N4 Collooney to Castlebaldwin, *Proposed Road Development*

APPENDIX NO. 4.3

'ENVIRONMENTAL ASSESSMENT REPORT'

Spoil Management

PREPARED BY: National Road Design Department, Sligo County Council;

Document Control

Status	Issued For	Developed	Approved	On behalf of
FINAL	*Publication*	*FM*	*AS*	*NRDD SCC*

Preface

The information contained herein has been undertaken **principally to fulfil the requirements of section 50(3) (a) and (c) of the Roads Act, 1993 (as amended) in relation to the information which is to be contained in an Environmental Impact Statement. Assumptions have been made which are unavoidable at the current stage of the project and consent procedure. Any conclusions made shall be verified by the contractor during Phase 5 and Phase 6 of the NRA PMG. In this regard, from a contractual viewpoint, no responsibility will be accepted by the Local Authority or the NRA for the:**

- **dimensions of identified sites;**
- **the actual volumes and composition of materials to be extracted or deposited;**
- **the methods of extraction or deposition; or**
- **additional statutory consents which may be required;**

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1 Introduction and Objectives

1.1 Background

This document has been prepared to address how Spoil[1] Material generated by the *Proposed Road Development* (*PRD*) during the earthworks phase will be handled. It has been formulated by the National Road Design Department of Sligo County Council with input at various stages by environmental and geotechnical consultants carrying out the EIS for the *PRD*. The responsibilities and inputs of the report are as outlined in Table 1-1 below.

Table 1-1: Report Responsibilities

Aspect	Company
Report Development	
Compilation, technical development and refinement of options;	*National Road Design (Sligo County Council)*
Environmental Screening Assessment	
Soils and Geology Assessment	*Minerex Environmental Ltd.*
Hydrology and Hydrogeology Assessment	*Minerex Environmental Ltd.*
Flora and Fauna Assessment	*Ecofact Ltd.*
Landscape and Visual Assessment	*MossArt Ltd.*
Agriculture & Material Assets Assessment	*Philip Farrelly Ltd. (consultation only)*
Noise and Vibration Assessment	*AWN Consulting Ltd.*
Air Quality Assessment	*AWN Consulting Ltd.*
Archaeology Assessment	*ADS Ltd.*
Geotechnical Review	
Geotechnical Considerations	*AGL Consulting Ltd.*
Review	
Report Review	*NRA Environment Unit*
Strategy Review	*Duncan Laurence Environmental Ltd.*

1.2 Contract Procurement

The Contract Procurement as outlined in Chapter 4 of the EIS is expected to be that of a Design/Build Contract. At the heart of the Design/Build approach is the concept that better value for money can be achieved through the utilisation of private sector enterprise due to the enhanced scope for innovation and by allocating the risk to the party best able to manage it. This type of contract places a responsibility on the appointed contractor to design and construct the project in accordance with the obligations of this EIS.

[1] Spoil Material is a shorthand definition used for the purposes of this report for material which is excavated during the construction works. The term has been selected on the basis that it is essentially neutral and free from any of the conotations associated with the word "waste". The latter has a more precise legal meaning in accordance to the Waste Management Act and EU law. As is discussed later in this chapter, material handled on-site does not fall into the legal definition of "waste"; by contrast, should it be taken off-site, it is likely to be regarded as "waste" and thus subject to additional environmental controls.

1.3 Environmental Impact Statement

1.3.1 Roads Act

The report has been prepared in order to fulfil the requirements of section 50(3) (a) and (c) of the Roads Act, 1993 (as amended) and as set out in paragraph 1.2. of Volume 2 (EIS Main Report) which states:

An environmental impact statement shall, in addition to and by way of explanation or amplification of the specified information referred to in subsection (2), contain further information on the following matters:

(a)

i. a description of the physical characteristics of the whole proposed road development and the land-use requirements during the construction and operational phases;

ii. an estimate, by type and quantity, of expected residues and emissions (including water, air and soil pollution, noise, vibration, light, heat and radiation) resulting from the operation of the proposed road development.....

(c) a description of the likely significant effects (including direct, indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative) of the proposed road development on the environment resulting from—

...

• the emission of pollutants, the creation of nuisances and the elimination of Waste*, and a description of the forecasting methods used to assess the effects on the environment;...*

...to the extent that such information is relevant to a given stage of the consent procedure and to the specific characteristics of the proposed road development or type of proposed road development concerned, and of the environmental features likely to be affected, and the road authority preparing the environmental impact statement may reasonably be required to compile such information having regard, inter alia, to current knowledge and methods of assessment."

1.3.2 Information available at the current stage of consent

Different levels of detail about the nature of the works and other relevant matters arise at successive stages of the development of this road project. All relevant aspects and significant environmental impacts are covered in the design proposed for the purposes of the consent applied for under Section 51(1) of the Roads Act, 1993 (as amended). That consent provides an envelope within which the final design can be drawn up in additional detail during phase 5 and 6 of the NRA PMG. The need for further detail at subsequent stages arises from the procurement method proposed (Design/Build), which must contain a degree of flexibility in the selection of final options, and the fact that the environmental impact assessment process should not be burdened with unnecessary information or by the consideration of essentially trivial matters.

Such considerations are particularly relevant in terms of how spoil from this project is generated and subsequently managed. The purpose of this Appendix is to add a degree of clarity about the various possible options available for spoil management, while also attempting to assist a Contractor in the detailed design/construction stage. However, this assessment has been based on the best information available at the current stage of the design and consent process. Its primary purpose is to satisfy the requirements of section 50(3) (a) and (c) of the Roads Act and the need to adequately document the full nature of the project and set out its key impacts, their mitigation, and so on. Thus no **responsibility** will be accepted for the contractor's use or reliance on any of the information contained herein. It will be the contractor's **responsibility** ultimately to manage this material, including compliance with and consideration of all statutory planning, environmental and other requirements.

1.3.3 Outline Spoil Management

The outcome of the process described in the previous section is to be called Outline[2] Spoil Management. The objective is to examine options/sites within or in the vicinity of the *PRD* which may be considered suitable in principle to accept or use this material.

[2] *Outline* is deemed appropriate to use given the current stage of the project.

In order to establish the most appropriate management techniques for the Spoil Material, a staged process of examination was developed. Various other sections of this EIS feed into the various stages, however, the following is a general outline of the key elements.

- **Stage 1** (Section 3 of Report): Initial Investigation which included a broad examination of the most likely options available*;*
- **Stage 2** (Section 4 of Report): Refinement of Stage 1 Options into a broad *Range of Options;*
- **Stage 3** (Section 5 of Report): An environmental investigation of Stage 2 options to determine if they are or are not suitable;
- **Stage 4** (Section 7 of Report): As assessment of what is considered to be the optimum option;
- **Stage 5** (Section 8 of Report): This Stage includes:
    - An examination if the identified optimum option from Stage 4 could be included within the limits of the *PRD*; and if so
    - An expansion in detail of this option for inclusion with direct assessment within the various chapters of the EIS;
- Additional considerations are made in the last two sections (Sections 8 and 9) in relation to the relevance of waste management law and the residual risk of the requirement to take material offsite;

1.4 EU and National Waste Policy Affecting this Project

Besides being governed by EU law and the requirement for an environmental impact assessment, certain aspects of this development are subject to the EU Directive on Waste and the Waste Management Acts 1996 to 2011. In summary, these provisions have two key influences on this development. Firstly, they set additional statutory and environmental protection requirements that affect the removal of surplus material off-site from this development. Secondly, they subject this material to what is known as the Waste Hierarchy, requiring that it is handled in the most optimal way. However, these requirements only apply to a proportion of the surplus material generated by this *PRD* and, given the significant amount expected to be produced, it seems important to set out where the boundary lies. Accordingly, this matter is summarised in the next section.

1.4.1 Exclusion from the Legislation for Excavated Material Re-used at a Construction Site[3]

The Directive on Waste contains a number of exclusions which make clear that certain materials are not subject to its requirements. A key one affecting construction projects such as this development is set down in Article 2(1)(c). This states that the requirements of the EU legislation do not apply to:

> *uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated*,

This provision is repeated in the Waste Management Act, as Section 3(1)(c)[4]. Should materials generated by construction activities fall within this provision, they are not then subject to the other requirements of the EU or national waste legislation. This means that, for example, such materials are not defined as “waste”, do not need to be handled by duly authorised waste collectors and do not need to pass to disposal or recovery facilities that are subject to waste licences or other equivalent form of statutory authorisation. In addition, the requirements of the Waste Hierarchy (explained in the next paragraph) do not apply.

That road construction projects are subject to this provision is confirmed by guidance issued by the European Commission. This guidance reflects the Commission’s responses to a wide range of questions emanating from

[3] Based on an interpretation by Duncan Laurence Environmental.

[4] As amended by the European Communities (Waste Directive) Regulations 2011 (SI 126 of 2011)

EU states over the period from the Directive on Waste's finalisation in 2008 to the guidance's publication in June 2012.

Section 2.3 of the guidance sets down the Commission's understanding of this exclusion. This is reproduced in full as Table 1-2 as it provides a succinct and helpful explanation of the key facets of this statutory exclusion. In essence, this element of the Directive on Waste has been drafted specifically to clear up legal uncertainty about whether or not the legislation applied when excavated natural materials were to be re-deposited at the same construction site. By placing this exclusion at the start of the Directive, the intention is to avoid any form of more complex discourse about the status of such materials, whether they are to be viewed as "discarded" and defined as "waste", whether statutory authorisation is applicable, and so on. Provided that what is proposed follows all aspects of the exclusion, the other requirements of the EU and national waste legislation do not apply. Instead, this aspect of the development is subject to An Bord Pleanála's consideration in its environmental impact assessment conducted under the Roads Act.

As is quantified later in this report, a very large quantity of sub-soil and surplus peat will be generated by the *PRD*. It is proposed (as a result of this report and assessment) that a very significant proportion of this material is to be handled within the boundaries of the *PRD* and that associated with its CPO. Although benefitting from the exclusion set by EU and national waste management law, the nature of how this material is proposed to be handled forms a significant part of this project. As such, details of what is proposed and the associated environmental impacts are included within this Environmental Impact Statement. In addition, the process under which the various options to handle this material were identified needs to be justified in the manner set out later in this report.

Table 1-2: European Commission's Explanation of Exclusion for Excavated Soil and other Naturally Occurring Materials[5]

2.3 Exclusion for excavated soil and other naturally occurring material (Article 2(1)(c) WFD)

2.3.1 Subject and background

The exclusion under Article 2(1)(c) WFD[6] *relates to 'uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated'.*

The background to this exclusion is that a Waste *management regime was commonly regarded as inappropriate for this kind of material, even if the definition of discarding is fulfilled.*

In order to be excluded from the scope of the WFD, the requirements here are three-fold. The material must be:

- *uncontaminated;*
- *excavated during the construction activities;*
- *certain to be used in its natural state for construction purposes on the same site.*

The Waste *management regime applies to any material used in construction that does not cumulatively meet these three criteria. However, it is possible to assess whether such material meets the criteria for by-products and end-of-*Waste *(see Chapter 1.3 above), as emphasised by Recital 11 of the WFD*[7].

2.3.2 What is meant by 'uncontaminated soil'?

'Uncontaminated soil' essentially relates to virgin soil or soil that is equivalent to virgin soil (see Chapter 2.2.2 above). Other naturally occurring material means soil, stones, gravel, rock, etc. Man-made material like concrete, or items that have been modified by man, e.g. wooden material, are not excluded from the scope of the WFD.

2.3.3 Examples of certainty of use of a material in the sense of Article 2(1)(c) WFD

In order to be excluded, the excavated material must be used in a construction activity on the site. Certainty of use could be inferred from, for example:

- *Construction plans or designs for the site in question. These may contain estimates of excavated amounts and whether there will be a surplus or deficit of such material;*
- *Planning-permission conditions;*
- *Construction and demolition* Waste *management plans, if required;*
- *For larger scale developments, the Environmental Impact Assessment (EIA).*

2.3.4 What does 'on the site' mean?

A construction site will usually be defined in relation to the associated planning permission.

Examples of what can be considered to be 'on the site' include:

- *A construction project for a 100 km motorway, where excavated material from one section of construction is used in its natural state in the same construction section.*
- *Soil or other such material temporarily taken from the site but returned later and used on the site for the purposes of construction (the transport operation as such is not relevant).*

1.4.2 The Waste Hierarchy

Besides the requirements that the off-site handling of waste generated by this project are subject to the required statutory authorisations under the Waste Management Act, there is also a necessity that it conforms to the Waste Hierarchy. This is a requirement of Article 4 of the Directive on Waste, being transposed as Section 21A of the Waste Management Act[8]. As explained above, the Hierarchy only applies to material that is defined as "waste". This means that is does not apply to the proportion of the spoil that is handled on-site in conformity with the statutory exclusion discussed earlier.

In order of priority, the hierarchy sets out the most desirable approaches to Waste management as comprising:

[5] European Commission (2012) Guidance on the Interpretation of Key Provisions of Directive 2008/98/EC on Waste, pp42-43

[6] The Directive on Waste, this is sometimes termed the Waste Framework Directive (WFD)

[7] "*The waste status of uncontaminated excavated soils and other naturally occurring material which are used on sites other than the one from which they were excavated should be considered in accordance with the definition of waste and the provisions on by-products or on the end of waste status under this Directive"* [author's emphasis]

[8] As amended by the European Communities (Waste Directive) Regulations 2011 (SI 126 of 2011)

(a) Prevention;

(b) Preparing for re-use;

(c) Recycling;

(d) Other recovery (including energy recovery); and

(e) Disposal;

How the off-site waste management element of this project confirms to the Hierarchy is discussed later in Chapter 9 of this Appendix.

2 Spoil Material to be Managed

The following is an overview of the results of analytical earthworks calculations which have been carried out on the *PRD.* An outline is also provided of the assumptions made[9] in determining that quantity of spoil expected to arise after the potentially re-usable material has been accounted for.

2.1 Earthworks Excavation

It is envisaged[10] that the construction of the N4 Collooney to Castlebaldwin *PRD* will require the excavation (from cut sections and areas of soft ground underneath embankments) of circa 1.4m m^3 of earthworks materials.

2.2 Estimation of Spoil material produced.

2.2.1 Material Suitable/Unsuitable for embankment construction

Circa 0.59m m^3 of the excavated material is expected to be directly re-useable within the permanent works for road embankment construction purposes. The remaining material (0.8m m^3) in its excavated state is estimated to be unsuitable for incorporation within the proposed road embankments.

In recognising the different properties which this remaining material is likely to exhibit, a categorisation for the purposes of this report has been applied:

- *Cat. X*: peat and soft alluvial or organic clay excavated predominately from underneath proposed road embankments;
- *Cat. Y:* Soft cohesive subsoil material classified as being U1 unacceptable[11] excavated predominately from the upper surfaces of drumlin hills which the *PRD* intercepts (i.e. road cuts).

2.2.2 Landscape Fill

Although this surplus material is not considered suitable for road construction purposes, its geotechnical properties may lend it to being suitable for landscaping within the confines of the CPO boundary. In this regard, there is potential for some of the material to be used for the purposes of construction in its excavated state.

2.2.2.1 Environmental Noise Bunds

The design was thus examined in consultation with the Noise & Vibration and Landscape & Visual Assessment specialists for locations where specific landscaping measures would ameliorate identified impacts from the road development. These included the following:

[9] Based on best available information at the current stage of consent

[10] The calculation of earthworks volumes is based on the preliminary alignment design and on preliminary ground investigations and the subsequent geotechnical interpretation of these investigations. The volumes are calculated primarily on a cut/fill basis outputted from the road design package '*MX Road',* the volumes are then categorized into their acceptability limits with the surplus volume being that which is required to be imported. Additionally, portions of the *Proposed Road Development* are located on soft ground, principally PEAT material that is not usually 'suitable' for road construction purposes. The exact method of construction will not be known until a contractor has been appointed for the project; however the Design aided by results of the preliminary GI has adopted the assumption that all soft material unsuitable for supporting the weight of the proposed route would be dug out and replaced with suitable fill material. These volumes have been calculated using *'Microsoft Excel'* and are generally based on the assumption that the soft ground will be excavated from within a 1V:1H influence line from the crest of the embankment, or to the embankment toe at the final ground surface, whichever is greater. Class 6A granular fill is required to fill below standing water. Class 1 or Class 2 general fill material can be used to construct the embankment above water level with a suitable geotextile separator or Class 6H blinding layer at the interface with the Class 6A fill.

[11] NRA SRW: Earthworks terminology

2.2.2.1.1 *Noise Barriers*

The Noise and Vibration Impact Assessment for the *PRD* has identified locations where Noise Mitigation is required in order to offset impacts. With available land space there is potential for these barriers to be constructed in the form of earthen bunds from the *'Cat Y'* subsoil material, in this regard the alignment and surrounding topography has been assessed for potential areas where bunds could be incorporated as an alternative to a proprietary noise barrier system.

Table 2-1 below outlines this consideration process resulting in the conclusion that none of the identified locations are suitable for the provision of noise bunds.

Table 2-1: Consideration of Noise Barrier locations for Environmental Earthen Bunds

Noise Barrier Location	Notes	Location suitable for Env. Bund	Volume (m^3)
Ch. 1,090m to Ch. 1,030m	Ref. Receptor 010 requires a 3.5m high noise barrier (assumed proprietary system). The distance to the adjacent property is circa 15m. In considering that an earthen bund would be required to be circa. 0.5m to 1m higher and would require 1V:3H to 1V:4H side slopes (as it is Class U1), this location is not considered suitable for construction of an environmental bund with the spoil material.	No	N/A
Ch. 1,600m to Ch. 1,700m	Ref. Receptor 016 requires a 1.5m high noise barrier (assumed proprietary system). Considering the proximity of the adjacent roundabout and the fact that provision of this will itself require a retaining wall on the mainline, this location is not considered suitable for construction of an environmental bund with the spoil material.	No	N/A
Ch. 4,050m to Ch. 4,200m	Ref. Receptor 119 requires a 4m high noise barrier (assumed proprietary system). There is a pinch point of c. 8m between the corner of an adjacent property and the top of the cut. In considering that an earthen bund would be required to be circa. 0.5m to 1m higher and would require 1V:3H to 1V:4H side slopes (as it is Class U1), this location is not considered suitable for construction of an environmental bund with the spoil material.	No	N/A
Ch. 10,550m to Ch. 10,700m	Ref. Receptor 227/336 requires a 2m high noise barrier (assumed proprietary system). The distance to the adjacent property is circa 25m. In considering that an earthen bund would be required to be circa. 0.5m to 1m higher and would require 1V:3H to 1V:4H side slopes (as it is Class U1), this location is not considered suitable for construction of an environmental bund with the spoil material.	No	N/A
Ch. 12,400m to Ch. 12,610m	Ref. Receptor 254 requires a 3.5m high noise barrier (assumed proprietary system). The distance to the adjacent property is circa 30m. In considering that an earthen bund would be required to be circa. 0.5m to 1m higher and would require 1V:3H to 1V:4H side slopes (as it is Class U1), this location is not considered suitable for construction of an environmental bund with the spoil material.	No	N/A

2.2.2.1.2 *Landscape & Visual Impact Assessment, Mitigation: Landscape Infill Site at Castlebaldwin*

The Landscape and Visual Impact Assessment Chapter of the EIS, has, as part of landscape mitigation screening, proposed that an area of severed agricultural land to the north-east of Castlebaldwin be graded to blend in with the existing and proposed public roads which bound it.

This landscape mitigation requires the low lying land to be raised above the profile of the embankments of the existing and proposed public roads as outlined in Figure 2-1and Figure 2-2 below. The area will then be planted with woodland planting, wild flower meadow and parkland grass.

In accordance with the NRA SRW the appropriate material for such landscaping would typically be Class 4 Landscape Fill. In consideration of the fact that much of the Category Y material would satisfy the geotechnical requirements of this material, it has been determined that a significant volume of the spoil material may be used for the purposes of construction in this regard.

Figure 2-1: Plan of Landscape infill area at Castlebaldwin

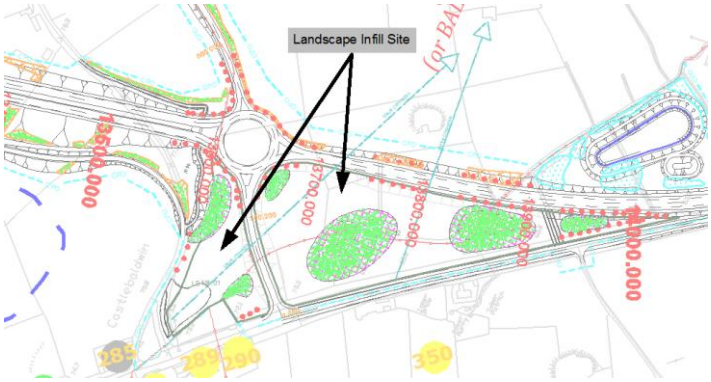


Figure 2-2: Section of Landscape infill area at Castlebaldwin

This proposal compliments and supports the objectives of the County Development Plan in relation to the Castlebaldwin Mini Plan which designates the north-western portion of the site as *open space* required to be developed for parks and play grounds.

These stated objectives of the Mini Plan are as follows:

24.1 Natural heritage and open space

C. Retain and enhance the existing public open space (OS-1) as shown on objectives map;

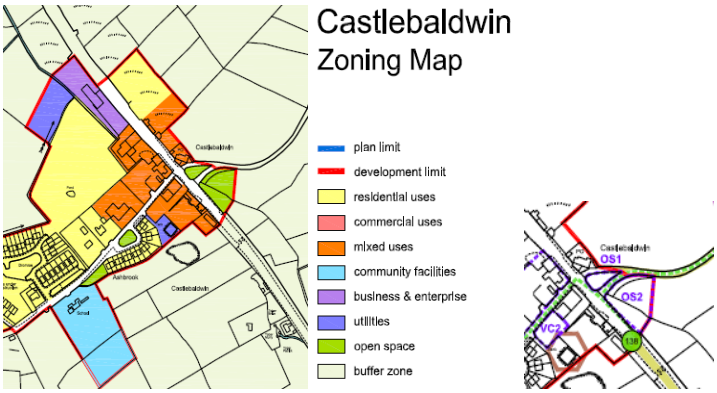
D. Reserve land for the provision of a new green area (OS-2), with picnic facilities and viewing point;

24.3 Circulation and parking

B. Facilitate the provision of a small car park within the site zoned for public open space (OS-2). The car park should be located at the northern end of the site.

Additionally, provision of such an area will also support objective 24.5 (Community Facilities) of the mini plan.

Figure 2-3: Castlebaldwin Zoning Map[12]



2.2.2.1.3 *Landscape infill of intercepting earthworks lines*

There are areas along the route of the *PRD* where the earthworks slopes of major and minor roads and/or constructed wetlands slopes intercept. From a landscape and visual perspective, these areas are best married together rather than leaving depressions between the slopes which would also encourage the ponding of water. In this regard, one such area has been identified as having the potential to accept a reasonable quantity of the spoil material.

2.2.2.2 Volumes achievable within Landscape Fill

Based on volumetric calculations, Table 2-2 indicates the volumes of material which may be incorporated as Landscape Fill along the *PRD*. In summary it is estimated that c. 147,500m^3 may be deposited at these sites leaving a net surplus of 661,220m^3 (Balance 1).

Table 2-2: Balance 1; Calculation of unsuitable material generated

		Cat. X		Cat. Y	
Description	**Total volume (m3)**	**Volume of PEAT (m3)**	**Volume of additional organic clay (m3)**	**Volume of subsoil (m3)**	***Comments***
Total Volume Generated	808,720	255,828	173,211	379,681	*Annalyitical Earthworks Calculation*
Landscape Mitigation Infill Site	139,500	-	-	139,500	*Landscaping proposed between road berms at Castlebaldwin.*
Landscape Infilling beteen adjacent earthw orks slopes	8,000			8,000	*This is an area on the RHS between Ch. 1,800m and Ch. 2,400m*
BALANCE 1	***661,220***	***255,828***	***173,211***	***232,181***	

2.2.3 Earthworks Material Processing

In the normal course of a construction contract of this nature, it is expected that a competent contractor would seek to process as much of the aforementioned material as is economically possible so that it may be incorporated into the permanent works.

2.2.3.1 Cat. 'X'

There may be potential for some of the *Cat. 'X'* material to be incorporated into the works for items such as topsoil improvements, however, in the overall scheme of the volumes being considered such a quantity is considered insignificant for the purposes of this report, therefore, a conservative approach is to consider that no quantities of Cat. 'X' will be reprocessed for use within the permanent works.

2.2.3.2 Cat. 'Y'

In relation to *Cat. 'Y'* material, it has been assessed in the Preliminary Geotechnical Interpretive Report prepared for the *PRD* that this '*material could be processed into acceptable Class 2C fill by air drying or lime stabilisation*'[13].

[12] Sligo County Development Plan, 2011-2017

[13] N4 Cloonamahon to Castlebaldwin, Preliminary Geotechnical Interpretive Report; AGL Consulting

Such a process could be considered as *'Reuse' or 'Recovery'* in accordance with the Directive on Waste and the Waste Management Acts, obligations will thus be placed on the Contractor within the Contract Documents to deal with this material in compliance with the provisions of the relevant legislation.

For the purposes of processing, this Cat *'Y'* material can be considered within three separate sub-categories:

(a) That portion of material which in reasonable circumstances any competent contractor would seek to process into suitable material;

(b) That portion of material which may be borderline in economic/environmental terms to process into suitable material; and

(c) That material which displays properties rendering it unlikely or difficult to be processed into suitable material.

In determining the base figures for these materials, it is reasonable to assume that the material falling within sub heading (a) above, would be standard practice under any roads construction project and should therefore be discounted when establishing the base figures. The conservative approach for the purposes of this report is not to attempt an estimation or quantification of options (b) and (c).

In determining this figure and in order to balance a *worst case scenario*, the local authority's geotechnical expert[14],[15] has advised that a contractor working under normal conditions would typically seek to process circa 10-20% into suitable material via air drying with a further 15-30% likely to be achievable via lime stabilisation.

Based on this; an interpretation has been made at this stage of spoil management that an overall 30% assumption would be reasonable for the prediction of base quantities. This amounts to c. 69,654 m^3 as outlined in Table 2-3, giving a figure – termed "Balance 2" in that Table of c. 591,565 m^3.

Table 2-3: Balance 2 (Considering conservative estimate of material processing)

		Cat. X		Cat. Y	
Decription	**Total volume (m3)**	**Volume of PEAT (m3)**	**Volume of additional organic clay (m3)**	**Volume of subsoil (m3)**	***Comments***
Allowance for Re-processing	69,654	-	-	69,654	*30% of Cat. Y from* ***BALANCE 1***
BALANCE 2	***591,565***	***255,828***	***173,211***	***162,526***	***BALANCE 1*** *less Re-processing*

2.2.3.3 Bulking Factors and Base Figures

In order to refine these quantities further, an allowance should be made for bulking following excavation, and then for a reduction in this factor consequent to land spreading or other placement. This provides for an accurate estimate of the material which will require to be transported and deposited onto land either in proximity to the development or away from it. This figure is termed Balance 3 in Table 2-4.

Table 2-4: Balance 3; Base Figures

		Cat. X		Cat. Y	
Decription	**Total volume (m3)**	**Volume of PEAT (m3)**	**Volume of additional organic clay (m3)**	**Volume of subsoil (m3)**	***Comments***
Bulking Factor for Transport (Req. for Noise & Air Assess)	684,695	255,828	233,835	195,032	*0% to Peat, 35% to alluvial, 20% to Cat. Y*
Bulking Factor reduced for post spreading compaction	655,829	255,828	222,700	177,302	*0% to Peat, 5% to alluvial, 10% to Cat. Y*
Bulking Factor for PEAT	706,995	306,994	222,700	177,302	*20% to Peat*
BALANCE 3 (Assessment figures)	**706,995**	**306,994**	**222,700**	**177,302**	***Basis of Assessment***

In summary, the spoil generated will comprise:

- circa 306,994m^3 of peat which will require transport;
- circa 233,835m^3 of soft alluvial clay which will require transport, reducing to circa 222,700m^3 for spreading;
- circa 195,032m^3 of unsuitable subsoil which will require transport, reducing to circa 177,302m^3 for after spreading;

[14] AGL Consulting

[15] See appendix 5 of this report for estimation details

2.2.3.4 Spoil Volumes: A Worst-Case Scenario

The above figures are presented as a worst-case scenario. As set out earlier in this Appendix, this approach is congruent with the requirements governing the content of an Environmental Impact Statement, whereby such a document should set out the nature of the full impacts and show how they are to be mitigated. In practice, it may well be that the approach the appointed Design/Build contractor adopts to deal with the spoil material generated by the *PRD* will reduce this quantity.

3 Spoil Management Options. Stage 1: Initial Investigation

3.1 Overview

A significant number of options were assessed for the handling of spoil over the course of the completion of the Design and the EIS for the *PRD*. Inevitably, some options were more viable than others, with Stage 1 weeding out those that did not warrant detailed investigation and assessment. The following outlines the outcome of this initial investigation.

3.2 Options

Numerous initial approaches were considered. These are outlined in the following paragraphs.

3.2.1 Improvement of adjacent agricultural lands

Consideration was given at an early stage to the potential use of the peat as a soil conditioner to adjacent lands. This could potentially be done by harrowing selected poor quality agricultural lands, applying 100mm – 150mm of peat material which would be harrowed into the topsoil and reseeded. Given the volumes of peat involved, a vast area of land would be required for such a purpose (e.g. ($0.1m^3$ – $0.15m^3$) per m^2). Accordingly, it is very difficult to identify the location of suitable land areas on this scale and, instead, it was considered more prudent to focus on a land spreading approach where much greater depths of material could be handled (i.e. +1m). That said this is an option an appointed contractor may seek to explore further in consultation with the various landowners.

3.2.2 Commercial Considerations

Commercial considerations were briefly explored during the preparation of this report for that peat material excavated during the course of the construction works. However, following informal discussions with Bord Na Mona, it was generally felt that given the volumes of material being produced and the likely minor volumes of same which could lend itself to commercial processing (such as fuel, compost material and filter media) any achievable benefits would be limited and in this regard were not explored further during the course of this report.

3.2.3 Spoil Repositories

A series of different approaches were considered, with such repositories being located:

- Within the confines of lands determined to be required for land severance reasons; or
- Directly adjacent to those determined to be required for land severance reasons; or
- Remote from but in proximity of the *PRD* (<1.5km)

In general sites which did not require extensive haulage on the existing N4 or adjacent local roads were preferred.

This initial investigation involved an examination of over 66 different areas of land. Numerous sites did not satisfy the practical or environmental criteria and were thus not considered any further. However a total of approximately 30 sites were considered to be broadly suitable and these proceeded to the second stage of assessment as outlined in sections 4 and 5 of this report. Fig. A4.3 (1) included within Appendix 2 of this report shows these locations spatially.

3.2.3.1 Spoil Repositories within those lands required for land severance reasons

3.2.3.1.1 *Landscaping/Infilling*

Suitable locations were identified directly adjacent to the permanent works. The key criteria included being that such locations were required for land severance reasons and being inherently suitable for this purpose,

i.e. basin shaped, flat, or between road embankments and without significant risk to flood plains. These sites are described in Table 3-1 below, with their locations being shown on Figure A4.3 (1).

Table 3-1: Initial Identification: Landscaping/Infilling within those lands required for land severance reasons

Site No.	Proximity to *PRD*	Note	Re-label
1.1	Adjacent	N/A; Removed following a design change	LDB1 (Nb. 1)
1.2	Adjacent	N/A; Removed following a design change	LDA1 (Nb. 1)
1.3	Adjacent	N/A; Removed following a design change	LDA2 (Nb. 1)
1.4	Adjacent	N/A; Removed following a design change	LDA3 (Nb. 1)
1.5	Adjacent	N/A; Removed following a design change	LDA4 (Nb. 1)
1.6	Adjacent	Not progressed considering topography and proximity to a Flood Plain	N/A
1.7	Adjacent	Not progressed considering topography and proximity to a Flood Plain	N/A
1.8	Adjacent	Not progressed considering topography and proximity to a Flood Plain	N/A
1.9	Adjacent	Site appears suitable, progress to Stage 2	LDB2
1.10	Adjacent	Site appears suitable, progress to Stage 2	LDA5
1.11	Adjacent	Site appears suitable, progress to Stage 2	LDA6
1.12	Adjacent	N/A; Removed following a design change	N/A
1.13	Adjacent	N/A; Removed following a design change	N/A
1.14	Adjacent	Site appears suitable, progress to Stage 2	LDB3
1.15	Adjacent	Site appears suitable, progress to Stage 2	LDB4
1.16	Adjacent	Site appears suitable, progress to Stage 2	LDB5
1.17	Adjacent	Site appears suitable, progress to Stage 2	LDA7
1.18	Adjacent	Site appears suitable, progress to Stage 2	LDA8
1.19	Adjacent	N/A; Removed following a design change	LDB6 (Nb. 1)
1.20	Adjacent	Site appears suitable, progress to Stage 2	LDB7(Nb. 2)
1.21	Adjacent	Site appears suitable, progress to Stage 2	LDB8 (Nb. 2)

Nb. 1: Site subsequently removed due to a design change

Nb. 2: Subsequently became landscape infill site at Castlebaldwin

3.2.3.2 Infilling/Ecological Reclamation of Cutover Bogs remote from but in proximity to those plots required for land severance reasons

3.2.3.2.1 *Outline of Concept*

Turf cutting is commonplace in peatland areas and it was considered that this practice may have left open plots in the nearby vicinity of the *PRD.* Of particular interest were sites which had been cut in the recent past and which have not yet ecologically regenerated. Reinstatement of such plots with uncontaminated peat from the *PRD* was considered a viable option, having the potential to return the peatland to its pre-extraction state.

The subsoil mapping required for the Geological Chapter of this EIS identified areas of cutover bog within the vicinity of the *PRD*, particularly to the south, west and north-west of Ch. 2,400m to 8,910m and to the south-east of Ch. 10,210m to Ch. 13,210m. These bogs may lend themselves to peat recovery which could result in

rehabilitation of existing bog lands. Following placement, these lands could be graded to blend in harmoniously with the adjacent landscape returning the bog to a pre-extraction condition. The success of this restorative measure would will depend on the careful reinstatement of the vegetated Acrotelm layer (0m-0.3m depth). Whilst field survey work indicated that the majority of sites appeared to be topographically unsuitable or now fully vegetated, there was one exception. This is shown in Table 3-2 below.

Table 3-2: Initial Identification: Infilling/Ecological Reclamation of Cutover Bogs remote from but in proximity to those plots required for land severance reasons

Site No.	Proximity to *PRD*	Note	Re-label
2.1	+500m	Site appears broadly suitable, progress to Stage 2	LDCB01

3.2.3.3 Land-spreading on areas containing Conifer Plantations remote from but in proximity to those plots required for land severance reasons

3.2.3.3.1 *Outline of Concept*

It has been determined from ecological mapping carried out as part of the EIS and with further reference to OSi vector mapping, OSi aerial photography, and Google Earth satellite imagery that there is a number of existing conifer plantations contiguous to the development which are planted on cutover bog. These sites, in their pre-afforestated state, would be suitable for accepting a peat spread insofar as they are flat or basin shaped. In this regard there is potential for a contractor to accelerate the felling process in accordance with the appropriate provisions of the Forestry Acts and utilise the available land for the spreading of the spoil material (principally peat). Such lands could then be suitably prepared to be either:

(1) Replanted; or

(2) Allowed to re-vegetate and re-colonise to peatland habitat thus allowing a return to original ecological status;

In the case of (2), a waiver may[16] be required from the Department of Agriculture, Food and Marine (Forestry Service) to re-establish the original habitat rather than replanting. This will require a bio-diversity plan to be prepared by the contractor outlining the ecological benefits of such an action.

The initial investigation stage of this option identified eight sites and these are listed in Table 3-3 below.

Table 3-3: Initial Identification: Land-spreading on areas containing Conifer Plantations remote from but in proximity to those plots required for land severance reasons

Site No.	Proximity to *PRD*	Note	Re-label
3.1	+ 500m	Site appears suitable, progress to Stage 2	LDCP 00
3.2	+ 500m	Site appears suitable, progress to Stage 2	LDCP 01
3.3	+ 400m	Site appears suitable, progress to Stage 2	LDCP 02
3.4	+ 500m	Site appears suitable, progress to Stage 2	LDCP 03
3.5	+ 1000m	Site appears suitable, progress to Stage 2	LDCP 04
3.6	+ 1500m	Site appears suitable, progress to Stage 2	LDCP 05
3.7	+ 500m	Site appears suitable, progress to Stage 2	LDCP 06
3.8	+ 500m	Site appears suitable, progress to Stage 2	LDCP 07

[16] If a felling licence is deemed to be required.

3.2.3.4 Reclamation of used and disused quarries remote from but in proximity to those plots required for land severance reasons

3.2.3.4.1 *Outline of Concept*

Consideration was had during this process to both disused and operational quarries in the vicinity of the *PRD*. This included an initial review of OSi vector mapping and mapping obtained from the Geological Survey of Ireland.

3.2.3.4.1.1 *Existing Operational Quarries*

Figure No. 13.4.9 of the EIS outlines identified operational (and recently operational) quarries in proximity to the *PRD*. Depending on the existing quarry operation, there may be potential in principle to dispose of surplus subsoil and peat material in these areas thus rehabilitating the existing landscape. There are 3 existing quarries located within 10km of the *PRD* (of the start and end points) and a further 4 located within 20km of the *PRD*. Arising from informal discussions with one of the operators, it was concluded that it was too early to confirm whether this option would be viable. There were two reasons for this:

(1) Whether surplus spoil material arising from the *PRD* could be accepted by the quarries would most likely be decided by a commercial agreement between an appointed contractor and the relevant quarry;

(2) Importing material into the quarries (in particular peat) could have contamination issues for the material being produced in the quarry, particularly if operations are still active.

Considering the foregoing it was felt that such an option could not be progressed with any degree of certainty at the current stage of the design or consent.

3.2.3.4.1.2 *Historical Quarries*

In addition to those operational quarries, historical quarries within the vicinity of the *PRD* were identified from OSi historical mapping. These are outlined in Fig. A4.3 (1) and in Table 3-4 below.

Table 3-4: Initial Identification: Reclamation of used and disused quarries remote from but in proximity to those plots required for land severance reasons

Site No.	Proximity to *PRD*	Note	Re-label
4.1	+ 1,000m	Site is small and isolated. Not progressed.	N/A
4.2	+ 1,000m	Site is small and isolated. Not progressed.	N/A
4.3	+ 5,000m	Site is small and isolated. Not progressed.	N/A
4.4	+ 3,800m	Site is small and isolated. Not progressed.	N/A
4.5	+ 2,500m	Site is small and isolated. Not progressed.	N/A
4.6	+ 2,500m	Site is small and isolated. Not progressed.	N/A
4.7	+ 2,500m	Site is small and isolated. Not progressed.	N/A
4.8	+ 1,000m	Site is small and isolated. Not progressed.	N/A
4.9	+ 1,000m	Site is small and isolated. Not progressed.	N/A
4.10	+ 1,000m	Site is small and isolated. Not progressed.	N/A
4.11	+ 1,000m	Site is small and isolated. Not progressed.	N/A
4.12	+ 500m	Site is small and isolated. Not progressed.	N/A
4.13	+ 500m	Site is small and isolated. Not progressed.	N/A

Considering the foregoing, it was generally felt that these sites would not be viable options considering their general isolated locations and their generally relative modest sizes.

3.2.3.5 Spoil Repositories within Borrow Pits

3.2.3.5.1 *Outline of Concept*

Given the substantial deficit of suitable material generated onsite it is expected that the appointed contractor would develop borrow pits within the immediate vicinity of the works. This infrastructure also provides a convenient outlet for the handling of the spoil material generated by the works.

For the purposes of this report, the evaluation of this option is confined to parcels of land that are being acquired for severance reasons or are directly contiguous to the *PRD*.

A review was carried out of suitable locations for borrow pits which could subsequently be reinstated as Spoil Repositories. The initial review focussed on:

- drumlin deposits; and
- areas where rock was expected to be in proximity of the surface (0m to 5m).

These criteria most readily identify the locations where subsequent reinstatement could be done with minimal impact to the existing environment. This follows the key objective that certain sites would allow for ecological regeneration as a mitigation measure in accordance with Chapter 12 of this EIS. The following discussion covers this initial assessment both within the severed areas of lands and directly adjacent to them. Those sites identified as potentially suitable were then subject to a Stage 2 assessment in the manner described in the next Section.

3.2.3.5.2 Spoil *Repositories/Borrow Pits within those plots required for land severance reasons*

The initial investigation stage of these particular sites is outlined in Table 3-5 below.

Table 3-5: Initial Identification: Spoil *Repositories/Borrow Pits within those plots required for land severance reasons*

Site No.	Proximity to *PRD*	Note	Re-label
5.1	Adjacent	*Potential for Rock extraction.* Not progressed considering topography, proximity to existing N4 and adjoining properties.	N/A
5.2	Adjacent	*Potential for acceptable cohesive soil extraction.* Not progressed considering topography, proximity to existing N4 and adjoining properties.	N/A
5.3	Adjacent	*Potential for Rock extraction.* Contained within LDA5 and assessed therein.	LDA5 (LDBP Type 02 no. 01)
5.4	Adjacent	*Potential for Rock extraction.* Contained within LDA6 and assessed therein. Not progressed due to proximity of adjacent property.	LDA6

3.2.3.5.3 Spoil *Repositories/Borrow Pits adjacent to those plots required for land severance reasons*

The initial investigation stage of these particular sites is outlined in Table 3-6 below.

Table 3-6: Initial Identification: Development of Spoil *Repositories/Borrow Pits adjacent to those plots required for land severance reasons*

Site No.	Proximity to *PRD*	Note	Re-label
6.0	Adjacent	*Potential for acceptable cohesive soil extraction.* Site initially appeared suitable for the extraction of rock material and was intended to progress to stage 2, however, on a re-	N/A

Site No.	Proximity to *PRD*	Note	Re-label
		examination and considering the rock level and the potential depth of drumlin deposit overburden it was considered that a significant excavation into the drumlin deposit would be required. This would make the potential rock excavation quite small and possibly unviable, or alternatively require a larger land area. Additionally considering the topography, the site would require to be in-filled with unsuitable subsoil material to return the land to agricultural use, this would require significant haulage (in comparison with other subsoil deposit sites) as the closest cut is circa 1.5km south. Therefore this particular site did not subsequently proceed to the next stage.	
6.1	Adjacent	*Potential for acceptable cohesive soil extraction.* Site appears suitable, progress to Stage 2	LDBP01
6.2	Adjacent	*Potential for Rock extraction.* Site appears suitable, progress to Stage 2	LDBP (T2) 02
6.3	Adjacent	*Potential for acceptable cohesive soil extraction.* Site appears suitable, progress to Stage 2	LDBP02
6.4	Adjacent	*Potential for acceptable cohesive soil extraction.* Cut is limited, considered that material win would be minimal. Not Progressed.	N/A
6.5	Adjacent	*Potential for Rock extraction.* Site initially appeared suitable for the extraction of rock material and was intended to progress to stage 2, however, prior to stage 2 being carried out it was determined during a geophysical examination (as outlined in section 8) that significant karst features were present. Therefore it did not subsequently proceed to the next stage.	~~LDBP (T2) 03~~
6.6	Adjacent	*Potential for Rock extraction.* Site initially appeared suitable for the extraction of rock material and was intended to progress to stage 2, however, on a re-examination and following a geophysical survey, it was confirmed that a significant excavation into the drumlin deposit would be required. This would make the potential rock excavation quite small and possibly unviable. Additionally although no significant karst features were identified in the geophysical survey, it was considered that the risk would still be high considering the proximity of site 6.5 and Cuileencroobagh Lough to the north. Additionally considering the topography, this pit would not be suitable for the infilling of peat. Therefore it did not subsequently proceed to the next stage.	~~LDBP (T2) 04~~
6.7	Adjacent	*Potential for acceptable cohesive soil extraction* Although the site appears suitable for the extraction, it was decided as it passes through an area of immature forestry not to progress to Stage 2.	N/A
6.8	Adjacent	*Potential for Rock extraction.* Although the site initially appeared suitable for the extraction of rock, it was decided considering the proximity to Cuileencroobagh Lough and Ardloy & Aghalenane Loughs (both GW dependent ecosystems) that the risk of intercepting karst flows would be too great.	N/A
6.9	Adjacent	*Potential for acceptable cohesive soil extraction* Site appears suitable, progress to Stage 2	LDBP03

Site No.	Proximity to *PRD*	Note	Re-label
6.10	Adjacent	*Potential for acceptable cohesive soil extraction* Site appears suitable, progress to Stage 2	LDBP04
6.11	Adjacent	*Potential for acceptable cohesive soil extraction* Site appears suitable, progress to Stage 2	LDBP05
6.12	Adjacent	*Potential for Rock extraction.* Rock considered to be greater than 5m from the surface and adjacent property to the west would be in full view shed of the extraction and deposition process. Therefore it did not subsequently proceed to the next stage.	N/A
6.13	Adjacent	*Potential for acceptable cohesive soil extraction* Site appears suitable, progress to Stage 2	LDBP06
6.14	Adjacent	*Potential for Rock extraction.* Site appears suitable, progress to Stage 2	LDBP (T2) 05
6.15	Adjacent	*Potential for Rock extraction.* Although the site initially appeared suitable for the extraction of rock, it was decided following targeted trial pits that circa 4-5m of peat would require removal and subsequent storage prior to the extraction of any rock material. For this reason it was decided that the site would not progress to stage 2.	~~LDBP (T2) 06~~
6.16	Adjacent	*Potential for acceptable cohesive soil extraction* Site appears suitable, progress to Stage 2	LDBP07
6.17	Adjacent	*Potential for Rock extraction.* Site appears broadly suitable for the extraction of rock material, however, considering the topography it would be a requirement to infill with unsuitable subsoil sourced predominately from the adjacent mainline road cut. Additionally considering the Castlebaldwin Fortified House which is in a state of dereliction to the south it was considered that very restrictive vibration controls would be required. On the basis of the foregoing, although it may be a case that this site could be examined further by a contractor; it was felt that for the purposes of this report that the site would not progress to stage 2.	~~LDBP (T2) 07~~

3.2.3.6 Land-spreading on low lying agricultural lands adjacent to those plots required for land severance reasons

3.2.3.6.1 *Outline of Concept*

Recent EIS's submitted for Roads Act approval on other *PRD*'s have considered areas of low value agricultural lands adjacent to the particular route which might lend themselves suitable to accepting a land spread of material across their surface. In general, similar characteristics to those outlined in section 3.2.3.1 of this report were considered appropriate. The end use of such an option would be to return the site to low value agricultural grazing after an appropriate establishment period, or, alternatively, to create an ecologically beneficial habitat.

The adjacent lands to the *PRD* were examined for locations potentially suitable for this form of land spread. The general requirement was that these should be basin shaped or between road embankments. This process discovered only two potential sites which would satisfy these criteria. These are shown in Table 3-7 below.

Table 3-7: Initial Identification: Land-spreading on low lying agricultural lands adjacent to those plots required for land severance reasons

Site No.	Proximity to *PRD*	Note	Re-label
7.1	Adjacent	Although this appeared initially to be a suitable site, the topography on examination did not appear to render it as same. Therefore not progressed.	N/A
7.2	Adjacent	This is an area of low lying land which is currently in a basin shaped valley. Additionally, new road embankments would aid to retain this material.	LD AG-01
7.3	Adjacent	This is an area of low lying land which is currently in a basin shaped valley. Additionally, new road embankments would aid to retain this material.	LD AG-02

3.3 Summary of Stage

Arising from the foregoing the sites which are Re-labelled in the last columns of Table 3-1, Table 3-2, Table 3-3, Table 3-5, Table 3-6 and Table 3-7 will proceed to the next stage (stage 2) of assessment as per sections 4 and 5 of this report.

4 Stage 2: Refinement of Stage 1 options into a broad *Range of Options*

4.1 Overview

Arising from the initial investigation described in Chapter 3 above, the range of selected sites was classified into the following broad Range of Options:

(1) ***OPTION 1:*** Spoil Repositories within those lands required for land severance reasons;
(2) ***OPTION 2:*** Ecological & Landscape Improvement Works on lands which are remote from but in proximity to those plots required for land severance reasons ;
   a. Existing conifer plantations of low ecological value;
   b. Restoration of existing Cutover Bogs;
(3) ***OPTION 3:*** Spoil Repositories/ Borrow Pits;
   a. Locations within those lands required for land severance reasons
   b. Configuration Type 1 directly adjacent to those lands required for land severance reasons;
   c. Configuration Type 2 directly adjacent to those lands required for land severance reasons;
(4) ***OPTION 4:*** Land infilling of low lying/low value agricultural lands which are directly adjacent to those lands required for land severance reasons

In developing these options further, input was provided from AGL Consulting in relation to the specific sites considered within the Range of Options in order to address the geotechnical engineering constraints and design considerations, such as peat stability, access, construction methods and slope stability. The report prepared by AGL is contained in Appendix 5 of this report.

4.2 Site Selection Criteria

4.2.1 **Landforms**

The primary purpose of these sites is that of a spoil repository, however, the final landform they take will dictate the configuration of each particular option. This is also in recognition that there is viable potential for some of the sites to be developed with the objective of providing complimentary ecological habitat mitigation. In this regard, the following final landforms are considered:

4.2.1.1 Natural Re-colonisation of peat

The peat surface is allowed to re-vegetate naturally, this option shall only be considered in areas where Erosion and Sediment Control is not considered a significant risk. The figure below outlines a peat repository which has naturally re-colonised itself 4 years after the final deposition.

Figure 4-1: Naturally Colonised peat Repository, Shramore, Co. Mayo (picture taken 4 years after deposition)

4.2.1.2 Encouraged Peatland rehabilitation

This option shall be used in areas where:

(1) The receiving land runoff area has been identified as being sensitive in the Outline Erosion and Sediment Control Plan;

(2) Establishment of peatland ecological habitats and in particular those ascribing to Annex I of the EU Habitats Directive is an intended objective;

Figure 4-2: peat land habitats (examples of Cutover Bog and Fen habitats)

4.2.1.3 Agricultural Land

This option shall be used where the primary objective is to maintain the existing landscape character of Drumlin hills which will in most circumstances require the land to be returned to agricultural use. The figure below outlines a subsoil repository which has been returned to agricultural use.

Figure 4-3: Deep landscape fill area returned to agricultural use (Class U1 cohesive till)[17]

4.2.1.1 Conifer Re-plantation

In the case of the sites considered in the conifer plantations, the sites may either be replanted or developed in accordance with a biodiversity plan.

4.3 *Range of Options*

4.3.1 **Option 1: Spoil Repositories within those lands required for land severance reasons;**

SECTION 3 REFERENCE: 3.2.3.1.1

Isolated parcels of land purchased under the CPO for severance reasons have been assessed for their suitability to accept surplus unsuitable material generated by the development, this includes *'Option 1'* within this document which is the:

(1) Integration of spoil material into the landscape;

[17] Picture Ref AGL consulting

4.3.1.1 Characteristics of Sites

Sites with the following characteristics were identified for the purposes of *Option 1*. These were:

- Sites that are flat or basin shaped;
- Sites which lend themselves to grading down and blending in of road construction embankments;
- Only sites where peat already exists have been considered for the spreading of peat;

4.3.1.2 Working assumptions for assessment

An assessment of the environmental impact of the short-listed sites was carried out based on the following geometric properties:

(1) These lands are to be filled to a depth (determined by the characteristics of each specific site) with the 'unsuitable' soil, subsoil material and where appropriate peat material;

(2) The perimeter edge of the graded lands shall be no greater that 1V:4H, sloping down to existing ground levels, onto road construction embankments or onto containment berms which shall have side slopes of 1V;4H and be greater than 1m in height;

4.3.1.3 Final Landform

(1) The final landform these sites shall take shall be that described in sections 4.2.1.1, 4.2.1.2 or 4.2.1.3 as is deemed appropriate.

4.3.2 **Option 2:- Ecological & Landscape Improvement Works;**

4.3.2.1 Option 2a: Existing conifer plantations of low ecological value

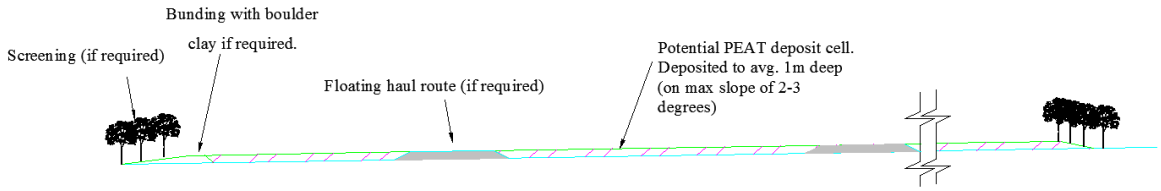
SECTION 3 REFERENCE: 3.2.3.3

4.3.2.1.1 *Characteristics of Sites*

Sites with the following characteristics were identified for the purposes of option 2a:

- Existing Conifer Plantations which have a low ecological value;
- Sites are gently sloping (2-3 degrees) or basin shaped;
- Only sites where peat already exists have been considered for the spreading of peat;

Figure 4-4: Indicative section showing peat deposition on Conifer Plantation site.



4.3.2.1.2 *Working assumptions for assessment*

For the purposes of assessment the following assumptions have been made in relation to the concept of the sites;

- Haul routes constructed through the site at circa 40m centres to allow for spreading of the peat material;
- Existing drainage systems which are not localised to the actual plantation shall be maintained or diverted as appropriate;
- Following placement, lands are to be graded to blend in with the adjacent land at slopes no steeper than1V:4H.

- Where required, it is anticipated that peat could be deposited and contained within bunds created by the subsoil material thus creating a containment measure;
- Preferably there will be no removal of hedgerows or tree lines, where this is unavoidable then replanting shall take place.
- The perimeter of the deposition site could be replanted as appropriate reducing the initial visual impact of the deposition site. A suitably qualified arborist should assess the condition of any retained trees during and post construction works (and in particular should advise on the risk of wind-throw and suitable protection measures which may be required).

4.3.2.2 Final Landform

(1) The final landform these sites shall take shall be that described in section 4.2.1.2

4.3.2.3 Option 2b: Restoration of existing Cutover Bog.

SECTION 3 REFERENCE: 3.2.3.2

4.3.2.3.1 *Characteristics of Sites*

Sites have been identified for the purposes of option 2b based on the following criteria:

- Existing cut over bog with depressions or basin shapes where peat has been extracted and where vegetation is not currently generating as an ecological sensitive habitat;
- Sites are located adjacent or close to the limits of the *PRD* allowing the appointed contactor scope to design suitable access points which minimise the distance from donor to recipient site;

4.3.2.3.2 *Working assumptions for sites*

For the purposes of assessment the following assumptions have been made in relation to the concept of the sites:

- There shall be no impact or alteration to existing drainage systems within the bog;
- Preferably there will be no removal of hedgerows or tree lines, and areas of scrub during recovery of peat material. Where this is unavoidable then replanting shall take place;

4.3.2.3.2.1 *Final Landform*

(1) The final landform these sites shall take shall be that described in section sections 4.2.1.1 or 4.2.1.2 as is deemed appropriate.

4.3.2.4 Option 3:- Spoil Repositories/Borrow Pits

SECTION 3 REFERENCE: 3.2.3.5

4.3.2.4.1 *Characteristics of Sites & Working Assumptions*

In the consideration of these options, it was required that the pit following extraction could be returned to a state which would either:

- Replicate as far as practicable its pre-extraction state; or
- Provide scope for ecological regeneration;

A number of configurations have been examined for this particular Option. Following a review of different factors including landscape and visual impacts, ecological and geotechnical stability, the configurations were refined into two particular types which would allow re-grading back into the existing topological landscape. These configuration types were developed with cognisance of the material which is required to satisfy the deficit, i.e. Granular Material (Class 1 and Class 6) and Acceptable Class 2 General Fill. For the purposes of this report it should be noted that, in the case of the former, a suitable rock formation is required for extraction; in the case of the latter the typical method of sourcing such fill is through the utilisation of glacial till deposits where the material satisfies the requirements of Series 600 of the NRA Specification for Roadwork's;

4.3.2.4.1.1 *Configuration Type 1*

4.3.2.4.1.1.1 General

Drumlin deposits which are contiguous to the Road Cuts of the *PRD* are the obvious locations for sourcing the aforementioned material. In accordance to the objective of returning the location as far as practicable to its pre-extraction state, geotechnical considerations suggested that placing peat in such cells would not satisfy the stability surface requirements. Accordingly, this type of repository was considered suitable only for the acceptance of subsoil. This restriction has the ensuing benefit that the land can be appropriately landscaped, top-soiled, reseeded and returned to agricultural use.

The configuration considered is described further in the figures outlined below.

Figure 4-5: Indicative outline of pre-excavation state

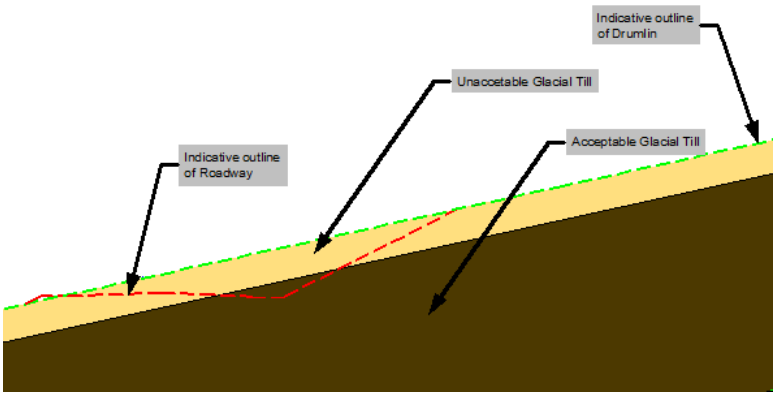
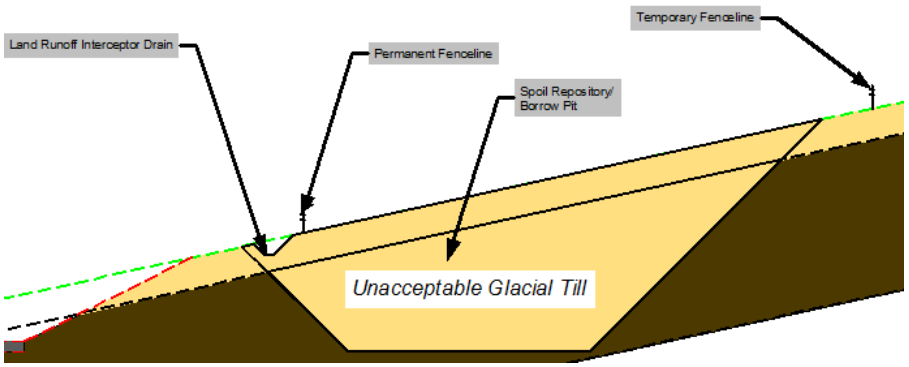


Figure 4-6: Indicative outline of post repository stage



4.3.2.4.1.1.2 Site Selection

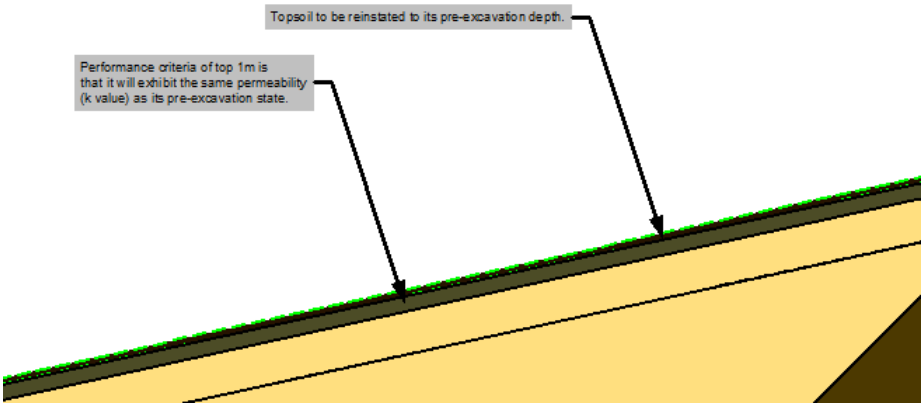
The following site selection process was applied:

- Road Cuts where an extension behind a maintained bund into the existing Drumlin would allow access to a pit;
- Review of Ground Investigation Factual Report in the relevant areas;
- Review of Preliminary Geotechnical Interpretive Report for the area in order to:
  - determine the material classifications predicted and arising from preliminary GI; and
  - karst risk in the area;
- Review of the Hydro-geological Chapter of the EIS to determine potential karst risks in the area;
- Review of the predicted Landscape and Visual Impact Assessment for the particular road cut;
- Initial Consultation with the various experts;

4.3.2.4.1.1.3 Final Landform

(1) The final landform these sites shall take shall be to return the site to agricultural use as outlined in section 4.2.1.3.

Figure 4-7: Indicative outline of final landform requirements



4.3.2.4.1.2 *Configuration Type 2*

4.3.2.4.1.2.1 General

Configuration Type 2 involves extending the borrow pit into the underlying bedrock formation and subsequently accepting peat (and organic/alluvial clay) in one or more repository cells. The after-use would be for Spoil ecological peatland regeneration and would form part of the ecological mitigation proposed in the Flora, Fauna & Fisheries Chapter of this EIS.

Given the opportunity afforded by the void content of the Borrow Pits Pit and the poor stability characteristics of extracted peat, sites were selected in areas where ground contours slope at no more than 2-3 degrees. Sensitive hydro-geological receptors in proximity were avoided.

The following additional criteria applied:

- All pits must be directly contiguous to the land required for land severance reasons;
- peat, soft alluvial clay and organic clay will be deposited within deep pre-determined cells
- The surface of the deposit cell will be capped with 2m of boulder clay and finished with a 1m depth of peat sourced from the Acrotelm layer;
- The peat surface will be seeded with a mix to be prescribed in the mitigation section of Chapters 10 and 12 of the EIS;
- Additional considerations for the potential design of the borrow pits are given in Stage 5 of this report.

The configuration considered is described further in the figures outlined below.

Figure 4-8: Pre-excavation outline of Spoil Repository/Borrow Pit

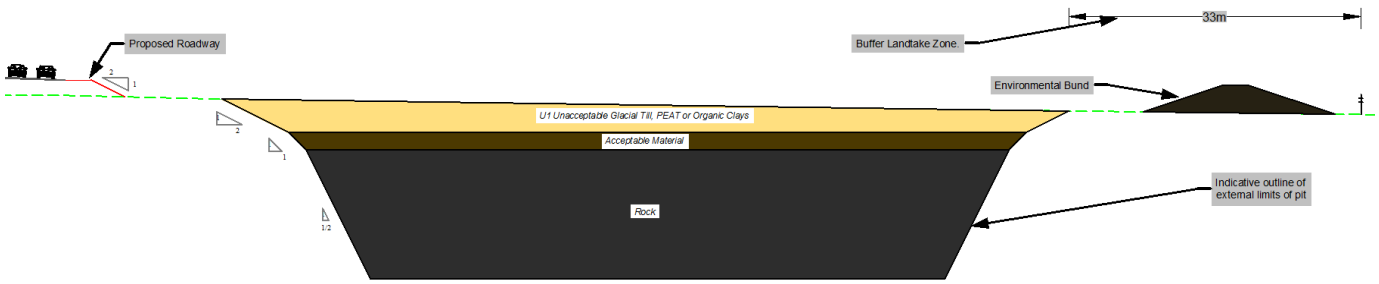
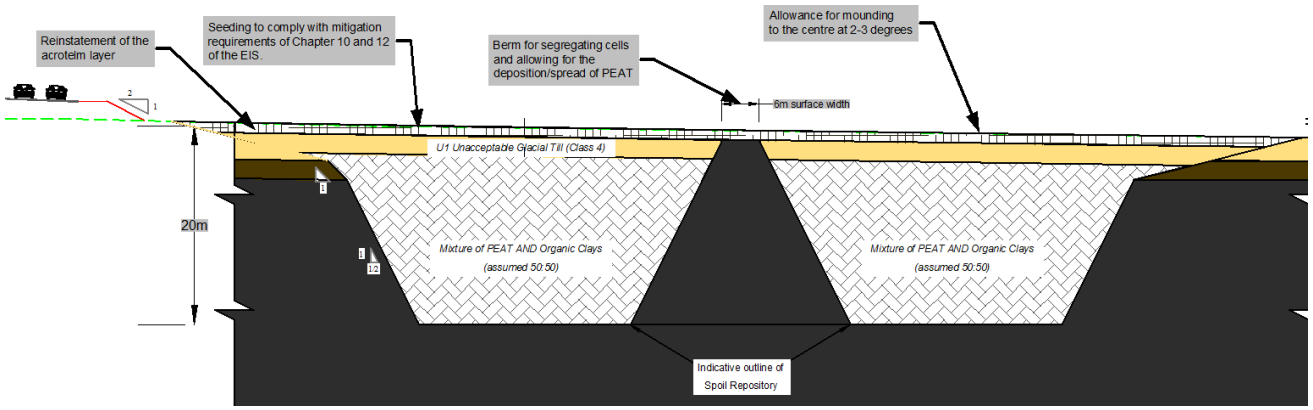


Figure 4-9: Spoil Repository and Final Landform



4.3.2.4.1.2.2 Site Selection

The site selection process was undertaken for this option:

- Review of Geological Survey of Ireland (GSI) online mapping to gauge rock formations in proximity of the surface;
- Review of the Ground Investigation Factual Report along the length of the *PRD* with an emphasis on determining locations which match the criteria set out in 4.3.2.4.1.2.1 and additionally where rock may be in the vicinity of the surface;
- Determination of receptors in the vicinity of each site which may be sensitive to changes in hydro-geological conditions;
- Review of the location of domestic and other properties in the vicinity of the potential sites. For this purpose, an arbitrary exclusion zone of 100m was set;
- Initial Consultation with the various experts.

4.3.2.4.1.2.3 Final Landform

(1) The final landform these sites shall take shall be to recolonise or encourage peatland habitat regeneration.

4.3.2.5 Option 4:- Land infilling of low lying/low value agricultural lands which are directly adjacent to those lands required for land severance reasons

SECTION 3 REFERENCE: 3.2.3.6

4.3.2.5.1 *Characteristics of Sites*

Agricultural land parcels adjacent to those lands required for land severance reasons which typically may be considered to be of low agricultural value, in a basin shape or with potential to be surrounded by a containment berm. It is considered such suitable lands could be acquired with the objective of returning the land to the landowner following an establishment period of 5 years.

4.3.2.5.2 *Working assumptions for sites*

For the purposes of assessment the following assumptions were made:

- The existing topsoil on the recovery areas will be stripped and stored for later reinstatement;
- Existing drainage systems shall be maintained or diverted as appropriate;
- Following placement, lands are to be graded to blend in with the adjacent land at slopes no steeper than1V:4H.
- Where required, it is anticipated that peat could be deposited and contained within bunds created by the subsoil material thus creating a containment measure;
- Preferably there will be no removal of hedgerows or tree lines, where this is unavoidable then replanting shall take place.
- The intended materials for placing in these areas are peat and sub-soil. No hazardous materials or contaminants will be placed.

- Before the placing of the top organic layer, the subsoil will be ripped with a mechanical ripper to a minimum uniform depth of 600mm. In all cases the depth of ripping shall exceed the depth of subsoil compaction. All surface stones and roots over 150mm (6") in size (in any direction) shall be picked before any topsoil is put back.
- The top 100mm placed will be organic material (i.e topsoil/ peat/ clay and not gravel or silt) and reseeded.

4.3.2.5.2.1 *Final Landform*

(1) The final landform these sites shall take shall be that described in section 4.2.1.3

5 Stage 3: Screening[18] Environmental Assessment

5.1 General

Those range of sites considered under Options 1, 2, 3 and 4 have been assessed from an environmental perspective by the various sub-consultants outlined in section 1 of this report. This has been with the objective of determining those sites which may be considered to be most environmentally suitable.

The assessments were undertaken as working information documents and as such have not been appended to this report, however, the following (which has been reviewed and confirmed by the various sub-consultants) gives a general overview of the results of same. Conclusions made are based on mitigation measures[19] considered appropriate by the relevant sub-consultants to offset potential impacts.

5.2 Noise & Vibration

5.2.1 **Noise**

The noise assessment is based on noise levels provided in the NRA document *Guidelines for the Treatment of Noise and Vibration in National Road Schemes (2004),* these limits are set out in Table 5-1.

Table 5-1: Maximum permissible noise levels at the façade of nearby dwellings during construction

Days & Times	$L_{Aeq\ (1hr)}$ dB	L_{Amax} dB(A)
Monday to Friday 07:00 to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60*	65*
Saturday 08:00 to 16:30hrs	65	75
Sundays and Bank Holidays 08:00 to 16:30hrs	60*	65*

***Note** ** Construction activity at these times, other that required for emergency works, will normally require the explicit permission of the relevant local authority.

The assessment of Construction Noise was based on the following worst case assumptions that have been used in the calculation of the indicative noise levels for each potential site at the nearest noise sensitive locations:

- 20 HGV movements per hour along the proposed haul roads to each of the disposal sites;
- 400 tractor & trailer movements per day across the disposal sites;
- 100 loading shovel movements per day across the disposal sites;
- 300 excavator movements across per day the disposal sites, and;
- 100 dozer movements per day across the disposal sites.

Based on the above expected noise levels were predicted at various distances from the specific site considered. This indicated the noise levels to be within the limit values shown in Table 6-1 for weekday daytime periods at distances greater than 10m from plant items. During scenarios where several items of plant are in operation simultaneously there is the potential for the limit values to be exceeded at greater distances; however this scenario is considered unlikely.

[18] Screening in terms of this Report (i.e. not Appropriate Assessment)

[19] Mitigation considered for the purpose of this report only

In addition to the above calculations, noise models of the each of the proposed spoil repository sites were developed. These models calculated the resultant noise level taking into account a range of factors including:

- the magnitude of the noise source in terms of sound power or traffic flow and average velocity;
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces, and;
- the hardness of the ground between the source and receiver.

Using the same assumptions discussed earlier for the frequency of construction activity predictions have been performed for every building in the vicinity of each spoil repository site.

The predicted levels at all locations assessed were in the range of 54 to 69dB $L_{Aeq,1hr,}$ less than the 70dB $L_{Aeq,1hr}$ daytime criterion. Notwithstanding this, AWN's report outlines generic type mitigation measures which are considered best practice for inclusion in Public Works Civil Construction Contracts.

5.2.2 **Vibration**

The NRA Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities should be limited to the values set out in Table 5-2.

Table 5-2: Allowable vibration levels during construction phase.

Allowable vibration velocity (Peak Particle Velocity) at the closest part of any sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

It is not expected that any significant sources of vibration (with the exception of potential rock breaking and blasting in the potential borrow pits) will be in use at the spoil repository sites. The primary source of vibration associated with these works is the movement of the haulage vehicles from the construction site to the disposal site.

...Where road surface conditions are less favourable, vibration from haulage traffic due to the development under consideration may become perceptible at some locations. However, it would be expected to be significantly less than the vibration limits specified by the NRA and reproduced in Table 5-2 above. It is therefore concluded that the proposed spoil repository activity is not expected to generate vibration of a magnitude that would cause cosmetic or structural damage to buildings.

5.2.2.1 Site Suitability

On the basis of the foregoing, no sites have been discounted on the basis of Noise & Vibration Impacts.

5.3 Air Quality

The Air Quality Assessment focused on the potential generation of dust by the potential *Range of Options,* a model was developed assessing the activity which assumed a worst case scenario, that there would be in and out of each site per hour between 7am and 7pm from Monday to Saturday, it considered principally:

- Movement of empty trucks along paved public roads;
- Movement of empty trucks along unpaved haul roads;
- Loading and unloading of material;
- Movement of full trucks along unpaved haul roads;
- Movement of full trucks along paved public roads;

The assessment involved air dispersion modelling of the disposal of approximately 900,000m^3 of soil and peat across a range of disposal sites.

The emissions from the combined operational processes lead to a dust deposition level averaged over the full year of 3.2 mg/(m^2*day) at the worst-case receptor. Based on a background deposition rate of 59 mg/(m^2*day) in the region of the subject site, the combined dust deposition level including the proposed peat disposal peaks at 62.2 mg/(m^2*day) which is only 18% of the TA Luft Limit Value of 350 mg/(m^2*day).

Predicted PM_{10} concentrations are significantly lower than the ambient air quality standards at the nearest residential receptors. The predicted 24-hour and annual concentrations (excluding background) at the worst-case receptor peak at 0.59 and 0.24 µg/m^3 respectively. Based on a background PM_{10} concentration of 18 µg/m^3 the combined annual PM_{10} concentration including the proposed peat disposal peaks at 18.24 µg/m^3. This predicted level equates to at most 46% of the annual limit value of 40 µg/m^3. The predicted 24-hour PM_{10} concentration (including background) peaks at 33.6 which is 67% of the 24-hour limit value of 50 µg/m^3 (measured as a 90th%ile).

Predicted $PM_{2.5}$ concentrations at the nearest residential receptors are significantly lower than the limit value of 25 µg/m^3 which will be in place after 2015. The predicted annual concentration (excluding background) at the worst-case residential receptor peaks at 0.04 µg/m^3. Based on a background $PM_{2.5}$ concentration of 12.2 µg/m^3 in the region of the facility, the annual $PM_{2.5}$ concentration including the proposed peat disposal operations peaks at 12.24 µg/m^3. This peak level equates to 49% of the annual limit value for $PM_{2.5}$.

The report continues to conclude that:

Results show that all emissions from the peat disposal will lead to ambient concentrations and deposition levels which are well within the relevant standards for dust, PM_{10} and $PM_{2.5}$,

5.3.1.1 Site Suitability

On the basis of the foregoing, no sites have been discounted on the basis of Air Quality Impacts.

5.4 Landscape and Visual

The Landscape and Visual consultant assessed each individual site within the *Range of Options* using the criteria:

- Description of Existing Environment;
- Proposed Works;
- Mitigation and Avoidance Measures;
- Post Mitigation Landscape and Visual Impact;

Following ameliorative measures it was concluded that:

- of the LDA1-A8 sites, S*light Adverse* impacts could be expected at LD A1, A2, A3, A4, A5 and A6 with *Imperceptible* Impacts at LD A7 and LD A8;
- of the LDCP00-07 sites, *Slight Adverse* impacts could be expected at LDCP 00, 01, 02, 03 and 06 with *Imperceptible* impacts at LDCP 04 & 05 and *Slight to Moderate* impacts at LDCP 07;
- In relation to LDCB 01 an *Imperceptible* impact is predicted;
- of the LDBP 01-07 sites and LDBP (T2) sites it was considered that impacts would at most be *slight to moderate* at most considering the existing landscape contours are largely being maintained.
- of the LDAG01-02 sites, *Slight Adverse* impacts could be expected at each.

The assessment concludes the following:

Residual landscape and visual impacts of potential material deposits as described under 'Nature of possible works' on sites LD A1- LD A8 (within CPO) are summarized as 'Slight Adverse to Imperceptible'. Due to these lower rated impacts these sites are considered to be potentially suitable for material deposits.

Residual landscape and visual impacts of potential material deposits as described under 'Nature of possible works' on sites LD CP00- LD CP07 (existing conifer plantations) and site CB01 (Cutover Bog) are summarized as 'Slight adverse to Imperceptible' with the exception of LD07, which is considered 'Slight to Moderate Adverse'. Due to these lower rated impacts these sites are also considered to be potentially suitable for material deposits.

Residual Landscape and visual impacts of potential borrow pit sites to the extent described under 'Nature of possible works' on sites LD BP01 – LD BP07 and LD BP (T2) no.'s 02 and 05 are summarized as being 'Slight to moderate adverse'.

5.4.1.1 Site Suitability

On the basis of the foregoing, no sites have been discounted on the basis of Landscape and Visual Impacts on the basis that no *Moderate to Significant* or *Significant Impacts* are predicted.

5.4.2 Flora, Fauna and Fisheries

The Flora and Fauna consultant assessed each individual site within the Range of Options in order to identify ecological interests and potential constraints at the identified deposition sites or in the adjacent landscape that may present constraints for the use of these sites to deposit spoil material.

This assessment included desktop and site visits which identified key ecological receptors allowing for an evaluation of impact significance based on the value of the affected feature (its ecological importance), the type of impact and the magnitude of the impact. Potential Impacts were considered to include:

- Loss of Annex I habitats listed in the EU Habitats Directive (1992);
- Loss of suitable habitat utilised or potentially utilised by Annex II, IV, and V species listed in the EU Habitats Directive (1992);
- Removal, damage or disturbance of hedgerow habitat that may have impacts on species protected under the Irish Wildlife Act (1976) and the Wildlife (Amendment) Act (2000) potentially utilising this type of habitat;
- Importation and / or spread of non-native species;
- Drainage and hydrological impacts giving rise to the potential for adverse effects on designated Natura 2000 conservation sites and also adjacent aquatic / water dependant habitats;
- Water quality impacts through slippage of deposited materials into watercourses with potential for effects on locally important aquatic ecological interests and also indirect impacts on water-dependant Natura 2000 sites;

The evaluation allowed the ecologist to develop a scale outlining the appropriateness of each site for the purpose outlined, this segmented the sites into what the consultant considered to be the most and least appropriate:

- Preferred: Where Impacts following Mitigation measures are considered to be Imperceptible. The consultant concluded sites LDA5, A6, A11, LDCP00, CP01, CP02, CP03, CP04, CP05, CP06, LDBP06 and LDBP Type 2 (05) to be within this category;
- Suitable: Where Impacts following Mitigation measures are considered to be Slight to Moderate. The consultant concluded sites LD A9, LDCP07, LDBP01, BP02, BP03, BP04, BP05, BP07, LD AG-01 & 02 and LDBP Type 2 (01 & 02) to be within this category;
- Unfavourable: Where Impacts following Mitigation measures are considered to be Significant to Profound. The consultant concluded sites LDA1, A2, A3, A4, A7, A8, B5 LDCB01, to be within this category;

5.4.2.1 Site Suitability

On the basis of the foregoing, those sites considered to be *unfavourable* as recommended by the ecological consultant were discounted from the process.

5.4.3 Soils & Geology

The Soils and Geology assessment considers the receiving environment in terms of bedrock geology, soil, subsoil geology, land cover and ground slopes. In terms of bedrock geology, the assessment indicates sites to be underlain by the Bricklieve Limestone (lower) formations for the majority of the sites with the exception of sites underlain by the Bricklieve Limestone (upper) formation which includes LDA7 and a portion of LDCP07

with a small portion of LDCP00 underlain by the Lisgorman Shale Formation. It was also noted under bedrock geology that were no published faults underlying any of the sites.

Sites LDA1-A4, LDCP00-05, LDCP07 and LDCB01 to be underlain wholly by peat with LDA5-A8 and LDCP06 to be underlain by a mixture of peat and GLACIAL TILL. All the BP locations were outlined to be underlain by GLACIAL TILL.

Potential Impacts as a result of the development of the potential sites is rated as having the following significance:

- For the deposition of the surplus subsoil material on the subsoil geology during the construction phase the impact significance is considered to be *Slight to Moderate* and *permanent* in nature;
- The change to the soil structure of peat, soft alluvial clay and soft mineral subsoil is considered to be of *moderate* impact significance and *permanent* in nature for the construction phase;

Following identified mitigation measures which relate principally to methods for handling of topsoil, subsoil and peat and the successful implementation of an Erosion and Sediment Control Plan, it is considered that the residual impacts which will remain will be for the permanent land spreading of material at the sites which is considered to carry an impact significance of *slight negative to neutral permanent* at each of the sites.

This assessment therefore concluded that assuming peat material will be deposited on sites which are currently underlain by peat and mineral soils and subsoils are deposited on sites currently underlain by same, with the exception of borrow pits which can be filled with peat and capped with mineral subsoil and topsoil (or peat), then the sites as identified are all suitable for use in treatment of surplus unsuitable material from the N4 realignment works in terms of the impacts on their soils & geology providing the proposed mitigation measures are implemented.

5.4.3.1 Site Suitability

On the basis of the foregoing, no sites have been discounted on the basis of Soils & Geology Impacts.

5.4.4 Hydrology and Hydrogeology

The Hydrological and Hydro-Geological assessment similar to the other assessments, considers the receiving environment, the do-nothing scenario, potential impacts, mitigation measures and residual impacts. The consultant utilised much information from the EIS for the main development including ground investigation and water quality results and considered such things as adjacent sensitive sites and hydrological/hydro-geological connections, surface water quality, flooding records, Karst features, ground water bodies and aquifer vulnerability.

In relation to the Receiving Environment, the more significant points to note include the following:

In terms of surface drainage and surface water quality, it was observed that sites LDA1-A4 posed a potential hydrological connection with the outfall from Lackagh Fen which was classified as having good status in accordance with Surface Water Regulations S.I. No. 272 of 2009. Historic Flooding evidence was also noted at LD A4 and LDCP03, with a potential for flooding at LDCP07 (See 5.4.6 for more details).

Karst features were identified within 200m of sites LDA4 & A7, LDCP07, LDBP01, LDBP05 and LDBP07, while in terms of Groundwater Bodies and Aquifer Vulnerability it was noted that all the identified sites were located in the Ballymote Ground Water Body which is classified[20] as having good status in terms of quantity but poor status in terms of quality. Aquifers within this GWB include the Brickleaf Limestone Formation Lower classified as a regionally important karstified bedrock aquifer, characterised by conduit flow (Rkc) and the Bricklieve Limestone upper classified as a locally important aquifer, which is moderately productive only in local zones. Aquifer vulnerability was considered to be Low for the majority of sites with the exception of LDA7, LDCP03 and LDBP01 which are considered to be High to Extreme and LDCP07, LDBP05, 06 & 07 which are considered to be Extreme.

Potential impact significance as a result of the outlined sites have been assessed as follows:

- Moderate/Slight for surface water quality during the Construction Phase;

[20] Based on interim classification work carried out as part of the Water Framework Directive

- Moderate for groundwater quality and groundwater flow during the Construction Phase ;
- Slight for karst features during the Construction Phase;
- Slight/Moderate for groundwater quality during the Operational Phase;

Following considered mitigation measures, residual impacts are those which remain, this has been assessed as follows:

The permanent increase in the depth of the unsaturated zone at the identified sites except the borrow pit sites is considered to be a slight positive permanent impact on each of the sites. The permanent decrease in the depth of the unsaturated zone at the identified borrow pit sites is considered to be a slight negative permanent impact on each of the sites.

The assessment therefore concluded that assuming with the exception of the borrow pits which will be filled and capped appropriately, that peat material will be deposited on sites which are currently underlain by peat and mineral soils and subsoils are deposited on sites currently underlain by same then the sites as considered with the exception of LDA4, LD CP03 (both due to potential flooding risks from historical evidence) are suitable for use in treatment of surplus unsuitable material from the N4 realignment works in terms of the impacts on their Hydrology & Hydrogeology providing the proposed mitigation measures are fully implemented.

5.4.4.1 Site Suitability

On the basis of the foregoing, sites LDA4 and LDCP03 are discounted from the process based on potential flooding issues which may arise.

5.4.5 Archaeology, Architectural and Cultural Heritage

The methodology employed to complete the Archaeological, Architectural and Cultural Heritage Impact Assessment was twofold, comprising a desktop study of RMP sites within 2km, all other cultural heritage features within 1km and a field survey of sites within 0.5km of the identified site options. National Monuments or sites of significant importance within 2km of each area were also visited.

The assessment describes the receiving environment, predicted impacts and possible mitigation measures. It highlights the fact that although numerous cultural heritage sites (CHS) were identified either along or adjacent to the outlined sites there are no direct impacts on any known Recorded Monuments or protected structures. Notwithstanding this, the assessment identifies mitigation measures which should be carried out including monitoring by a suitably qualified archaeologist, recording, archaeological test trenching allowing for preservation in-situ or preservation by record.

5.4.5.1 Site Suitability

On the basis of the foregoing, no sites have been discounted on the basis of Archaeology, Architectural and Cultural Heritage Impacts.

5.4.6 Additional Studies

As part of the drainage design for the PRD it has been identified during flood analysis modelling that it is likely for the 1 in 100 year storm that a significant portion of LDCP07 may experience flooding.

5.4.6.1 Site Suitability

On the basis of the foregoing, site LDCP07 is discounted from the process based on potential flooding issues which may arise. This in addition to those sites already identified in 5.4.4.

5.4.7 Additional Sites within CPO

During the course of the assessment process additional sites were identified within the CPO due to design changes. These sites included LDB01 to LDB08. Each site was vetted from the perspectives outlined above and it was concluded that all were suitable with the exception of LDB5 which was discounted for impacts on Flora, Fauna and Fisheries.

5.4.7.1 Overall Suitability

5.4.7.1.1 *Initial Design Goal Test*

Without compromising any of the content of sections 8 and 9 of this report (relating to the relevance of Waste), it was considered appropriate to determine a design threshold or goal which would determine at an early stage if sites were or were not suitable for the acceptance of the spoil material. In this regard the Directive on Waste (as transposed by S.I. No. 126 of 2011; European Communities (Waste Directive) Regulations, 2011) sets a very useful test if the word Waste is substituted by spoil:

Protection of human health and environment[21]

32. (1) A person holding, treating or otherwise in control of Waste *shall ensure that* Waste *management is carried out without endangering human health, without harming the environment and, in particular—*

(a) without risk to water, air, soil, plants or animals;

(b) without causing a nuisance through noise or odours, and;

(c) without adversely affecting the countryside or places of special interest...

Table 5-3 outlines the overall suitability of sites following the aforementioned assessments.

These are sites which in applying the test described above are considered suitable in principle to accept this material.

[21] S.I. No. 126 of 2011; European Communities (Waste Directive) Regulations, 2011

Table 5-3 Overview of Environmental Review and Suitability

Option	Site Number	Suitability following Environmental Assessment (considering mitigation)								Site Broadly considered suitable	
		V&N	AQ	L&VIA	F,F&F	S&G	H&H	CC	A&A	*YES/NO*	*Comments*
OPTION 1											
Option 1	LD A1	√	√	√	✗	√	√	√	√	✗	Discounted based on F&F and H&H
	LD A2	√	√	√	✗	√	√	√	√	✗	Discounted based on F&F
	LD A3	√	√	√	✗	√	√	√	√	✗	Discounted based on F&F
	LD A4	√	√	√	✗	√	✗	√	√	✗	Discounted based on F&F
	LD A5	√	√	√	√	√	√	√	√	√	
	LD A6	√	√	√	√	√	√	√	√	√	
	LD A7	√	√	√	✗	√	√	√	√	✗	Discounted based on F&F
	LD A8	√	√	√	✗	√	√	√	√	✗	Discounted based on F&F
	LD B1	√	√	√	√	√	√	√	√	√	
	LD B2	√	√	√	√	√	√	√	√	√	
	LD B3	√	√	√	√	√	√	√	√	√	
	LD B4	√	√	√	√	√	√	√	√	√	
	LD B5	√	√	√	✗	√	√	√	√	✗	Discounted based on F&F
	LD B7	√	√	√	√	√	√	√	√	√	
	LD B8	√	√	√	√	√	√	√	√	√	
OPTION 2											
Option 2a	LD CP01	√	√	√	√	√	√	√	√	√	
	LD CP02	√	√	√	√	√	√	√	√	✗	Discounted based on haulage length
	LD CP03	√	√	√	√	√	✗	√	√	✗	Discounted based on H&H
	LD CP04	√	√	√	√	√	√	√	√	√	
	LD CP05	√	√	√	√	√	√	√	√	√	
	LD CP06	√	√	√	√	√	√	√	√	√	
	LD CP07	√	√	√	√	√	✗	√	√	✗	Discounted based on H&H as a result of 'other studies'
Option 2b	LD CB01	√	√	√	✗	√	√	√	√	✗	Discounted based on F&F
OPTION 3 (TYPE 1 PITS)											
Option 3	LD BP01	√	√	√	√	√	✗	√	√	✗	Removed due to Hydro-geological/ F&F sensitivity issues
	LD BP02	√	√	√	√	√	√	√	√	√	
	LD BP03	√	√	√	√	√	√	√	√	√	
	LD BP04	√	√	√	√	√	√	√	√	√	
	LD BP05	√	√	√	√	√	√	√	√	√	
	LD BP06	√	√	√	√	√	√	√	√	√	
	LD BP07	√	√	√	√	√	√	√	√	√	
OPTION 3 (TYPE 2 PITS)											
Option 3	LD BP (T2) No. 1	√	√	√	√	√	√	√	√	√	
	LD BP (T2) No. 2	√	√	√	√	√	√	√	√	√	
	LDBP (T2) No. 3	√	√	√	√	√	√	√	√	√	
OPTION 4											

Option	Site Number	Suitability following Environmental Assessment (considering mitigation)								Site Broadly considered suitable	
										YES/NO	*Comments*
Option 4	LD AG 01	√	√	√	√	√	√	√	√	√	
	LD AG 02	√	√	√	√	√	√	√	√	√	

Note- acronyms denote the following:

V&N: Vibration & Noise ; *AQ* : Air Quality; *L&V*: Landscape; *F,F &F*: Flora, Fauna & Fisheries; *S&G*: Soils & Geology; *H&H*: Hydrology & Hydrogeology; *CC*: Climate Change; *A&A*: Archaeology and Architectural Cultural Heritage

6 Volume Quantification of the Range of Options

6.1 General

As outlined in section 2.2, it is estimated that c. 0.8k[22] m^3 of spoil material will be excavated from the line of the *PRD*.

These quantities need to handled by the different Options set out earlier, having regard to spatial and other constraints. The following text gives an overview of the results for the various options considered, with Appendix 3 to this report giving more specific details on the various calculations.

6.2 Commentary on Environmentally Suitable Sites;

6.2.1 ***OPTION 1:*** Spoil **Repositories within those lands required for land severance reasons**

The areas initially assessed under this category are marked LD A1-A8 and LDB1-B8 in Appendix 2 to this report.

Quantifying only those sites considered suitable following the assessment as outlined in section 5 of this report, it is estimated that there is capacity to accept approximately 102k m^3 of surplus spoil material within the CPO line of the *Proposed Road Development*.

Table 6-1: Material identified for management within Option 1 and the balance remaining.

		Cat. X		Cat. Y	
Decription	**Total volume deposited (m3)**	**Volume of PEAT deposited (m3)**	**Volume of additional organic clay deposited (m3)**	**Volume of subsoil deposited (m3)**	***Comments***
Option 1: Estimated potential volume which may be deposited within CPO	102,345	83,308	-	6,100	*See CALC. Sheet 2, Appendix 3*
BALANCE 4 Volume requiring offsite managment	**604650**	**223686**	**222700**	**171202**	

It should be noted that one number Spoil Repository/Borrow Pit identified in that option and contained within the lands required for land severance reasons is included in the above calculations.

6.2.2 ***OPTION 2:*** **Ecological & Landscape Improvement Works on lands which are remote from but in proximity to those plots required for land severance reasons**

6.2.2.1 ***OPTION 2a;*** Existing conifer plantations of low ecological value;

It has been demonstrated in section 5 of this report that LDCP 01, 04, 05, 06 & 07 are likely to be suitable from an environmental perspective to accept circa 391k m^3 of *Category X* material and circa 125k m^3 of *Category Y* material as outlined in Table 6-2.

In addition to the appropriate approvals and consents required, such an activity may still pose development/implementation difficulties, insofar as:

(1) Compliance may be required with the provisions of the Forestry Act, 1946-1988;

(2) Should ecological regeneration be considered, a biodiversity plan (and implementation of) will most likely be required to outline the objectives/benefits of such a proposal;

(3) Significant advance works including access arrangements and site infrastructure including haulage routes and drainage control/treatment is likely to be required;

(4) Agreement or purchase of lands will be required;

[22] k denotes values of 1,000

6.2.2.2 ***OPTION 2b;*** Restoration of existing Cutover Bogs;

Given the fact that the one identified Cutover Bog in the vicinity of the *PRD* is considered to be of ecological importance, no sites have progressed to volume quantification within this category.

6.2.3 ***OPTION 3:*** **Borrow Pits/Spoil Repositories;**

6.2.3.1 ***OPTION 3;*** Locations within those lands required for land severance reasons

One site has been identified within this option, as previously outlined the quantities estimated for this pit are included in section 6.2.1 above.

6.2.3.2 ***OPTION 3;*** Configuration Type 1 directly adjacent to those lands required for land severance reasons;

It has been demonstrated in section 5 of this report that Borrow Pits LDBP02, 03, 04, 05, 06 and 07 are suitable from an environmental perspective to accept subsoil material with a possible nominal quantity of organic clay (circa 10%). This amounts to an adjusted[23] circa 51k m^3 of *Category X* material and circa 461k m^3 of *Category Y* material.

The quantities which have been determined to be potentially accepted within this option are outlined in Table 6-2.

6.2.3.3 ***OPTION 3;*** Configuration Type 2 directly adjacent to those lands required for land severance reasons;

Based on the foregoing it has been confirmed that LDBP (T2) 01, 02 and 05 are suitable from an environmental perspective to accept Peat, Organic Clays and subsoil material. This amounts to an adjusted[24] circa 281k m^3 of *Category X* material, however, it should be noted that section 8 of this report will focus further on the suitability of these sites.

The quantities which have been determined to be potentially accepted within this option are outlined in Table 6-2.

6.2.4 ***OPTION 4:*** **Land infilling of low lying/low value agricultural lands which are directly adjacent to those lands required for land severance reasons**

The single agricultural parcel of land identified for this purpose as outlined in Table 6-2 has potential to accept circa 153k m^3 of *Category X* material.

6.3 Balance Remaining

This iterative process provides the results summarised in Table 6-2. At this stage, no regard has been made to economic, legislative or land purchase/agreement issues. Notwithstanding such factors, the result is a net surplus within the identified '*Range of Options'* to accept c. 1.4m m^3 giving a positive balance of c. 858k m^3.

[23] Adjusted for the potential actual requirement for a Borrow Pit, i.e. the fill deficit on the project.

[24] Adjusted for the potential actual requirement for a Borrow Pit, i.e. the fill deficit on the project.

Table 6-2: Balance 5; considering suitable sites within the Range of Options

		Cat. X		Cat. Y	
Decription	**Total volume deposited (m3)**	**Volume of PEAT deposited (m3)**	**Volume of additional organic clay deposited (m3)**	**Volume of subsoil deposited (m3)**	***Comments***
OPTION 2 VOLUMES					
Option 2a: Estimated potential volume within conifer plantations	516,360	391,360	-	125,000	*See CALC. Sheet 3, Appendix 3*
OPTION 3 VOLUMES					
Option 3: Type 1 Configuration	512,397	-	51,240	461,157	*See CALC. Sheet 4, Appendix 3*
Option 3: Type 2 Configuration	281,000	152,000	129,000	-	*See CALC. Sheet 5, Appendix 3*
OPTION 4 VOLUMES					
Option 4: Adjacent Agrii Lands	153,000	122,400	30,600	-	*See CALC. Sheet 6, Appendix 3*
OPTIONS TOTAL					
Total volume identified within offsite *Range of Options (Off Site)*	**1,462,757**	**665,760**	**210,840**	**586,157**	*Options 2 , 3 and 4*
BALANCE REMAINING					
BALANCE 4	604,650	223,686	222,700	171,202	*Total volume generated less volumes estimated within Option 1*
BALANCE 5 (Volume Remaining)	- 858,107	- 442,074	11,860	- 414,956	*Negative value indicates spare capacity.*

7 Stage 4: A determination of the Optimum Solution

7.1 Spoil Management Refinement and Selection of Most Appropriate Options.

7.1.1 The Optimum Environmental Solution

It is apparent from the *Range of Options* considered that there are 5 broad options which may be suitable to accept this material. These all require varying methods of application to existing lands.

In order to draw a comparison between each option a Comparable Risk Matrix has been developed which considers in broad quantitative terms the potential Risks (and perceived scores). The Risk scores allow for a comparison of the complexities and difficulties which may be attributable to each option. This will allow for a further refinement of the Outline Spoil Management for the *PRD* with an intended move closer towards reducing uncertainties which may hamper the intended procurement contract.

7.1.2 Comparative Risk Assessment

Risk Assessment is an integral part of environmental analysis and is a method of recognising and quantifying a potential risk to a certain element of the receiving environment. When the resulting harm is measureable (e.g. loss of a particular body of land), risk may be calculated as the probability of an action occurring and multiplied by the severity of the harm if the action does occur:

Risk = (Probability) **X** (Severity of the Consequence)

This tool is considered useful in the context of this report, insofar as it will allow for a method of comparing the aforementioned options in broad quantitative terms. It should be pointed out that there is certain amount of subjectivity involved in developing the Risk Matrices, however, professional judgements have been applied as far as possible in order to maintain impartiality.

Appendix 4 to this report outlines the risk assessment process which is described in summary below.

7.1.2.1 Risk Scoring Chart

The risk scoring chart developed is attached within the aforementioned appendix.

7.1.2.2 Commentary on Risk Assessment Results

The Risk Matrices developed are based on the criteria set out in the scoring chart which is attached in appendix 2. They have been developed for each of the relevant options which have been identified to be suitable from an environmental perspective to accept Spoil material, i.e.:

- ***OPTION 1:*** Spoil Repositories within those lands required for land severance reasons;
- ***OPTION 2:*** Ecological & Landscape Improvement Works on lands which are remote from but in proximity to those plots required for land severance reasons ;
  - (a) Existing conifer plantations of low ecological value;
- ***OPTION 3:*** Spoil Repositories/Borrow Pits;
  - (a) Configuration Type 1 directly adjacent to those lands required for land severance reasons;
  - (b) Configuration Type 2 directly adjacent to those lands required for land severance reasons;
- ***OPTION 4:*** Land infilling of low lying/low value agricultural lands which are directly adjacent to those lands required for land severance reasons

The matrices developed indicate negative high end weightings against the Option 2 and 4 sites, this is principally for a number of reasons which include:

- The haulage distances from the donor site to the repository in comparison with those options which are within or adjacent to the *PRD*;
- The large land area required in comparison with the Option 1 and 3 sites;

- Potential impacts as a result of modifications to flood plains when compared against those sites where the deposit will take place mainly below existing ground level;
- The increased potential for construction related water quality impacts which is due in the main to the large area of land required and the potential exposed nature of the spoil material. This is in comparison with those sites which require a much smaller land area;
- A increased risk of perceivable change to the landscape as a result of the development of the repository, this is principally due to the large land area required;
- The increased time and cost to develop these repositories which is particularly attributable to:
    - The advanced infrastructure required to access the repositories;
    - The increased water quality controls required as a result of the large land area;
    - The higher risk for the requirement to apply for a Waste licence or for a separate statutory consent which might include a specific EIS

7.1.2.3 The Optimum Solutions

The Risk Assessment process allowed for a concerted comparison of the *Range of Options*. Although the shortcomings of some of the options were perceived in advance of the Risk Scoring, the outputs of this exercise provide a clear comparative indication between the options. It became clear from this exercise that the sites which could be considered to be the optimum solution to accepting this material should preferably:

- Be close to the donor site;
- Generally contained below ground level;
- Provide as low a surface area as possible;
- Not entail the handling of material that falls within the definition of Waste[25];
- Be associated with the higher (reuse) rather than the lower end (recovery/disposal) of the Waste Management Hierarchy (see section 9 of this report);
- Be of reasonable cost against other options.

In this regard the risk assessment process as outlined above indicates that those landscape infill sites contained within Option 1 and the Spoil Repositories/Borrow Pits contained within Option 3 appear from a range of different perspectives to be the most suitable approaches. There are a number of reasons for this including:

(1) They are within or directly adjacent to the *PRD*;
(2) The material is stored below ground level, therefore:
    a. There is no risk of impacting on flood plains;
    b. There is no risk of a material slide;
(3) Considering the depth of material which they can accept, they have a much smaller land area requirement when compared with the other options;
(4) As already discussed, both EU and national law suggests that the material used to reinstate these borrow pits falls outside the term “waste” when it is being used for the purposes of construction.

It is noted however that in particular the Spoil Repositories/Borrow Pits are not without risk particularly in relation to:

(1) Health & safety;
(2) Interception of karstic flows;
(3) Noise & vibration impacts during the extraction process;

These risks however are short term, being construction related and manageable through the appropriate application of specified controls, thresholds and monitoring procedures.

In this regard as it has been established that there is a potential *Need* for the pits from a spoil repository perspective; accordingly, the objective now is to determine if there is a *Need* from a material resource perspective. Section 7.1.3 below assesses this requirement.

[25] As per the Waste Directive and the Waste Management Act

7.1.3 Justification for the Borrow Pit approach

7.1.3.1 Material Deficit

The *PRD* as a linear project will run both above and below existing ground levels providing a Cut:Fill balance for the earthworks material. Road projects by their nature seek to obtain sufficient quantities of material from the Cut[26] balance which is suitable for use as a Fill material. Although the design was progressed with this objective, sufficient quantities of acceptable material are not achievable from the cut sections to balance the need in the fill sections. This balance at approximately 44%:56% has resulted principally due to the following factors:-

- The Fill design requirements for:
  - Underbridges; and
  - Watercourse culvert crossings;
- The undulating topography;
- The environmental need to avoid cutting into the groundwater table (and saturated bedrock) in sensitive locations;

The aforementioned ratio is further compounded by the fact that only circa 60% of the Cut material is considered re-useable and that an additional significant amount of material requires to be excavated from underneath (as opposed to the cut sections) proposed embankments.

On a worst case assumption, if it is considered that the deficit material is fully attained as material import from licensed quarries the total import of acceptable and granular material required is expected to be circa 1.1m m^3 (excluding capping and processed) as outlined in more detail in Table 7-1 and Appendix 1 to this report.

Table 7-1: Estimated Material Requirements for Excavate/Replace and embankment construction

Description	Quantity	Potential Material Source
Cohesive Fill	768,570	*Glacial Till Drumlin Depoit*
Grannular Material	239,616	*Rock Formation*
Starter Layer	107,235	*Rock Formation*
Capping Layer	143,892	*Rock Formation*
Total (excl. Capping)	**1,115,421**	
Total (incl. Capping)	**1,259,314**	

7.1.3.1 Material Categories Required

In general for the main element of earthworks construction, two types of material are required. These are described below.

- Acceptable material which corresponds to the requirements of series 600 of the NRA Specification for Roadwork's for road embankment construction. Where there are no specific requirements, this material is generally suitable cohesive fill (or firm subsoil). The contractor will initially seek to win this material from road cuts in the *PRD* which pass through drumlins as it obviously has to be excavated from the cut and as demonstrated in section 7.1.3.2 is much cheaper than purchasing quarried material.
- There are instances where the material required must have more specific characteristics in order to be included with the embankment construction. In the case of this particular *PRD*, this includes the requirement for granular fill below standing water in excavate/replace areas and the typical requirements of granular material for starter and capping layers.

[26] Which extends in this case to the material excavated in soft ground areas underneath embankments

7.1.3.2 Comparative Costs[27]

While it is difficult to accurately predict the exact material cost of using quarry imported material against material generated from on site borrow pits, a calculation based on the NRA Unit Rates Database suggests that there could potentially be a saving of circa €6m if the material was to be won on site (see Table 7-2).

Table 7-2: Material Import –v- Onsite won material

Cost Comparision: FULL material import V FULL onsite won material			
Full Material Import			
Potential Imports	**Rate**	**Q**	**Cost**
Material Import and compaction: Granular	€ 11.00	490,743.04	€ 5,398,173.44
Material Import and compaction: Acceptable	€ 10.00	768,570.46	€ 7,685,704.62
Total			€ 13,083,878.06
Comparable Site Won Costs			
Resource Pits	**Rate**	**Q**	**Cost**
Excavate/Deposit/Compact acceptable material	€ 4.00	768,570.46	€ 3,074,281.85
Process Rock	€ 4.00	490,743.04	€ 1,962,972.16
Place & Compact Granular Material	€ 4.00	490,743.04	€ 1,962,972.16
Total			€ 7,000,226.17
Difference			€ 6,083,651.89

7.1.3.1 Fuel Costs[27]

While the above figure is only a ball-park one, it suggests a very significant saving being accrued by the borrow pit approach. This saving is compounded by others, of which comparative fuel costs are the most obvious and significant.

Based on the identified access points to the construction site, Calc Sheet 9 in Appendix 3 sets out estimated calculations for haulage fuel costs if it is to be assumed that the material is purchased from registered quarries. This indicative calculation demonstrates a potential cost of in the region of €1.2m. This is a conservative estimate as it is based on distances to the closest quarries in the vicinity of the *PRD*.

7.1.4 **Summary**

It has been demonstrated in the preceding sections that:

- There are a number of good reasons why the borrow pit approach is the most suitable environmental option to accept the spoil material from the *PRD*;
- Similarly a very clear picture is provided on economic grounds alone that the use of Borrow Pits as a material resource for the *PRD* is of significant benefit and requirement for the construction stage;

[27] Calculations are based on the basic assumption that all material is either import or won onsite as the case may be. This is a comparable exercise and is notwithstanding the fact that section 8 of this report limits the extent of onsite borrow pits to the equivalent volume of material which is available for reinstatement.

8 Stage 5: The *Proposed Road Development*

8.1.1 **Outline**

As already discussed in section 1.3.2 the customary approach of dealing with the aforementioned spoil material on national road projects where the design/build form of contract is used was to place all of the various responsibilities and onus's on the appointed contractor.

Over the past number of years certain drawbacks to this approach have been realised, these include *inter-alia*:

- A lack of certainty involved at the Roads Act consent stage as to the approach an appointed contractor may take, primarily due to the procurement contract being adopted;
- Potential subsequent delays from a contractual viewpoint in identifying suitable methods and subsequently applying for and obtaining consent for the use of sites to accept these methods;

In an attempt to add some certainty to this quandary, this report in the preceding stages has demonstrated quantifiably the options which are considered to be the best methods for dealing with the spoil material. Additionally it has been shown that there is a justifiable dual purpose to the *PRD* in advancing the Spoil Repositories/Borrow Pits. In this regard and arising from NRA approval the aforementioned repositories which have been previously described as Option 3 within this report will be included wholly within the land acquisition requirements of the *PRD* and assessed directly within the EIS. This will be in addition to the Option 1 sites which are already included. **This is done with the caveat that it will be the contractor's responsibility to confirm the viability of such sites/methods (and apply for any additional approvals as required) as such assumptions made to date are relative only to the information available at the current stage of the project and consent stage.** This however is deemed the most responsible approach based on the information available at the current stage of consent.

The process to this point has considered sites in broad terms and from a Range of Options perspective. Considering now that the focus has changed to considering such sites within the confines of the *PRD*, an examination is presented in this chapter of those specific sites which are deemed to be the optimal ones, together with a further more specific proposal for the characteristics of the different sites. This approach will allow the EIS to set down reasonable provision for such sites, providing what is effectively a maximum envelope on the nature of this *PRD*, its impacts and mitigation. The intention will be that the contractor can later select from within that envelope. This is done notwithstanding the fact that it will be the contractor's prerogative to design and quantify such areas as part of the detailed design and construction stage.

8.2 Sites and Characteristics[28]

8.2.1 **Option 1: Landscape Infilling**

8.2.1.1.1 *Site Selection*

Considering the output of section 6.2.1 it is considered appropriate that all suitable sites be considered directly in the EIS as outlined in Table 8-1 below

Table 8-1: Selection of Option 1 Sites

Site No.	Chainage	Notes	Label No. for EIS
LDB2/LD A5	Circa. Ch. 5,410m – 5,530m RHS	Repository to contain peat with the intention of creating ecological peatland regeneration. Peat to be fully contained between road embankments.	SR-LI-01
LD A6	Circa. Ch. 5,600m –	Repository to contain peat with the intention of recreating ecological peatland regeneration. Peat to be fully contained	SR-LI-02

[28] Specific design details contained within have been developed to allow the impacts of such features to be adequately assessed within the EIS. It will be the contractor's responsibility as part of the design stage to develop the detail so that the performance objectives are achieved.

Site No.	Chainage	Notes	Label No. for EIS
	5,700m LHS	between road embankments and the existing ground contours.	
LD B3	Circa. Ch. 6,600m – 6,700m LHS	Repository to consist of subsoil deposited as a landscape infill measure fully contained between the contours of the exiting ground and road embankments.	SR-LI-03
LD B4	Circa. Ch. 6,720m – 6,870m LHS	Repository to consist of subsoil contained between a shallow berm and the road embankment.	SR-LI-04

There are no further characteristics to be applied to these sites to that already described in this document, however, regard should be had to the Outline Erosion and Sediment Control Plan which outlines water quality controls for these sites.

8.2.2 **Option 3: Borrow Pits/Spoil Repositories**

8.2.2.1 Configuration Type 1

Figure 4.11.11 contained in volume 3 of this EIS describes this configuration in figurative terms. Site Selection and additional characteristics are outlined below.

8.2.2.1.1 *Site Selection*

The sites selected for this particular configuration were based on:

(1) The environmental suitability of the pit arising from the assessment carried out in section 5 of this report; and

(2) The perceived geotechnical suitability of the material contained within the pit established principally from Preliminary Ground Investigation information (including referral to the Preliminary Geotechnical Interpretive Report). This suitability obviously has implications on the material:

a. which can be used in road construction embankments,

b. the material that will need to be returned to the pit, and thus

c. the material which can be deposited from the soft ground areas along the route;

Table 8-2 outlines the selection process which ultimately results in the selection of four pits.

Table 8-2: Selection of Borrow Pit/*Spoil* Repository Type 1 Configuration

Site No.	Chainage	Notes and decision	Label No. for EIS
LDBP 01	Circa. Ch. 2,900m – 3,200m RHS	This location was initially selected based on a November 2011 version of the alignment design which had a substantial cut in this area. As outlined in Chapter 4 of the EIS, this cut was subsequently raised to avoid intercepting saturated bedrock which could potentially be feeding the Lackagh Fen GW dependent biodiversity site. The pit at that stage was removed from consideration as the restrictions on the depth of excavation would make such a pit unviable.	N/A
LDBP 02	Circa. Ch. 5,800m – 6,500m LHS	Although there is potential for this particular pit to be considered as a Borrow Pit location it is considered its viability may be compromised by the fact that the Geotechnical Factual Report and the subsequent Preliminary Geotechnical Interpretive Report (GIR) indicates that the upper 5m below existing ground level may be unsuitable material which would in all likelihood need to be returned to the pit during the repository Phase. In due consideration of each of the pits it is considered that this pit may provide a lower level of suitable material in comparison with the other more suitable locations.	N/A
LDBP 03	Circa. Ch. 10,300m-	The material within this drumlin appears suitable The invert level of the pit will be set at 1m below the design level to the adjacent *PRD* centreline.	SR/BP Type 01-01

Site No.	Chainage	Notes and decision	Label No. for EIS
	10,550m LHS		
LDBP 04	Circa. Ch. 10,300m-10,550m LHS	Due to the topography of the Drumlin and the hydrogeological requirement to maintain the vertical invert of the pit at a similar level to the centreline of the *PRD*, this pit is not considered to be suitable to consider within the *PRD*.	N/A
LDBP 05	Circa. Ch. 10,840m-11,000m LHS	The discussion in the Geotechnical Factual Report and the Preliminary Geotechnical Interpretive Report indicate that the top 3m-4m of the glacial till deposit may need to be returned to the pit later; however, considering that there is circa 7m below this level to the formation level of the centreline of the *PRD* it has been decided to include this pit within the *PRD*.	SR/BP Type 01-02
LDBP 06	Circa. Ch. 11,400m-11,780m RHS	The material within this drumlin appears to be suitable. The invert level of the pit will be set at 1m below the design level to the adjacent *PRD* centreline.	SR/BP Type 01-03
LDBP 07	Circa. Ch. 12,690m-12,900m RHS	The material within this drumlin appears to be suitable. The invert level of the pit will be set at 1m below the design level to the adjacent *PRD* centreline. The pit has been modified to include only the northern section	SR/BP Type 01-04

8.2.2.1.2 *Development Characteristics*

In addition to characteristics already described, it shall be a requirement in the development of these pits that the criteria outlined below are used for Environmental Impact Assessment.

8.2.2.1.2.1 *Outline*

(1) The lands will be made available for return to the appropriate landowner following completion of the landscape establishment period;

(2) The topographical slope following a period of 24 months from the final reinstatement will resemble as close as possible its pre excavation slopes. During this 24 month period and following grass seeding, the appointed contractor shall manage the land as part of the landscape maintenance works for the *Proposed Road Development*. To demonstrate compliance with this, the contractor will be required to develop a method statement for backfilling the pit and a monitoring programme which shall outline the rate of settlement;

(3) The topsoil quality and depth at the site shall be surveyed pre-excavation and returned to a similar state following the repository stage;

(4) The permeability (measured by K value) of the upper 1m of the repository shall match as far as is reasonably practicable its pre-excavation value;

(5) Following the period of 24 months outlined above, the objective will be that the agricultural value of the field will as far as is reasonably practical resemble its pre-excavation state;

8.2.2.1.2.2 *Material Extraction*

The material extraction process shall generally be by machine excavation in accordance with the following general principles:

(1) Prior to excavation, the contractor shall have the material required to reinstate the pit identified both in terms of quantity and source.

(2) The upper surface of the drumlin which is determined by the contractor to be unsuitable for use in the embankments, environmental bunds or the constructed wetland attenuation facilities shall be set aside for eventual restoration as part of the repository stage;

(3) The suitable material won from the pit shall in the first instance be used in the adjacent fill areas of the *Proposed Road Development*, where haulage is required further afield this shall be done principally within the confines of the CPO boundary on tracks which will be the responsibility of the contractor to provide;

(4) Should rock be encountered during the extraction stage, the same controls as those outlined for the Type 2 Spoil Repository/Borrow Pits shall apply;

(5) Water quality management within the development of the pit shall be in accordance with the criteria set out in the Erosion and Sediment Control Plan;

8.2.2.1.3 Spoil *Repository Stage*

(1) The material to be deposited shall be from the glacial till subsoil material generated in the first instance from the adjacent road cut which is considered to be unsuitable for the purposes of road embankment construction. Provision may be made for alluvial clay (max 10%) to be mixed into the bottom 3m of this pit provided it can be proven that this will not compromise the final landform;

(2) A land drain shall be completed 2m from the roadside edge of the containment bund prior to final reinstatement of the pit. Controls as outlined in the Erosion and Sediment Control Plan shall be incorporated into these drains prior to their discharge to the adjacent watercourse;

8.2.2.1.4 *Fencing and Return to the Landowner*

(1) A temporary boundary fence shall be constructed around the perimeter of the pit which shall remain in place until the following conditions have been met:

a. The grass sward has fully re-established itself;

b. As per point 1 of section 8.2.2.1.2.1 at least 24 months following reinstatement or in any event until the settlement monitoring indicates that the material within the pit has fully consolidated itself. Should this result in any noticeable deviations in the surface of the pit, then an additional spread of topsoil shall be applied and seeded appropriately;

8.2.2.2 Configuration Type 2

Figure 4.11.12 contained in volume 3 of this EIS describes this configuration in figurative terms. Site Selection and additional characteristics are outlined below.

8.2.2.2.1 *Site Selection*

The sites selected for this particular configuration were based on:

(1) A close examination of the topography of the exiting ground;
(2) The environmental suitability of the pit arising from the assessment carried out in Chapter 5 of this report; and
(3) The Geotechnical Suitability:
    a. The geotechnical classification of the material contained within the pit obviously has implications on:
        i. the material which can be used in road construction embankments;
        ii. the material which will need to be returned to the pit; and thus
        iii. the material which can be deposited from the soft ground areas along the route.

    The geotechnical objective based on the *Need* for these pits and the fact that the Type 1 Repositories will most likely substantially satisfy the cohesive fill requirements for embankment construction, resulted in a conclusion that the targeted material should be the granular fill requirements for the *PRD*;

    b. The determination of the above commenced with the initial review as discussed in section 4.3.2.4.1.2.2, this was followed by targeted trial pit excavation (to probe for rock head) in the areas deemed to be initially the most suitable and then by a more focussed Seismic Refraction/Resistivity Survey in five locations. The Seismic Refraction/Resistivity Survey was preferred to Rotary Coreholes as it gives a broader picture of the geological conditions in comparison to point information provided by a the Corehole. This preference was aided by the fact that it will be the contractors overall responsibility to determine the viability of the pits.
(4) Proximity of structures which may be sensitive to vibration impacts.

A desktop study in consultation with the specialist sub consultants determined the location and extent of this type of Spoil Repositories/Borrow Pit. The result was that three sites were selected (see Table 8-3)

*Table 8-3: Selection of Borrow Pit/*Spoil *Repository Type 2 Configuration*

Site No.	Chainage	Notes and decision	Label No. for EIS
LDBP (T2) 01	5,600-5,710m	Ground Investigation and Geophysical Survey in this area indicate rock is in proximity of the surface (3m-5m), making this a financially and technically viable borrow pit. No significant karst features in this location were found, and it is anticipated that there will be no significant impact on the existing groundwater regime. The closest property is circa 210m from the nearest edge of the pit; therefore it is considered that vibration from blasting can be adequately controlled. This area is in the confines of land infill spoil repository SR-LI-01 and is adjacent to the Toberscanavan Loughs County Biodiversity Site, thus the ecological regeneration will provide for complimentary mitigation for flora and fauna.	SR/BP Type 2-01
LDBP (T2) 02	5,500-5,780m	Ground Investigation and Geophysical Survey in this area indicate rock is in proximity of the surface (3m-5m), making this a financially and technically viable borrow pit. No significant karst features in this location were found, and it is anticipated that there will be no significant impact on the existing groundwater regime. The closest property is circa 200m from the nearest edge of the pit; therefore it is considered that vibration from blasting can be adequately controlled. This area is adjacent to the Toberscanavan Loughs County Biodiversity Site, thus the ecological regeneration will provide for complimentary mitigation for Flora and Fauna.	SR/BP Type 2-02
LDBP (T2) 05	--	Ground Investigation and Geophysical Survey information in this area indicate that rock is in the vicinity of the surface (3m-7m). In comparison with the above two locations, the quality of rock is not deemed as high, however it is expected that there is still potential to win class 1 and class 2 material from the pit. From a hydro-geological viewpoint, the aforementioned data has not identified any significant karst features in this location, therefore, it is anticipated that there will not be a significant impact to the existing groundwater regime. The closest property is circa 270m from the nearest edge of the pit; therefore it is considered that vibration from blasting can be adequately controlled.	SR/BP Type 2-03

8.2.2.2.2 *Development Characteristics*

In addition to characteristics already described, it shall be a requirement in the development of these pits that the criteria outlined below are used for Environmental Impact Assessment.

8.2.2.2.2.1 *General*

(1) It is generally acknowledged that deposition of peat and organic clays to depths of 15m to 20m will ultimately result in consolidation over time. However, it is considered that if the materials are appropriately mixed (or placed) then this settlement can be substantially reduced.
To adequately address the risk of settlement, it is considered that a slope of 1V:4H be provided into the pit (within the repository level) to a depth of 3m. Additionally it is recommended that the peat surface be mounded at 1-2 degrees towards the centre of the pit to compensate for settlement. At a point 5 years after reinstatement of the surface peat layer, the site shall be re-examined by the Local Authority to determine if additional landscaping is required;

(2) The final performance objective (following the above mentioned period of 5 years) of the repository shall be that:
   a. The site will have regenerated (or be at that stage showing positive signs of regenerating) into a peatland habitat;
   b. It will be safely adequate to allow light agricultural livestock access across the site;
   c. It will be safely adequate to access the site with light agricultural machinery;

(3) Provision is made in the landtake requirements for an environmental bund where this is deemed necessary.

8.2.2.2.2.2 *Material Extraction*

(1) A 2.1m high fence shall be constructed around the perimeter of the site prior to extraction commencement;

(2) Prior to excavation, the contractor shall have the material required to reinstate the pit identified both in terms of quantity and source;

(3) The topsoil layer or peat Acrotelm layer of the pit shall be stripped prior to excavation and set aside for the eventual reinstatement of the surface of the pit;

(4) The upper surface of the pit which is determined by the contractor to be unsuitable for use in the embankments, environmental bunds or the constructed wetland attenuation facilities shall be set aside for eventual restoration as part of the repository stage (to the base of the pit or used as a capping layer);

(5) The locations for use of the suitable material (predominately granular) won from the pit shall be determined by the contractor, however, in accordance with the Outline Erosion and Sediment Control Plan, it will be a requirement that excavations underneath the road embankment will be backfilled as that excavation advances, therefore, as far as is deemed practicable by the contractor the extraction of suitable material and the excavation of unsuitable material from underneath the proposed embankments shall be carried out in sequence. In addition to the requirement of the Outline Erosion and Sediment Control Plan this will ensure a controlled approach to the extraction/repository process;

(6) Specific limits in terms of Noise & Vibration, Air Quality, Hydrology and Hydrogeology will apply in during the extraction process of the pits. These relate to such things as vibration limits from blasting, dust emissions and interception of karstic flows and are expanded upon in the various chapters of the EIS Volume 2;

(7) In advance of any blasting or rock breaking being carried out in the pits, a pre condition survey shall be carried out on all structural properties within a 500m radius of the pits. An additional survey shall be carried out within 6 weeks of the final extraction at the site;

(8) Haulage of the material arising from the pits shall be done principally within the confines of the CPO boundary on tracks which will be the responsibility of the contractor to provide;

(9) Water Quality management within the development of the pit shall be in accordance with the criteria set out in the Outline Erosion and Sediment Control Plan. Water discharged into the surface water system must be within the limits set out in the second schedule to the European Communities (Quality of Salmonid Waters) Regulations, 1988, measured at the point of discharge to the nearest watercourse. If groundwater inflows are encountered which are greater than this, then recharging this groundwater to the ground outside the borrow pit via recharge wells or pits could be carried out. If such groundwater recharging was not possible and if it was then impossible to keep discharges to the surface water system within acceptable limits then the cell in question shall be closed at that point for commencement of the repository stage;

8.2.2.2.2.3 Spoil *Repository Stage*

(1) For the purposes of the EIS, the following is considered for reinstatement:

a. Pit invert to 3m from Ground Level: peat & organic clays (50:50) with possibly some category Y material;

b. 1m - 3m below Ground level: Class 4 Fill;

c. 0m - 1m below Ground Level: peat from the Acrotelm layer elsewhere on site with a vegetation mulch on the surface as per the erosion and sediment control plan;

d. Surface: Grass seed mix in accordance with the requirements of Chapters 10 and 12 of the EIS;

(2) The 2m capping layer is intended to act as a consolidation and safety layer prior to restoration of the peat surface;

(3) In accordance with the requirements of the Erosion and Sediment Control Plan, a sedimentation pond shall be provided on site (at a low Point) for sediment control during the re-establishment period discussed below;

(4) Erosion and Sediment Control shall include the provision of the above pond and shall contain additional measures as outlined in the Outline Erosion and Sediment Control Plan;

(5) Settlement monitoring shall be carried out following the repository stage at bi-annual intervals for a period of 5 years;

(6) 2.1m Perimeter Fencing shall remain in place for a period of at least 5 years after which point and following examination of the settlement monitoring results a decision shall be taken if the fence may be removed and replaced with a 1.2m high timber post and rail fence. Ecological Land Management shall be considered at that time, the Local Authority shall determine the most appropriate method of this which might include a long term agricultural lease or selling on the plot;

8.3 Material to be treated within the *PRD*

This chapter sets out and identifies specific sites within the confines of the *PRD* which will accept spoil material generated. Table 8-4 below outlines that if all the sites transpire to maximise their full potential then a balance of 63k m^3 of peat material will remain, how this material is treated will be elaborated on further in section 9 of this report. Calc sheet 7 contained within Appendix 3 provides more detail.

Table 8-4: Balance remaining after use of sites to be considered within the limits of the PRD

		Cat. X		Cat. Y	
Decription	**Total volume deposited (m3)**	**Volume of PEAT deposited (m3)**	**Volume of additional organic clay deposited (m3)**	**Volume of subsoil deposited (m3)**	***Comments***
Total Volume Generated	604,650	223,686	222,700	171,202	*Arising after use of option 1*
Options arising from Stage 5					
Volume achievable within Type 1 SR/BP's	483360	0	86480	396880	*Type 1 Pits included in PRD*
Volume achievable within Type 2 SR/BP's	304000	152000	129000	23000	*Type 2 Pits included in PRD*
Balance		**71686**	**7220**	**-248678**	*Positive value indicates a surplus; Negative value indicates a defecit*

As already described it will be a requirement that, before the opening of any of the potential pit locations, **the excavation volume of the pit will be no greater than the volume which has been identified to be available as spoil material to be used for the reinstatement purposes.**

The locations and layouts of the above sites are set out in Fig. 4.11.1 to 4.11.10 contained within volume 3 of the EIS.

8.4 The Waste Hierarchy

Whether the spoil material falls within the context of the aforementioned exclusion explained in section 1.4.1 of this report determines whether the Waste Management Hierarchy does or does not apply. It has been demonstrated in section 8.3 of this report through analytical volumetric calculations that if the design elements assumed (in this report) transpire into actual dimensions that all the spoil material can be contained onsite, that is with the exception of circa 72k m^3 of peat material. This quantification however, comes with the unavoidable[29] caveat that the calculations are based on the best information which is available at the current stage of the design process and that it will be the appointed contractor who will ultimately determine the precise suitability of the material within the pits and the subsequent depths the pits may be extended to, considering the restrictions which will be prescribed particularly within the following chapters of the EIS:

- Chapter 8: Noise and Vibration;
- Chapter 9: Air Quality & Climate Change;

[29] Due to the type of Procurement Contract being proposed

- Chapter 13: Soils and Geology;
- Chapter 14: Hydrology and Hydrogeology

With cognisance of this, it is recognised that should there not be capacity to accept all the spoil material within the limits of the *PRD*, then there is an increased likelihood that the surplus may ultimately fall within the definition of Waste. The Waste Management Hierarchy will thus in such a scenario become activated, in this regard the contract documents for the detailed design/construction project will clearly set out the staged approach which the contractor will be required to adhere to through the use of the Hierarchy. This is further expanded upon in section 9 of this report.

In order of priority, the hierarchy sets out the most desirable approaches to Waste management as comprising:

(f) Prevention;

(g) Preparing for re-use;

(h) Recycling;

(i) Other recovery (including energy recovery); and

(j) Disposal;

9 The Consideration of Alternatives

9.1 Background

A requirement governing the content of Environmental Impact Statements and their consideration is how what are known as "alternatives" have been considered. In other words, there is a need for a developer to show how whatever has been proposed is optimal and justifiable. While the issue of alternatives relating to the N4 project as a whole has been covered in the EIS main volume, it needs to be considered in respect of associated spoil management sub-element.

A significant amount of information about alternatives for spoil management has already been presented in earlier chapters of this Report. In summary, a large number of potential options were considered, both on- and off-site. Reasons such as financial cost, traffic impacts, fuel consumption and so on all pointed to an on-site, within the CPO, approach. A variety of different locations were then considered, with a total of 12[30] being shortlisted. Others were rejected due to their unsuitability, for reasons including hydrogeological factors and proximity to housing.

In addition, alternatives need to be considered in the wider sense, most obviously whether there are other techniques that allow a proportion of the unsuitable material to remain in-situ. This will be done in the section of this chapter that follows. However, what needs to be emphasised at this juncture is that, in terms of this EIS, the options and their impacts set out up to now are being presented as a worst-case scenario and it is shown how these can be mitigated without unacceptable environmental effects. Accordingly, the approval by an Bord Pleanála of what has been proposed allows the creation of an envelope within which the contractor selected to carry out the works can operate, with the body appointed being able to determine options that both have a lower impact and less cost. By contrast, dictating such options at EIS approval stage may lead to inflexibility and additional cost to the State in carrying out this development.

9.2 Alternative Construction Techniques;

It is possible that the appointed contractor may decide to employ alternative construction techniques in the deep sections of soft ground. An example of such an alternative would be a structural piled solution as opposed to the excavate/replace option considered for the purpose of the EIS and cost estimation.

The following outlines the likely options a contractor may consider in this regard and the possible savings that may be made. In reality, these type of considerations seem most likely to occur when triggered by economic, legislative or land purchase/agreement difficulties arising from disposal/recovery proposals offsite.

AGL have outlined a range of scenarios, each based on depths of organic soils, of when a structural piled foundation could be considered against the excavate/replace option. Based on the geotechnical report these scenarios have been used by the design team to identify areas based on broad probabilities where pilling could be considered.

9.2.1 **Piling Considerations**

It is stated within appendix 5 to this report that:

Excavation of peat up to 2.0 m depth is normally a straightforward operation, depending on the groundwater conditions in the area. Between 2.0 m and about 4.0 m depth the stability of the peat at the edges of the excavation will depend on the shear strength of the soils and the groundwater conditions. Excavations in very weak peat with a high groundwater table will require some stabilisation works at the edges of the excavation to prevent shear failure in the peat. This will typically involve some groundwater control, battering back the sides of the excavation to a stable slope, or, in extreme conditions, supporting the sides of the excavation with a rockfill berm. Nevertheless, depths of excavation up to 4.0m would normally be achievable by an experienced earthworks contractor, and where there is a suitable disposal site for the peat within close proximity to the works it is typically the most cost-effective design solution.

[30] Including the 2 landscape mitigation sites

The depth of soft organic soils encountered along the mainline carriageway is up to 6.0 to 7.0 m in places, generally adjacent to watercourses. Excavation to these depths is a specialist operation which should be carried out by an experienced earthworks contractor....

- *Depth of organic soils: 0-2.0m*

  For depths of organic soils <2.0 m the excavate/replace option would typically be the most cost effective solution and a pile-supported option would only be considered if there were severe constraints on peat excavation and disposal (e.g. hydrological and environmental restrictions).

- *Depth of organic soils: 2m – 4m*

  For depths of organic soils between 2.0 and 4.0 m, the cost difference between the excavate/replace option and the pile-supported embankment would be quite significant.

  Therefore, the likelihood of using a pile-supported embankment would depend on a range of conditions including the extent of soft soil up to about 3.0 to 4.0 m, the distance to a suitable borrow pit for the Class 6A rockfill, and the environmental, logistical and economical constraints on peat excavation and disposal ...

- *Depth of organic soils: 4m – 7m*

  For depths of organic soils of 4.0 - 7.0 m the excavate/replace option would still normally be used by an earthworks contractor if there was a suitable disposal site for the peat within close proximity to the works. However, if there are significant constraints on peat disposal and on the supply of rockfill then the pile-supported platform could become a cost-effective alternative to reduce the volume of spoil.

In addition to the above, consideration has also been given to ground conditions and embankment height in determining the suitability of specific locations to piling.

Ground Conditions:- *the depth to rock and the depth and characteristics of the glacial till below the soft ground will determine the length of pile foundations.*

Embankment height:- *a minimum embankment height of about 2.5 m would be required to construct a reinforced earth load transfer platform. Below this the road would need to be constructed on a reinforced concrete deck, which would be more expensive. Also, for high embankments > about 7.0-10.0 m it may be necessary to use higher capacity bored piles socketed into rock, depending on the ground conditions, which would be more expensive than the driven pre-cast reinforced concrete piles that are normally used.*

From the foregoing data, three option have been developed by the design team which reflect the probability of piling being considered in the event of difficulties arising treating the spoil material offsite, these are:

(A) High Probability: Where depth of organic soils is 4m to 7m deep and ground conditions/embankment height are favourable,

(B) Medium Probability: Where depth of organic soils is 2m to 4m deep and ground conditions/embankment height are favourable;

(C) Low Probability: Where depth of organic soils are in the range of (A) and (B) but embankment height provides difficult constraints;

For the purposes of this report, piling has not been considered as a viable alternative where there is less than 2m of organic soil.

Table 9-1: Alternative Construction Techniques.

Cat.	Location	Alternative Construction Technique	Potential reduction in Volumes (m3)	Notes
A	Ch 4460-Ch 4660m (200m)	*This section could be constructed as a pile-supported embankment with a reinforced earth load transfer platform.*	29,500m^3	*The depth of soft ground between Ch. 4+460 and 4+660 (200m) is on the order of 4.0 - 4.5 m, and locally >4.5 m on the west side at Ch. 2+200. The embankment is between 4.0 and 5.1 m*

Cat.	Location	Alternative Construction Technique	Potential reduction in Volumes (m3)	Notes
				high.
C	Ch 5210-Ch 5560m (350m)	*This section could be constructed as a pile-supported embankment. North of Ch. 4+210 the road may have to be constructed on a reinforced concrete deck due to the low height of the embankment (<2.5 m). South of this it could be constructed on a reinforced earth load transfer platform.*	42,500m^3	*The depth of soft ground between Ch. 5+210 and 5+560 (350m) is on the order of 3.5 to >4.5 m, possibly reducing to <2.5 to 3.5 m on the east side. The embankment is 1.0 to 4.5 m high.*
A	Ch 6910-Ch 7510m (600m)	*This section could be constructed as a pile-supported embankment with a reinforced earth load transfer platform.*	78,000m^3	*The depth of soft ground between Ch. 6+910 and 7+510 (600m) is on the order of 4.0 to 7.0 m along the west side of the embankment, reducing to <1.5 to 3.0 m along the east side. The embankment is 2.5 to 5.2 m high.* *Note: in soft peat and organic soils up to 6.0 to 7.0 m deep the pile-supported embankment may be the main construction option.*
C	Ch 9510-Ch 9610m (350m)	*This section could be constructed as a pile supported embankment with a reinforced earth load transfer platform.* *High embankment may necessitate larger bored piles with rock sockets.*	12,500m^3	*The depth of soft ground between Ch. 9+510 and 9+610 (100m) is on the order of 3.0 to 3.5 m. The embankment is up to 7.7 m high.* *Note: given height of embankment (up to 7.7 m), the short section of relatively shallow peat (<4.0 m) and possible need for bored piles with rock sockets, there is a lower probability that this section of the road would be constructed as a pile-supported embankment.*
C	Ch 10710-Ch 10810m (100m)	*This section could be constructed as a pile-supported embankment with a reinforced earth load transfer platform. High embankment would probably necessitate larger bored piles with rock sockets.* *The extent of piling and geotextile reinforcement could be reduced by replacing the embankment side slopes with reinforced earth panels for the full height of the embankment.*	20,500m^3	*The depth of soft ground between Ch. 10+710 and 10+810 (100m) is between 3.3 m and 6.3 m. The embankment is up to 10.6 m high.* *Note: given height of embankment (up to 10.6 m), the limited extent of deep peat >4.0 m, and the possible need for bored piles with rock sockets which increases the cost of piling and the karst risk, there is a lower probability that this section of the road would be constructed as a pile-supported embankment.*
C	Ch 12230-Ch 12360m (130m)	*This section could be constructed as a pile-supported embankment. The section between Ch. 12+230 and 12+310 could have a reinforced earth load transfer platform as the embankment is >2.5 m high. However, between Ch. 12+310 and 12+360 the embankment is <2.5 m high and a reinforced concrete platform would probably be required.*	9,000m^3	*The trial pits and probes indicate that the depth of soft ground is generally <2.0 m and locally up to 3.0 m at the road crossing at Ch. 12+310. The deeper soft ground (3.0 m+) may extend over a wider area, possibly between Ch. 12+230 and 12+360.* *Note: given the limited extent of relatively shallow peat between 2.0 and 3.0 m, and the low height of the embankment to the south of Ch. 12+230, there is a lower probability that this section of the road would be constructed as a pile-supported embankment.*
B	Ch 13860-Ch 13960m	*This section could be constructed as a pile-supported embankment. It may be possible to*	12,000m^3	*The depth of peat and organic silt between about Ch. 13+860 and 13+960*

Cat.	Location	Alternative Construction Technique	Potential reduction in Volumes (m3)	Notes
	(130m)	*construct the embankment with a reinforced earth platform. However, the section to the south of Ch. 13+910 is <2.5 m high and this may necessitate a design with a reinforced concrete deck.*		*(100m) is on the order of 4.0 m. The embankment is between 2.0 and 3.3 m high.*

The volume reductions outlined in Table 9-2 are achievable under the various probabilities. This indicates that in the event of any of the material coming under the definition of Waste then a detailed consideration shall be had by the contractor to *prevention* with a particular emphasis on Category X. This assessment shall effectively consider environmental and economic issues which will be expanded upon in the Contract Documents for the Construction Project.

Table 9-2: Alternative Construction, Summary

Probability Category	Volume
Category A	107,500m^3
Category B	12,000m^3
Category C	84,500m^3
Total	204,000m^3

9.2.2 **Other geotechnical Considerations**

9.2.2.1 Material Processing and Reuse;

Processing of unsuitable material has already been discussed in section 2.2.2.1.3. The assumption made in determining a base figure of 30% processing is based on information contained within the AGL report[31] which assesses two method of processing, namely air drying and lime stabilisation. Under the different techniques AGL's assessment concludes that circa 10-20% and circa 15-30% could be processed into suitable material via air drying and lime stabilisation respectively.

As alluded to in the main Preliminary Geotechnical Interpretive Report for the development, there is scope to increase these figures further, should economic, legislative or land purchase/agreement difficulties arise in dealing with the material; however, such an exercise is not considered to be warranted for the purposes of this EIS on the grounds that significant additional environmental impacts are not expected from such activities.

9.2.2.2 Potential for dewatering

Dewatering of the peat material is an option which could potentially reduce the volume being excavated or the volume being deposited. The contract documents for the design and construction stage by their nature (Design/Build) will encourage the appointed contractor to apply *innovative* solutions to achieve the most economical design. While this may well be one area a contractor may seek to investigate further, at the current design and consent stage it is difficult to see any significant savings being made. This is principally due to the time it would take to reduce these volumes by any significant degree. Having said that options a contractor might explore include:

- pre draining the upper peat surface with land drainage, which although potentially effective to possibly the upper 1m, would require a significant period of time to make any significant saving;
- Surcharging the peat over a period of time and with the application of vertical drains effectively squeezing out the water. The main drawback to this process would be the construction difficulties in applying this surcharge and the knock on cost which would be arising;
- Excavation and air drying which would obviously require a very large land area to make any significant saving;
- Mixing the peat with acceptable subsoil material to make the material more workable;

[31] Attached as Appendix 6 to this report

- Mechanical dewatering through the use of a filter press such as that used in the treatment of sewage sludge. This again would be time consuming and would be difficult to achieve any significant savings.

10 The *Range of Options*

10.1 General

As outlined in section 1, the objective of this report has been to add a degree of clarity about the various possible options available for spoil management which is in effect an attempt to the bridge the gap between the design which is considered for the current stage of consent and the methods by which an appointed contractor may develop, manage and construct the detailed design, this is in order to effectively satisfy the requirements of section 50(3) (a) and (c) of the Roads Act.

Based on information available at the current stage of consent, the staged results contained herein are considered to demonstrate a careful approach to this matter effectively allowing the most accurate *description of the physical characteristics of the whole proposed road development and the land-use requirements during the construction and operational phases.* That said there are assumptions contained herein which are reflective of the stage of design and consent taking cognisance of the procurement method proposed. There is therefore some potential that the use of the outlined sites in stage 5 (section 8) may not materialise to realise some of their potential for one or more reasons, this might include for example the interception of significant karstic flows in the bedrock which have not been identified to date or the contractors determination that the material suitability within the pits may not meet his requirements.

In acknowledgment of this caveat it is considered prudent to provide a proxy option which assesses the potential impact of the alternative to the options 1 and 3 described in the preceding paragraphs. Such an option would involve the contractor preferring or being required to deviate to something other than what has been described in section 8 of this report.

10.2 *Range of Options*

In order to effectively consider this situation it is considered that a return to those sites within the *Range of Options* is required. This would obviously and more likely than the recommended approach already described in this document require deviations to the lower tiers of the Waste Hierarchy. It also recreates the complexity of the uncertainty such an approach would present, however, if the recommended approach fails then it appears that this would be the most likely alternative available to the contractor.

10.2.1 **Points of Note**

It is important to note the following points in relation to those options already described and assessed herein;

- The options are not considered an exhaustive list, but rather those which are considered environmentally viable in close proximity to the *PRD*;
- They are not intended to pre-empt/influence any considerations by the appointed contractor nor are they considered in any form of preferential sequence;
- Although an environmental assessment may indicate sites are suitable, the sites should not be considered to be without limitations, and it may be a case that difficulties with the following items may make a particular site unviable from a contractor's perspective.
    - Initial site preparations;
    - Waste permitting and licensing; and
    - Land purchase/landowner agreements;

These caveats are outside the scope of this particular report.

Considering this alternative would be outside the CPO of the *PRD* and would most likely fall within the definition of Waste within the WMA, such an alternative approach would **not** be developed to gain statutory consent for those sites identified outside the CPO of the development as it will ultimately be the **responsibility of the appointed contactor** in accordance with the contract documents to:

- Identify methods for dealing with the Waste;
- Comply with all necessary planning, environmental and Waste legislation;

- Apply for and obtain all necessary approvals, consents and licences in accordance with *inter-alia* the provisions of the Waste Management Acts (1996-2011) and Regulations (1996-2011) and also with regard to the *NRA Guidelines on* Waste *Management from National Road Schemes (2009)*, and to
- Liaise with and secure consent from the relevant landowner where suitable lands are identified outside the CPO.

Notwithstanding the foregoing the *Range of Options* would allow for an overview of the Environmental Impacts of such an activity, which although it might not be the activity the appointed contractor would proceed to use would allow a fulfilment of the requirements of section 50(3) (a) and (c) of the Roads Act. This would be on the assumption that the contractor seeking other sites outside the CPO would apply the same criteria (*not to endanger human health or harm the environment*) to the suitability of sites as has been applied in this report.

10.3 Consideration within EIS Chapters

It is acknowledged that the consideration of this more speculative approach in the EIS would present a double counting of impacts from the activity (insofar as the impacts will already have been assessed directly for those already recommended options), however, it is considered that some provision should be made in the relevant chapters, in this regard assessment in each of the relevant chapters of the EIS is to be in a *Macro* sense in terms of *Indirect* and *Cumulative* Impacts.

10.3.1 **Options to be considered**

Given the assessment that has been carried out on the recommended options already and the confidence level in their appropriateness, it is difficult to see where significant issues may arise in terms of material suitability contained within, however, given that there is a significant envelope provided in the Type 1 Spoil Repositories/Borrow Pits a reasonable assumption to make is that the Type 2 Spoil Repositories/Borrow Pits may present difficulties and in this regard that a holistic worst case scenario is that no material goes into this pits (although it is recognised that this is a highly unlikely situation). In this regard the alternatives are considered to be the remaining sites arising from the *Range of Options* outlined in section 4 and 5 which are:

- LD CP01;
- LD CP04;
- LD CP05;
- LD CP06;
- LD AG01;
- LDAG02;

11 References

(1) *NRA Project Management Guidelines:* National Roads Authority (2010);

(2) *NRA Guidelines on* Waste *Management from National Road Schemes:* National Roads Authority (2009);

(3) *S.I. No. 126 of 2011; European Communities (*Waste *Directive) Regulations:* Statutory Office (2011);

(4) *Sligo County Development Plan (2011-2017):* Sligo County Council;

(5) *N4 Collooney to Castlebaldwin Realignment Preliminary ground investigation – factual report;* Priority Geotechnical 2007;

(6) *N4 Collooney to Castlebaldwin Realignment & N17 Collooney to Tobercurry realignment Preliminary ground investigation – phase II draft factual report;* Priority Geotechnical 2012;

(7) *Preliminary Soils and Geology Report for the N4 Realignment - Collooney to Castlebaldwin road scheme*: AGL Consulting Engineers, 2012;

(8) www.gsi.ie (online mapping);

(9) www.osi.ie (online mapping);

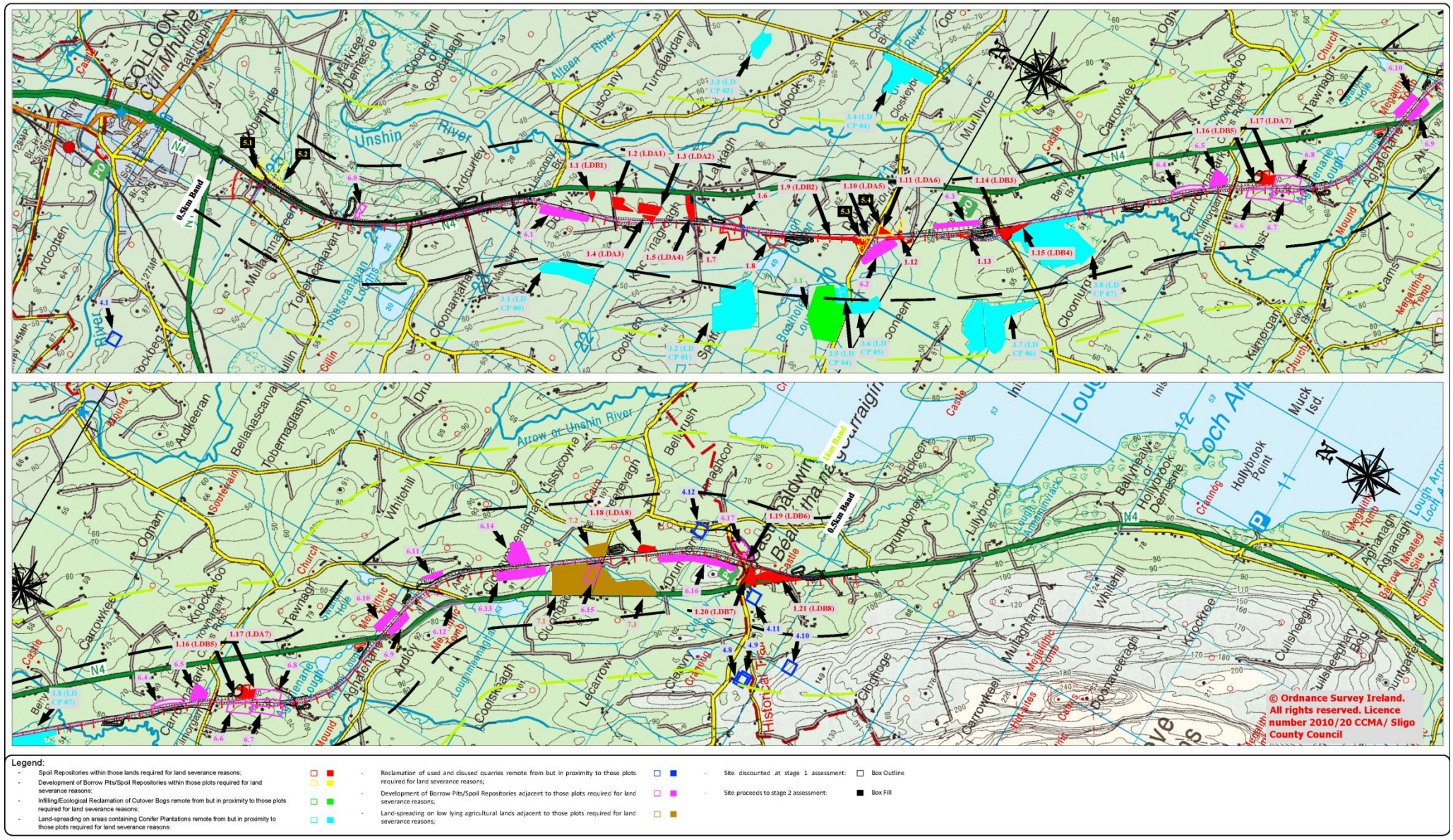
(10) *NRA Manual of Contract Documents for Roadworks*; NRA

(11) Various unpublished sub reports prepared for the purpose of feeding into this report as per Table 1-1;

12 Appendix 1: Earthworks Analytical Calculations

Earthworks Totals (Estimated)		
Main Earthworks		
Element	**Unprocessed Total (m3)**	**Processed Total (m3)**
Topsoil excavated	163651.68	163651.68
Road construction capping	143892.44	143892.44
FILL (in road embankment)	1235679.55	1235679.55
Starter layer (Granular)	107235.00	107235.00
CUT unnacceptable material (unsuitable)	379680.62	265776.43
CUT acceptable (suitable)	559436.30	673340.49
CUT rock	27309.00	27309.00
Deposit FILL	586745.30	673340.49
Imported FILL	648934.25	562339.06
Main Earthworks		
Element	**Unprocessed Total (m3)**	**Processed Total (m3)**
Excavate PEAT & soft alluvial clay from under embankments	445847.00	445847.00
Place acceptable material under embankments	206231.40	206231.40
Place granular material under embankments	239615.60	239615.60

13 Appendix 2: Stage 1 – 2: Figure A 4.3 (1)


Legend:
- Spoil Repositories within those lands required for land severance reasons;
- Development of Borrow Pits/Spoil Repositories within those plots required for land severance reasons;
- Infilling/Ecological Reclamation of Cutover Bogs remote from but in proximity to those plots required for land severance reasons;
- Land-spreading on areas containing Conifer Plantations remote from but in proximity to those plots required for land severance reasons:
- Reclamation of used and disused quarries remote from but in proximity to those plots required for land severance reasons;
- Development of Borrow Pits/Spoil Repositories adjacent to those plots required for land severance reasons;
- Land-spreading on low lying agricultural lands adjacent to those plots required for land severance reasons;
- Site discounted at stage 1 assessment: Box Outline
- Site proceeds to stage 2 assessment: Box Fill
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14 Appendix 3: Relevant Analytical Calculation Sheets

CALC. SHEET 1 **LANDSCAPE SITE AT CASTLEBALDWIN**

Peat Deposition within CPO (LANDSCAPING AND AMENITY MEASURE)

Site No	Existing Habitat within proposed site	Site Description	Approx area available	Average depth deposited	Approx volume deposited	Cat. X: Volume of PEAT deposited	Cat. X: Volume of additional organic clay deposited	Cat. Y: Volume of subsoil deposited	PEAT conv to tonnage (Factor = 1.1)	subsoil/alluvial conv to tonnage (Factor = 1.65)	Notes	Site No. for main Volume of EIS
LD B6	Improved Agricultural Land	Circa. Ch. 13600m - 13630m RHS	7000	4.5	31500	0		31500	*0*	*51975*	This is a landscape mitigation site. Infill shall be predominately with Class Y material which satisfies the requries of Class 4 Landscape Fill as per the NRA SRW Series 600. Localised shallow area of peat also considered for ecological regeneration.	LS Mit. 01
LD B7	Improved Agricultural Land	Circa. Ch. 13650m - 14000m RHS	24000	4.5	108000	0		108000	*0*	*178200*	This is a landscape mitigation site. Infill shall be predominately with Class Y material which satisfies the requries of Class 4 Landscape Fill as per the NRA SRW Series 600. Localised shallow area of peat also considered for ecological regeneration.	LS Mit. 02
TOTAL					**139500**	**0**	**0**	**139500**				

CALC SHEET 2 **OPTION 1: SITES WITHIN THOSE LANDS AQUIRED FOR SEVERANCE REASONS**

Peat Deposition within CPO													
							Cat. X		Cat. Y				
SITE No.	Existing Habitat within proposed site	Site Description	Above Ground Deposit		Below Ground Deposit	Approx volume deposited	Volume of PEAT deposited	Volume of additional organic clay deposited	Volume of subsoil deposited	PEAT conv to tonnage (Factor = 1.1)	subsoil/alluvial conv to tonnage (Factor = 1.65)	Notes	Site No. for main Volume of EIS
			Approx area available	Average depth deposited	Volume Deposited								
LD B1	GS4 (Wet Grassland)	Circa. Ch. 3100m - 3150m LHS	~~2000~~	1	0	0	0	0	0	*0*	*0*	Site eliminated due to design change	N/A
LD A1	PF1 (Rich Fen and Flush)	Circa. Ch. 3360m - 3525m LHS	~~14000~~	0	0	0	0	0	0	*0*	*0*	Site not considered suitable for ecological and hydrological reasons. In any event site eliminated due to design change	N/A
LD A2	PF1 (Rich Fen and Flush)	Circa. Ch. 3560m - 3730m LHS	~~12500~~	0	0	0	0	0	0	*0*	*0*	Site not considered suitable for ecological and hydrological reasons. In any event site eliminated due to design change	N/A
LD A3	PF1 (Rich Fen and Flush)	Circa. Ch. 3610m - 3710m RHS	~~2300~~	0	0	0	0	0	0	*0*	*0*	Site not considered suitable for ecological and hydrological reasons. In any event site eliminated due to design change	N/A
LD A4	GS4 (Wet Grassland)	Circa. Ch. 4010m - 4050m LHS	~~8625~~	1.5	0	12937.5	0	0	0	*0*	*0*	Site not considered suitable for ecological and hydrological reasons. In any event site eliminated due to design change	N/A
LD B2	PB4 (Cutover Bog)	Circa. Ch. 5010m - 5410m RHS	5000	1.5	0	7500	7500	0	0	*8250*	*0*	This is land available and severed between the proposed route and a parallel service track. Potential to fill PEAT material from a maximum high of 2m at the embankment of the proposed N4 to 1m at the embankment of the service track, assume average deposit of 1.5m. Assume all PEAT deposit.	SR-LI-01
LD A5	GS4 (Wet Grassland)	Circa. Ch. 5410m - 5500m RHS	10044	3	22500	52632	52632	0	0	*57895.2*	*0*	This is a basin created by the proposed road embankment intercepting falling contours. Above ground depth is based on output from an AutoCAD civil 3 surface analysis. Below Ground calculation is from the calculation in Sheet X.	SR-LI-01 & SR/BP Type 02-No. 1
LD A6	GS4 (Wet Grassland)	Circa. Ch. 5500m - 5530m LHS	6226	1.75	0	10895.5	10895.5	0	0	*11985.05*	*0*	This is a basin created by the proposed road embankment intercepting falling contours. Average embankment height along this section is 3.5m, assume average deposit of 1.75m above ground .	SR-LI-02
LDB3	GS4 (Wet Grassland) & Improved Agricultural land & PB4 (Cutover Bog)	Circa. Ch. 6600m - 6700m RHS	6100	1.5	0	9150	3050	0	6100	*3355*	*10065*	Land available within Compact Connector Road. Assume PEAT deposit capped with 1m of U1 unsuitable material. Assume average deposit of 4m.	SR-LI-03
LDB4	PB4 (Cutover Bog)	Circa. Ch. 6720m - 6870m RHS	4600	1	0	4600	4600	0	0	*5060*	*0*	Portion of relatively flat land severed by the proposed route. Assume shallow spread of PEAT, Contours fall away from the route. Assume average deposit of 1m . Assume all PEAT. Shallow Bund required to the south-west offset 5m from the existing land drain.	SR-LI-04
LDB5	GS4 and PB4 (Wet Grassland and Cutover Bog)	Circa. Ch. 8870m - 8900m LHS	4630	1	0	4630	4630	0	0	*5093*	*0*	Extension of LDA7. Portion of land severed by the proposed route. assume average deposit of 1m above ground .Contours fall away from the route.	N/A
LD A7	GS4 and PB4 (Wet Grassland and Cutover Bog)	Circa. Ch. 8900m - 8960m LHS	8300		0	0	0	0	0	*0*	*0*	Site not considered suitable for ecological reasons	N/A
LD A8	GS4 (Wet Grassland)	Circa. Ch. 12610m - 12755m LHS	5700	0	0	0	0	0	0	*0*	*0*	Site not considered suitable for ecological reasons	N/A
		TOTAL				102345	83308	0	6100				

CALC SHEET 3 **OPTION 2(a): CONIFER PLANTATIONS**

Bog Restoration: Deposition of PEAT in existing conifer plantations following felling

Site No	Existing Habitat within proposed site	Site Description	Approx area available	Average depth deposited	Approx volume deposited	Cat. X Volume of PEAT deposited	Cat. X Volume of additional organic clay deposited	Cat. Y Volume of subsoil deposited	PEAT conv to tonnage (Factor = 1.1)	Subsoil/alluvial conv to tonnage (Factor = 1.65)	Notes
LD CP00	No classification *assume Conifer Plantation*	Circa. Ch. 3110m RHS:- 450m offsite	43000	1.4	60200	60200	0	0	*66220*	*0*	Depth of spread based on ground slopes of less than 5 degrees, assumed to be 1m at the perimeter mounded at 1 degree to the centre (consider a maximum of 1.5m). Haulage will potentially be directly from the proposed CPO line with a potential access requirement through private lands for a distance of circa 170m. Coillte Information: described as Commercial Conifer for Timber Production, expected to be felled in the period 2016-2020
LD CP01	No classification *assume Conifer Plantation*	Circa. Ch. 4410m LHS:- 400m offsite	110000	1.5	165000	165000	0		*181500*	*0*	Depth of spread based on ground slopes of less than 5 degrees, assumed to be 1m at the perimeter mounded at 1 degree to the centre (consider a maximum of 1.5m). Haulage will potentially be along local road L55016-0 for circa 400m (outside CPO) with also the potential access requirement through private lands for a distance of circa 180m. Coillte Information: described as Commercial Conifer for Timber Production, expected to be felled in the period after 2020
LD CP02	No classification *assume Conifer Plantation*	Circa. Ch. 4410m RHS:- 1.4km offsite	22000	0	0	0	0	0	*0*	*0*	Site not considered suitable
LD CP03	No classification *assume Conifer Plantation*	Circa. Ch. 5710m LHS:- 2.8km offsite	55000	0	0	0	0	0	*0*	*0*	Site not considered suitable
LD CP04	WD4 on PB4 (Conifer Plantation on Cutover Bog)	Circa. Ch. 5510m RHS:- circa 600m offsite.	11500	1.2	13800	13800	0	0	*15180*	*0*	Depth of spread based on ground slopes of less than 5 degrees, assumed to be 1m at the perimeter mounded at 1 degree to the centre (consider a maximum of 1.5m). Haulage will potentially be along local road L5502-0 for circa 380m (outside CPO) with also the potential access requirement through private lands.
LD CP05	WD4 on PB4 (Conifer Plantation on Cutover Bog)	Circa. Ch. 5310m RHS:- circa 600m offsite	22800	1.2	27360	27360	0	0	*30096*	*0*	Depth of PEAT spread based on ground slopes of less than 5 degrees. Assumed to be 1m at the perimeter mounded at 1 degree to the centre (consider a maximum of 1.5m). Haulage will potentially be along local road L5502-0 for circa 380m (outside CPO) with also the potential access requirement through private lands. Coillte Information: described as Open Space for Timber Production, expected to be felled in the period after 2020.
LD CP06	No classification *assume Conifer Plantation*	Circa. Ch. 6510m RHS:- Circa 600m offsite	125000	2	250000	125000	0	125000	*137500*	*206250*	Depth of PEAT spread based on ground slopes of less than 5 degrees. Assumed to be 1m at the perimeter mounded at 1 degree to the centre (consider a maximum of 1.5m). Average 2m spread of subsoil. Haulage will potentially be along local road L5502-32 for circa 280m (outside CPO) with also the potential access requirement through private lands. Indications are that this is Till on shale and sandstone, in this regard assume no PEAT in this repository, spread to 1.5m deep graded down at 1 in 4 on the perimeter. Replant around the perimeter. Coillte Information: described as Commercial Conifer for Timber Production, expected to be felled in the period 2016-2020
LD CP07	WD4 on PB4 (Conifer Plantation on Cutover Bog)	Circa. Ch. 7120m RHS:- Circa 100m offsite	163400	0	0	0	0	0	*0*	*0*	Site not considered suitable due to Flooding considerations
TOTAL					516360	391360	0	125000			
	Options Balance 1 (Volume of Material requiring offsite disposal/recovery)				604650	223686	222700	171202			
	Options Balance 2 (Balance considering suitable CPxx sites)				88290	-167674	222700	46202			

CALC SHEET 4 **OPTION 3: SPOIL REPOSITORIES/BORROW PITS (TYPE 1)**

				MATERIAL						
				Cat. X		Cat. Y				
Site No	Existing Habitat within proposed site	Site Description	Approx volume deposited	Volume of PEAT deposited	Volume of additional organic clay deposited (assumed 10%)	Volume of subsoil deposited	PEAT conv to tonnage (Factor = 1.1)	subsoil/alluvial conv to tonnage (Factor = 1.65)	Notes	Site No. for main Volume of EIS
LD BP 01	No classification *assume Agricultural Grassland*	Circa. Ch. 2,900m – 3,200m		0	0	0	*0*	*0*	Site eliminated due to design change	N/A
LD BP 02	GS4 (Wet Grassland) & Improved Agricultural grassland	Circa. Ch. 5,800m – 6,500m LHS	59997	0	5999.7	53997.3	*0*	*98995.05*	Agricultural Lands to be returned to Agricultural grazing use following repository stage.	N/A
LD BP 03	No classification *assume Agricultural Grassland*	Circa. Ch. 10,300m-10,550m LHS	120000	0	12000	108000	*13200*	*198000*	Agricultural Lands to be returned to Agricultural grazing use following repository stage. NB. Calculations are modified to the volume being incorporated directly into the EIS.	SR/BP Type 01-01
LD BP 04	No classification *assume Agricultural Grassland*	Circa. Ch. 10,300m-10,550m LHS	20000	0	2000	18000	*2200*	*33000*	Agricultural Lands to be returned to Agricultural grazing use following repository stage.	N/A
LD BP 05	No classification *assume Agricultural Grassland*	Circa. Ch. 10,850m-11,00m LHS	57600	0	5760	51840	*6336*	*95040*	Agricultural Lands to be returned to Agricultural grazing use following repository stage. NB. Calculations are modified to the volume being incorporated directly into the EIS.	SR/BP Type 01-02
LD BP 06	No classification *assume Agricultural Grassland*	Circa. Ch. 11,400m-11,800m RHS	210000	0	21000	189000	*23100*	*346500*	Agricultural Lands to be returned to Agricultural grazing use following repository stage. NB. Calculations are modified to the volume being incorporated directly into the EIS.	SR/BP Type 01-03
LD BP 07	No classification *assume Agricultural Grassland*	Circa. Ch. 12,600m-13,500m RHS	44800	0	4480	40320	*0*	*73920*	Agricultural Lands to be returned to Agricultural grazing use following repository stage. NB. Calculations are modified to the volume being incorporated directly into the EIS.	SR/BP Type 01-04
TOTAL			**512397**	**0**	**51240**	**461157**				
Estimated Cohesive Fill Requirement			**768570**						**Cohesive Fill requirement > balance aquired: OK**	

CALC SHEET 5 **OPTION 3: SPOIL REPOSITORIES/BORROW PITS (TYPE 2)**

						MATERIAL						
						Cat. X		Cat. Y				
Site No	Existing Habitat within proposed site	Site Description	Approx area available (Measured from MX design)	Average depth deposited	Approx volume deposited	Volume of PEAT deposited	Volume of additional organic clay deposited (assumed 20%)	Volume of subsoil deposited	PEAT conv to tonnage (Factor = 1.1)	subsoil/alluvial conv to tonnage (Factor = 1.65)	Notes	Site No. for main Volume of EIS
LDBP (T2) 01	GS4 (Wet Grassland)	LD A5			N/A	N/A	N/A	N/A	N/A	N/A	Quantities are already included in Option 1	SR/BP Type 02-No. 1
LDBP (T2) 02	Agricultural	Circa Ch. 5,500-5,780m			235000	126500	108500	0	*139150*	*179025*	See Table8-3 of the report	SR/BP Type 02-No. 2
LDBP (T2) 05	Agricultural	Circa Ch. 11,550-11,700m		15	46000	25500	20500	0	*28050*	*33825*	See Table8-3 of the report	SR/BP Type 02-No. 3
TOTAL					**281000**	**152000**	**129000**	**0**				
Granular Fill Requirement					**490743**						Granular Fill requirement > balance aquired: No adjsutment	
TOTAL ADJUSTED					**281000**	152000	129000	0	*167200*	*212850*	This is an adjustment for the Q of material required	

CALC SHEET 6 **OPTION 4: INFILLING OF ADJACENT AGRICULTURAL LANDS**

						MATERIAL						
						Cat. X		Cat. Y				
Site No	Existing Habitat within proposed site	Site Description	Approx area available (Measured from MX design)	Average depth deposited	Approx volume deposited	Volume of PEAT deposited	Volume of additional organic clay deposited (assumed 20%)	Volume of subsoil deposited	PEAT conv to tonnage (Factor = 1.1)	subsoil/alluvial conv to tonnage (Factor = 1.65)	Notes	Site No. for main Volume of EIS
LDAG 01	GS4 (Wet Grassland)	Low lying relatively poor quality agricultural land	91000	1	91000	72800	18200	0	*80080*	*30030*	Depth of spread based on ground slopes of less than 5 degrees, assumed to be 1m at the perimeter mounded at 1 degree to the centre (consider a maximum of 1.5m).	N/A
LDAG 02	GS4 (Wet Grassland)	Low lying relatively poor quality agricultural land	62000	1	62000	49600	12400	0	*54560*	*20460*	Depth of spread based on ground slopes of less than 5 degrees, assumed to be 1m at the perimeter mounded at 1 degree to the centre (consider a maximum of 1.5m).	N/A
TOTAL					**153000**	**122400**	**30600**	**0**	**134640**	**50490**		

CALC SHEET 7 — OPTION 3: SPOIL REPOSITORIES/BORROW PITS (Material Excavated)

				Material Excavated within Pit					
					U1 (unsuitable)				
Configuration	Site Number	*Chainage*	*Initial Range of Options Number*	Total	Class X	Class Y	%	Acceptable Subsoil	Rock
TYPE 2	SR/BP T.02-01 within SR LI-01	Ch. 5,600-5,710m	**LDA5**	35000	3500	9000		2000	22500
TYPE 2	SR/BP T.02-02	Ch. 5,500-5,780m	**LD BP (T2) 02**	295000	5000	55000		5000	235000
TYPE 2	SR/BP T.02-03	Ch. 11,550-11,700m	**LD BP (T2) 05**	61000	0	15000		2500	46000
TYPE 1	SR/BP T.01-01	Ch. 10,300-10,500m	**LDBP 03**	150000	0	30000	20%	120000	0
TYPE 1	SR/BP T.01-02	Ch. 10,840-10,980m	**LDBP 05**	72000	0	14400	20%	57600	0
TYPE 1	SR/BP T.01-03	Ch. 11,400-11,770m	**LDBP 06**	280000	0	70000	25%	210000	0
TYPE 1	SR/BP T.01-04	Ch. 12,690-12,900m	**LDBP07**	56000	0	11200	20%	33600	11200

CALC SHEET 7 (Contd.) — OPTION 3: SPOIL REPOSITORIES/BORROW PITS (Material Deposited)

		Material Backfilled in Pit							
					U1 (unsuitable) from excavate/replace				
Configuration	Site Number	Total void	Material returned to pit	Balance of available space	Class X: PEAT	Class X: Alluvial & Organic Clays	Class Y	Acrotelm Req. from PEAT	Notes
TYPE 2	SR/BP T.02-01 within SR LI-01	35000	12500	22500	0	0	0	0	*Portion of material returned assumed to be used for the 2m capping, remainder assumed to be deposited within the cell. Already calculated in Calc. sheet 1.*
TYPE 2	SR/BP T.02-02	295000	60000	235000	108500	108500	0	18000	*Portion of material returned assumed to be used for the 2m capping, remainder assumed to be deposited within the cell.*
TYPE 2	SR/BP T.02-03	61000	15000	46000	20500	20500	0	5000	*Portion of material returned assumed to be used for the 2m capping, remainder assumed to be deposited within the cell.*
TYPE 1	SR/BP T.01-01	150000	30000	120000	0	24000	96000	0	*Assumption is 20% alluvial and organic clays backfilled.*
TYPE 1	SR/BP T.01-02	72000	14400	57600	0	11520	46080	0	*Assumption is 20% alluvial and organic clays backfilled.*
TYPE 1	SR/BP T.01-03	280000	70000	210000	0	42000	210000	0	*Assumption is 20% alluvial and organic clays backfilled.*
TYPE 1	SR/BP T.01-03	56000	11200	44800	0	8960	44800	0	*Assumption is 20% alluvial and organic clays backfilled.*
TOTALS					129000	215480	396880	23000	
TYPE 1 TOTALS					0	86480	396880	0	
	Balance Remaining				223686	222700	222700		

CALC SHEET 8 **OPTION 3: SPOIL REPOSITORIES/BORROW PITS**

Option	Site Number from initial *Range of Options*	Topography	Ground Conditions	Material Suitability from Cut sections in GIR	Notes	EIS Site Number
Type 1 Configuration	LD BP01	N/A	N/A	N/A	Site was discounted following a design change which removed the extremity of the cut. Therfore decided not to proceed with this pit.	N/A
	LD BP02	Western slope of a NW/SE trending drumlin. Ground rises up to +80 mOD at the top of the drumlin to the east but is probably <75 mOD within the borrow pit. N4 is in cut up to 12 m deep with a finished road level at +51.6 to +52.9 mOD.	1-3 m of soft and very soft Boulder Clay over firm, stiff, very stiff and hard Boulder Clay and dense to very dense Gravel with cobbles and boulders. No rock encountered within the depth of cut.	GIR indicates that there may be up to 5m of unsuitable material at the surface. This may make a possible pit unviable from an economic view point. Estimated that circa 35% of the material extracted would need to be returned to the pit as part of the repository process.	The GI characteristics of the material within this cut section are a little vague in terms of their suitablity. Therfore decided not to proceed with this pit.	N/A
	LD BP03	Proposed N4 is cut through the centre of a NW/SE trending drumlin with a ground surface elevation of +85 mOD at the top of the drumlin at the centre of the cut. LD-BP-03 and LD-BP-04 are on the east and west sides of the road, widening the cut. The ground level at the outer edges of the pits would be lower than the maximum level. The N4 is in cut up to 15 m deep with a finished road level between +69.5 and +71.3 mOD	1.0 to 1.5 m of soft Boulder Clay over firm, stiff, very stiff and hard Boulder Clay with seams or pockets of dense to very dense Gravel with cobbles and boulders. Moderately strong to very strong grey fossiliferous LIMESTONE was encountered below the depth of cut at between Elev. +62.4 mOD and +68.8 mOD. A cavity was noted in one of the coreholes (RC-33) in the rock at a depth of 23.0 m.	GIR indiactes that the material within the drumlin may be substantailly suitable	Suitably of material within this drumlin appears to render the pit to be of a high suitability. The invert level of the pit should be set at 1m below the design level to the adjacent PRD centerline.	SR/BP (Type 1) No.1
	LD BP04	Ditto LD BP03	Ditto LD BP03	GIR indiactes that the material within the drumlin may be substantailly suitable	Due to the topography of the Drumlin and the requirement to maintain the vertical invert of the pit at a similar level; to the mainline, this pit is not considered to be suitable to consider within the PRD.	N/A
	LD BP05	Western slope of a NW/SE trending drumlin. Ground rises up to above +90 mOD at the top of the drumlin to the southwest but is probably <90 mOD within the borrow pit. Road is in cut up to 12-15 m deep on the east side with a finished road level at +72.9 to +73.0 mOD.	2-3 m of soft and firm Boulder Clay over stiff, very stiff and hard Boulder Clay, and dense to very dense Gravel with cobbles and boulders. Strong dark grey thinly laminated LIMESTONE Rock was encountered below the depth of cut at a depth of 15.9 m.	Only 45% suitability	Suitably of material within this drumlin appears to render the pit to be of a poor to moderate suitability. The invert level of the pit should be set at 1m below the design level to the adjacent PRD centerline.	SR/BP (Type 1) No.2
	LD BP06	Eastern slope of a NW/SE trending drumlin. Ground rises up to +91 mOD at the top of the drumlin along the western edge of the borrow pit. Road is in cut up to about 10 m deep on the west side with a finished road level at +71.5 to +69.5 mOD.	1-3 m of soft and firm Boulder Clay over stiff, very stiff and hard Boulder Clay and dense to very dense Gravel with cobbles and boulders. Strong grey LIMESTONE rock was encountered approximately 3.5 m below the depth of cut at Ch. 9+200 - 13.5 mBGL (+67.2 mOD).	30% Class U1 (the upper 3m approx.), 70% Class 1/Class 2C	Suitably of material within this drumlin appears to render the pit to be of a high suitability. The invert level of the pit should be set at 1m below the design level to the adjacent PRD centerline.	SR/BP (Type 1) No.3
	LD BP07	Eastern slope of a NW/SE trending drumlin. Ground rises up to +111 mOD at the top of the drumlin to the west but is probably <100 mOD along the western edge of the borrow pit.Road is in cut up to 10-15 m deep along the west side, with a finished road level at +73.9 mOD and +79.0 mOD.	The ground conditions within the depth of cut consist of 2.0-4.5 m of soft Boulder Clay over stiff, very stiff and hard cohesive glacial till (Boulder Clay) or medium dense to very dense granular glacial till with occasional to some cobbles and boulders. Up to 4.8 m of competent strong grey LIMESTONE rock was encountered within the depth of cut at Ch. 13+000, reducing to 0.0 m at Ch. 13+500.	35% Class U1 (the upper 3m approx.), 65% Class 1/Class 2C	Suitably of material within this drumlin appears to render the pit to be of a high suitability. The invert level of the pit should be set at 1m below the design level to the adjacent PRD centerline.	SR/BP (Type 1) No.4
Type 2 Configuration	LD BP (T2) 01	Relatively Flat	Approx 3-5m of generally unsuitable subsoil material overlying bedrock as indicated by GI points and Geophysics.	N/A	See Table 9-2 of Report	SR/BP Type 02-No. 1
	LD BP (T2) 02	Relatively Flat	Approx 3-5m of generally unsuitable subsoil material overlying bedrock as indicated by GI points and Geophysics.	N/A	See Table 9-2 of Report	SR/BP Type 02-No. 2
	LD BP (T2) 05	Relatively Flat	Approx 3-5m of generally unsuitable subsoil material overlying bedrock as indicated by GI points and Geophysics.	N/A	See Table 9-2 of Report	SR/BP Type 02-No. 3

CALC SHEET 9 — **FUEL CALC'S**

Access Point	Approx. Volumes	Haulage Calcs				Fuel Calcs						
	Approx. Volume Required	*Nearest Quarry distance*	*Load Unit Weight*	*No. of Trips*	*Total Haulage Miles (One Way)*	*Unlaiden Fuel Consumption*	*Fuel Volume*	*Laiden Fuel Consumption*	*Fuel Volume*	*Two way Fuel Volume*	*Unit Fuel Cost*	*Unit Fuel Cost*
	(m3)	(Miles)	(m3)		(Miles)	Miles per gallon	Gallons	Miles per gallon	Gallons	Gallons	€/Gallon	€
Doorly Td.	590000	6	12	49167	295000	10	29500	8	36875	66375	€ 6.73	€ 446,576.31
Ardloy Td.	460000	10	12	38333	383333	10	38333.3	8	47916.66667	86250	€ 6.73	€ 580,296.90
Castlebaldwin Td.	150000	10.25	12	12500	128125	10	12812.5	8	16015.625	28828	€ 6.73	€ 193,957.93
TOTAL												€ 1,220,831.14

15 Appendix 4: Comparable Risk Assessment

N4 Collooney to Castlebaldwin:- Proposed Road Development

Comparable Risk Matrix Scoring Chart

Colour Codes		
Colour Code	**Legend**	**Comment**
	Concern	Outline Control
	Caution	Comment or outline Control
	Low concern	Comment

Probability						
90%	Very High	5	10	15	20	25
	5					
70%	High	4	8	12	16	20
	4					
50%	Medium	3	6	9	12	15
	3					
20%	Low	2	4	6	8	10
	2					
10%	Very Low	1	2	3	4	5
	1					

Scoring CHART					
Score Item	1	2	3	4	5
Proximity to PRD	Within Severed Areas	Directly contiguous to severed areas	>500m Remote from severed area	500m - 1000m Remote from severed area	>1000m Remote from severed area
Land Area Required, directly related to repository height above existing Ground Level. Based on a volume of 100,000m3	0 - 7,000m2	7,000m2 - 10,000m2	10,000m2 - 17,000m2	17,000m2 - 33,000m2	33,000m2 - 100,000m2
Flood Risk	Imperceptible (land topo remains the same)	N/A	Topo raised, land area low (impacts 1-3 above),	N/A	Topo raised; land area high (impacts 4-5 above)
PEAT Stability Risk	PEAT stored below ground.	N/A	PEAT may extend up to 1m above ground. Ground Slopes is less than 2-3 degrees	N/A	PEAT may extend up to 1m above ground. Ground Slopes is greater than 2-3 degrees
Construction H&S	N/A	N/A	Potential for Minor Injury	Potential for Serious Injury	Potential for Fatality
Operational H&S	N/A	N/A	Potential for Minor Injury	Potential for Serious Injury	Potential for Fatality
Groundwater Quality	No indication of Karst	N/A	N/A	Karstified Bedrock	Highly Karstified
Construction Water Quality (directly relates to land area)	Land Area above (1)	Land Area above (2)	Land Area above (3)	Land Area above (4)	Land Area above (5)
Landscape Impacts	Landscape returned to pre-repository surface state	Noticeable Surface Change	N/A	Noticeable change to the landscape	Noticeable and agressive change to the landscape
Landuse	Minor Change, temporary CPO, land returned to original use	N/A	N/A	Low value Agricultural to Ecological Biodiversity. (Infers agricultural use will be lost)	Commercial to Non-Commercial (i.e. Conifer Plantations)
Ecological	Ecological Mitigation to Chapter 12 of the EIS	N/A	No nett change	N/A	Ecological Loss
Waste Hierarchy	Potentially not considered Waste	Potentailly considered Waste Reuse	N/A	Potentailly considered Waste Recovery	Potentailly considered Waste Disposal
Estimated Time to develope	<3 months	>3 months	>6 months	>9 months	>12 months
Estimated Cost to develope	<100k	>100k	>400k	>€700k	>€1m

Additional Scoring CHART (For extraction, to reflect extraction impacts)					
Karst	No indication of Karst	N/A	N/A	Karstified Bedrock	Highly Karstified
Rock Blasting/Breaking	Properties within 500m	Properties within 400m	Properties within 300m	Properties within 200m	Properties within 100m

OPTION 1: Spoil Repositories within those lands required for land severance reasons;											
Landscape Infilling											
	Notes 1	**P**	**Environment**	**H&S**	**Cost**	**Time**	**Env Rank**	**H&S Rank**	**Cost Rank**	**Time Rank**	**NOTES**
Environment	Impact to local road network as a result of haulage requirements;	0	2	0	0	0	0	0	0	0	Loctaions are wholly within the lands severed by the PRD;
Environment	Impact resulting from Land Area Required;	5	1	1	0	0	5	5	0	0	The probability is high as it is certain land area is required. The impact is low as a result of low surface area. Related controls are covered below. i.e.: Flooding, Water Quality.
Environment	Potential impact to cause Flooding (I)	2	1	1	0	0	2	2	0	0	The sites are of a low land area, therefore the Flood Risk is low.
Environment	Potential impact as a result of a soil slide	2	3				6	0	0	0	Lands are relatively flat or gently sloping. Containment Bund will be provided if required.
Environement	Potential impact to ground water	0	0				0	0	0	0	Material stored above ground, no perceived impact to ground water
Health and Safety	Risk of Falls or engulfment during cons (I)	1	0	5	0	0	0	5	0	0	The probability is low as it is expected that this will be adequately covered by the Contractor in the devisement and implementation of a Site Specific Safety Statement.
Health and Safety	Risk of Falls or engulfment post cons (I)	1	0	4	0	0	0	4	0	0	The probability is low as the site will be fenced off between the end of reinstatement and the end of an establishment period. Additionlly the pit is developed with a capping layer.
Environment	Potential for Construction realted Water Quality impacts (directly relates to land area) (I)	3	1	0	0	0	3	0	0	0	The probability is high as it is certain that there is inevitably some potential impact. The potential impact is directly related to the surface area required as this is the volume of surface water to be treated. To be considered in the Erosion and Sediment Control Plan.
Environment	Landscape Impacts (I)	5	1	0	0	0	5	0	0	0	The probability is high as there is certain to be a change to the landscape. The impact is low as the change will not be noticeable following the establishment period.
Environment	Landuse Impacts (I)	1	1	0	0	0	1	0	0	0	Probaility is low as there will be a change in landuse regardless of the the development of the infill sites .
Time	Time Related Impacts	3	0	0	0	1	0	0	0	3	Time implications will be minimal
Cost	Cost to develope	3	0	0	1	0	0	0	3	0	There may be a cost to develope, this similar to the time implication above.
Environment	Potential risk of activity being considered waste as per the WMD.	2	2	0	1	1	4	0	2	2	It is expected the material can be reused in its natural state
Environment	Ecological (L)	1	1	0	0	0	1	0	0	0	
Indicative Sum of Scores. For broadbrush comparision purposes.							27	16	5	5	

OPTION 2: Ecological & Landscape Improvement Works on lands which are remote from but in proximity to those plots required for land severance reasons

OPTION 2a; Existing conifer plantations of low ecological value

	Notes 1	P	P Type	Environment	H&S	Cost	Time	Env Rank	H&S Rank	Cost Rank	Time Rank	NOTES
Environment	Impact to local road network as a result of haulage requirements;	5	I	4	0	0	0	20	0	0	0	Closest sites are generally in the order of 300m to 600m from the PRD
Environment	Impact resulting from Land Area Required;	5		5				25	0	0	0	Spread is generally 1m deep, therefore the land mass requried is considerable;
Environment	Potential impact to cause Flooding (I)	2		5				10	0	0	0	Sites are not considered to be within Flood plains, therfore the probability is low.
Environment	Potential impact as a result of a PEAT slide	3		3				9	0	0	0	Lands are flat or gently sloping. Control is use of containment bund.
Environement	Potential impact to ground water	0		0				0	0	0	0	Material stored above ground, no perceived impact to ground water
Health and Safety	Risk of Falls or engulfment during cons (I)	1		0	4			0	4	0	0	The probability is low as it is expected that this will be adequately covered by the Contractor in the devisement and implementation of a Site Specific Safety Statement.Impact considered to be a serious injury only given that the spread is relatively shallow (1m).
Health and Safety	Risk of Falls or engulfment psot cons (I)	1		0	4			0	4	0	0	The probability is low as the site will be fenced off between the end of reinstatement and the end of an establishment period.
Environment	Potential for Construction realted Water Quality impacts (directly relates to land area) (I)	3		5				15	0	0	0	The probability is high as it is certain that there is inevitably some potential impact. The potential impact is directly related to the surface area required as this is the volume of surface water to be treated. To be considered in the Erosion and Sediment Control Plan.
Environment	Landscape Impacts (I)	5		4				20	0	0	0	The probability is high as there is certain to be a change to the landscape. The impact is high as the change will be noticeable. Control: Sites to be developed as ecological regeneration sites, consider foremost locations where existing wetland habitats are in proximity. Objective is to blend sites in with the exiting landscape.
Environment	Landuse Impacts (I)	5		5				25	0	0	0	Probaility is high as there will be a change in landuse. Following establishment period, it is expected that land will be of use only for rough grazing purposes. Note this is offset against the gains of the ecological regeneration which will provide mitigation for impacts in the Ecological Chapter of the EIS.
Time	Time Related Impacts	5		5			5	25	0	0	25	This is potentaillly a waste recovery/disposal activity therefore a waste license and possibly a specific EIS may be required.
Cost	Cost to develope	5		0		4		0	0	20	0	There will be a considerable cost in developing on site access, cost of land (in relation to potentail loss of felling rights) and cost of surface water treatments systems;
Environment	Potential risk of activity being considered waste as per the WMD.	5		5		0		25	0	0	0	Recovery or Disposal
Environment	Ecological (L)							0	0	0	0	
Indicative Sum of Scores. For broadbrush comparision purposes.								174	8	20	25	

OPTION 3: Spoil Repositories/Borrow Pits												
Configuration Type 1 directly adjacent to those lands required for land severance reasons												
	Notes 1	**P**	**P Type**	**Environment**	**H&S**	**Cost**	**Time**	**Env Rank**	**H&S Rank**	**Cost Rank**	**Time Rank**	**NOTES**
Environment	Impact to local road network as a result of haulage requirements;	1	I	2	0	0	0	2	0	0	0	Pits are directly contiguous to the PRD, limited access is estimated to the local network;
Environment	Impact resulting from Land Area Required;	5	I	1	1	0	0	5	5	0	0	The probability is high as it is certain land area is required. The impact is low as a result of low surface area. Related controls are covered below. i.e.: Flooding, Water Quality.
Environment	Potential impact to cause Flooding (I)	1	I	1	1	0	0	1	1	0	0	The pits have been developed so that there is limited filling above ground level, therefore the Flood Risk is low.
Environment	Potential impact as a result of a soil slide	1		1				1	0	0	0	Lands are flat or gently sloping. Material stored below ground.
Environement	Potential impact to ground water	2		4				8	0	0	0	It is not anticipated that rock will be encountered in these pits, however if it is encountered carefull design considerations will be required, particularly in reltion to the sealing of karst features encountered during the extraction process;
Health and Safety	Risk of Falls or engulfment during cons (I)	1	I	0	5	0	0	0	5	0	0	The probability is low as it is expected that this will be adequately covered by the Contractor in the devisement and implementation of a Site Specific Safety Statement.
Health and Safety	Risk of Falls or engulfment post cons (I)	0	I	0	0	0	0	0	0	0	0	Considering the site will be appropriately filled and compacted, there in no perceived risk here.
Environment	Potential for Construction realted Water Quality impacts (directly relates to land area) (I)	5	I	1	0	0	0	5	0	0	0	The probability is high as it is certain that there is inevitably some potential impact. The potential impact is directly related to the surface area required as this is the volume of surface water to be treated. To be considered in the Erosion and Sediment Control Plan.
Environment	Landscape Impacts (I)	5	I	1	0	0	0	5	0	0	0	The probability is high as there is certain to be a change to the landscape. The impact is low as the change will not be noticeable following the establishment period.
Environment	Landuse Impacts (I)	1	I	1	0	0	0	1	0	0	0	Probaility is low as the change in landuse will be during the construction period only.
Time	Time Related Impacts	3	I	1	0	0	0	3	0	0	0	This does not relate to the time to extract the material within the pit, but rather for the time to make the pit suitable for the reporitory, e.g. Strenghtening of berm on the propsoed road side;
Cost	Cost to develope	3	I	0	0	1	0	0	0	3	0	There may be a cost to develope, this similar to the time implication above.
Environment	Potential risk of activity being considered waste as per the WMD.	2	L	1	0	1	1	2	0	2	2	There is a credible argument to be made that the material is being used for the purposes of construction therfore the probability is low that the material could come witin the WMD.
Environment	Ecological (L)	1	L	1	0	0	0	1	0	0	0	
Indicative Sum of Scores. For broadbrush comparision purposes.								34	11	5	2	

OPTION 3: Spoil Repositories/Borrow Pits												
Configuration Type 2 directly adjacent to those lands required for land severance reasons												
	Notes 1	P	P Type	Environment	H&S	Cost	Time	Env Rank	H&S Rank	Cost Rank	Time Rank	NOTES
Environment	Impact to local road network as a result of haulage requirements;	1	I	2	0	0	0	2	0	0	0	Pits are directly contiguous to the PRD, limited access is estimated to the local network;
Environment	Impact resulting from Land Area Required;	5	I	1	1	0	0	5	5	0	0	The probability is high as it is certain land area is required. The impact is low as a result of low surface area. Related controls are covered below. i.e.: Flooding, Water Quality.
Environment	Potential impact to cause Flooding (I)	1	I	1	1	0	0	1	1	0	0	The pits have been developed so that there is limited filling above ground level, therefore the Flood Risk is low.
Environment	Potential impact as a result of a PEAT slide	1		1				1	0	0	0	Lands are flat or gently sloping. PEAT stored in basins or behind berms.
Environment	Potential impact to ground water	3		4				12	0	0	0	Material stored below ground, carefull design considerations will be required, particularly in reltion to the sealing of karst features encountered during the extraction process;
Health and Safety	Risk of Falls or engulfment during cons (I)	1	I	0	5	0	0	0	5	0	0	The probability is low as it is expected that this will be adequately covered by the Contractor in the devisement and implementation of a Site Specific Safety Statement.
Health and Safety	Risk of Falls or engulfment psot cons (I)	1	I	0	4	0	0	0	4	0	0	The probability is low as the site will be fenced off between the end of reinstatement and the end of an establishment period. Additionlly the pit is developed with a capping layer.
Environment	Potential for Construction realted Water Quality impacts (directly relates to land area) (I)	5	I	1	0	0	0	5	0	0	0	The probability is high as it is certain that there is inevitably some potential impact. The potential impact is directly related to the surface area required as this is the volume of surface water to be treated. To be considered in the Erosion and Sediment Control Plan.
Environment	Landscape Impacts (I)	5	I	3	0	0	0	15	0	0	0	The probability is high as there is certain to be a change to the landscape. The impact is moderate as the change may be noticeable. Control: Sites to be developed as ecological regeneration sites, consider foremost locations where existing wetland habitats are in proximity. Objective is to blend sites in with the exiting landscape.
Environment	Landuse Impacts (I)	5	I	3	0	0	0	15	0	0	0	Probaility is high as there will be a change in landuse. Following establishment period, it is expected that land will be of use only for rough grazing purposes. Note this is offset against the gains of the ecological regeneration which will provide mitigation for impacts in the Ecological Chapter of the EIS.
Time	Time Related Impacts	5	I	0	0	0	1	0	0	0	5	This does not relate to the time to extract the material within the pit, but rather for the time to make the pit suitable for the reporitory, e.g. Sealing of significant karst fissures.
Cost	Cost to develope	5	I	0	0	2	0	0	0	10	0	There will be a cost to develope, particularly in relation to sealing of karst features, ecological mitigation implementation measures, erosion and sediment control;
Environment	Potential risk of activity being considered waste as per the WMD.	2	L	1	0	1	1	2	0	2	2	There is a credible argument to be made that the material is being used for the purposes of construction therfore the probability is low that the material could come witin the WMD.
Environment	Ecological (L)	1	L	1	0	0	0	1	0	0	0	
Indicative Sum of Scores. For broadbrush comparision purposes.								59	15	12	7	
Material Resourse/Spoil Repository Configuration Type 2: ADDITIONAL CONSIDERATIONS												
	Notes 1	P	P Type	Environment	H&S	Cost	Time	*Env Rank*	*H&S Rank*	*Cost Rank*	*Time Rank*	*NOTES*
For those where the Probability relates to Impacts (i.e. Very high to Very Low)												
Environment: Perceived impacts which might arise during the extraction process;	*Perceived nuisances/damage as a result of construction vibration;*	5	I	4	0	0	0	20	0	0	0	*Blasting by its nature will cause vibration impacts which will be perceivable by human beings. The Noise and Vibration Impact Assessment Chapter of the EIS will set out thresholds for Peak Particle Velocity, Monitoring Requirments, Condition Surveys etc. This is standard practice in quarry operations and will reduce the Risk;*
Environment;	*Potential impacts to karst features/aquifers;*	3	I	4	0	0	0	12	0	0	0	*Interception of conduits cannot definitively be ruled out until during construction. The Hydro-Geological Impact Assesment will set out measures for dealing with this which will reduce the Risk.*

OPTION 4: Agricultural Land Infill Sites												
	Notes 1	**P**	**P Type**	**Environment**	**H&S**	**Cost**	**Time**	**Env Rank**	**H&S Rank**	**Cost Rank**	**Time Rank**	**NOTES**
Environment	Impact to local road network as a result of haulage requirements;	3	I	2	0	0	0	6	0	0	0	Identified site is adjacent to the PRD
Environment	Impact resulting from Land Area Required;	5		5				25	0	0	0	Spread is generally 1m deep, therefore the land mass requried is considerable;
Environment	Potential impact to cause Flooding (I)	2		5				10	0	0	0	Sites are not considered to be within Flood plains, therfore the probability is low.
Environment	Potential impact as a result of a PEAT slide	3		3				9	0	0	0	Lands are flat or gently sloping. PEAT stored in basins or behind berms.
Health and Safety	Risk of Falls or engulfment during cons (I)	1		0	4			0	4	0	0	The probability is low as it is expected that this will be adequately covered by the Contractor in the devisement and implementation of a Site Specific Safety Statement.Impact considered to be a serious injury only given that the spread is relatively shallow (1m).
Health and Safety	Risk of Falls or engulfment psot cons (I)	1		0	4			0	4	0	0	The probability is low as the site will be fenced off between the end of reinstatement and the end of an establishment period.
Environment	Potential for Construction realted Water Quality impacts (directly relates to land area) (I)	5		5				25	0	0	0	The probability is high as it is certain that there is inevitably some potential impact. The potential impact is directly related to the surface area required as this is the volume of surface water to be treated. To be considered in the Erosion and Sediment Control Plan.
Environment	Landscape Impacts (I)	5		4				20	0	0	0	The probability is high as there is certain to be a change to the landscape. The impact is high as the change will be noticeable. Control: Sites to be developed as ecological regeneration sites, consider foremost locations where existing wetland habitats are in proximity. Objective is to blend sites in with the exiting landscape.
Environment	Landuse Impacts (I)	5		5				25	0	0	0	Probaility is high as there will be a change in landuse. Following establishment period, it is expected that land will be of use only for rough grazing purposes. Note this is offset against the gains of the ecological regeneration which will provide mitigation for impacts in the Ecological Chapter of the EIS.
Time	Time Related Impacts	5		5			5	25	0	0	25	This is potentailly a waste recovery/disposal activity therefore a waste license and possibly a specific EIS may be required.
Cost	Cost to develope	5		0		4		0	0	20	0	There will be a considerable cost in developing on site access, cost of land (in relation to potentail loss of felling rights) and cost of surface water treatments systems;
Environment	Potential risk of activity being considered waste as per the WMD.	5		5		0		25	0	0	0	Recovery or Disposal
Environment	Ecological (L)							0	0	0	0	
Indicative Sum of Scores. For broadbrush comparision purposes.								170	8	20	25	

16 Appendix 5: Geotechnical Report

APPENDIX NO. 4.3

Sub Appendix 5

REPORT ON POTENTIAL SPOIL REPOSITORY SITES, PROCESSING OF CLASS U1 GLACIAL TILL, AND CONSTRUCTION ALTERNATIVES FOR EMBANKMENTS IN SOFT GROUND AREAS

PREPARED BY: AGL Consulting;

Document Control

Status	Issued For	Developed	Date	Approved
FINAL	*Publication*	*COD*	*December 2013*	*COD*

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Tables

1 INTRODUCTION

AGL Consulting were requested by the National Road Design Department of Sligo County Council to review the Environmental Report outlining considerations for the treatment of spoil material arising from the proposed N4 Collooney to Castlebaldwin Realignment and to comment on suitability of the potential options for repository and/or borrow pit areas considering any geotechnical constraints that would apply.

A significant portion of the Class U1 Unacceptable Material will be Boulder Clay with a high natural moisture content which would be classified as "soft" and would typically have a Moisture Condition Value (MCV) <7 at natural moisture content. This material would fall outside the acceptability limits that would normally be specified for Class 2C cohesive fill in Appendix 6/1 of the earthworks contract specifications.

The balance of the Class U1 unacceptable material is comprised of PEAT, MARL and Organic SILT or CLAY from the soft ground areas under the embankments.

Section 2 of this report addresses the geotechnical constraints and design considerations, such as the stability of existing and stored peat, access to the relevant site, construction methods, slope stability and drainage. We were also requested to outline geotechnical principles which should be considered in the development of the TYPE 1 and TYPE 2 Spoil Repositories/Borrow Pits which are as described in the main body of the Spoil Management Report. The potential environmental and ecological impact of the works has been addressed by others.

AGL were also requested to advise on possible methods for reducing the volume of Class U1 material by processing Class U1 fine-grained glacial till from the cut sections into acceptable Class 2C cohesive fill, and by using alternative construction methods for the embankments in the soft ground areas to reduce the volume of Class U1 organic soils. These issues are addressed in Sections 3.0 and 4.0 of the report, respectively.

2 REPOSITORY AREAS FOR CLASS U1 MATERIAL

Based on the initial Range of Options, three categories of repository areas have were initially identified for surplus Class U1 unacceptable material:

- Option 1 - Integration of surplus Class U1 material into the landscape within the CPO of the proposed development (LD-A1 to LD-A8 & LD-B1 to LD-B8);
- Option 2 - Integration of surplus Class U1 material into existing conifer plantations of low ecological value (LD-CP-00 to CP-07), or cutover bogs (LD-CB-01) outside the CPO of the proposed development;
- Option 3 - Integration of surplus Class U1 material into possible Borrow Pit sites outside the CPO of the proposed development [LD-BP-01 to LD-BP-07, LDBP(T2)-01, LDBP(T2)-02 & LDBP(T2)-05]

Two types of borrow pit/spoil repository configurations were considered for Option 3:

- Type 1 - shallow borrow pits in drumlins reinstated to original ground profile with Class U1 cohesive glacial till.
- Type 2 - deep borrow pits in flat or gently sloping low-lying areas with shallow rock reinstated to original ground profile with Class U1 peat, organic soil and cohesive glacial till.

The location of the potential disposal areas are shown on Figures Nos. 4.11.1 to 4.11.8. Figures 4.11.9 to 4.11.10 show the location of the Type 2 Configuration potential borrow pits under Option 3. Typical details of the Type 1 and Type 2 Configuration are illustrated on Figures 4.11.10 and 4.11.11, respectively. (Figures are contained within volume 3 of this EIS).

In Options 1 and 2 the Class U1 material would be spread out evenly over the existing ground surface to an appropriate depth with stable permanent side slopes or berms around the perimeter so that the fill material would be fully contained with a negligible risk of a slope failure at the edges, or a flow slide in the remoulded peat. Appropriate controls would also be implemented to prevent bearing failure or shear failure in weak underlying soils due to overloading or temporary stockpiling of Class U1 materials on the surface. Overall site stability in areas of peat would also have to be considered.

In Option 3 the Class U1 materials would be placed in exhausted borrow pits opened up by the Contractor within or outside the CPO line for the purpose of extracting acceptable fill material for the construction of the scheme, subject to approval through appropriate statutory procedures. For the Type 1 Configuration the borrow pits would be reinstated using Class U1 cohesive glacial till placed and compacted in controlled lifts up to original ground level. The deeper Type 2 Configuration borrow pits could potentially be used to extract rock for processing into Class 1 or select Class 6 granular fill materials. The exhausted pits could then be used to store excavated soft peat, organic and alluvial soils below ground level within the pits. The material would then be capped with a suitable cover of Class 4 landscaping fill and either returned to agricultural use with topsoil, or used for regeneration of boglands by reinstating acrotelm peat across the surface of the landscape fill at original ground level.

Class U1 cohesive glacial till used for landscaping purposes would be classified as suitable Class 4 Landscaping Fill under the NRA Specification for Road Works.

2.1 Option 1 - Integration of surplus unsuitable material into the landscape within the CPO of the proposed development (LD-A1 to LD-A8 & LD-B1 to LD-B8):

16 No. sites were identified at varying stages of the design process occurring within the potential CPO line at particular times. These sites included: LD-A1 to LD-A8 and LD-B1 to LD-B8; LD-B3 and LD-B6 were not considered within this report. Tables No. 2.1 presents a summary of the location, topography, ground conditions and hydrology in each area, as well as comments on the stability of existing and stored peat and other general geotechnical considerations.

The majority of these sites are in flat or gently sloping (<3°) low-lying soft ground areas adjacent to the proposed permanent works. In general, all of these areas would be suitable for storage of up to 1.0 m of Class U1 material - organic soils or glacial till. However, due to the low shear strength of the underlying intact peat and due to the low weight of remoulded peat, which is half the weight of glacial till, the sites would be more suited to the deposition of peat rather than glacial till because there would be a lower risk of bearing capacity or shear failure in the underlying intact peat if it was temporarily overloaded by stockpiling or overfilling. It should be possible to prevent this with appropriate site controls. The risk of a large scale peat slide should be negligible due to the flat ground profile in the areas.

Remoulded excavated peat up to 1.0 m thick should be stable on the flat slopes <3º. Photo No. 2.1.1 shows an image of 1.0 m of peat been deposited and spread out over the surface of a blanket bog by a long reach excavator.

Photo No.2.1.1 - Deposition and spreading of peat up to 1.0 m deep in a repository area on a gently sloping blanket bog (<3º). Access provided by a floating road on the left.

Depths of >1.0 m would only be recommended where the perimeter of the deposition area is fully contained by the topography, or by existing road embankments or new embankments above the finished level of the peat. The low strength of the existing peat would prevent the construction of earth berms greater than about 1.0 m in height on the peat specifically constructed to contain the remoulded peat. Brash, vegetation or boulder clay can be mixed in with the remoulded peat to improve the stability at the edges. However, in general the depth of spoil would generally be limited to 1.0 m where there is an unsecured boundary along one or more sides of the disposal area (e.g. along a stream or field boundary).

The existing hydrology in each of the deposition areas will need to be preserved. This will mean that the remoulded peat will need to be set back from drains, culverts and streams within each area. A minimum setback of 2.5 m would be recommended for small drains, increasing to 5.0 m for streams and larger channels allowing for future access. Alternatively, some of the smaller drains can be culverted under the fill.

The soft ground and high water table in most of these areas would restrict access for conventional earth moving equipment, and wide-tracked excavators would be required for operating directly on the surface of the peat. Sections of floating road may be required to gain access to parts of the sites that are inaccessible from the proposed permanent works. These would be constructed directly over the surface of the peat with a geotextile separator at the interface and typically between 450 mm and 750 mm of well graded Class 6F1 rockfill reinforced with 1-2 layers of geogrids.

LD-B7 and LD-B8 are located at the Castlebaldwin junction on the north side of the existing N4. LD-B7 is on the west side of the link road between the existing and proposed new N4. LD-B8 is on the east side of the link road in the area formed between the existing and new N4 embankments at the southern tie-in. Both LD-B7 and LD-B8 are in basins formed by the embankments for the existing and new roads in the area on all sides, which provides natural containment for fill material. The embankments are up to 4.0 m high at the highest point. LD-B7 is on glacial till whereas there is up to 4.0 m of very soft peat and organic soils in the low lying area around the Stream that flows through LD-B8.

LD-B7 and LD-B8 sites have been classified as Landscaping and Amenity areas. They may be filled up to the level of the surrounding embankments with Class U1 unacceptable cohesive glacial till as Class 4 Landscaping fill placed in controlled lifts tracked in place with a bulldozer or compacted with a vibratory roller to maximise the capacity of the sites. Where there is soft ground below existing ground level the material needs to be spread out evenly in thin lifts to prevent any shear failure at the edges of the fill. The stream passing through the site (LD-B8) will be maintained as a channel to maintain the existing hydrology. Depending on the landscaping and aesthetic constraints and sightline requirements at the junction, it may be possible to place Class U1 cohesive glacial till in LD-B7 and LD-B8 as Class 4 Landscaping Fill above the level of the existing and proposed new roads in the area. Above finished ground level the fill material would be compacted in place with 1V:2H side slopes for fill up to 3.0 m, and 1V:2.5H for depths of fill in excess of 3.0 m. The fill should be covered in 150-200 mm of topsoil and re-seeded to establish vegetation on the slopes, or with 1.0 m of peat on slopes <3° where there is a requirement to regenerate peatlands within the sites.

2.2 Option 2 - Integration of surplus Class U1 material into existing conifer plantations of low ecological value (LD-CP-00 to CP-07), or cutover bogs (LD-CB-01) outside the CPO of the Proposed Road Development.

These potential deposition areas are similar in characteristics to most of the sites in Option 1 in that they are generally on low-lying flat or gently sloping (<3º) poorly drained peat bogs. However, these sites are close to but not adjacent to the *Proposed Road Development* so access will be off the public roads network. Conifer plantations have been established on sites LD-CP-00 to LD-CP-07. LD-CB-01 is a cutover bog.

In general, all of these areas will be suitable for storage of up to 1.0 m of Class U1 material - organic soils or glacial till. However, they would be more suited to disposal of peat due to the low strength of the underlying intact peat and the low unit weight of peat. With peat there is a lower risk of bearing capacity or shear failure in the underlying soils if they are temporarily overloaded by stockpiling or overfilling. The risk of a large scale peat slide should also be negligible due to the gently sloping ground profile in the sites.

The existing trees would need to be felled prior to peat placement and the stumps would restrict access for some equipment moving across the site. Wide tracked excavators should still be able to move across the site provided that the stumps are cut close to ground surface.

The repositories cover a wide area that is not immediately accessible from the permanent works within the CPO line. Therefore, access could be a significant constraint. Temporary roads would be required to gain access to the sites for the machinery used to transport the peat to the site and for the equipment used to spread the peat out over the surface of the site. These would typically be in the form of floating roads constructed directly on the surface of the peat with a geotextile separator and 450-750 mm of Class 6F1 crushed rockfill reinforced with 1-2 layers of geogrid.

Brash and branches from the felled trees could also be used to form temporary access tracks for tracked machinery moving across the site. Culverts or temporary bridges would be required to cross existing open drains or streams.

As a general indication, over a wide area access tracks for peat deposition may be required on about a 40 m spacing. This would allow for spreading up to 10.0 m either side of the roads with a long-reach excavator from the track, and double handling from 10-20 m by a wide tracked excavator operating on the surface of the peat or on brash.

The stability of the remoulded peat placed up to 1.0 m deep on these sites should be acceptable. The surface of the peat should be relatively flat but can be mounded up at about 1-2º towards the centre of the peat, where possible. Depths >1.0 m would not generally be recommended because of the open nature of most of the sites with no containment berms around the perimeter. Up to 2.0 m of peat can be placed where it is contained by the topography or existing road embankments. Brash, vegetation or boulder clay can be mixed in with the remoulded peat to improve the stability at the edges.

The existing hydrology in each of the disposal areas will need to be preserved. This will mean that the remoulded peat will need to be set back from drains, culverts and streams within each area. A minimum setback of 2.5 m would be recommended for small drains, increasing to 5.0 m for streams and larger channels to allow future access. Alternatively, some of the smaller drains can be culverted under the fill.

2.3 Option 3 - Spoil Repositories within Borrow Pits (both within and outside the limits of the CPO)

Two types of borrow pit/spoil repository configurations were considered for Option 3:

- Type 1 - shallow borrow pits in drumlins reinstated to original ground profile with Class U1 cohesive glacial till.
- Type 2 - deep borrow pits in flat or gently sloping low-lying areas with shallow rock reinstated to original ground profile with Class U1 peat, organic soil and cohesive glacial till.

2.3.1 TYPE 1 Borrow Pits/Spoil Repositories (LD-BP-01 to LD-BP-07)

For the Type 1 Configuration the borrow pits would be reinstated using Class U1 cohesive glacial till placed and compacted in controlled lifts up to original ground level.

Borrow pits LD-BP-01 to LD-BP-07 would be located in drumlins adjacent to the mainline carriageway within cut sections along the proposed route. The borrow pits would be initially used to extract acceptable Class 1 or Class 2 general fill material for construction of embankments along the proposed road development. Where Limestone rock is encountered within the depth of excavation it would be processed into Class 1 general granular fill and possibly Class 6 select granular fill materials and Clause 804 subbase.

Much of the material within the depth of excavation in the potential borrow pit locations at LD-BP-01 to LD-BP-07 should be acceptable as Class 2C and/or Class 1 general fill which could be used in the construction of the permanent embankments for the proposed road development. Some material within the upper 1-3 m may not be acceptable as Class 2C material and may need to be stockpiled within or adjacent to the borrow pit for re-use in capping the pit after completion.

Limestone rock is likely to be encountered within the depth of excavation to finished road level in LD-BP-01. This is likely to make the excavation more difficult and expensive. However, the slope angles in the competent rock can be steepened up to 2V:1H and the rock may be suitable for re-use as Class 6F1/6F2 capping and/or Clause 804 subbase material in the road construction.

Under the current schematic proposals the pits would be excavated down to finished road level leaving a berm of undisturbed ground between the road and the borrow pit. The minimum crest width along this berm would be 5.0 m to provide temporary access. All of the permanent slopes around the pit would be trimmed back to stable slopes of 1V:2H. Temporary slopes below finished ground level would be battered back to slopes of 1V:1H in cohesive glacial till, 1V:1.5H in granular till, and possibly 2V:1H or steeper in rock, subject to detailed design and analysis.

Temporary dewatering may be required to draw down the water level inside the cell prior to filling. A cutoff drain should be constructed behind the crest of the slope on the upslope side of the borrow pit to intercept and surface water flow and prevent it from entering the pit.

On completion the borrow pits would be reinstated by filling with excess inert cohesive glacial till that falls outside the limits of acceptability for Class 2 general cohesive fill in the Earthworks Specification. These would include Class U1 cohesive glacial till or Class 4 Landscape Fill and should be free of any contaminants or construction waste.

The fill material should be spread out in thin lifts of about 300 mm and compacted by tracking with a bulldozer or tracked excavator to remove large voids so that it forms a stable coherent mass whilst preventing over-compaction and any build-up of excess pore water pressures. Compaction with a vibratory roller would increase the volume of material that could be placed in the pits.

It is proposed to fill these exhausted borrow pits with Class 4 Landscape Fill and/or Class U1 cohesive glacial till so that the original ground profile can be reinstated. However, it may be possible to mix small volumes of peat, organic and alluvial soils with the glacial till at the base of the pit, subject to detailed design. Peat stability would not be an issue because the mixed material would be contained within the pit. However, the fill would be required to have sufficient strength to restore the original slope of the ground surface rising away from the road up to a maximum slope angle of 1V:2.5H above the crest level of the berms without a risk of slope failure. The final fill profile should be landscaped to blend in with the natural contours of the land and re-instate, as much as possible, the original profile of the ground surface.

In general, the original topsoil that was on the site should be re-instated to its original depth. However, if the site is to be returned to agricultural use then the minimum topsoil depth should be 250 mm. The topsoil should be seeded to establish vegetation on the land. It could take up to 12 months for natural drainage to establish on the site to biological aeration.

To re-establish the natural vegetation and site drainage, the permeability of the top 1.0 m of fill material below the topsoil should be equivalent to the material that was originally below the topsoil on the site.

2.3.2 TYPE 2 Borrow Pits/Spoil Repositories [LDBP(T2)-01, LDBP(T2)-02, LDBP(T2)-05]

The deeper Type 2 Configuration borrow pits could potentially be used to extract rock for processing into Class 1 or select Class 6 granular fill materials. Areas where rock is shallow, or where there is a relatively shallow cover of acceptable Class 1 or Class 2 general fill material would generally be more cost effective.

The exhausted borrow pits could subsequently be used to store excavated soft peat, organic and alluvial soils below ground level within the pits. The material would be capped with a suitable cover of Class 4 landscaping fill and either returned to agricultural use with topsoil, or used for regeneration of boglands by reinstating acrotelm peat across the surface of the landscape fill at original ground level.

In general, all of these potential borrow pits could be suitable for storing surplus peat and Class U1 unacceptable material when the borrow pits have been exhausted. However, prior to developing the borrow pits the existing cover of peat, organic soils and Class U1 cohesive glacial till would have to be stripped and stored securely elsewhere on the site. Consideration would also have to be given to the potential impact of the existing and proposed road networks on the geometry and depth of the borrow pit, particularly where existing roads are constructed on peat.

With the current proposals peat excavated from the soft ground areas would be placed in exhausted cells in the borrow pits so that it is fully contained below ground level within the pits. Consequently, the risk of a flow slide or large scale shear failure of the peat would be negligible. The deeper Type 2 borrow pits would also be able to accommodate a larger volume of peat on completion within a confined area.

The borrow pits could be filled with remoulded peat by end-tipping from controlled ramps around the perimeter. The peat should only be placed up to within 2-3 m of the crest of the perimeter berm or ground level to leave sufficient room to cap the peat.

Where there is a fall in the ground level across the site it may be necessary to construct a containment berm along the downslope side to allow the borrow pits to be reinstated up to ground level on the high side of the pits.

The berm should be constructed of acceptable Class 1 or Class 2 fill with 1V:2H side slopes and a minimum crest width of 1.5 m. All permanent slopes above final ground level in the borrow pit should be trimmed back to 1V:2H.

The temporary slopes below the final ground level can be trimmed back to 1V:1.0H in cohesive overburden and 1V:1.5H in granular overburden, and 2V:1H or steeper in rock subject to detailed design and analysis. The temporary slope angles in the rock will depend on the characteristics of the joints, bedding planes and fractures in the rock. In bedded Limestone rock where the bedding planes are gently dipping and the rock has a matrix of orthogonal sub-vertical joints it is often possible to excavate near vertical temporary slopes. Where joints, fractures or bedding planes are dipping into the excavation, then the temporary slopes should be battered back to prevent planar, wedge or toppling failure into the borrow pit.

Water level would be high at these sites. Therefore, temporary dewatering may be required to draw down the water level inside the cell prior to filling. Surface swales should be constructed on the upslope side of the borrow pits to intercept surface water runoff and prevent it from entering the pit. Sediment control ponds should be provided at outfall points.

At the end of construction the peat within the borrow pit should be capped with a minimum of 2.0 m of Class 2C Cohesive Fill or Class 4 Landscape fill (typ. Class U1 - Cohesive Glacial Till). A perimeter fence should be erected around the perimeter of the peat to restrict access to people and livestock with appropriate signage to warn of the risk of engulfment.

To facilitate capping, the drier, stronger peat should be used near the top of the pits, where possible. It will probably be necessary to place a separator layer of Terram 2000 geotextile over the surface of the peat possibly reinforced with a geogrid to allow the Boulder Clay fill to be spread out over the very weak surface of

the remoulded peat. The fill should be spread out evenly across the surface of the peat in staggered 0.25 - 0.5 m thick layers using low ground pressure wide-track excavators or long reach excavators set back from the edge of the fill to prevent any shear failure or heave at the edges. The surface of the fill over the peat should be graded with a maximum 1-2% slope to facilitate drainage of surface runoff.

If the site has to be returned to agricultural use then 250 mm of topsoil should be reinstated over the surface of the fill and seeded to establish vegetation on the land. It could take up to 12 months for natural drainage to establish on the site to biological aeration. Land drains at the interface between the peat and the fill would assist site drainage.

Alternatively, acrotelm peat could be placed across the surface of the fill to re-establish natural bogland on the site.

Some surface settlement will occur over time due to consolidation of the underlying peat. The settlement may not be uniform and may result in localised ponding or dipping towards the centre of the fill. It would be recommended to compensate for this by mounding slightly towards the centre. Some re-grading may still be necessary over time.

The supplemental site investigation indicates that much of the overburden will not be acceptable as Class 1 or Class 2 general fill materials and would require processing to render then acceptable. Where possible this material should be re-used in the re-instatement of the borrow pit.

Where LIMESTONE rock is excavated from the borrow pits it may be possible to process the rock into select Class 6 or Clause 804 granular fill materials for use in the construction of the permanent works, subject to further investigation and testing. The weathered rock layers and the more argillaceous rock encountered at LDBP(T2)-05 would be less suitable for processing into select granular fill materials but it should be possible to process the material into Class 1 or Class 2 general fill materials.

Photos No. 2.3.1 shows an example of a deep borrow pit being backfilled with peat. Photo No. 2.3.2 shows the pit when it has been filled, and Photo 2.3.3 shows an example of a pit 2.5 years after filling (no surface finish, i.e. topsoil or acrotelm layer), when a crust has formed on the peat.

Photos Nos. 2.3.4 to 2.3.6 show views of capped deep repository sites for peat, organic soils and Class U1 adjacent to the N2 Carrickmacross Bypass which have been landscaped and returned to agricultural use. The fill was placed in a soft ground area in a deep hollow between drumlins so the extent of fill and reinstatement would be similar to the potential borrow pit areas. The capped peat repository in Photo No. 2.3.5, which is to the left of the road in Photo 2.3.4, was fully contained by the natural drumlin topography and the embankment for the new road, which were up to 6.5 m above original ground level. The final earthworks profile on this side was up to 2.5 m above finished road level for the new road to incorporate an environmental screening bund of Class 4 landscape fill. The peat and organic soils were capped by about 2.0 m of Class U1 cohesive till with a cover of topsoil. Photo No. 2.3.7 shows an image of the site during construction.

The area in Photo No. 2.3.6, which is to the right (east side) of the road in Photo 2.3.4 was raised by over 6 m up to finished road level with Class 4 landscape fill to grade out the hollow adjacent to the road, which was prone to flooding. Soft ground was left in place below the fill in both sites.

Figure No. 2.3.8 shows the location and topography in the vicinity of the repositories. Photos Nos. 2.3.9 and 2.3.10 show aerial photographs of the area during construction in 2005 and after construction in 2007, respectively.

Access to the borrow pit can determine the depth to which it can be excavated, particularly in confined sites. A ramp has to be provided for plant and machinery operating within the borrow pit and for trucks transporting the extracted rock. An area would also have to be set aside for stockpiling and crushing rock for processing into select granular fill materials.

Photos Nos. 2.3.11 and 2.3.12 show images of a borrow pit that was excavated up to 20 m into rock to extract rock for processing into fill material and to store large volumes of remoulded excavated peat on completion. The access ramp in Photo No. 2.3.11 is inclined at about 20° (1V:2.6H) and the material is being stockpiled behind the pit. Photo 2.3.12 shows the pit prior to backfilling with near vertical sides in mudstone rock. The backfilled pit is on the left side of the image in Photo No. 2.3.2. The pits are very suitable for storing peat because the peat is fully contained within the rock below ground level on all sides.

Photo 2.3.1 - Temporary borrow pit being backfilled with peat.

Photo No. 2.3.2 - Backfilled peat repository

Photo No. 2.3.3 - Deep bunded peat repository approximately 2.5 years after filling

Photo No. 2.3.4 - Capped deep repository sites adjacent to the N2 Carrickmacross Bypass

Photo No. 2.3.5 - Capped peat repository site returned to agricultural use

Photo No. 2.3.6 - Deep landscape fill area returned to agricultural use (Class U1 cohesive till)

Photo No. 2.3.7 - Peat repository site in Photo 2.3.5 during construction

Figure No. 2.3.8 - Location of deep repository sites

Photo No. 2.3.9 - 2005 aerial photographs of deep fill area

Photo No. 2.3.10 - 2007 aerial photograph of capped and landscaped deep fill areas

Photo No. 2.3.11 - Excavating a deep borrow pit in rock

Photo No. 2.3.12 - Completed deep borrow pit in rock

3 MATERIAL PROCESSING

Table No. 3.1 summarises our preliminary estimates for the material acceptability in the cut sections along the route for the *Proposed Road Development*.

A significant portion of the Class U1 Unacceptable Material is Boulder Clay with a high natural moisture content which would be classified as "soft" and would typically have a Moisture Condition Value (MCV) <7 at natural moisture content. This material would fall outside the acceptability limits that would normally be specified for Class 2C cohesive fill in Appendix 6/1 of the earthworks contract specifications.

Given the large volume of excess spoil that could be generated from the Class U1 Material, consideration has been given to how some of this material could be processed into acceptable Class 2C cohesive fill for use in the permanent works. This would reduce the volume of spoil that has to be disposed of and would also reduce the volume of acceptable material that would have to be sourced from borrow pits off site.

The two main options that are normally used for processing this material would be:

(1) air drying, and
(2) lime stabilisation.

3.1 Air Drying

Air drying involves drying the wet Class U1 glacial till by exposing it to air until the MCV increases to within the acceptable range for Class 2C cohesive fill.

The Class U1 material is normally spread out over a wide area in thin loose lifts approximately 300 mm deep and then rotavated over a period of 1-4 hrs to ensure that the material is dried over the full depth of the lift prior to compaction. For maximum benefit the air drying would be carried out on the embankments so that the material can be compacted in place and incorporated into the permanent works without double handling. A large working area with well-coordinated earthworks operations would be required to ensure that the work can be carried out efficiently without leaving earthworks plant idle.

Air drying is very weather dependent as it can only be carried out in dry weather. The optimum drying conditions occur during warm, sunny days with a steady breeze and low humidity. Cool cloudy summer or autumn days can also be effective provided that there is still a steady breeze. Air drying can also be carried out on dry sunny days in winter but there is a higher risk of inclement weather and lower productivity.

The material characteristics of the soil also influence how effective air drying can be. Class 2C materials that have between 15% and 25-30% fines and a high gravel content would be expected to break up more readily and dry out quicker than the cohesive glacial till with a higher fines content. Also, air drying is most cost effective for processing Class 2C soils that are only marginally unacceptable so that they only need a small reduction in water content to render them acceptable, which could be achieved in 1-2 hrs.

Table 3-1: Summary of preliminary material acceptability assessment

	% of Total Cut Volume	**Class U1 Unacceptable**	**Acceptable Class 2C Cohesive Fill**	**Acceptable Class 1 Granular Fill**
Cut 1/2: Circa Ch. 2+790 to 3+180				
Overburden	**100%**	75%	25%	0%
***Weathered Rock**	**0%**	N/A	N/A	
Rock	**0%**	N/A	N/A	
Cut 3: Circa Ch. 3+870 to 4+180				
Overburden	**100%**	50%	50%	0%
***Weathered Rock/Rock**	**0%**	N/A	N/A	
Cut 4: Circa Ch. 4+860 to 5+110				

	% of Total Cut Volume	Class U1 Unacceptable	Acceptable Class 2C Cohesive Fill	Acceptable Class 1 Granular Fill
Overburden	**100%**	100%	0%	0%
***Weathered Rock**	**0%**			
Rock	**0%**			
Cut 5: Circa Ch. 5+750 to 6+610				
Overburden	**100%**	35%	65%	
***Weathered Rock**	**0%**			
Rock	**0%**			
Cut 7: Circa Ch. 8+140 to 8+400				
Overburden	**100%**	35%	65%	
***Weathered Rock**	**0%**			
Rock	**0%**			
Cut 8: Circa Ch. 8+970 to 9+230				
Overburden	**100%**	40%	60%	
***Weathered Rock**	**0%**			
Rock	**0%**			
Cut 9: Circa Ch. 10+310 to 10+540				
Overburden	**100%**	15%	85%	
***Weathered Rock**	**0%**			
Rock	**0%**			
Cut 10: Circa Ch. 10+920 to 11+220				
Overburden	**100%**	55%	45%	
***Weathered Rock**	**0%**			
Rock	**0%**			
Cut 11: Circa Ch. 11+360 to 11+860				
Overburden	**100%**	30%	70%	
***Weathered Rock**	**0%**			
Rock	**0%**			
Cut 12: Circa Ch. 12+550 to 13+640				
Overburden	**85%**	35%	65%	
***Weathered Rock**	**5%**		100%	
Rock	**10%**			100%

* May also be comprised of very stiff to hard cohesive glacial till or very dense granular till with numerous cobbles and boulders which may require secondary processing.

We have taken a reasonably conservative assessment of the percentage of unacceptable material in each of the cut sections based on the limited information from the preliminary ground investigation. Nevertheless, the investigations indicate that in many of the cuts there is a surface layer 1-3 m deep of soft and very soft Boulder Clay that would be classified as Class U1 unacceptable material. The sample descriptions on the logs often classify the soil as very soft, and the MCV and CBR test results are typically very low, which does not indicate

that these soils are marginally unacceptable. On the other hand, a significant number of the laboratory classification tests indicate that these soils had a fines content <25-30%, making them potentially suited to air drying.

It is reasonable to assume that some of the Class U1 unacceptable material could be processed into acceptable Class 2C material under the right conditions by an experienced earthworks contractor, particularly where there is a deficit of acceptable fill material on the project and a large volume of Class U1 material that needs to be considered as spoil.

The actual percentage of Class U1 material that could be processed into Class 2C cohesive fill would be a function of the weather conditions at the time of construction and commercial considerations. However, for preliminary design and cost estimate purposes it would not be unreasonable to assume that the volume of Class U1 unacceptable fill that could be processed into Class 2C cohesive fill by air drying could be on the order of about **10-20%** of the total volume of Class U1 material.

3.2 Lime Stabilisation

Lime stabilisation can also be used to render Class U1 clayey glacial till into acceptable Class 2C cohesive fill. It involves spreading powdered lime evenly over the surface of thin loose lifts (150-350 mm) of the Class U1 material, mixing it with the clay by rotavating, and then allowing the mix to dry or cure over a short period of time prior to compaction. Similar to air drying, for maximum benefit the process would be carried out on the embankments so that the material can be compacted in place and incorporated into the permanent works without double handling. A large working area with well-coordinated earthworks operations would be required to ensure that the work can be carried out efficiently without leaving earthworks plant idle.

The Lime is applied in two forms, either as quicklime (calcium oxide, CaO, created by heating hydrated lime to 450ºC), or hydrated (slaked) lime (calcium hydroxide ($Ca(OH)_2$, formed when CaO comes into contact with water or water vapour). In Ireland quicklime is the most common type that is used. A typical application for processing Class U1 clayey glacial till into acceptable Class 2C cohesive fill would involve adding up to about 2% by dry weight of soil.

The stabilisation effect is most effective in clayey soils where it reacts with the clay particles themselves and alters the structure of the soil. The plasticity index is used as a measure of the clay content and a value of 10% is usually taken as the lower limit. The stabilizing effect depends on the reaction between the lime and the clay minerals. Three sets of reaction take place, namely

a) Drying out by absorption and evaporation

b) Rapid physio-chemical reactions between the lime and the clay minerals which produce immediate changes in soil plasticity and workability. A cation exchange reaction takes place where the soil is transformed to a needle like interlocking metallic structure, hence there are significant changes to its engineering properties. This is known as improvement or modification.

c) Long term soil-lime pozzolanic reactions between the lime and the clay particles which results in the formation of cementing agents which increase strength and durability. This is known as lime stabilization. The lime added to the soil increases the pH which results in an increase in the solubility of siliceous and aluminous compounds which react with calcium which eventually results a cementitous process. The hydration of the lime is an expansive reaction.

The curing time for the long-term soil-lime pozzolanic reactions would be on the order of 24-72 hrs. However, the clay mineral content of the fine-grained glacial tills in Ireland is typically relatively low, so the benefit of these reactions is small. The rapid physio-chemical reactions that occur on initial mixing are more significant for processing Class U1 cohesive glacial till into Class 2C cohesive fill. Therefore, the curing time prior to compaction would normally be limited to less than 1-2 hrs, and for some marginal soils the fill would be compacted immediately after mixing with the quicklime.

Lime/soil reaction reduces or effectively ceases when the temperature drops below 4^{o}, and this temperature limit is normally included in the specifications for the method. It should also not be carried out in wet weather.

The clay, once modified, must be considered to be a new material. Technically speaking, the lime increases the plastic limit of the soil and reduces the liquid limit and the potential for volume change. The addition of lime to clayey soils also increases the optimum moisture content and can reduce the maximum dry density.

The modified material has properties that change with time. The stabilized soil undergoes volume changes during the reaction stage although heave should not be an issue provided that there is a low sulphate content in the soil. The treated soil should be compacted with no more than 5% air voids.

The presence of sulphates in the treated soil can cause problems by reacting with the cementitious material to cause heave. Because of this, sulphate limits have been set in the UK, along with a requirement that heave tests be carried out. The possibility of sulphates in the groundwater must also be investigated.

The cost of carrying out lime stabilisation or modification to process Class U1 cohesive glacial soils into Class 2C cohesive fill in a bulk earthworks operation can be about 3-5 times more expensive than using material that is acceptable at its natural moisture content. However, where there is a deficit of Class 2C material and a large volume of excess Class U1 material that needs to be disposed of, then the cost of lime stabilisation must be balanced against the cost of importing the Class 2C from an off-site borrow pit, and disposing of the Class U1 material.

The majority of the Class U1 material on this project would be fine-grained glacial till with a high natural moisture content. Therefore, in theory, much, if not all of this material could be processed into Class 2C fill. However, commercial considerations that are outside the scope of this report, and the weather at the time of construction would strongly influence the volume of soil that would actually be treated by lime stabilisation.

Lime stabilisation within a commercial earthworks operation could still be cost-effective in the marginally unacceptable cohesive glacial soils, so for preliminary design purposes it could be assumed that, in addition to air drying, a further **15-30%** of the Class U1 material might be processed into Class 2C cohesive fill by lime stabilisation.

4 ALTERNATIVE DESIGNS/CONSTRUCTION METHODS FOR SOFT GROUND AREAS

The balance of the Class U1 unacceptable material is comprised of PEAT, MARL and Organic SILT or CLAY from the soft ground areas under the embankments.

The Preliminary GIR lists all of the soft ground areas along the proposed route of the N4 Mainline Carriageway and the embankment details in each area. It also includes the main construction option for the embankments assuming low cost storage for excavated pits in borrow pits or designated peat repository areas within close proximity to the works, and alternative construction options which may become commercially viable when significant costs for spoil disposal are taken into account.

The majority of the soft ground along the route is comprised of organic deposits of peat marl and organic silt or clay. The low shear strength, high compressibility, and long term creep characteristics of these soils makes them unsuitable for leaving in place under the embankments. Therefore, they need to be excavated out from under the embankment unless the road is constructed on a pile-supported platform.

Some fine-grained alluvial or fluvioglacial soils were encountered below the peat at the southern end of the scheme (Ch. 11+300 to 11+550). The classification tests indicate that the soils are inorganic and the shear strength of the soil ranges from soft-firm, to firm, stiff and very stiff with depth, which would indicate that they are over-consolidated with a relatively low compressibility. Therefore, the construction option in this area could include excavating the peat, constructing the embankment on the underlying inorganic alluvial soils with 1.0 m thick Class 6C drainage layer, and building out the consolidation settlements within the construction period, possibly using a surcharge to accelerate settlements. Fine sand seams were recorded in the clay in one of the trial pits, which would accelerate drainage and consolidation in the clay.

For the excavate/replace option the organic soils are excavated out from under the embankment to support it on the underlying glacial till, rock or inorganic fine or coarse grained alluvium. The organic soils are excavated out within a 1V:1H influence line from the crest of the embankment, or to the toe of the embankment at finished ground level, whichever is greater. This means that the extent of the excavation can extend beyond the toe of the embankment, particularly for low embankments in deep peat. The organic soils are replaced with a Class 6A crushed rock granular fill below standing water (min. 1.0 m thick). General Class 1 or Class 2 fill can be used above this level with a suitable geotextile separator or Class 6H blinding layer at the interface.

Excavation of peat up to 2.0 m depth is normally a straightforward operation, depending on the groundwater conditions in the area. Between 2.0 m and about 4.0 m depth the stability of the peat at the edges of the excavation will depend on the shear strength of the soils and the groundwater conditions. Excavations in very weak peat with a high groundwater table will require some stabilisation works at the edges of the excavation to prevent shear failure in the peat. This could typically involve some groundwater control, battering back the sides of the excavation to a stable slope, or, in extreme conditions, supporting the sides of the excavation with a rockfill berm. Nevertheless, depths of excavation up to 4.0 m would normally be achievable by an experienced earthworks contractor, and where there is a suitable disposal site for the peat within close proximity to the works it is typically the most cost-effective design solution.

The depth of soft organic soils encountered along the mainline carriageway is up to 6.0 to 7.0 m in places, generally adjacent to watercourses. Excavation to these depths is a specialist operation which should be carried out by an experienced earthworks contractor. Poor stability and rapid groundwater ingress can be expected in the excavation. Temporary supports such as steel sheetpiles or rockfill berms are likely to be required outside the permanent works outline to prevent shear failure in the peat that could extend for some distance from the excavation. Some groundwater control may also be required to prevent inundation of the excavation, although in some cases it may be effective to excavate the peat by draglining in a flooded excavation, which can significantly reduce the risk of shear failure at the edges.

The cost of the excavate/replace option in organic soils up to depths of 7.0 m (or greater) can become comparable to the pile-supported embankment because of the difficulties in excavating the peat and the large volumes of spoil and rockfill.

For depths of organic soils of 4.0 - 7.0 m the excavate/replace option would still normally be used by an earthworks contractor if there was a suitable repository site for the peat within close proximity to the works. However, if there are significant constraints on peat disposal and on the supply of rockfill then the pile-supported platform could become a cost-effective alternative to reduce the volume of spoil.

For depths of organic soils <2.0 m the excavate/replace option would typically be the most cost effective solution and a pile-supported option would only be considered if there were severe constraints on peat excavation and disposal (e.g. hydrological and environmental restrictions).

For depths of organic soils between 2.0 and 4.0 m, the cost difference between the excavate/replace option and the pile-supported embankment would be quite significant. Therefore, the likelihood of using a pile-supported embankment would depend on a range of conditions including the extent of soft soil up to about 3.0 to 4.0 m, the distance to suitable borrow pit for the Class 6A rockfill, and the environmental, logistical and economical constraints on peat excavation and disposal. A full evaluation of all of these conditions is outside the scope of this report. Nevertheless, in some cases the pile-supported embankment has been presented as a possible alternative technical solution, albeit at a lower probability.

Other relevant considerations for evaluating alternative construction options would include the ground conditions and embankment height, i.e:

Ground Conditions:- the depth to rock and the depth and characteristics of the glacial till below the soft ground will determine the length of pile foundations.

Embankment height:- a minimum embankment height of about 2.5 m would be required to construct a reinforced earth load transfer platform. Below this the road would need to be constructed on a reinforced concrete deck, which would be more expensive. Also, for high embankments > about 7.0-10.0 m it may be necessary to use higher capacity bored piles socketed into rock, depending on the ground conditions, which would be more expensive than the driven pre-cast reinforced concrete piles that are normally used.