Planning Application:

Ballinlea E/2013/0093/F – Construction of an exploratory borehole to a depth of approximately 2700m including conventional exploratory testing to evaluate the potential hydrocarbon reserve in the Rathlin Basin under DETI license pl 3/10 issued to Rathlin Energy Ltd. Site preparation comprising ground works and ancillary operations to include: road widening of part of the Kilmahamogue Road, parking, offices and workshops, earth bunding, flood lighting, wheelwash, storage area, security fence and site restoration on lands at 49 Ballinlea Road, Ballycastle for Rathlin Energy Ltd.

Review of Hydrological & Hydrogeological ES Information

Consultant Review

From: Conor Lydon, WYG Principal Hydrogeologist, 27th March 2015

Consultant Review

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Planning Application Reference: E/2013/0093/F

Ballinlea 2 – drilling exploratory borehole to approximately 2,700m depth to investigate underground strata for hydrocarbon exploration

It is our view that this application has the potential to result in significant environmental impact, and that certain risks have not been addressed by the Environmental Statement. We have outlined a number of concerns in relation to the application below, in particular areas where there is insufficient detail provided, which we urge Planning Service and its Consultees to consider.

The following outlines our initial comments in relation to our review of selected Environmental Statement (ES) chapters Volume I, II and III prepared in support of the above application. The following reference documents have reviewed in preparation of this response:

- Ballinlea 2, Non Technical Summary, December 2014;
- Volume I, ES Ballinlea 2, December 2014
  - Chapter 1 (Introduction);
  - Chapter 2 (Project Description);
  - Chapter 3 (Alternatives Version);
  - Chapter 4 (Scoping & Consultation);
  - Chapter 10 (Water Quality & Hydrogeology);
  - Chapter 11 (Waste);
  - Chapter 13 (Traffic and Transportation);
  - Chapter 14 (Public Health);
  - Chapter 17 (Interactions);
- Volume II, ES Ballinlea 2 Figures, December 2014
  - Figure 2.1 (Site Location);
  - Figure 6.35 Restoration Plan;
  - Figure 9.1 Designations;
  - IBH0366 0000 Existing Survey;
  - IBH0366 1010 Proposed Layout;
  - IBH0366 1050 Construction Makeup;
  - IBH0366 1060 Existing & Proposed Storm Drainage;
  - IBM0397-PL-100_Rev_B;
  - IBM0397-PL-101_Rev_C;
  - IBM0397-PL-102_Rev_C;
  - IBM0397-PL-103_Rev_C;
  - IBM0397-PL-104_Rev_C;
  - IBM0397-PL-105_Rev_C;
  - IBM0397-PL-106_Rev_C;
  - IBM0397-PL-107_Rev_C;
- Volume III, ES Ballinlea 2 Appendices, December 2014

Appendix 2.1 Relevant Standards

Appendix 2.2 Drilling Rig Spec KCA Deutag T-61
Appendix 2.3 Chemical Inventory
Appendix 2.5 Outline CEMP
Appendix 4.1 Request for Additional Information;
Appendix 4.2 EIA Determination and Acceptance;
Appendix 4.4 Summary of Consultation;
Appendix 10.1 Correspondence to November 2014;
Appendix 10.2 GSI Report;

Non Technical Summary;

NTS (p6) - The ES states that the Carboniferous sandstone is the target reservoir. This is re-iterated in Section 2.5.2. Despite this, the exploratory borehole will be drilled to a depth of up to 2,700m. The general geological succession in this area of Antrim is included in Appendix 10.2 (repeated as Figure 11.5 in Chapter 11) and is summarised in Section 10.4.2.3. The information provided suggests that the Carboniferous Millstone Grits will be the target sandstone reservoir (appears at depths of between 1,950 and 2,450m). The Carboniferous Millstone Grits are understood to consist of massive sandstone horizons separated by intervening mudstones and shales [1]. The description of the target geology stratigraphy is very limited and no information is provided in terms of its structural geology.

There is insufficient information presented as part of the ES to reach a conclusion on all of the risks to the water environment or human health. It is requested that DOE Planning seek further assessment information in respect of the target reservoir and surrounding units; namely interpretation of any seismic results; likelihood of a structural trap being present; a detailed description of the expected reservoir hydraulic properties; details of any uncertainties in relation to the reservoir geology; details of any expected seals based on seismic results.

NTS (p2) – It is proposed that the works will involve the drilling and setting of surface conductor casing to a depth of approximately 200m. The predicted depth of exploitable water formations (upper aquifers) is between ground level and 191.5m (based on Ballinlea 1) and the GSNI's predicted geology for Ballinlea 2 (Appendix 10.2).

NTS (p18) - Ballinlea 1 exploratory borehole observed Ulster White Limestone between 140.0m and 191.5m (Hibernian Greensands were absent).

We request that DOE Planning seek justification from the Applicant for the proposed 200m setting depth for the surface conductor casing. It is unclear whether the proposed installation depth is sufficient to ensure that the upper aquifers are completely sealed off. The proposed depth of 200m only allows for the installation of conductor casing circa

8.5m into the underlying Waterloo Mudstone; this is less than would typically be undertaken during standard water well construction.

Chapter 1 (Introduction);

No comment

Chapter 2 (Project Description);

2.3 Project Description – The project description clearly states that the proposed exploratory well will be to test the prospect for commercial quantities of petroleum. Given the target reservoir will be the Carboniferous Millstone Grits the works would be considered as Conventional Exploratory Testing. It is however noted that the description of the general geological succession in this area of Antrim included in Appendix 10.2 (repeated as Figure 11.5 in Chapter 11) describes the target reservoir as having coal, clay and tight sandstones and siltstones. Insufficient detail has been provided as part of the ES to support the statement that the target reservoir is in fact a conventional reservoir. The description of the Carboniferous Millstone Grits, suggest that the deposits are likely to be of very low permeability and it is unclear whether additional information, such as a review of the seismic stratigraphy or data from other exploratory wells drilled into the same deposits, has been examined to arrive at the conclusion that conventional oil or gas can flow freely from these units.

Appendix 10.1 Extract from the General Geological Succession provided below for ease of reference:

- *1950 – 2450m Carboniferous Wesphalian Coal Measures and Millstone Grits consisting of units of coal, clay and tight sandstones and siltstones. The coal are potential sources of hydrocarbons, especially gas.*
- *2450 – base Carboniferous Visean Murlough Bay Formation is the equivalent to the Bowland Shale and is a possible source rock for the region. It is a potential target for shale gas development in the region.*

Insufficient evidence has been presented by the applicant to demonstrate that the target reservoir is in fact a conventional reservoir and instead the geological descriptions provided suggest that the Carboniferous Wesphalian Coal Measures and Millstone Grits constitute an unconventional reservoir. This has potentially significant consequences not least in terms of the much larger volumes of water required to test unconventional units.

There is insufficient information presented as part of the ES to permit adequate characterisation of the target reservoir as conventional; as opposed to unconventional. It is requested that DOE Planning seek further assessment information in respect of the target reservoir and surrounding units; namely interpretation of any seismic results; likelihood of a structural trap being present; a detailed description of the expected

reservoir hydraulic properties; details of any uncertainties in relation to the reservoir geology; details of any expected seals based on seismic results. Clarification is required on what deposits within the Millstone Grits will be targeted.

2.4.10 Fuels, Lubricants and Chemicals – It is unclear what fuels and lubricants will be used during the construction phase and stored in portable bunded containers on the site. In order to characterise the risk of potential spills it is important to understand the likely volume and nature of these fuels and lubricants. In accordance with the European Registration, Evaluation, Authorisation & restriction of CHemicals (REACH) regulations there is a requirement to disclose the composition of all fluids and present a risk assessment.

The ES contains insufficient information in respect of what fuels and lubricants will be stored on site during the construction stage. It is requested that DOE Planning seek further information in this regard.

2.5.2 Drilling Operation – Conflicting information is presented between Chapter 2 and subsequent chapters in relation to the expected drilling phase duration. Chapter 2, Section 2.5.2 suggests drilling operations (excluding mobilisation and demobilisation) will be completed within 9 - 12 weeks, dependent on progress of drilling through the different rock formations. Section 2.5.1 states that mobilisation and demobilisation of drilling rigs will take a combined duration of 4 weeks. The above information appears to suggest that the total drilling works may take 13 - 16 weeks. Chapter 2, Table 2.6 assumes a 10 week drilling programme consisting of a 6 week drilling programme and a further 4 weeks associated with mobilisation and demobilisation. Chapter 10 (p19) suggests that the total drilling phase could be between 8- 13 weeks: *"the duration of activities are estimated to be five to ten weeks for the well drilling with an additional two weeks mobilisation and one week demobilisation."*

We request that DOE Planning seek clarification on what the drilling works duration is expected to be as it has a significant bearing on the likely volumes of water required.

2.5.4 Drilling Muds and Water - The ES states that the following water volumes will be required during the drilling process:

(a) Initial requirements - c. 20,000 m^3

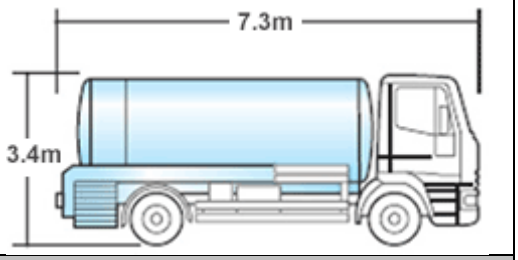
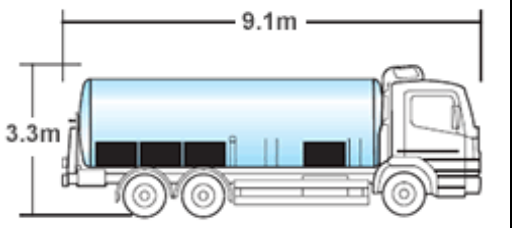
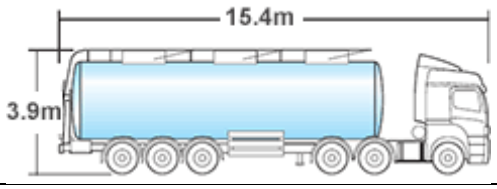
(b) Daily operations - c. 10,000 m^3

(c) Potable water - c. 1,000 m^3 per week

Despite the conflicting information in terms of the drilling works duration we have completed some preliminary calculations based on a drilling duration (phase requiring water; excluding testing, mobilisation and demobilisation) of between 7 and 12 weeks.

Based on the anticipated water requirements detailed in Section 2.5.4 it is likely that between 520,000m^3 (7 weeks) - 872,000m^3 (12 weeks) will be required to facilitate the drilling of Ballinlea 2. The Department of Transport (UK) defines Heavy goods vehicles (HGV) as all goods vehicles over 3.5 tonnes gross vehicle weight. A standard HGV water tanker typically carries 30m^3 of water. The inset below provides an overview of typical water tanker specifications, namely capacity, discharge capability and turning circle.

Tanker specifications

10,000 Ltr Rigid Tankers		
Capacity (ltrs)	10,000	
Vehicle weight (tonnes)	18	
Length (m)	7.3	
Width (m)	2.4	
Height (m)	3.4	
Turning circle (m)	18	
Discharge Rate (hydraulic pump):	666L/min	
Max Discharge Rate:	920L/min	
15,000 Ltr Rigid Tankers		
Capacity (ltrs)	15,000	
Vehicle weight (tonnes)	26	
Length (m)	9.1	
Width (m)	2.5	
Height (m)	3.3	
Turning circle (m)	20	
Discharge Rate (hydraulic pump):	600L/min	
Max Discharge Rate:	750L/min	
30,000 Ltr Articulated Tankers		
Capacity (ltrs)	30,000	
Vehicle weight (tonnes)	44	
Length (m)	15.4	
Width (m)	2.5	
Height (m)	3.9	
Turning circle (m)	25-30	
Discharge Rate (hydraulic pump):	857L/min	
Max Discharge Rate:	857L/min	

Assuming water is mobilised to site via a standard 30m3 tankers this would suggest that there will be a need for between 346 (12 week) and 354 (7 week) tanker deliveries per day. This number of potential HGV movements appears to be inconsistent with that presented in Chapter 2. The HGV movements associated with water delivery have been omitted from Table 2.6 which indicates that the total HGV movements will be 270 vehicles between week 3 and week 7 (Table 2.6 assumes a 6 week drilling programme).

Articulated Tanker: Each 30,000L tanker takes 35 minutes to discharge its full volume of water. To achieve timely delivery of all 346 tankers per day, 14 tankers must empty 30m^3 of water at the site every hour. To achieve this between 8 and 9 articulated tankers would have to decant their full volume simultaneously. Each tanker has a turning circle of between 25m and 30m.

Chapter 2, Section 2.5.4 suggests that *"the supply of water will be subject to discussions with the* [sic] *NI Water or from a private source".* It should be argued that security of a water supply is critical to the viability of this project. Water volumes in the order of 10,381m^3/day and 10,612m^3/day will be required to meet demands during drilling. It is unlikely that a shallow abstraction well or even multiple wells into the basalt locally could yield this water sustainably.

Chapter 2, Section 2.5.4 states that *"...water abstraction at the site is not part of the proposed development".* This statement appears to indicate that the provision of water has been kept separate from this application. It is unclear whether such an approach is legal or appropriate in terms of Environmental Impact Assessment. The proposed development cannot proceed without a secure water supply and as a result the risks associated with such should be evaluated in full. It is simply misleading to annex more high risk activities and suggest that they will be dealt with outside the planning or assessment process.

Provision of the large volumes of water required could result in significant short term to medium term impacts on water resources if sourced from groundwater or a local surface water supply.
Once abstracted, the water will be lost as a resource as it will become wastewater. Wastewater treatment plants typically discharge either directly to sea or to streams which discharge to sea. Large volumes of water abstracted and lost, even for a short term project need to be considered in terms of the water resources of the area and potential impact of the abstraction on available water resources. No regional groundwater resource modelling appears to have been undertaken to assess this potential impact.

Dependent on whether the water is sourced it could have a significant impact on the likely number of HGV's visiting the site; increasing the daily HGV count by many hundreds of vehicles from that presented in Table 2.6.

We request that DOE Planning seek clarification on what the source of water will be and that a full evaluation of all risks associated with the sourcing of water be completed. Without this information risks associated with the application cannot be fully assessed. We request that clarification is sought in terms of the expected total volume of water required during the project and that the Applicant consider what direct and indirect implications this has on noise, dust, water resources, traffic and public health as a minimum.

Chapter 10 (Water Quality & Hydrogeology)

Table 10.10 (p19) - Conflicting information presented between Chapter 2 and Chapter 10 in relation to the expected drilling phase duration. The duration of activities are estimated to be 5-10 weeks for the well drilling with an additional two weeks mobilisation and one week demobilisation. This discrepancy is discussed in further detail under Chapter 2 comments above.

10.4.2.6 Groundwater Abstractions - Correspondence with NIEA Water Management Unit (Appendix 10.1) indicates that there are 25No. historical groundwater abstractions within 5km of the site. The majority of the abstractions are located between 2km and 5km from the site. The insert map below shows the location of the boreholes identified by NIEA. As part of this review we have consulted the following additional resources to establish if there are any other known abstractions:

- WYG Northern Ireland borehole database (consisting of 3,000+ borehole records);
- NIEA Private Water Supply borehole database (current and historical DWI registered abstraction wells);
- Geological Survey of Northern Ireland water well database (dataset contains water wells only, drilled pre-2009);
- Rural Borewell Scheme borewell database (2012 – present DARD funded grant scheme);
- We have been unable to consult with NIEA Abstraction and Impoundment Licensing Team due to time constraints in preparing this review;

The above searches identified only 1No. additional historical abstraction record on the WYG Northern Ireland borehole database. This abstraction is considered to be a shallow well located 4.4km north west of the proposed development site.

There is no centralised borehole database for Northern Ireland. As such data is fragmented between multiple sources. Despite this the records are incomplete as many boreholes can be drilled by private individuals and never make their way onto any register / record.

10.4.2.7 Private water supplies – It is suggested that correspondence with the Drinking Water Inspectorate (Appendix 10.1) has been undertaken and that the correspondence indicates that there were no private water supplies (including at dairy farms) registered with the Inspectorate under the Private Water Supplies Regulations (Northern Ireland), 2009, within 5 km of the site as of October 2013. No evidence of such appears to be presented at Appendix 10.1. We note the applicants consultants have consulted with NIEA Water Management Unit (a separated department within NIEA), but DWI do not appear to have been consulted directly. No supporting evidence of any consultation with DWI is presented at Appendix 10.1.

The Water Abstraction and Impoundment (Licensing) Regulations (Northern Ireland) 2006 came into effect in Northern Ireland on the 1st February 2007. Since February 2007 NIEA (AIL Team) have focused their efforts on registering the largest water users. Abstractions of less than $10m^3$ per day do

not require a licence. The $10m^3$ per day threshold therefore rules out most private wells and most of these smaller abstractions go unregistered. It is important to ensure that a comprehensive assessment of all available resources when trying to ensure that non-licensed protected rights are captured. Given the relatively remote nature of the site it is possible that many properties are not connected to mains and as such are reliant on their own private water supply. Consultation with NIW should be undertaken to assess the number of properties not served by mains water.

The level of assessment completed as part of ES Chapter 10 appears to put a heavy reliance on incomplete databases held by NIEA/Moyle District Council/Geological Survey of Northern Ireland. Despite the large number of known historical abstractions insufficient consideration appears to have been given to the potential for un-registered protected rights in the area.

It is requested that DOE Planning seek further information in respect of the private water supply assessments in order that it can be confirmed that the risks to protected rights have been fully considered.

Appendix 10.1 Correspondence – Reference is made to groundwater quality data having been sourced from NIEA. Whilst the email of 18th October 2013 appears to contain the data file (WQU08500); no data has been presented. Only a short description of the data is provided. This information should be presented and considered in more detail, as it may offer further understanding about the likely recharge mechanisms to the basalt aquifer in the vicinity of the site and in particular may provide a better, more site specific, understanding of the aquifer vulnerability. This water quality data is also referenced in an email to Dave Foster (DoE) on 16th May 2013 (appendix 10.1): *"Regional shallow groundwater monitoring network data (2006)...".*

It is requested that DOE Planning seek further information in respect of the groundwater quality data (NIEA Reference: WQU08500) in order that it can be confirmed that the risks to protected rights have been fully considered.

Appendix 10.1 Correspondence – Moyle District Council indicates in their correspondence of 6th June 2013 that they are aware of 1No. property at Straid Road that has a Private Water Supply. Straid Road is 18.6km long and extends both west and east of the site between Bushmills and Ballycastle. It is unclear where this supply is located and whether it will be impacted by the development.

It is requested that DOE Planning seek further information in respect of the Private Water Supply abstraction on Straid Road in order that it can be confirmed that the risks to protected rights have been fully considered.

Appendix 10.2 GSNI Report - Aquifer Vulnerability: The GSNI report Figure 8 classifies the aquifer vulnerability of the site as being 4d. We recognise that this classification is derived by the Geological Survey of Northern Ireland using 1:250,000 scale regional superficial geology mapping and sparse depth to bedrock measurements. As such, it is not suitable for targeted site assessments. The GSNI advise that groundwater vulnerability classification is not a substitute for site specific field investigations to characterise the permeability of the superficial deposits and the depth to bedrock. It is unclear whether this site specific characterisation has been completed as part of the RPS (2013) Ballinlea Exploration Well Site Hydrogeological Risk Assessment Report. The vulnerability of the aquifer may be greater or less that the classification presented on the GSNI mapping and could affect the ES Impact Assessment (Chapter 10) and subsequent mitigation applied.

This classification is based on soils being of limited thickness over bedrock. This appears to be consistent with Figure 3 (Superficial Geology Map), with superficial cover mapped as absent immediately west of the proposed development site, possibly extending beneath the site area (unclear from the scale of map presented).

We request clarification from DOE Planning as to whether the 2013 Hydrogeological Risk Assessment is available. The document does not appear on the Northern Ireland Planning Portal for Application reference E/2013/0093/F. This information should be available for review so that it can be determined whether all hydrogeological risks have been fully considered.

Appendix 10.2 GSNI Report – Intrusive Dykes: There are a number of inferred igneous dykes mapped running in an east west orientation circa <1km north and 2.7km south of the proposed development site. A further dyke is mapped circa 2.5km west of the site. It is unclear whether these dykes have formed along zones of weakness / faulting. The nature of the superficial geology in the area, (boulder clay cover) means that the presence of many faults can be obscured by the clay cover and as such these features are frequently unmapped. The same applies to many of Northern Ireland's geological faults.

It is requested that DOE Planning seek further information in respect of the presence of faults within proximity of the site and clarity on whether mapped igneous intrusions have followed lines of weakness in the rock. It is unclear what implication this may have on

the potential migration of chemicals used as part of the hydraulic fracking process. The RPS (2013) Ballinlea Exploration Well Site Hydrogeological Risk Assessment Report has not been reviewed and therefore it is not possible to verify whether this risk has been adequately assessed.

10.4.2.3 (p7) Overlying deposits – The description of the general geological succession provided shows that the two geological successions overlying the target reservoir are both sandstone units (Permian and Triassic). It has not been demonstrated whether there is a reasonable reservoir cap confining the target reservoir for hydrocarbons / gas. No discussion in relation to the potential risk of the overlying Permian and Triassic sandstones being impacted during the drilling and or testing phase is provided.

It is requested that DOE Planning seek further information in respect of the potential risk of gas and or hydrocarbon migration into the overlying Permian and Triassic sandstones during the drilling and or testing phase.

10.4.2.3 (p7) Geological Description Error – It is noted that an error is presented in the description of the geology on page 7 of Chapter 10. The Mercia Mudstones (670m thickness) are not represented and subsequent to that the Triassic Sandstones (150m thickness) have been incorrectly labelled as Mercia Mudstone.

It is requested that DOE Planning seek clarification on what risk this discrepancy may have on the risk assessment completed.

10.4.2.3 (p8) - States that the closest mapped fault is the Lemnagh Fault, which is around 1km to the west of the site. This fault does not appear on any of the maps presented as part of the ES supporting information. No discussion on how these faults may be affected, trigger seismic tremors or act as a pathway for contamination/gas migration between geological units has been provided.

It is requested that DOE Planning seek further assessment information in respect of potential risks of drilling and testing related seismic activity, the risk of hydraulic connection between units and the potential contamination risk to groundwater as a result of such.

10.4.2.8 Groundwater levels and quality – Table 10.9 summarises data obtained from the NERBD Strategic Environmental Assessment Environmental Report 2009. The 2015 Predicted

Quantitative Quality status is left blank in the table. It is unclear why this is, and whether the Ballycastle-Armoy (UKGBNI4NE001) unit is under stress. This has particular relevance in terms of the potential risk posed to groundwater resources, should the application need to be supported by local abstractions to meet the very large volumes of water required as part of the drilling and preliminary testing works. Pumping from groundwater or surface water sources locally could severely impact baseflow to rivers, a PWS's ability to abstract water and or the water level in lakes.

It is requested that DOE Planning seek further clarification why this information has been omitted from Table 10.9. We would also like to re-iterate at this point the relevance and importance of completing a full evaluation of any risks associated with the sourcing of water be completed. We request that clarification is sought in terms of the expected total volume of water required during the project. We consider it appropriate that the application consider what direct and indirect implications this has on noise, water resources, traffic and public health as a minimum.

10.4.2.18 Landfill and other waste sites – It is suggested that there is no available information on landfills or other waste sites within 500m based on the available mapping information. It is unclear whether the author has made any attempt to consult with NIEA (Waste Team) and or Moyle District Council to validate this.

Additional consideration should be afforded to whether landfills or waste sites are present locally so that a representative baseline for the site can be presented as part of the ES. It is requested that DOE Planning seek further baseline information in respect of landfills or waste sites and their potential risks related seismic activity and or contamination to groundwater.

'Flowback' is the waste fluid that is returned to the surface after hydraulic fracturing. This fluid generally contains fracturing fluids and saline (brine) rich formation waters that can pose potentially major health hazards if improperly managed or if there are accidents such as surface spills or leaks. Heavy metals and naturally-occurring radioactive materials (NORMs) may also be present in flowback, posing further potential health risks. Produced water must be properly disposed of to prevent environmental and public health problems. Most municipal wastewater treatment plants are not equipped or designed to handle flowback fluids, mainly because of high Total Dissolved Solids (from brine), NORMs, & other chemicals.

In considering appropriate disposal options for waste waters, including NORM, the Management of Radioactive Waste document (Appendix 7 to Volume III, Appendix 2.5) states that (Section 9.1.1

Direct Discharge from Site into a Watercourse) there will be no direct discharge to a watercourse. At present there is no commercially available treatment technology to treat relatively low volumes of aqueous waste and any necessary on-site pre-treatment prior to discharge is not considered as being economically viable. The waste management plan concludes that the Best Practicable Environmental Option (BPEO) for the aqueous waste stream 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 Out-of-Scope solid material as defined within the Radioactive Substances Act 1993. It is suggested that treatment of the aqueous waste will take place at either a RSA Authorisation-holding facility in Northern Ireland, or an EPR10-permitted facility in England or Wales. There are currently no RSA Authorisation-holding facilities in Northern Ireland.

It is requested that DOE Planning seek additional information on the anticipated volumes of water that will be required during the testing stage.

It is widely accepted that high volumes of water is required to facilitate the hydraulic fracturing of an average well vertical exploratory well.

The Getches-Wilkinson Center for Natural Resources, Energy, and the Environment website of Best Management Practices (BMPs)[2] for oil and gas development states that over 90% of vertical and horizontal oil and gas wells require some form of hydraulic fracturing and that *"unconventional hydraulic fracturing uses more water than conventional hydraulic fracturing. Conventional hydraulic fracturing of vertical wells is referred to as "low-volume" hydraulic fracturing because less than 80,000* [303m^3] *gallons of water are used to frac a single well. Unconventional hydraulic fracturing is referred to as "high-volume" hydraulic fracturing because 3-7 million gallons* [11,356m^3 - 26,498m^3] *of water are typically used to frac a well. Larger volumes of water are required because unconventional wells are deeper and require higher pressures than conventional vertical wells."*

The USGS Scientific Investigations Report (2014) reference 5131, entitled *"Trends in Hydraulic Fracturing Distributions and Treatment Fluids, Additives, Proppants, and Water Volumes Applied to Wells Drilled in the United States from 1947 through 2010—Data Analysis and Comparison to the Literature"* details the Average, Minimum, Maximum and Median volumes of water used to hydraulically fracture vertical wells drilled from 2000 through 2010. The results are based on the testing of 88,488 vertical gas wells and on the testing of 40,198 vertical oil wells.
The USGS Scientific Investigations Report states that the median volume of water used to hydraulically fracture vertical gas wells drilled from 2000 through 2010 was 310m^3 (average volume 758m^3 and the median volume of water used to hydraulically fracture vertical oil wells drilled from 2000 through 2010 was 312m^3 (average volume 734m^3). The average volumes of water used to

hydraulically fracture vertical oil and gas wells drilled between 2000 and 2010 are slightly lower than the ranges cited in Harper (2008) for slick water–based treatments of 1,892m^3 – 3,785m^3 per vertical well.

No information is presented within the ES on likely volumes of water that will be required during the testing stage. The Phase 3 testing (Chapter 2, Section 2.6) does not state what volumes of water will be required during the proposed testing.

We request that DOE Planning seek clarification on what the likely testing water volumes will be; details of where this water will be sourced and a full evaluation of any risks associated with the sourcing of the water completed. Without this information the risks of the application cannot be fully assessed. We consider it appropriate that the application consider what direct and indirect implications this has on noise, water resources, traffic and public health as a minimum.

Chapter 11 (Waste)

The Ballinlea 2 exploratory operations will involve the circulating to surface of fluids exposed to the formation during drilling and/or well testing, which may or may not contain Naturally-Occurring Radioactive Materials (NORM) in concentrations sufficient to trigger duties under the act. Until such time as the concentration of NORM can be established, an authorisation is required to authorise the management and disposal of NORM. NORM is produced during drilling and or testing following the dissolution of radionuclides within the formation.

Section 11.6.2 Potential Impacts during Drilling and Testing – discusses the possibility of Naturally Occurring Radioactive Materials (NORM) being present in strata in the ground. The ES Chapter states that *"The strategy for dealing with NORM, should it be present, is defined in the Management of Radioactive Waste document (RE-05- MRA-B2-001). The document is attached as Volume III, Appendix 2.5"*. Volume III, Appendix 2.5 Outline CEMP - contains further information in relation to the likely volumes, disposal options considered and likely environmental effects.

The Management of Radioactive Waste document (Appendix 7 to Volume III, Appendix 2.5) states that *"waste water volumes of approximately 275 m3 have been estimated for the Ballinlea 2 exploratory operations, including a 100% contingency."* It is unclear how this number has been arrived at. The percentage of predicted hydraulic fracturing fluid to be returned as 'Flowback' from the proposed exploratory borehole is unclear.

We request that DOE Planning seek clarification on what the source of drilling and testing water will be. We request that a full evaluation of any risks associated with the sourcing of water be completed, as without this information the risks of the application cannot be fully assessed. We request that clarification is sought in terms of the expected total volume of water required during the project and in particular during the testing phase. We consider it appropriate that the application consider what direct and indirect implications this has on noise, water resources, traffic and public health as a minimum. We request that DOE Planning seek clarification on how the volume of predicted waste water has been calculated.

Volume III, Appendix 2.5 Outline CEMP - states that *"It has been demonstrated 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"*. It is assumed that this is a general statement and not one relating to any treatment facility earmarked for the treatment of waters generated as part of Ballinlea 2, because it is unclear what treatment plant will receive water from the site and as such it has not been demonstrated that the treatment process will not give rise to any significant radiological impacts.

Section 2.6.3.3 Conventional Hydraulic Fracture Stimulation - It is understood that relatively small volumes of water in the order of $5m^3$ will be required during the mini-fall off test, however if the well has poor permeability, *"it may be necessary to conduct a conventional hydraulic fracture stimulation to enable any petroleum contained in the target reservoir rock to flow into the wellbore. Conventional hydraulic fracture stimulation is designed to improve the permeability (connectivity) of pores within the target reservoir."* It is this Conventional Hydraulic Fracture Stimulation that could conceivably require volumes in the order of $735m^3$ ([3] USGS, 2014) with the potential for multiple tests should "*...more than one interval within the target reservoir is to be tested, the operation will be repeated"*.

We request that DOE Planning seek clarification on what the source of drilling and testing water will be. We request that a full evaluation of any risks associated with the sourcing of water be completed, as without this information the risks of the application cannot be fully assessed. We request that clarification is sought in terms of the expected total volume of water required during the project and in particular during the testing phase. We consider it appropriate that the application consider what direct and indirect implications this has on noise, water resources, traffic and public health as a minimum.

Appendix 10.2 GSNI Report – Ballinlea 2 Basic Geology: It is unclear whether the conceptual geological log has been prepared by the GSNI or others. The log presumably takes consideration of other available drilling records in the area, namely Ballinlea 1 exploratory borehole. In our opinion the use of the word 'impermeable' to describe the Waterloo Mudstone Formation (positioned immediately below the aquifers – the top of which is expected to be present at a depth of circa 185m) is too definitive and potentially misleading. It is unclear at this stage whether there is any deep faulting that extends through the upper aquifers and the underlying Waterloo Mudstone Formation.

The conceptual geological log states that the Waterloo Mudstone (which extends from 185mbgl - 780mbgl) acts as an impermeable barrier to fluid flow. It is unclear whether further consideration has been afforded as part of the completed hydrogeological risk assessment (RPS, 2013) to explaining how the Waterloo Mudstone Formation is considered impermeable and not an aquitard. There is not detailed description of the mudstone unit in the ES and therefore it is unclear whether the unit contains fractures or discontinuities that may permit the movement of water laterally or vertically.

Given the predicted thickness of the Waterloo Mudstone Formation and proposed telescopic, multi-layered steel casing installation of the exploratory borehole, it is our opinion that the unit should act as a good barrier between the overlying aquifers and other water bearing units at much lower depths; however detailed consideration should be afforded to assessing the likelihood of vertical pathways being induced / enhanced during the testing phase (i.e. through the process of hydraulic fracturing).

A 2012 study entitled "Potential Contaminant Pathways from Hydraulically Fractured Shale to Aquifers" published in GroundWater [4], used computer modelling and concluded that natural faults and fractures in the Marcellus Shale, exacerbated by the effects of fracking, could allow fracking fluids and its chemicals to reach the surface within "tens of years" challenging the argument that impermeable layers of rock would keep fracking fluid and or other contaminants, confined to almost one mile below water supplies.

It is unclear whether the Permian Belfast Group, the Triassic Sherwood Sandstone Group and to a lesser extent the Triassic Mercia Mudstone Group (in zones where anhydrite, siltstones and rarely found sandstones are present) will be impacted structurally and or by the use of chemicals as part of the testing stage, over and above the near borehole impacts described in ES Chapter 10. In particular it is unclear whether natural faults and fractures within units could be exacerbated by the effects of fracking and as such could allow fracking fluids and its chemicals to reach the surface.

The GSNI report presented as supporting information to the application (Appendix 10.2) does not include a map showing the locations of faults in the area. In particular the Lemnagh Fault falls within the GSNI search area, but is omitted from any of the maps. Other known faults in the area are the Portbraddon and Portmore Faults. It is unclear where these faults are located and whether they have been adequately addressed in terms of their potential to act as pathways for fault induced mobilisation of fracking fluids/gas or other waste waters to reach the surface.

It is requested that DOE Planning seek further assessment information in respect of the potential risk of fault induced gas and contaminant migration to near surface aquifers. This information is needed to confirm that the risks to water resources and human health have been fully considered.

Appendix 10.2 Geological Log – The GSNI Conceptual geological log suggests that there is 1,765m between the deepest aquifer and the shallowest source. The log also states that *"In Ballinlea 2 the top of the Murlough Bay Formation is 2.2km from the deepest aquifer".* The GSNI Conceptual geological log also suggests that the Carboniferous Visean Murlough Bay Formation (depth 2,450m) is a possible source rock and is a potential target for shale gas development in the region. Does this suggest that the unconventional host rocks of the Murlough Bay Formation (shale) will be targeted for testing?

We request that DOE Planning seek clarification on whether the Murlough Bay Formation (shale) will be targeted for testing.

Volume III, Appendix 2.5 Outline CEMP - states (Appendix B: Ballinlea 2 - Waste Management Plan, dated December 2014) at Section 5 (Operational Summary) that a *"Carboniferous shale mini fall-off test"* will form part of the proposed testing programme for Ballinlea 2.

Whilst Section 2.6.3.1 of the ES provides an overview of the *"Mini Fall Off Test"* it omits any reference of the word 'shale' or reference to the Murlough Bay Formation (shale layer). It is therefore unclear whether testing of unconventional shale units will take place as part of this application.
As per our comments under Section 2 above, it is unclear whether the Planning Application description is correct. The proposed exploratory borehole will be drilled through conventional and unconventional (shale) reservoirs and it appears that testing of testing may take place in the unconventional Carboniferous Shale reservoir. This by definition would result in unconventional exploration well testing.

We reiterate our request that DOE Planning seek clarification on whether the Murlough Bay Formation (shale) will be targeted for testing and whether this application constitutes unconventional testing. In the interest of clarity we urge DOE Planning and its consultees to seek clarification on what geological units will be target and what testing will be take place in each.

An aquifer is *'a subsurface rock or sediment unit that is porous and permeable. To be an aquifer it must have these traits to a high enough degree that it stores and transmits useful quantities of water'* (http://geology.com/dictionary/glossary-a.shtml). It is therefore reasonable to suggest that some of the sandstone units within the Millstone Grit are aquifers. While these aquifers are not considered viable groundwater sources today, Climate Change implications may lead to the assessment of these deeper groundwater sources in the future, as technological development makes abstraction and treatment economically viable. The protection of all aquifer units should therefore be maintained.

We request that DOE Planning seek clarification on whether the applicant considers the Permian Belfast Group and the Triassic Sherwood Sandstone Group (1,450 – 1,950m) as aquifers, given their ability to transmit water. We also request that DOE Planning seek clarification on what implication this might have for the future use of these deeper aquifer units. The site is located in an area of good geothermal potential and such units could otherwise be considered for geothermal purposes.

Chapter 11, Section 11.6.2 Potential Impacts during Drilling and Testing (p10) – states that the only known loss zone in the strata to be penetrated by the Ballinlea 2 Well is an interval of 29 metres in height which is between 929 and 958 metres below ground level. It is unclear why this zone is identified as potentially at risk.

We request that DOE Planning seek clarification on what is meant by the risk identified above.

Human Health (Chapter 14)

Section 14.4.1 Construction Health Pathways – Given the potential for much greater volumes of traffic coming and leaving the site, Chapter 14 is likely to require revision to reflect how these traffic numbers might influence the construction health pathway risk.

Section 14.4.1 Water & Health – states that *"all households in the vicinity get their water from mains"*. No evidence has been presented to support this claim. It is possible given the relatively remote nature of the site that many properties are not connected to mains and as such are reliant on

their own private water supply. Consultation with NIW should be undertaken to assess the number of properties not served by mains water.

Summary/ Conclusion

Further geological information is required in relation to the Millstone Grits (target reservoir) and the strata immediately above the Carboniferous rocks, so that the risks associated with the proposed development can be fully evaluated.

The proposed setting depth for the primary conductor casing appears to be insufficient and clarification is required to provide reassurance that the proposed borehole will adequately seal off the upper aquifer units.

The Millstone Grits (target reservoir) contains both conventional and unconventional strata. It is therefore unclear whether the Planning Application description is correct. The proposed exploratory borehole will also be drilled through an unconventional shale reservoir and clarification is required from the Applicant on whether testing will take place within any unconventional reservoir(s); as to do so would result in the borehole by definition, becoming an unconventional exploration well.

Conflicting information is presented within the ES in relation to the duration of the proposed drilling works. This has a bearing on many of the ES chapters, but most importantly on the water, noise, dust and traffic sections. The ES appears to distance itself from the issue of sourcing vast quantities of water to facilitate the drilling and testing of the proposed exploratory borehole. It is our opinion that it is not possible to separate the issue of sourcing water from the exploratory drilling application as the two are intrinsically linked. Whilst the Applicant suggests that the future testing or exploitation will be subject to a further planning application it is clear that this application hinges on the operator being able to source very large volumes of water for the drilling and 90 day test period. Both of these elements require very large volumes of water.

The traffic assessment has not taken consideration of all HGV movements; in particular HGV's delivering water, to and from the site during the drilling phase.

Available information on mains water availability and private abstraction wells within 4km of the site suggests that there is potentially a greater than average reliance on groundwater as a source of drinking water when compared to Northern Ireland as a whole. Consultations in relation to Private Water Supplies completed as part of the ES do not adequately characterise the risk to protected rights within proximity of the proposed development site.

Further geological assessment is required by the Applicant, as it has not been demonstrated in the ES that due consideration has been afforded to identifying geological faults both at shallow and greater depths. Faults have the potential to act as pathways for the migration of chemicals used as part of the hydraulic fracking process and gasses encountered during drilling and testing. Insufficient characterisation of such faults may fail to identify the risk to human health from gasses migrating along such features towards properties nearby.

The thickness of mapped superficial cover at the site is thin and absent from areas close to the site. Given the scale which the mapping information represents, there are concerns that the aquifer vulnerability is higher than mapped and the consequence of this may be that the proposed groundwater protection mitigation at the site may be insufficient.

The development proposals include the provision for a mini-frac. Insufficient detail has been provided in relation to the anticipated volumes of water that will be required during the testing stage. No risk assessment is provided in relation to the potential impact on water resources or the impact this may have on traffic volumes arriving and leaving the site.

No consideration has been afforded to the future use of deeper aquifer units at the site. The Permian and Triassic aquifers located directly above the target reservoir offer good geothermal potential and could while these aquifers are not considered viable groundwater sources today, Climate Change implications may lead to the assessment of these deeper groundwaters sources in the future, as technological development makes abstraction and treatment economically viable.

References:

[1] Baseline Report Series: 18. The Millstone Grit of Northern England (2005), reference Groundwater Systems and Water Quality Commissioned Report CR/05/015N & Science Group: Air, Land & Water Technical Report NC/99/74/18: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/290918/scho0207blyp-e-e.pdf

[2] Getches-Wilkinson Center for Natural Resources, Energy, and the Environment website of Best Management Practices (BMPs): http://www.oilandgasbmps.org/resources/fracing.php

[3] USGS Scientific Investigations Report (2014) reference 5131, entitled Trends in Hydraulic Fracturing Distributions and Treatment Fluids, Additives, Proppants, and Water Volumes Applied to Wells Drilled in the United States from 1947 through 2010—Data Analysis and Comparison to the Literature.

[4] Myers, T. (2012), Potential Contaminant Pathways from Hydraulically Fractured Shale to Aquifers. Groundwater, 50: 872–882. doi: 10.1111/j.1745-6584.2012.00933.x