

8 SOILS AND GEOLOGY

8.1 Introduction

This section is prepared for a development comprising the deposition of up to 75,000m³ of peat to the Srahmore Peat Deposition Site. The 75,000m³ of peat will be generated during the construction of the onshore pipeline development. The Srahmore Peat Deposition Site has previously been successfully utilised for the deposition of approximately 448,000m³ of peat from the Bellanaboy Bridge Gas Terminal site. Significant information and experience has been gained during the original operation, which has been applied to this development proposal.

The information contained below is concerned with a description of the existing geological character of the Srahmore Peat Deposition site. This section also addresses the hydrogeological character of the site, as the groundwater environment is intrinsically linked to the geological material through which it flows.

The geological material existing within the site has been generated by the deposition of detritus over millions of years. The development of the blanket bog peat in north Maigh Eo (Mayo) is considered to be recent in the geological timescale, having occurred in the last 4,500 years. Its formation is concurrent with human activity, as demonstrated by the identification of Neolithic field systems at Céide. The formation of blanket bog, which is the dominant landscape character in the region, occurred due to a significant change in climatic conditions approximately 4,500 years ago, bringing about wetter conditions and creating an ideal environment for peat formation.

The geological material underlying the blanket bog, both the Quaternary glacial mineral soil and the bedrock, are concealed. The nature, extent and complexity of the geological material, from the surface downwards through the mineral subsoil to the bedrock, is detailed below based on available published information and site specific investigation data.

The hydrogeological environment, in terms of the hydraulic characteristics of the bedrock and the subsoil, are also discussed, as such details are intrinsically linked to the geological environment.

8.2 Study Methodology

This report has been prepared using the recommendations set out in the Environmental Protection Agency (EPA) document ‘Guidelines on Information to be contained in Environmental Impact Statements’ (2002). The guidelines and recommendations of the Institute of Geologists of Ireland (IGI) publication ‘Geology in Environmental Impact Statements – A Guide’ (2002) was also taken into account in the preparation of this section.

This section describes the geological material existing within the site, from the surface downward, through the mineral subsoil to the bedrock. The composition and the extent of these deposits are discussed. Groundwater and the hydrogeological setting of the site are also discussed in this section, as is the nature of the existing geological material and the hydraulic characteristics of the various materials through which the groundwater flows.

In the preparation of this section the following protocol was used in order to assess the regional and site specific context and character of the site:

1. The site was assessed using regional geological publications and maps;
2. All available information was collected from the Geological Survey of Ireland (GSI);
3. A site investigation programme was designed and undertaken within the site, that included topographic surveys, trial pitting of soils/subsoils, drilling into subsoils/bedrock, laboratory and field testing of the various materials and sampling; and
4. Preparation of this geological report was undertaken following the collation of all available information.

The available geological information provided in this section is considered sufficiently detailed to adequately characterise the geological setting of the site. The information included in this section is considered to meet the data requirements suggested in the IGI publication ‘Geology in Environmental Impact Statements - A Guide’.

All projects and developments that require an EIS are of a scale or nature that they have the potential to have an impact on the environment. In this section the potential impact on the geological environment resulting from the importation and deposition of up to 75,000m³ of peat is assessed and mitigation measures provided to reduce such impacts. Based on the mitigation measures provided, the significance of the predicted impact on the geological environment is determined. A programme of monitoring is provided to demonstrate that development is not impacting the surrounding geological environment.

8.3 Receiving Environment

8.2.1 *Topography and Topographic Landform*

The topographic landform of this region of Northwest County Mayo is dominated by expansive tracts of land that are relatively flat. However, the relief is broken by dramatic upland terrains (Nephin Beg and Owenduff area).

Large tracts of blanket bog terrain have been worked on an industrial scale by Bord na Móna in northwest Maigh Eo (Mayo), to provide a material feed to the Bellacorick Power Station. Although the extraction of peat in this region has now ceased, the previous industrial activity has had a significant impact on the topographic landform and has resulted in exposure of cut-over peat surfaces throughout the site.

8.2.2 *Soil*

Reference to the General Soil Map of Ireland (published by National Soil Survey, An Foras Talúntais in 1980 at a scale of 1:575,000) indicates that the entire site is underlain by low level blanket bog. The Soil Map of West Mayo (published by the National Soil Survey, An Fóras Talúntais in 1974 at a scale of 1:126,720) indicates that the peat material is part of the Bellacorick-Glenamoy soil series of blanket bog.

Blanket bog is so called because its development is mostly independent of basins or topographical features where water collects; rather it simply covers the landscape like a blanket. In Ireland, the distribution of blanket bogs is confined to the western extremities of the country and upland areas where precipitation is high (greater than 1,200mm annually) and evaporation is low. Blanket bogs are maintained by rainfall and thus have a low nutrient content. The pH of a blanket bog lies between 3.5 and 4.2.

On virgin blanket bogs there is a thin layer of highly decomposed peat, which acts as an impermeable barrier for infiltrating water and creates waterlogged conditions favourable for peat production. The peat in a blanket bog is generally consistent throughout the soil profile. The peat is derived from plant remains, mainly grasses, sedges and heathers. Blanket bog peat is generally very dense and highly decomposed, which results in a very slow downward movement of water through the soil profile. In its natural state, undrained blanket bog is composed of 85-95% water.

Based on visual assessment of the proposed site, the peat material has not been completely exhausted within the subject site. Peat still occurs at the base of each production field.

As part of the site characterisation, the thickness of the remaining peat material within the site was assessed. Bord na Móna undertook a peat depth survey of the Srahmore Peat Deposition site in 1998, using a 'Hiller Borer' sampler, which is a hollow stem sampler. This sampler was pushed into the peat material and the hollow stem was used to indicate

when mineral subsoil had been encountered. The results of the 1998 survey were adjusted to account for the extraction programme undertaken in the intervening period and the elevation was reduced.

With respect to Area 5, the peat thickness is estimated as varying from 0.34m to 0.7m in the zone where it was proposed to construct the existing reception hardstand. The peat thickness is greatest to the north of Area 5, immediately adjacent to the R313 (up to 6m), where no peat extraction has been undertaken.

With respect to Area 6, the Hiller Borer survey indicates that between 0.1m and 2.16m of peat overlies the mineral subsoil in the low fields.

As part of the site investigation programme and in order to verify the correction of the Hiller Borer results, 14 No. trial pits were excavated within the proposed site (2003). The trial pit information was also valuable in that it allowed an opportunity to examine the nature and extent of the peat material. The trial pit logs are included in Appendix 8.1, Book 3 and the locations where the trial pits were excavated are shown on Figure 8.1.

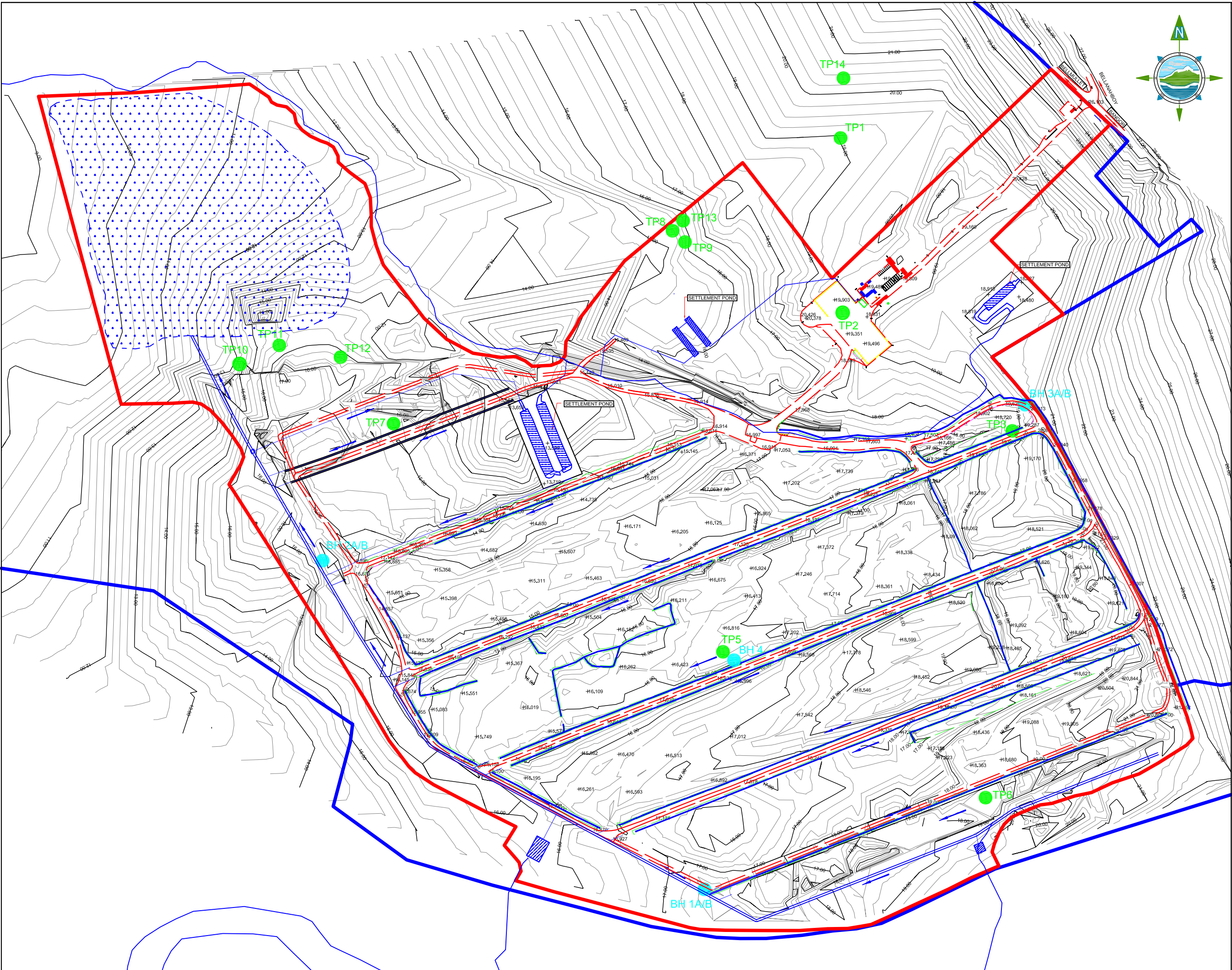
A total of six of the trial pits were excavated within Area 5. Five of these trial pits (TP1, TP8 and TP9, TP13 & TP14) were undertaken in areas not assessed as part of the Hiller Borer Survey. These trial pits encountered very thin peat cover to the southwest of Area 5 (TP8 and TP9), with between 0.2m and 0.4m cover of peat encountered, whereas 2.4m of peat cover was encountered to the northwest of Area 5 (TP1). The other trial pit (TP2) was excavated in the area of the proposed reception hardstand. The depth of peat encountered in this trial pit (0.65m) coincides exactly with the thickness of peat recorded from the Hiller Borer survey.

Five trial pits were excavated in Area 6. The information recorded from the trial pits (TP3, TP4, TP5, TP6 and TP7) coincides closely with the thickness of peat recorded from the Hiller Borer survey, with between 0.84m (TP7) and 1.8m (TP3) of peat recorded overlying mineral subsoil. In general, the thickness of peat is at a minimum to the west of Area 6 and appears to thicken to the south.

A further 3 No. trial pits were excavated in Area 7 (TP10, TP11 & TP12). The thickness of peat cover in this area was very thin, measured as varying from 0.1m to 0.3m thick.

The most recent activities to occur within the Srahmore Peat Deposition Site, involved the construction of an access road from the R313 and peat reception hardstand slab. Ancillary infrastructure was also imported and/or constructed to support the previous peat deposition activity. Approximately 448,000m³ of peat from the Bellanaboy Bridge Gas Terminal site was accepted to the Srahmore Peat Deposition site and deposited within Area 6 in 2005 and 2007.

The areas where peat infill has previously been undertaken are shown on Figure 8.2. Approximately 448,000m³ of peat was infilled in Bays 2 (partially), Bay 3, Bay 4 and Bay 5 of Area 6. The deposited peat was handled, mounded and graded within each bay to achieve a maximum approximate height at the centre of each lowfield bay of approximately 2m. The grade from crest towards the margin toe was required to ensure rainwater was shed from the areas. The net result of the peat deposition has been to raise the topographic elevation in each lowfield where activity occurred.



GENERAL LEGEND

LANDS UNDER CONTROL OF DEVELOPER	SITE ACTIVITY BOUNDARY
INTERNAL ACCESS ROAD	EXISTING MAJOR CONTOUR 40.00m
PUBLIC ROAD	DRAINAGE
EXISTING TEMPORARY BUILDING/STRUCTURE	PROPOSED TEMPORARY BUILDING/STRUCTURE
TOP OF BANK	FENCING
BOTTOM OF BANK	WALL
SETTLEMENT LAGOON	SPOT LEVEL +###.###
TRIAL PIT LOCATION	BOREHOLE LOCATION

NOTES

- FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING
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- ENGINEER TO BE INFORMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES
- ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD
- OS 6" SHEET NO'S: MAYO 18 & 26

50m 0 50m 100m 150m

Rev	Date	Description	By	Chkd.
F	07-05-10	ISSUED FOR RE-SUBMISSION	MN	ST
E	01-02-09	ISSUED FOR RE-SUBMISSION	VB	MC
D	10-11-08	ISSUED FOR SUBMISSION	VB	MN

Applicant: **Shell E&P Ireland Limited**
Corrib House, 52 Leeson Street Lower, Dublin 2, Republic of Ireland.

Operator: **BORD NA MÓNA**

Project: **CORRIB ONSHORE PIPELINE DEVELOPMENT**

Aspect: **SRAHMORE PEAT DEPOSITION SITE**

Title: **SITE INVESTIGATION LOCATIONS**

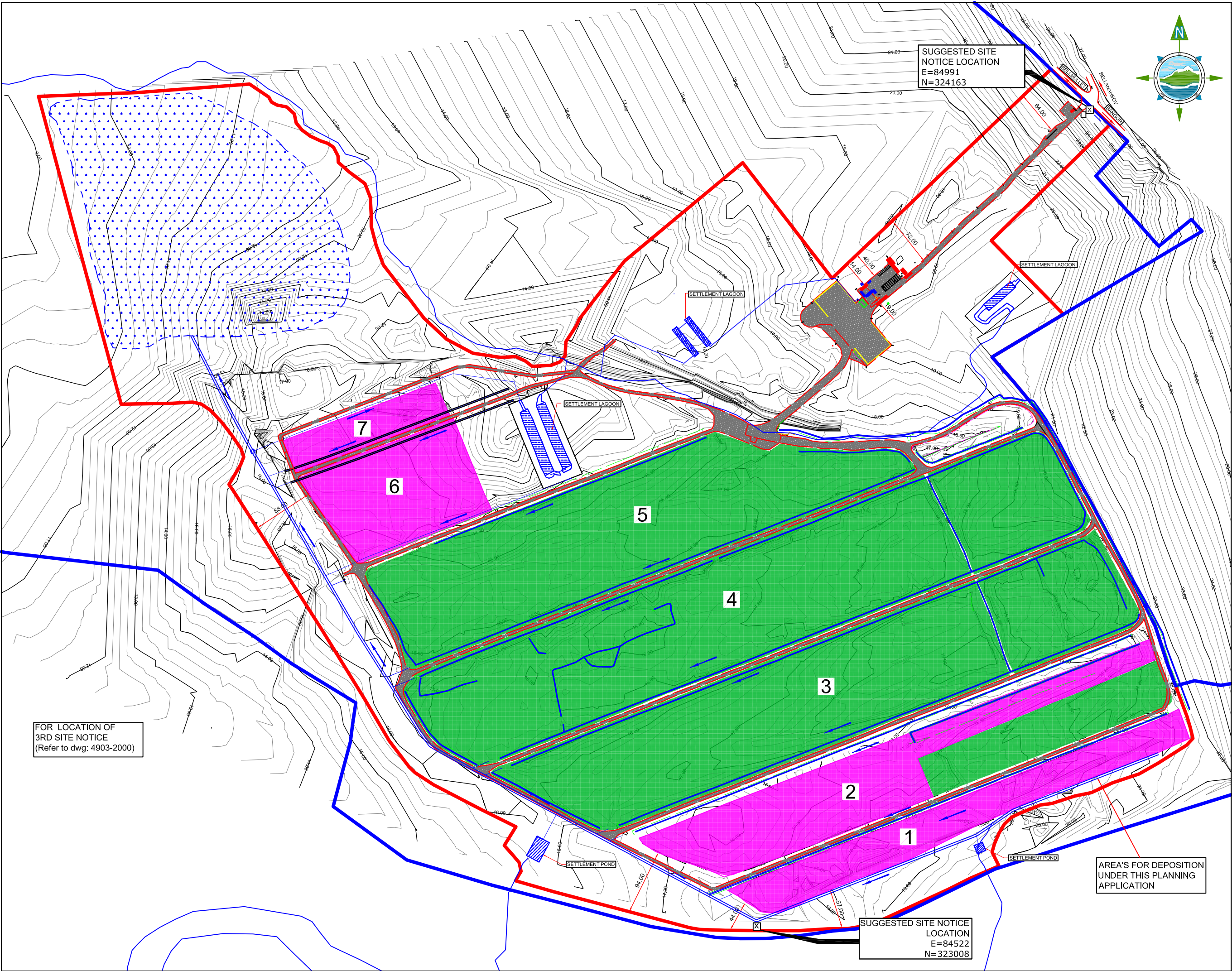
Scale @ A3: 1:5,000

Prepared by: V.Bonney
Checked: M.Nolan
Date: March 2010

Project Director: S.Finlay

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Revision: **F**



GENERAL LEGEND	
LANDS UNDER CONTROL OF DEVELOPER	SITE ACTIVITY BOUNDARY
ROADS & HARDSTAND UNDER CURRENT APPLICATION	EXISTING MAJOR CONTOUR
AREAS FILLED WITH PEAT 2005/2007	DEPOSITION AREAS UNDER CURRENT APPLICATION
PUBLIC ROAD	DRAINAGE
EXISTING TEMPORARY BUILDING/STRUCTURE	PROPOSED TEMPORARY BUILDING/STRUCTURE
TOP OF BANK	FENCING
BOTTOM OF BANK	WALL
SETTLEMENT LAGOON	EXISTING TREE
SUGGESTED SITE NOTICE LOCATION	LAMP STANDS

- NOTES
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- 50m 0 50m 100m 150m

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E	01-02-09	ISSUED FOR RE-SUBMISSION	VB	MC
D	10-11-08	ISSUED FOR SUBMISSION	VB	MC
Rev	Date	Description	By	Chkd.

Applicant: **Shell E&P Ireland Limited**
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Operator: **BORD NA MÓNA**

Project: **CORRIB ONSHORE PIPELINE DEVELOPMENT**

Aspect: **SRAHMORE PEAT DEPOSITION SITE**

Title: **EXISTING & PROPOSED PEAT DEPOSITION (Survey 2008)**

Scale @ A3: 1:5,000

Prepared by: V.Bonney Checked: M.Nolan Date: March 2010

Project Director: S.Finlay

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Drawing No.: **FIGURE 8.2** Revision: **F**

The full area of Area 6 was not infilled during the deposition of peat from the Bellanaboy Bridge Gas Terminal site. Due to delays in the peat excavation and haulage operation, the peat was partially drained, which reduced the natural moisture content of the peat. This drainage increased the density of the peat and therefore a smaller storage area was required for approximately 448,000m³ of peat.

8.2.3 Subsoil Geology/Superficial deposits

8.2.3.1 Subsoil Geology

During site investigations within the Srahmore Peat Deposition site, 14 No. trial pits which were excavated within the site continued to sufficient depth so that at all locations the mineral subsoil was encountered. This allowed the nature and composition of the subsoil material to be examined. The location of the trial pits are shown on Figure 8.1.

The trial pits were excavated to depths varying from 1.65m to 3.45m below ground level (bgl). Mineral subsoil was encountered at depths ranging from 0.1m bgl (TP10) to 2.4m bgl (TP1). The uneven elevation of the interface between the peat and the mineral subsoil is a function of the uneven elevation of the topography prior to the formation of the blanket peat and the uneven elevation of the current topography due to extraction of peat.

The mineral subsoil encountered in each trial pit was recorded and logged. All trial pit logs are included in Appendix 8.1, Book 3 with the locations where the trial pits were excavated shown on Figure 8.1. The dominant subsoil is described as a predominantly light grey, clayey/silty, fine grained SAND, with angular to rounded cobbles and boulders of quartzite, schist, sandstone and gneiss.

A sample of the mineral subsoil encountered in each trial pit was obtained for laboratory testing. The particle size distribution (PSD) of each sample was examined to determine the exact composition of the subsoil. The PSD curves for each subsoil sample are contained in Appendix 8.2, Book 3. The PSD curves confirm the field description of the subsoil. The laboratory description of the dominant subsoil is a pale grey, silty SAND with gravel. In general the percentage of fine material (fine sand, silt and clay) of each sample is high, and the percentage of gravel is high.

Further to the excavation of the 14 No. trial pits, 7 No. boreholes were drilled within the site. The material encountered during drilling was recorded and logged. The borehole logs are provided in Appendix 8.3, Book 3 with the location of the boreholes shown on Figure 8.1. The drilling programme provided information on the thickness of unconsolidated material (mineral subsoil and weathered rock) overlying bedrock.

At the margins of the site, shallow and deep boreholes were installed at three different locations upgradient and downgradient of the site. Bedrock was encountered in all deep boreholes around the margins of Area 6 (boreholes BH1B, BH2B and BH3B). The depth to bedrock recorded from these boreholes was 13.5m bgl at BH1B, 14.3m bgl at BH2B and 6m at BH3B. Borehole 4 was drilled close to the centre of Area 6 and continued to a depth of 30m and was terminated while still in unconsolidated material. A geological cross section is shown on Figure 8.3.

This indicates that the elevation of the bedrock across Area 6 can be viewed as a basin, which is closest to the surface at the margins of Area 6 and is deepest close to the centre of the site.

8.2.4 Bedrock Geology

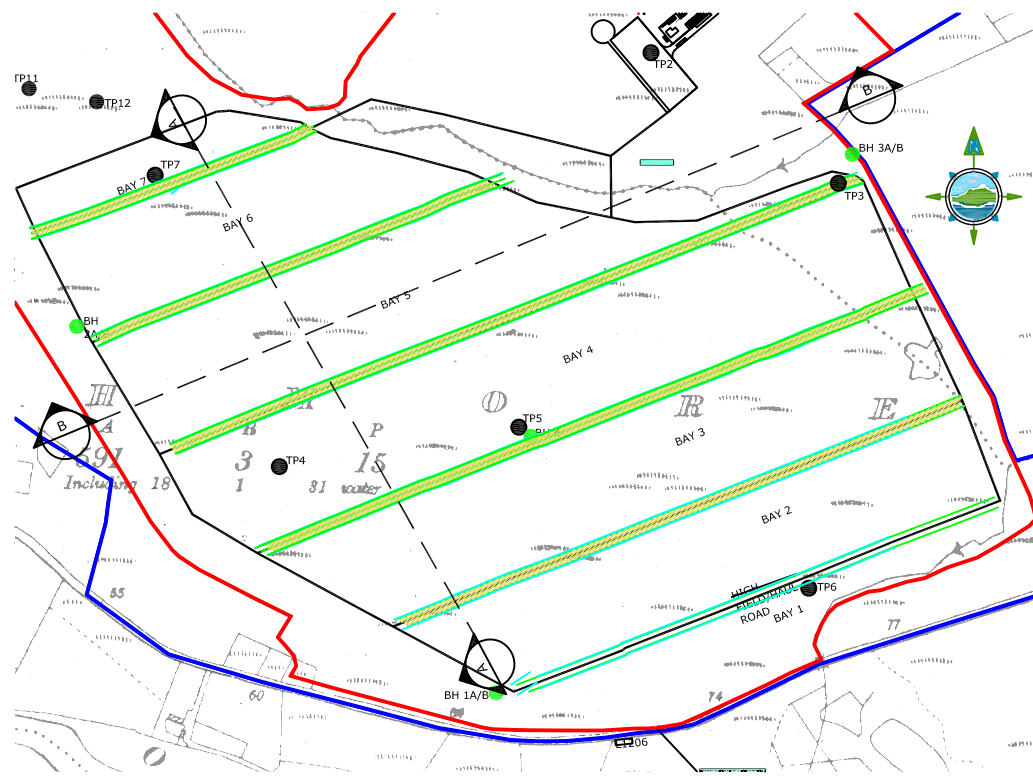
Reference to Sheet No. 6 – Geology of North Mayo, published by the Geological Survey of Ireland (1992), indicates that the bedrock underlying the site is recorded as belonging to the Bangor Succession of the Dalradian Supergroup of rock types. The Dalradian Supergroup is composed entirely of metamorphic rocks (rocks altered by heat and pressure). An extract of Sheet No. 6, showing the proposed site is shown on Figure 8.4.

The rock types found in the Baingear (Bangor) area are principally metamorphosed sedimentary rocks. It should be noted that the delineation of rock units are interpreted from limited bedrock exposure due to the extensive cover of blanket bog and mineral subsoil over much of the low lying areas in the Baingear (Bangor) region.

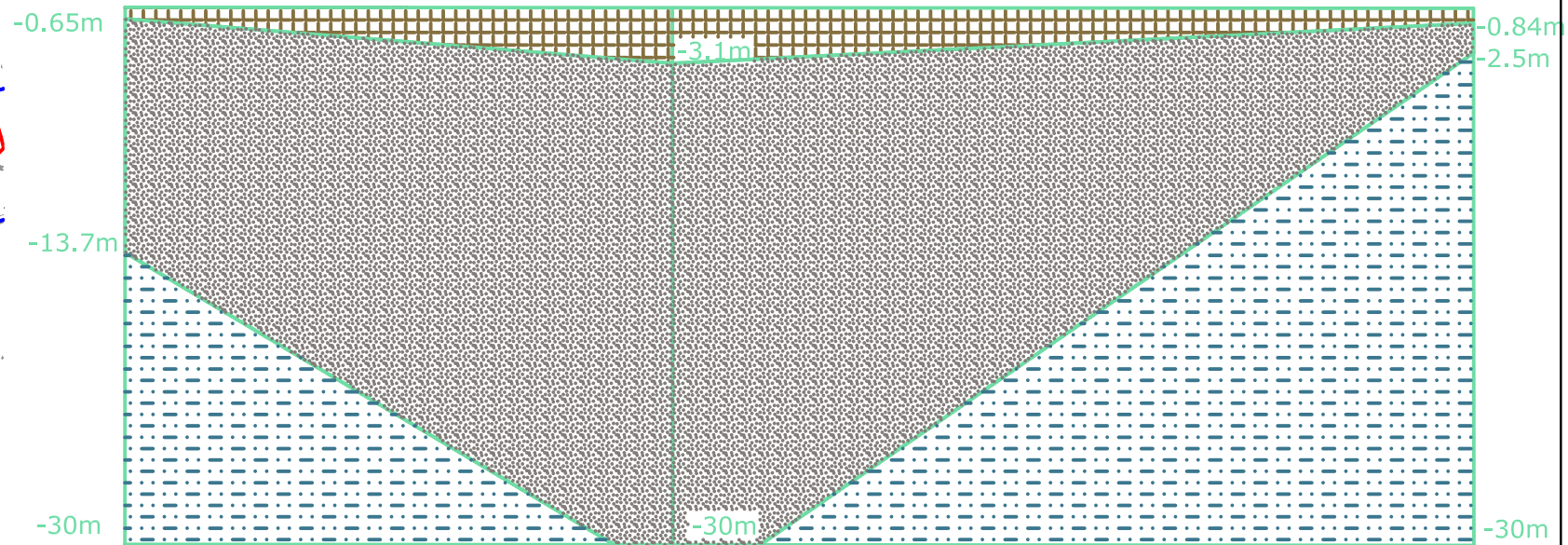
The geological map delineates a number of rock types across the site, which are recorded as distinct formations. The map indicates that the Broadhaven Formation and the Benmore Formation from the Erris Group of rocks underlie the extreme southwest of the site. The Pollacappul Schist Formation, the Bellagarvan Formation, the Kinfinalta Formation, the Doon na Dell Schist Formation, the Ballybeg Park Limestone Formation and the Inver Schist Formation, which are all part of the Inver Group are recorded underlying the remainder of the site.

The lithological units of the Dalradian rocks are predominantly composed of quartzites, psammitic schists and pelitic schists, with minor units of metamorphosed limestones (marble).

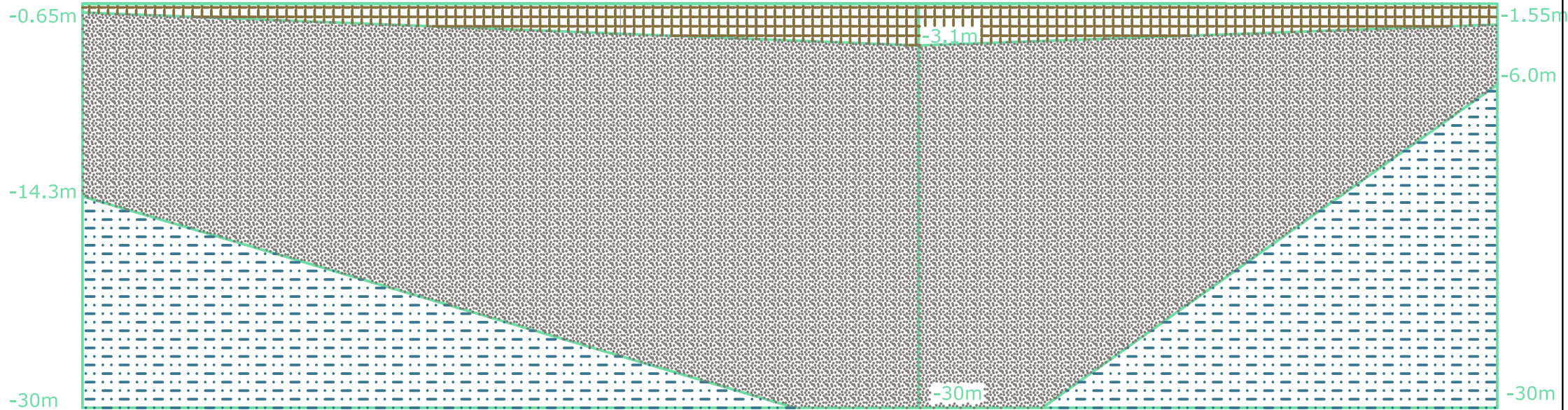
All rock types occurring in the Baingear (Bangor) region have undergone significant structural deformation. The rocks have undergone metamorphism and structural faulting and folding at various times over the geological timeframe (i.e. over 590 million years) since deposition. This deformation has occurred during crustal stretching, crustal compression and various orogenic events.



SECTION KEY PLAN
NTS



SECTION A-A



SECTION B-B

- LEGEND**
- SITE OWNERSHIP BOUNDARY
 - SITE ACTIVITY BOUNDARY
 - HAUL ROAD
 - HIGH FIELD
 - ACCESS ROAD
 - EXISTING RAILWAY
 - STRATA**
 - PEAT
 - CLAYEY/GRAVELLY SAND
 - BEDROCK (QUARTZITE TO PSAMMITE)

- NOTES**
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Rev	Date	Description	By	Chkd.
F	07-05-10	ISSUED FOR RE-SUBMISSION	MN	ST
E	01-02-09	ISSUED FOR RE-SUBMISSION	VB	MC
D	10-11-08	ISSUED FOR SUBMISSION	VB	MN

Applicant: **Shell E&P Ireland Limited**
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Operator: **BORD NA MÓNA**

Project: **CORRIB ONSHORE PIPELINE DEVELOPMENT**

Aspect: **SRAHMORE PEAT DEPOSITION SITE**

Title: **GEOLOGICAL LONG SECTIONS**

Scale @ A3: **H: 1:4,000 / V: 1:400**

Prepared by: **V.Bonney** Checked: **M.Nolan** Date: **March 2010**

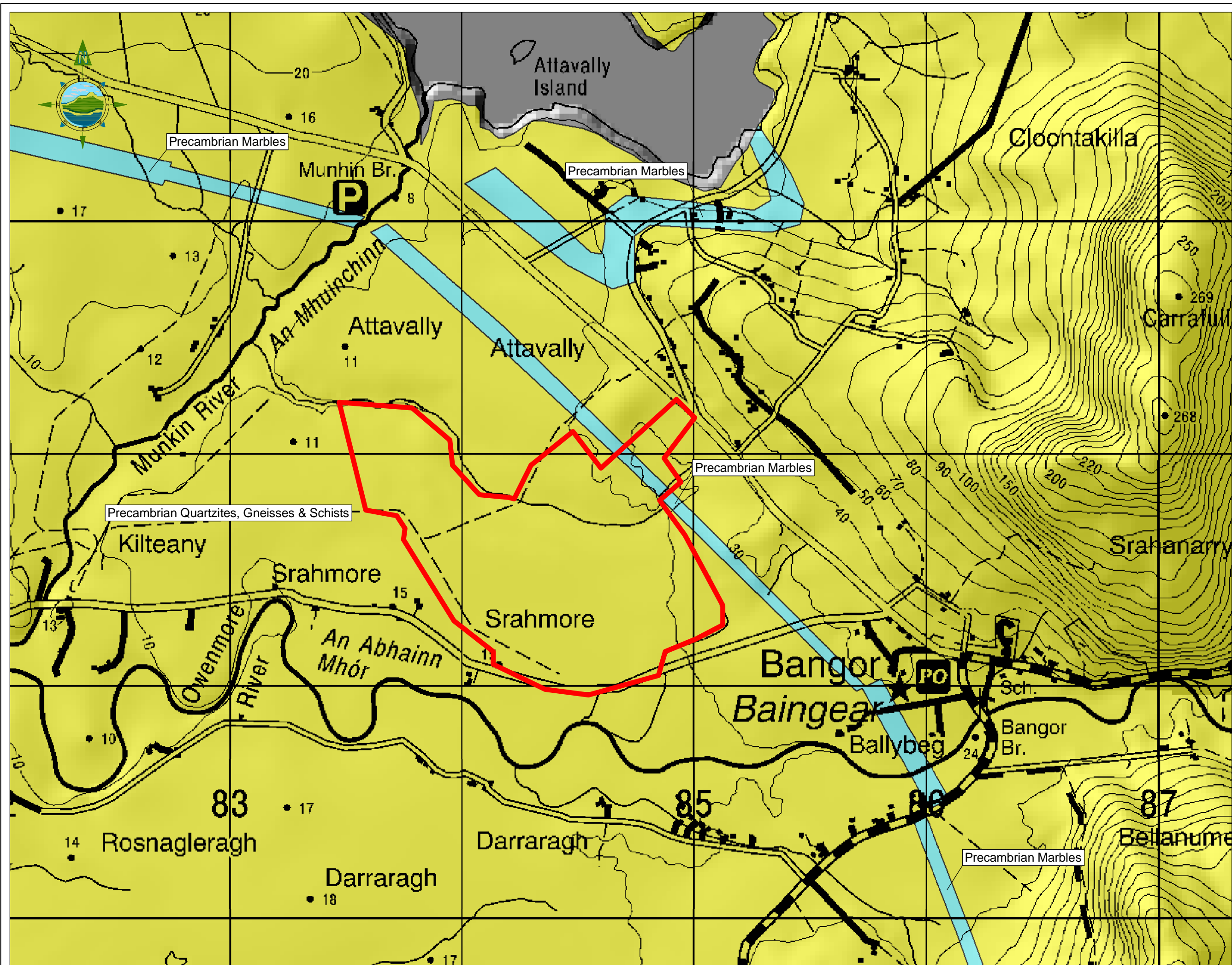
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Figure 8.3

Revision: **F**



Legend


- Site Boundary
- Precambrian Marbles
- Precambrian Quartzites, Gneisses & Schists

0 62.5125 250 375 500
Metres

NOTES

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Issue	Date	Description	By	Chkd.
F	14.05.10	ISSUED FOR RE-SUBMISSION	A.G.	S.F.

Applicant:  Shell E&P Ireland Limited
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Operator: **BORD NA MÓNA** 

Project: CORRIB ONSHORE
PIPELINE DEVELOPMENT

Aspect: SRAHMORE PEAT
DEPOSITION SITE

Title:
BEDROCK MAP

Scale @ A3: 1:15,000

Prepared by: A.Gruschka Checked: S.Finlay Date: May 2010

Project Director: S.Finlay


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Drawing No.: Figure 8.4 F

As part of the site investigation programme 3 No. of the 7 No. boreholes drilled within the site continued into bedrock (Boreholes BH1B, BH2B & BH3B). The location of the boreholes drilled on site is shown on Figure 8.1, with logs provided in Appendix 8.3, Book 3.

Bedrock was encountered within the interval 6m bgl (BH3B) and 14.3m bgl (BH2B). Borehole BH4, located within the centre of the peat deposition area, continued to a finished drill depth of 30m bgl without encountering bedrock.

The bedrock encountered within borehole BH1B, BH2B and BH3B was cored to obtain full details of the rock material underlying the site. With specific reference to the bedrock, the percentage core recovery was very high, with almost 100% recovery. The solid core recovery increased with depth, suggesting some weathering and fissuring of the rock at shallow levels.

The core recovered from BH2B and the upper portion of the core from BH1B comprised moderately weak to moderately strong, greenish brown, fine to coarse grained Psammite, which is moderately weathered. Psammite is a metamorphosed sedimentary rock, predominantly comprising quartz and a lesser percentage of feldspar and mica.

The core recovered from the lower portion of BH1B and the entire interval encountered in BH3B comprised strong to very strong, massive to faintly banded, fine to medium grained, micaceous Quartzite, which is fresh to slightly weathered.

The rock encountered underlying the site, as described from the borehole logs, is fully consistent with the description of the Dalradian rock types described in the GSI Sheet 6 – Geology of North Mayo.

8.2.5 Hydrogeology

8.2.5.1 Aquifer Classification

Information available from the Geological Survey of Ireland indicates that the aquifer potential for the Dalradian rock types in I gContae Maigh Eo (County Mayo) is Poor and is generally unproductive, except in localised zones (GSI Aquifer Code: PI).

The recovery of the bedrock material during drilling indicates that the rock is not highly fractured, with a very high total core recovery percentage (almost 100%). This indicates that the rock has not undergone significant weathering, fracturing or dissolution. The solid core recovery percentage is slightly lower within the upper 1 to 2m of rock, but increases with depth. This suggests that the rock is slightly fissured or fractured close to rockhead, however the rock becomes progressively tighter and unfissured/unfractured with depth, with a very high solid core recovery at the base of each borehole.

8.2.5.2 Bedrock Permeability

As part of the site investigation programme the hydrogeological properties of the bedrock were tested to determine the hydraulics of the bedrock and consequently the aquifer potential. In total 3 No. packer test were undertaken on borehole BH1B, BH2B and BH3B. The results of the packer tests are included in Appendix 8.4, Book 3. A packer test (or Lugeon test) gives a measure of the acceptance potential of undisturbed rock by injection of water under pressure. In essence, it comprises the measurement of the volume of water that can escape from an open section of rock in a given time under a given pressure. The permeability values determined from the tests vary from 3.23×10^{-6} m/sec (BH1B) to 8.01×10^{-6} m/sec (BH3B). The permeability of the rock was tested over significant lengths of the open cored holes. The permeability values determined for the bedrock underlying the site are considered to be very low, in relation to other Irish rock types. The in-situ hydraulic tests confirm the poor aquifer potential of the bedrock.

8.2.5.3 Mineral Subsoil Permeability

Due to the gravelly nature of the mineral subsoil it was not possible to obtain undisturbed samples to determine the permeability of the material. Therefore in order to determine some basic hydraulic characteristics of the subsoil field tests were undertaken on the shallow boreholes that were isolated in unconsolidated material. Permeability tests were undertaken on boreholes BH1A, BH2A, BH3A and BH4, using recognised testing procedures. The method of testing involved two different procedures, the first involved undertaking a rising head permeability test (Slug Test) and the second method of testing involved recording the recovery of water levels following purging of the borehole standpipe. Hydraulic characteristics can be determined by monitoring the changes in water levels over recorded time.

The hydraulic permeability of the unconsolidated material, interpreted from the data recorded from the test and interpreted using aquifer analysing software (AQTESOLV) is presented in Appendix 8.5, Book 3. The average permeabilities, based on a number of different interpretations of the data for each shallow borehole are listed below:

- BH1A : $K(\text{average}) = 3.10 \times 10^{-7}$ m/sec
- BH2A: $K(\text{average}) = 3.59 \times 10^{-7}$ m/sec
- BH3A: $K(\text{average}) = 9.65 \times 10^{-7}$ m/sec
- BH4: $K(\text{average}) = 2.45 \times 10^{-6}$ m/sec

Based on the range of permeabilities recorded within the site, which range from 2.45×10^{-6} m/sec at the upper range and 3.10×10^{-7} m/sec at the lower range of values, the permeability of the subsoil would be regarded as a low permeability material.

8.2.5.4 Piezometry and Groundwater Flow Direction

The natural piezometric levels in this region are considered to have been permanently altered due to the artificial drainage of the blanket bog areas and the extraction of the majority of the peat material. This artificial drainage would have resulted in a general lowering of the perched watertable associated with the virgin blanket bog.

All boreholes drilled within Area 6 were retrofitted with screen and casing to act as groundwater monitoring points. The paired boreholes around the margins of Area 6 permit water level entry within the unconsolidated material and the bedrock separately to determine if there was any piezometric head difference between the two strata. The static water level in each borehole was monitored on the 04th November 2003 to give an indication of winter maximum levels, with the measured data detailed below:

Table 8.1: Piezometric Levels within Srahmore Peat Deposition site

Borehole	Grid Ref.	Topographic elevation of boreholes	Water Level 04/11/03 (m to top casing)	Water Level 04/11/03 (mOD)
BH1A (Subsoil)	E084447, N323042	17.56	2.57	15.088
BH1B (Bedrock)	E084447, N323042	17.524	2.85	14.794
BH2A (Subsoil)	E083900, N323514	17.204	3.25	14.104
BH2B (Bedrock)	E083900, N323514	17.171	3.23	14.091
BH3A (Subsoil)	E084908, N323738	20.287	2.02	18.517
BH3B (Bedrock)	E084908, N323738	20.26	2.24	18.02
BH4 (Subsoil)	E084490, N323371	17.218	2.51	14.808

The first issue regarding the water levels is that the watertable in Area 6 is almost entirely below the peat, (i.e. water table is located in the mineral subsoil). The perched watertable associated with virgin blanket bogs has been altered by artificial drainage of the bog and the peat extraction activity.

The water level recorded in the overburden boreholes is slightly higher than the water level in the bedrock. The difference in piezometric head suggests a downward hydraulic gradient, resulting in recharge conditions. The downward hydraulic gradient measured within this site is very slight.

Further analysis of the water level data indicates that, based on the piezometric levels of the overburden, the groundwater flow direction is generally towards the west to southwest

within the site, towards the Munhin and Owenmore River. The piezometric levels of the bedrock also indicate that groundwater flow is to the west to southwest, almost mirroring the flow direction of the overburden groundwater.

Based on the available data, a groundwater flow map for the overburden is shown in Figure 8.5, which shows schematic groundwater flow contours and the inferred groundwater flow direction. The groundwater flow in the bedrock is very similar to that of the overburden.

8.2.6 Groundwater Vulnerability

Groundwater vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities. The vulnerability category is based on the relative ease with which infiltrating water and potential contaminants may reach groundwater in a vertical or sub-vertical direction. The permeability and thickness of the subsoil, which influence the attenuation capacity of a subsoil, are important aspects in determining the vulnerability of groundwater.

At present (2010) there is no published groundwater vulnerability map for I gContae Maigh Eo (County Mayo). The interim groundwater vulnerability rating for the site, as published by the GSI is High to Low.

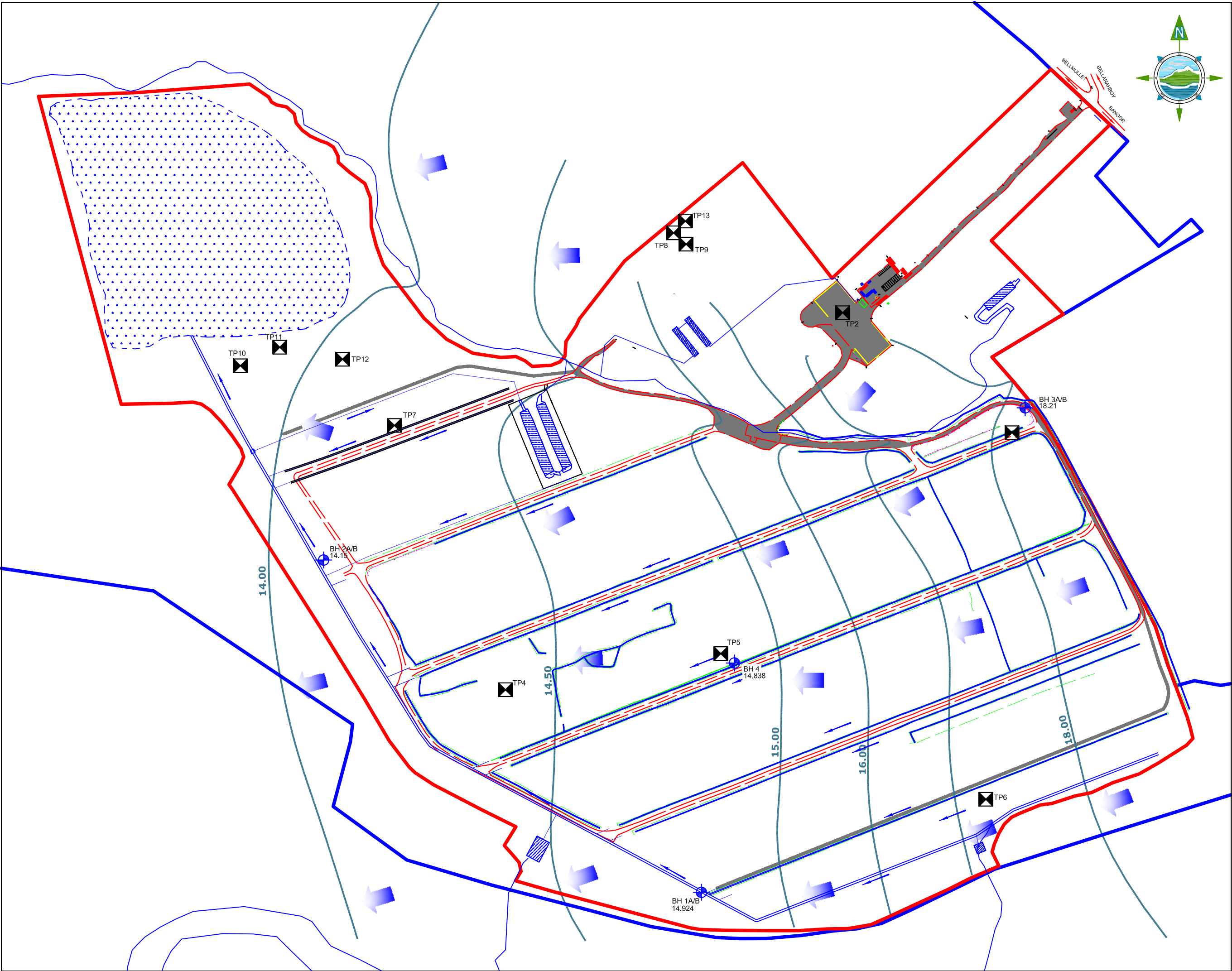
However, based on the site specific information gathered and using the guidelines for Groundwater Vulnerability categorisation, it is possible to determine the vulnerability rating for the Srahmore Peat Deposition site.

The borehole records for the site indicate that rockhead varies from 6m bgl to greater than 30m bgl. The remaining peat material is low permeability and the hydraulic testing of the mineral subsoil indicates that it is also low permeability. Therefore, based on the site specific information and the GSI guidelines, the vulnerability rating for the site is assessed as Moderate or Low Vulnerability around the margins of the site and Low Vulnerability within the centre of the site.

8.2.7 Groundwater Abstraction

As part of the baseline assessment for the original application (2003) all domestic dwellings within 500m of the proposed peat deposition site were identified. The survey indicates that 22 No. domestic dwellings, 14 No. agricultural buildings and 6 No. derelict houses exist within 500m of the proposed peat deposition site boundary.

The aquifer potential of the mineral bedrock and mineral subsoil is considered to be poor.



GENERAL LEGEND

LANDS UNDER CONTROL OF DEVELOPER	SITE ACTIVITY BOUNDARY
PUBLIC ROAD	EXISTING MAJOR CONTOUR
INTERNAL ACCESS ROAD	DRAINAGE
GROUNDWATER CONTOUR	SETTLEMENT LAGOONS
TRIAL PIT LOCATION	BOREHOLE LOCATION
GROUNDWATER FLOW DIRECTION	

NOTES

- FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING
- ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE
- ENGINEER TO BE INFORMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES
- ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD
- OS 6" SHEET NO's: MAYO 18 & 26

50m 0 50m 100m 150m

Rev	Date	Description	By	Chkd.
F	07-05-10	ISSUED FOR RE-SUBMISSION	MN	ST
E	01-02-09	ISSUED FOR RE-SUBMISSION	VB	MC
D	10-11-08	ISSUED FOR SUBMISSION	VB	MN

Applicant: **Shell E&P Ireland Limited**
Corrib House, 52 Leeson Street Lower, Dublin 2, Republic of Ireland.

Operator: **BORD NA MÓNA**

Project: **CORRIB ONSHORE PIPELINE DEVELOPMENT**

Aspect: **SRAHMORE PEAT DEPOSITION SITE**

Title: **BASELINE GROUNDWATER LEVELS AND FLOW DIRECTION**

Scale @ A3: 1:5,000

Prepared by: V.Bonney	Checked: M.Nolan	Date: March 2010
Project Director: S.Finlay		

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Drawing No.: **Figure 8.5**

Revision: **F**

No boreholes or wells were identified during the baseline assessment and local information indicates that all drinking water for the region is derived from Carrowmore Lake, upstream of and to the north of the proposed site (Location of Carrowmore Lake shown on Figure 1.1).

Carrowmore Lake is a major public drinking water supply source in this region of north I Maigh Eo (Mayo). The Carrowmore Public Supply is operated and maintained by Mayo County Council. During the baseline assessment the water reservoir for Bangor was identified on elevated land to the north of the site. The storage capacity of the reservoir is approximately 2,250m³, which is recharged from Carrowmore Lake as required. The capacity of the reservoir is capable of meeting the peak requirements of the population of Baingear (Bangor) village and its hinterland. This surface source is utilised due to the poor aquifer potential of the bedrock and subsoil.

Service and potable water for the Srahmore Peat Deposition Site is provided, and will continue to be provided, from connection to the Carrowmore Public Supply scheme.

8.2.8 *Geotechnical Assessment*

Prior to the import and deposition of the peat from the Bellanaboy Bridge Gas Terminal site, a preliminary geotechnical assessment of the Srahmore Peat Deposition site was carried out by Applied Ground Engineering Consultants Ltd. (AGEC); a copy of AGEC's Report is presented in Appendix 8.6, Book 3.

AGEC undertook a ground investigation, assessed found conditions and examined the stability of the pre-in-filled deposition area and its projected stability following peat deposition; the stability of proposed internal and perimeter haul roads were also examined, as was the proposed access and peat reception area.

AGEC's conclusions were as follows:

- Factors of Safety for the global stability of the deposition area were considerably in excess of the requirements of British Standard BS 6031 for both the present and filled condition;
- Factors of Safety for the internal haul roads were in excess of the requirements of BS 6031;
- Careful assessment and maintenance of the more heavily used sections of haul roads was recommended; and
- Various construction options for the access road and peat reception areas were assessed and where peat is left in place a biaxial geotextile laid on granular material will be required along segments of the entrance road.

Dan Duggan of TOBIN Consulting Engineers undertook a subsequent stability assessment of the Srahmore Peat Deposition site in December 2007, following the import and deposition of approximately 448,000m³ from the Bellanaboy Bridge Gas Terminal site.

This stability assessment, included in Appendix 8.7, Book 3, concludes that there is no indication of instability in the internal high fields, the perimeter high fields or the drainage network. The report continues that, based on the current condition of the deposited peat, the risk of a mass flow of deposited peat in the infilled bays entering adjacent watercourses is very low. Regular maintenance of the drainage system is recommended to ensure the drains remain open.

A more recent stability assessment of the Srahmore Peat Deposition site was undertaken by Dan Duggan in March 2010 and the report is included in Appendix 8.7, Book 3. This assessment concludes that there is no indication of any significant deterioration in the stability of the perimeter high fields, deposited peat and drainage network since the site was last inspected in December 2007.

The deposited peat is contained within each bay and, in its current condition, the risk of a mass of deposited peat flowing out of Bays 2, 3, 4 & 5 and entering the surrounding watercourses is very low. The report also concludes that in the deposition area the maintenance of the drainage network is critical to ensure the continued stability of the deposited peat. Bord na Mona have confirmed that they are monitoring the drainage system and that plant is available to re-open drains in the event that section of the side walls of drainage channels collapse.

8.4 Characteristics of the Proposed Development

The Srahmore Peat Deposition site was granted planning permission by An Bord Pleanála (Ref. PL16.207212) and a Waste Licence from the EPA (Ref. W0199-01) for deposition of 450,000m³ of peat generated in the construction of the Bellanaboy Bridge Gas Terminal site. At the planning stage of the original application it was anticipated that the 450,000m³ would be accommodated within full extent of Area 6 of the Srahmore Peat Deposition site.

The planning permission for the Terminal site and waste licence for the Srahmore Peat Deposition site was granted in October 2004. The peat excavation and deposition activity was undertaken in 2005 and 2007.

Upon completion of the deposition of approximately 448,000m³ of peat, significant remaining voids exists within the previously permitted site. This is remaining void area within the previous activity area granted planning permission by An Bord Pleanála and a waste licence by the EPA.

The peat from the Terminal site was deposited in Bay 2 (20-25% occupied), Bay 3 (100% occupied), Bay 4 (100% occupied) and Bay 5 (100% occupied).

Under this development proposal it is proposed to infill the remaining void space within Bay 2 and progress to infill Bay 1 and Bay 6 with up to 75,000m³ of peat from the onshore pipeline development. Bay 7 will be used as a reserve area for deposition if required. These bays are within the activity area previously granted planning permission for peat deposition.

The difference in the design occupancy of the peat and the actual occupancy of the peat in Area 6 is explained by drainage of the peat at the Terminal site and the higher density of the peat accepted at the deposition site. This led to a greater volume of peat being stored in a smaller deposition area.

Owing to the proven track record of the peat deposition within the Srahmore Peat Deposition site, it is proposed to deposit up to 75,000m³ of peat material sourced from the onshore pipeline within Bay 2, Bay 1 and Bay 6 (with 7 available if required).

It is proposed that activities within the Srahmore Peat Deposition site will be consistent with activities previously undertaken within the site. It should be noted that the infrastructure necessary for the successful peat deposition activity is largely intact within the site, with some temporary infrastructure requiring re-import or establishment within the site.

The proposed deposition works at Srahmore will be carried out by an approved contractor, under the management of Bord na Móna, in accordance with the requirements of planning conditions, together with the requirement of the Waste Licence issued by the EPA.

The peat will be excavated from the pipeline development in a controlled manner, as detailed in Volume 1 & 2 of the EIS. Following inspection of the peat at the Srahmore Reception area, to ensure the water content of the peat is appropriate for deposition, the material will be transported by deposition area by low ground bearing vehicles utilising Haku Trailers. This is the same methodology for peat deposition previously employed at the site during previous operations.

The activities associated with the development are summarised below and are dealt with in more detail in Section 2 herein:

- The material transported by road from the onshore pipeline development will access the Srahmore Peat Deposition site from the existing access road south of the R313, in Area 5 of the Bord na Móna land;
- All road vehicles will unload the peat in the existing purpose built reception hardstand area;

- The peat will be loaded onto specialist low ground bearing machinery (Haku Trailers) for transport to the deposition area;
- It is proposed that all the peat will be deposited in Bay 2 initially and thereafter deposited in Bay 1 and then Bay 6 (with Bay 7 available as reserve, if required) of Area 6. These bays were previously identified for infill under the previous planning permission;
- The plant and machinery will travel from the reception area to deposition bays on the existing internal haul road;
- It is proposed to construct an access road along the centre of Bay 2, by laying a geotextile layer along a linear strip of the lowfields and laying rock hardcore;
- Temporary timber mat roads will be laid parallel to the central haul road;
- Peat deposition will commence either side of on the temporary timber mat haul roads. Once the deposition is complete, excavators will trim the gradient to produce a cross fall of 1:37.5;
- The timber mats will then be removed and peat deposition will occur from the central haul road;
- Deposition from timber mats will be undertaken within Bay 1 and Bay 6, without the requirement for a rock access road;
- Excavators will trim the gradient along the central spine of the bay to achieve a peat depth at the centre of approximately 2m and a cross fall from the centre to either side of 1:37.5. This cross fall is required to ensure water is shed off the deposited peat mounds;
- Following initial settlement of the deposited peat, Bord na Móna will undertake visual inspection of the peat and determine if any additional slit drainage is required to enhance water shed from the deposited peat mounds;
- The shape of the deposited peat has been designed to enhance water run-off from the peat to the drains so as to minimise the risk of surface water pooling on deposited peat;
- Drainage of the bays will be an important aspect of the overall project. Drains will be excavated and maintained in the bays, immediately adjacent to the high fields. All runoff from the deposited peat will be collected in these drains and transmitted to a perimeter swale;
- The perimeter swale will discharge the water collected from the site to the adjoining surface watercourses, following settlement to lower the suspended solid content;
- Following the placement and shaping of the peat, it is envisaged that the peat surface will be anchored by vegetation during the stabilisation process.

The existing drainage systems constructed and successfully utilised under the previous application in Area 5 (Reception Area) and Area 6 (Deposition Area) will continue to operate in order to allow effective drainage of the peat to ensure any run-off from the peat reception hardstand is effectively treated and to ensure the long-term stability of the peat.

A portion of Area 7 continues to be included in the site boundary. This area will be utilised to be reserved as a controlled overflow area, to ensure that the drainage system constructed within Area 6 operates at optimal performance design at all times. The drainage system has been designed to cater for an intense rainfall event of 34.6mm over 1 hour (1:100 year return period). In the event of a higher rainfall event occurring, the controlled overflow area will be utilised to manage the excess water so as not to damage the integrity of the treatment structures constructed to lower the sediment content of the runoff.

8.5 Potential Impact of the Proposed Development

With respect to the regional soil and geology environment, the past industrial activity has resulted in a permanent and significant impact on the geological environment, in the form of removal of peat from the surface. This activity has impacted the shallow geological environment. The peat harvesting has resulted in a change in the topographic landform and the lowering of the topographic elevation within worked areas.

The site has been used previously in 2005 and 2007 for the deposition and infill of approximately 448,000m³ of peat within the cut-over area of the site. This infill of peat was designed to enhance the rehabilitation of the cut-over peat.

This proposed peat deposition development, involving the deposition of up to 75,000m³ of peat from the onshore pipeline development, will not impact on the surrounding environment outside the boundary of the proposed peat deposition site. All peat acceptance handling and deposition will be undertaken within the boundary of the Srahmore Peat Deposition site.

In order to minimise any potential impact on the environment, including the soil and geological environment, 'Avoidance of Impact' was incorporated into the design of the development. Bord na Móna has extensive experience of the handling and deposition/storage of peat, especially through the recent deposition of approximately 448,000m³ of peat from the Bellanaboy Bridge Gas Terminal site. The experience gained through this operation will be used to ensure that the continued deposition works are undertaken in an environmentally sound manner.

Due to the nature of the development, i.e. importation and deposition of peat, there is the potential for impacting the shallow soil and geology environment within the site. The magnitude of the impact is considered low. The assessment of the magnitude has taken account of the deposition of peat on peat previously. The deposition of peat onto an exposed peat surface will not significantly impact the geological environment, other than to raise the topographic elevation.

It is essential that the peat is deposited in a manner that ensures it is stable and does not pose a risk of movement. The experience of the previous activities on-site was used to design the current deposition methodology.

The impact on the mineral subsoil and the bedrock environment is considered negligible, as these strata are not exposed on-site and the peat will be deposited directly onto the native peat.

The aquifer potential of the mineral subsoil and the bedrock has been demonstrated to be poor. The deposition of peat material within areas of exposed peat surface would be considered to pose a negligible impact to hydrogeology of the area.

Based on the water levels recorded from the boreholes installed within the site, the watertable varies in depth from 2.2m bgl to 3.2m bgl, and is located in the mineral subsoil layer. Any historical natural perched watertable associated with virgin blanket bogs has been removed as a result of drainage and peat extraction within the site.

8.6 Do Nothing Scenario

The previous deposition of peat from the Terminal site has resulted in full occupancy of peat in Bay 3, Bay 4 and Bay 5. Approximately 20-25% of Bay 2 has been infilled. The areas where peat from Bellanaboy Bridge site has been infilled has quickly vegetated and anchored the peat, leading to reduced instability risk.

The industrial harvesting of peat by Bord na Móna has now ceased in I gContae Maigh Eo (County Mayo). It is not envisaged that this site will be worked in the future. In areas where no infill has occurred there has been a very poor re-vegetation.

Under the do-nothing scenario, the Srahmore site will not significantly alter from current conditions.

8.7 Mitigation Measures

The principal mitigation measure to ensure that the proposed facility does not impact on the soil and geology environment is that all works associated with any further peat deposition will be limited to optimal weather conditions and will be undertaken over a relatively limited timeframe during the construction of the onshore pipeline (which in itself is weather dependent). Peat will be deposited at Srahmore over two phases, in line with the construction programme for the onshore pipeline. Works will be limited to periods of good weather to ensure minimal impact and, if necessary, up to 3000m³ of peat can be temporarily held on the existing hardstanding area.

The exact timeframe envisaged for deposition of up to 75,000m³ of peat will be dictated by the rate of extraction along the pipeline development this is dependent on climatic variables and other contributory factors.

The deposition of up to 75,000m³ of peat is lower than deposition activities previously undertaken during the successful import and deposition of approximately 448,000m³ of peat from the Terminal site.

All peat will be inspected within the reception area to ensure it is appropriate for deposition. The operations will be undertaken by an appointed contractor, but overseen and dictated by a Bord na Móna management team. Peat will not be deposited until Bord na Móna are satisfied as to its suitability for deposition.

In order to stabilise the peat within the storage area, the material will be deposited and shaped to enhance water runoff from the peat. This will involve creating a cambered surface to reduce the risk of rainwater being retained on the surface of the peat. The cambered surfaces will be graded to perimeter drains. All bays where peat is stored will drain to a perimeter swale to prevent the risk of water being retained onsite. This drainage is proposed to ensure the deposited peat does not become saturated.

The sediment control measures constructed on and adjacent to the reception area, comprising a sediment trap and a series of oil interceptors, will continue to be utilised to reduce the risk to the surrounding environment. All water draining from the site will gravity flow to open water channels and flow to settlement ponds/lagoons. These settlement devices are designed to provide low energy environment and high residence times to allow suspended solids to fall out of suspension. During previous activities within the peat reception area and the peat deposition site, this infrastructure has proven highly effective in minimising discharges to the receiving environment. Details of the water control measures are included in Section 9 (Hydrology and Drainage).

All potentially polluting materials, including hydraulic fluid, engine oil and fuel, will be stored in specified areas, which will be bunded to ensure total containment in the unlikely event of total failure of the storage facility. This will reduce the risk of soil contamination due to activity of plant and equipment.

Due to the minimal disturbance of the geological environment, the mitigation measures are restricted to the stabilisation of exposed soil surfaces.

8.8 Predicted Impact of the Proposed Development

The predicted impact due to the placement of up to 75,000m³ of peat, in a site previously successfully used for mass storage of approximately 448,000m³ of peat will represent a minor but permanent predicted impact on the existing geological environment.

However, the predicted permanent impact involves the raising of topographic elevations within an industrially worked out peatland and within a relatively small area of the overall site. This predicted permanent impact is not considered significant and does not represent a risk to the soil and geology environment.

8.9 Monitoring

During and post peat deposition it is proposed to continue the existing monitoring programme, in compliance with the requirement of the existing waste licence.

The stability of the peat is not considered to represent a risk to the surrounding environment as it will be completely contained within the bays and bound by the high fields and the margins of Area 6. However a stability assessment will be undertaken following the deposition of peat within the site.

Each mound will be visually assessed on a monthly basis or following heavy rainfall by Bord na Móna site operatives to check that the topographic camber has not settled to allow ponding of free water. If such settlement occurs the mound will be reshaped if possible, however if such reshaping is not feasible, drainage channels will be excavated to allow water flow to the arterial drains adjacent to the high fields. Such monitoring will further ensure the stability of the peat mounds.

During and following deposition of the peat it is proposed to monitor the surface water and groundwater chemistry to ensure there is no significant deviation in water quality from background levels. The placement of the peat on a cutover peatland has not previously and is not anticipated to impact on the receiving environment.

An annual assessment of the vegetation cover will be conducted. It is envisaged that the mounds will be completely stabilised within 5 years of placement and complete vegetation cover will have established across the site.

The drainage channels will be maintained to transmit water offsite during this period. Any further rehabilitation plans will only be reviewed when Bord na Móna and the regulatory authorities are completely satisfied that the peat is completely stabilised and there are no inherent risks to the surrounding environment.

8.10 Reinstatement and Residual Impacts

As a result of the permanent storage of peat in the cut-over bog, there is no potential for reinstatement. The deposition activity itself could be considered a reinstatement activity to the previous industrial harvesting activities undertaken by Bord na Móna in the past.

Due to the previous industrial use of the Srahmore Peat Deposition site and the nature of the proposal to deposit peat in the low elevation bays, coupled with the extensive mitigation measures to stabilise and control the peat, it is considered that there will be no residual impact in this area.

The timescale of activities within the site is relatively short in duration, over two phases (in line with the construction programme for the onshore pipeline) and thereafter, the only activities will be associated with maintaining drains and monitoring the stability of the peat.