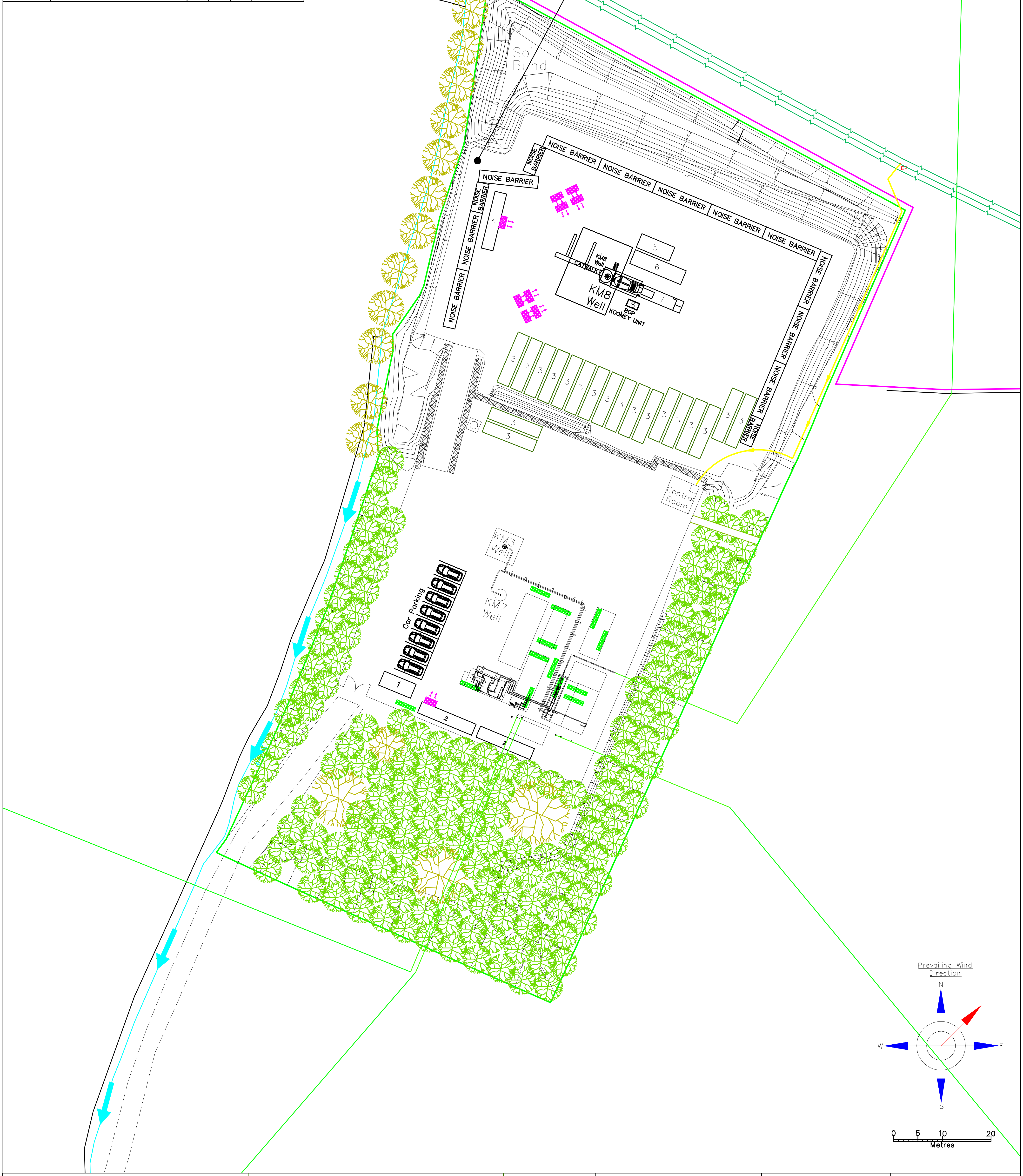
PRE–STIMULATION WORKOVER PHASE					
EQUIPMENT#	EQUIPMENT DESCRIPTION	DIMENSIONS			WEIGHT
		L	W	H	
WELLSITE ACCOMMODATION DESCRIPTION					
1	SECURITY CABIN	7.0	3.0	2.8	TBC
2	OFFICE ACCOMMODATION	12.00	2.44	3.2	TBC
WORKOVER EQUIPMENT DESCRIPTION					
3	ROADABLE TANKS	11.16	2.5	3.99	12,000 Kgs
4	TOOLPUSHER ACCOM/WORKSHOP	12.00	2.44	3.2	TBC
5	CIRCULATING TANK	7.32	3.05	2.0	TBC
6	FLUID PUMP TRUCK	11.28	3.05	3.0	TBC
7	WORKOVER RIG	17.5	2.54	37.0	TBC
8	BOP KOOMEY UNIT	2.5	1.5	2.0	TBC

The proposed development phases 1 to 4 (pre–stimulation workover, hydraulic fracture stimulation/well test, production test and production) do not propose any alterations to the construction, landscaping or boundary treament of the KMA wellsite.



Key:

- 🟩 Site Boundary
- Water Features (Ponds, Drains)
- Water Features Direction of Flow
- Public Rights of Way
- Overhead Electricity Cables
- Burried Electricity Cables
- Underground Pipelines
- Existing Wellsite Landscaping

Lighting Specification Details:

- ▨ EX Linear Fluorescent Lamp (2 x 36W)
- ▨ 2 X Portable Lighting Towers (4 x 1000W Metal Halide)
- ▨ EX Floodlight 400W

N

PSSL
Petroleum Safety Services Limited

Petroleum Safety Services Limited
23a Milton Street
Saltburn by the Sea
TS12 1DJ

Client: Third Energy UK Gas Ltd

Project: KM8 Hydraulic Fracturing Operation

Drawing Title: KM8 Pre-Stimulation Workover Layout Plan

Scale: 1:750 (Print A3)

Drawn By: Jonathan Foster

Date Drawn: 11/08/2015

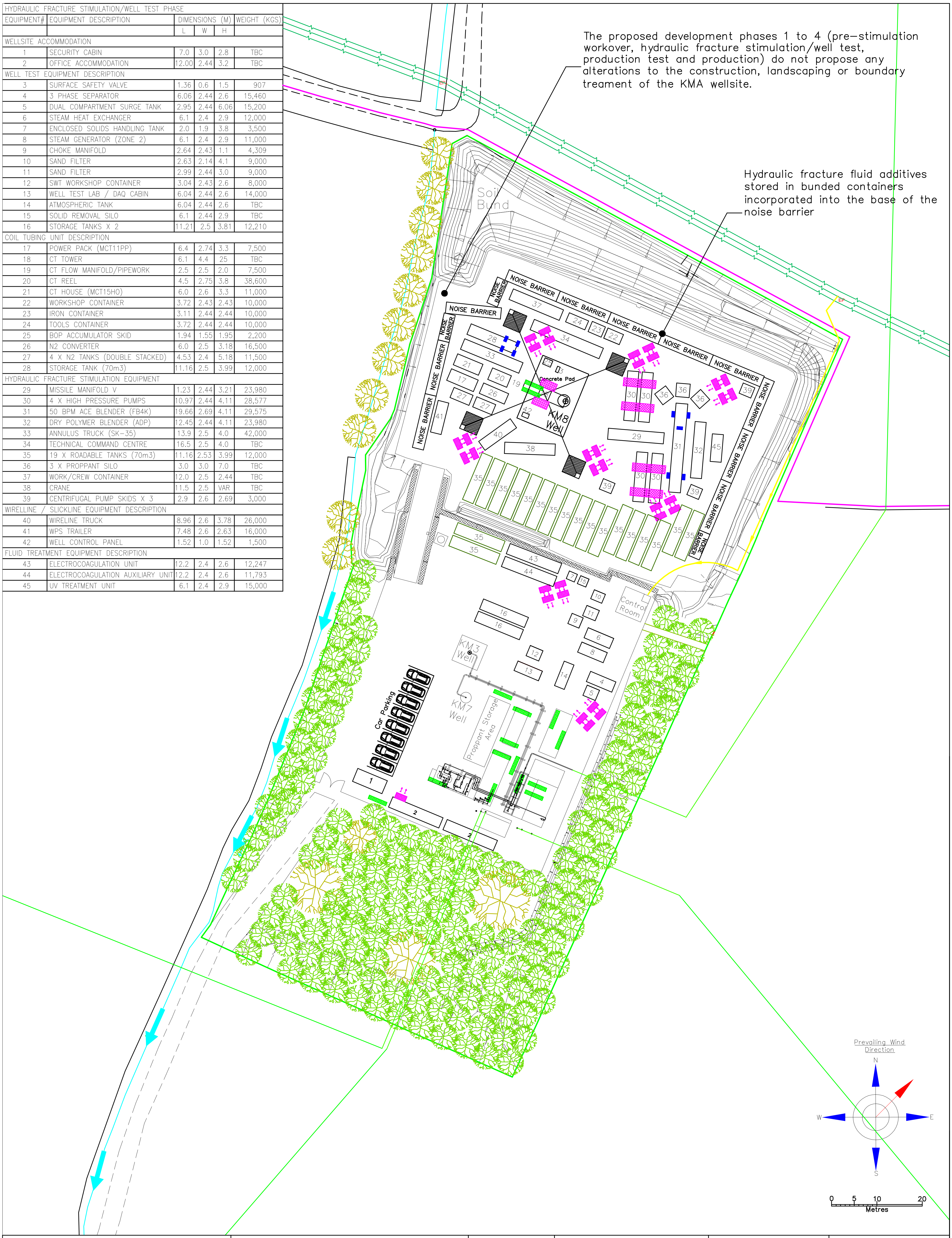
Approved By: Jonathan Foster

Date Approved: 11/08/2015

Drawing No: TE-EPRA-KM8-HFS-SP-09-01

Rev: 0

HYDRAULIC FRACTURE STIMULATION/WELL TEST PHASE					
EQUIPMENT#	EQUIPMENT DESCRIPTION	DIMENSIONS (M)			WEIGHT (KGS)
		L	W	H	
WELLSITE ACCOMMODATION					
1	SECURITY CABIN	7.0	3.0	2.8	TBC
2	OFFICE ACCOMMODATION	12.00	2.44	3.2	TBC
WELL TEST EQUIPMENT DESCRIPTION					
3	SURFACE SAFETY VALVE	1.36	0.6	1.5	907
4	3 PHASE SEPARATOR	6.06	2.44	2.6	15,460
5	DUAL COMPARTMENT SURGE TANK	2.95	2.44	6.06	15,200
6	STEAM HEAT EXCHANGER	6.1	2.4	2.9	12,000
7	ENCLOSED SOLIDS HANDLING TANK	2.0	1.9	3.8	3,500
8	STEAM GENERATOR (ZONE 2)	6.1	2.4	2.9	11,000
9	CHOKE MANIFOLD	2.64	2.43	1.1	4,309
10	SAND FILTER	2.63	2.14	4.1	9,000
11	SAND FILTER	2.99	2.44	3.0	9,000
12	SWT WORKSHOP CONTAINER	3.04	2.43	2.6	8,000
13	WELL TEST LAB / DAQ CABIN	6.04	2.44	2.6	14,000
14	ATMOSPHERIC TANK	6.04	2.44	2.6	TBC
15	SOLID REMOVAL SILO	6.1	2.44	2.9	TBC
16	STORAGE TANKS X 2	11.21	2.5	3.81	12,210
COIL TUBING UNIT DESCRIPTION					
17	POWER PACK (MCT11PP)	6.4	2.74	3.3	7,500
18	CT TOWER	6.1	4.4	25	TBC
19	CT FLOW MANIFOLD/PIPEWORK	2.5	2.5	2.0	7,500
20	CT REEL	4.5	2.75	3.8	38,600
21	CT HOUSE (MCT15HO)	6.0	2.6	3.3	11,000
22	WORKSHOP CONTAINER	3.72	2.43	2.43	10,000
23	IRON CONTAINER	3.11	2.44	2.44	10,000
24	TOOLS CONTAINER	3.72	2.44	2.44	10,000
25	BOP ACCUMULATOR SKID	1.94	1.55	1.95	2,200
26	N2 CONVERTER	6.0	2.5	3.18	16,500
27	4 X N2 TANKS (DOUBLE STACKED)	4.53	2.4	5.18	11,500
28	STORAGE TANK (70m3)	11.16	2.5	3.99	12,000
HYDRAULIC FRACTURE STIMULATION EQUIPMENT					
29	MISSILE MANIFOLD V	1.23	2.44	3.21	23,980
30	4 X HIGH PRESSURE PUMPS	10.97	2.44	4.11	28,577
31	50 BPM ACE BLENDER (FB4K)	19.66	2.69	4.11	29,575
32	DRY POLYMER BLENDER (ADP)	12.45	2.44	4.11	23,980
33	ANNULUS TRUCK (SK-35)	13.9	2.5	4.0	42,000
34	TECHNICAL COMMAND CENTRE	16.5	2.5	4.0	TBC
35	19 X ROADABLE TANKS (70m3)	11.16	2.53	3.99	12,000
36	3 X PROPPANT SILO	3.0	3.0	7.0	TBC
37	WORK/CREW CONTAINER	12.0	2.5	2.44	TBC
38	CRANE	11.5	2.5	VAR	TBC
39	CENTRIFUGAL PUMP SKIDS X 3	2.9	2.6	2.69	3,000
WIRELLINE / SLICKLINE EQUIPMENT DESCRIPTION					
40	WIRELINE TRUCK	8.96	2.6	3.78	26,000
41	WPS TRAILER	7.48	2.6	2.63	16,000
42	WELL CONTROL PANEL	1.52	1.0	1.52	1,500
FLUID TREATMENT EQUIPMENT DESCRIPTION					
43	ELECTROCOAGULATION UNIT	12.2	2.4	2.6	12,247
44	ELECTROCOAGULATION AUXILIARY UNIT	12.2	2.4	2.6	11,793
45	UV TREATMENT UNIT	6.1	2.4	2.9	15,000



The proposed development phases 1 to 4 (pre-stimulation workover, hydraulic fracture stimulation/well test, production test and production) do not propose any alterations to the construction, landscaping or boundary treament of the KMA wellsite.

Hydraulic fracture fluid additives stored in bunded containers incorporated into the base of the noise barrier

Key:

☐	Site Boundary
—	Water Features (Ponds, Drains)
←	Water Features Direction of Flow
—	Public Rights of Way
—	Overhead Electricity Cables
—	Burried Electricity Cables
—	Underground Pipelines
●	Existing Wellsite Landscaping

Lighting Specification Details:

🟩	EX Linear Fluorescent Lamp (2 x 36W)
▨	8 X Portable Lighting Towers (4 x 1000W Metal Halide)
▨	EX Floodlight 400W
▨	150W Tungsten Halogen Light

N

PSSL
Petroleum Safety Services Limited

Petroleum Safety Services Limited
23a Milton Street
Saltburn by the sea
TS12 1DJ

Client:
Third Energy UK Gas Ltd

Project:
KM8 Hydraulic Fracturing Operation

Drawing Title:
KM8 Hydraulic Fracture / Well Test Layout Plan

Scale: 1:750 (Print A3)

Drawn By:
Jonathan Foster

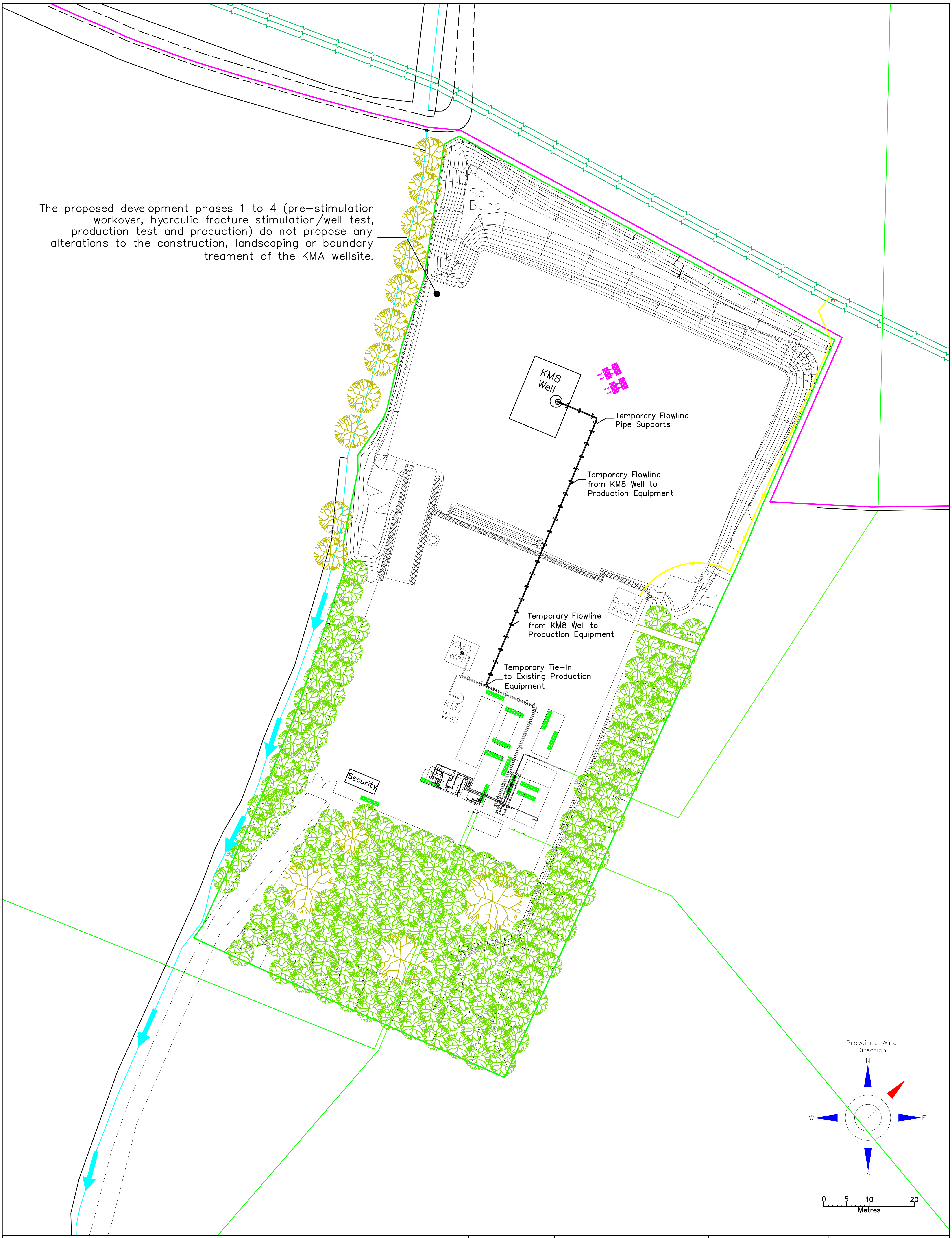
Date Drawn: 11/08/2015

Approved By:
Jonathan Foster

Date Approved: 11/08/2015

Drawing No:
TE-EPRA-KM8-HFS-SP-09-02

Rev: 0



Key:

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- Public Rights of Way
- Overhead Electricity Cables
- Burried Electricity Cables
- Underground Pipelines
- Existing Wellsite Landscaping

Lighting Specification Details:

- ▨ EX Linear Fluorescent Lamp (2 x 36W)
- 🟥 1 X Portable Lighting Tower (4 x 1000W Metal Halide)

N

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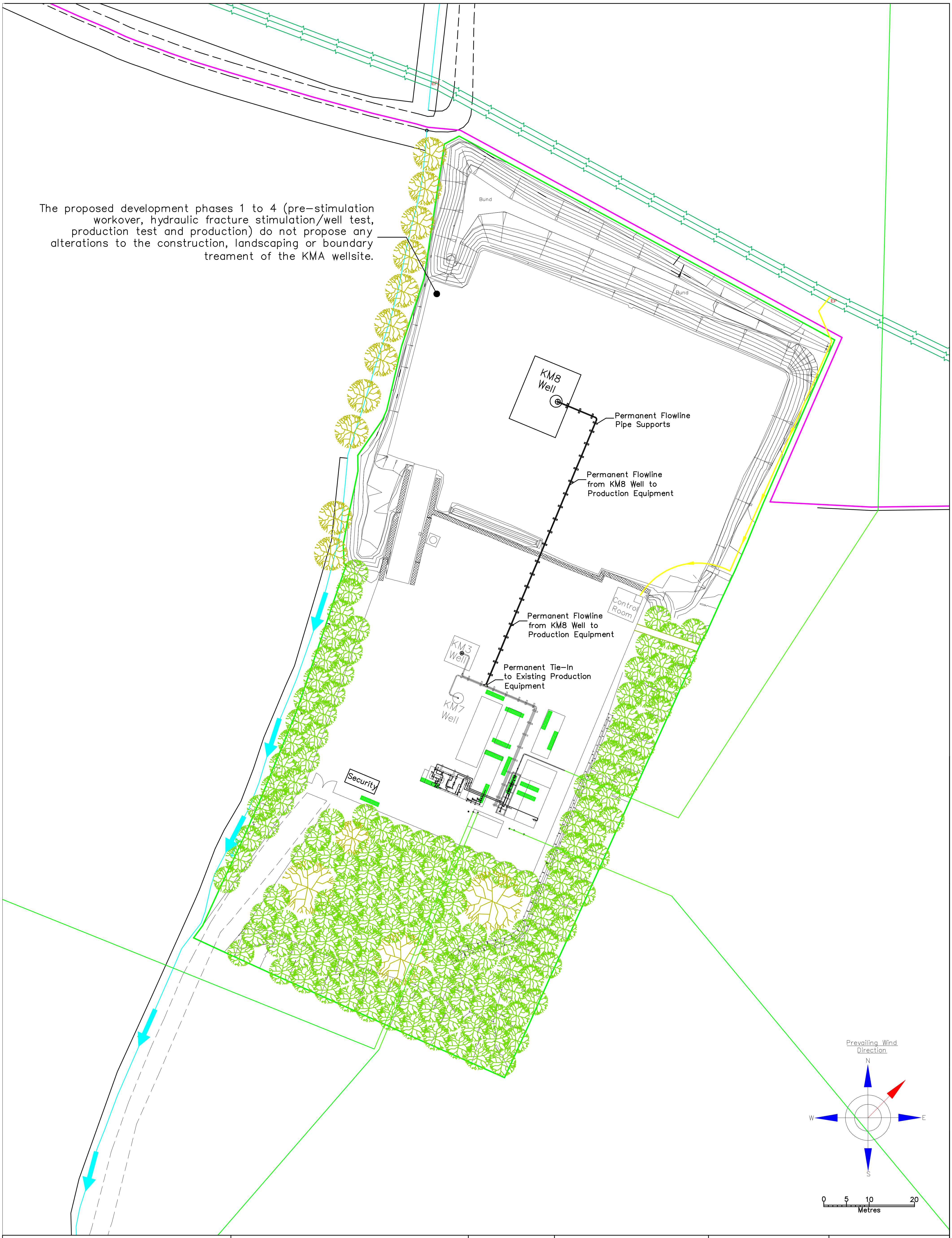
23a Milton Street
Saltburn by the Sea
TS12 1DJ

Client: Third Energy UK Gas Ltd	**Drawn By:** Jonathan Foster **Date Drawn:** 11/08/2015
Project: KM8 Hydraulic Fracturing Operation	**Approved By:** Jonathan Foster **Date Approved:** 11/08/2015
Drawing Title: KM8 Production Test Layout Plan	**Drawing No:** TE-EPRA-KM8-HFS-SP-09-03
Scale: 1:750 (Print A3)	**Rev:** 0



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- 🟩 Site Boundary
- — Water Features (Ponds, Drains)
- ← Water Features Direction of Flow
- — Public Rights of Way
- — Overhead Electricity Cables
- — Burried Electricity Cables
- — Underground Pipelines
- ● Existing Wellsite Landscaping

Lighting Specification Details:

▨ EX Linear Fluorescent Lamp (2 x 36W)

N

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Client:
Third Energy UK Gas Ltd

Project:
KM8 Hydraulic Fracturing Operation

Drawing Title:
KM8 Production Layout Plan

Scale: 1:750 (Print A3)

Drawn By:
Jonathan Foster

Date Drawn: 11/08/2015

Approved By:
Jonathan Foster

Date Approved: 11/08/2015

Drawing No:
TE-EPRA-KM8-HFS-SP-09-04

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