N4 Collooney to Castlebaldwin, *Proposed Road Development*

APPENDIX NO. 13.1

Geophysical Survey

PREPARED BY: **Minerex Geophysics Limited**

Document Control

Status	Issued For	Signed	Approved
FINAL	*Publication*	*CQ*	*CQ*

NOTE:

Chainages and designs presented in this report are based on a 2006 version of the design, therefore chainages do not represent the current chainage of the *Proposed Road Development.*

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1 INTRODUCTION

1.1 Background

Minerex Geophysics Ltd. (MGX) carried out a geophysical survey for the N4 realignment Collooney to Castlebaldwin. The survey consisted of 2D-Resistivity measurements and was carried out over a length of 5,020m in areas where karstified bedrock would be expected.

1.2 Objectives

The main objectives of the geophysical survey are:

- To reduce the risk of encountering difficult subsurface conditions.
- To estimate the depth to rock and overburden thickness.
- To detect lateral changes within the geological layers.
- To determine the presence of possible faults and fracture zones.
- To detect possible karstified zones and water conduits within the rock.

1.3 Site Description

The survey work covered a total length of 5,020m and was carried out in two areas from chainage 7,600 – 12,100 and 13,280 – 13,800. Apart from intersections with roads the survey was continuous and the 2D-Resistivity data was acquired in a roll-along overlapping fashion. Initially the survey was to start at chainage 7,100 but a dense forest at the beginning could not be penetrated, otherwise the landscape consists of agricultural lands.

1.4 Geology

The bedrock geological map of Sligo/Leitrim (Ref. 2) indicates that the surveyed areas are underlain by the Bricklieve Limestone formation (lower and upper). It is described as a **bioclastic cherty limestone, consisting of medium to thick-bedded grey bioclastic limestone, generally wackestone and packstone, devoid of internal bedding features. Shale is almost absent except in the lowest exposed beds**. A fault is indicated crossing the proposed alignment at CH10,600. Several lakes, springs, turloughs, wells and possible dolines are located on or near the chainage (Ref. 5).

1.5 Report

This report includes the results and interpretation of the geophysical survey. Maps, figures and tables are included to illustrate the results of the survey. More detailed descriptions of geophysical methods and measurements can be found in Engineering Geophysics (1988), Milsom (1989) and Reynolds (1997).

The client provided a map of the site and the digital version was used as the base map for the maps in this draft report. Elevations were taken from the draft alignment.

The interpretative nature and the non-invasive survey methods must be taken into account when considering the results of this survey and Minerex Geophysics Limited, while using appropriate practice to execute, interpret and present the data, give no guarantees in relation to the existing subsurface.

2 GEOPHYSICAL SURVEY

2.1 Methodology

The 2D-Resistivity profiles were as continuous as possible along the chainage. The areas covered are CH7,600 – 12,100 and CH13,280 – 13,800 (Maps 1 and 2). The last profile at CH 13,800 was carried out oblique to the centreline. All other profiles followed the centreline.

2D-Resistivity profiles with electrode spacing of 5m and 32 – 55 electrodes per set-up were surveyed at the locations shown on Map 1 and Map 2. The readings were taken with a Tigre Resistivity Meter and Imager Cables.

2.2 Site Work

The survey was carried out between the 3rd and 17th of January 2006. The weather conditions ranged from fair to poor.

3 RESULTS AND INTERPRETATION

The interpretation of geophysical data was carried out utilising the known response of geophysical measurements, typical physical parameters for subsurface features that may underlay the site, and the experience of the authors.

The measured resistivity data was positioned in relation to the chainage and adjacent profiles were concatenated. The topography from the draft vertical alignment was used, then the data was inverted with the RES2DINV inversion package. The resulting models were colour contoured and they are displayed as cross sections (Figs. 1 - 5). The figures also show the proposed vertical alignment of the road.

The interpretation has been made by using typical ranges of resistivities for common geological materials and from geological information. The model resistivities indicate the material within a layer, and have been used to delineate between overburden and rock types. Table 1 summarises the interpretation of the 2D-Resistivity data.

Table 1: Summary of Results and Interpretation

Layer	**General Resistivity Range (Ohmm)**	**Interpretation**
1	<140	Overburden (Gravely Clay) or Very weathered/fractured/broken/karstified Limestone or Shales
2	140 – 300	Overburden (Clayey Gravel) Or weathered/fractured/broken/karstified Limestone or Shaley Limestone
3	300 – 800	Overburden (Clean Gravel/Sand) Or slightly weathered/fractured/broken/karstified clean Limestone
4	> 800	Clean Limestone

The resistivities have been grouped into four layers. The interpretation on the figures has been drawn along these ranges, with some considerations where sudden changes (strong gradients) occur in the model resistivities and where island-type patterns occur.

Different lithologies can have the same or similar resistivities. The lowest resistivity range in this report (< 140 Ohmm) could represent gravely clay (glacial till), a very weathered and karstified limestone or by a mudstone. Where the lower resistivities occur on topographical highs, they would represent the gravely clay of glacial drumlin deposits. Where the lowest resistivities occur at depth (e.g. CH9,160) they could indicate weathered and karstified rock within a fault zone.

Several sudden lateral changes occur in the resistivities (e.g. CH8,650) and these indicate a possible fault. Where changes occur close together these could indicate a fault zone with a lateral extent of the fractured rock (e.g. CH 9,112 – 9,230).

The bedrock geology seen over the whole survey length has the appearance of a fault-bounded system. The faults separate the bedrock geology into various zones. Zones with high resistivity bedrock (blue colour range) close to the surface indicate a clean limestone with a thin overburden (e.g. CH8,650 – 9,000). Areas with deep-reaching (to 25m depth b.g.l. and more) low resistivities (e.g. CH10,900-12,100) represent the materials of Layer 1 in Table 1. Targeted drilling in these areas will required to prove the geological material.

The description of weathered/fractured/broken/karstified rock has been used to indicate any clean limestone that has been affected by various processes and as a result has a reduced resistivity. These processes include weathering of rock, fracturing and breaking caused by faulting or folding, and karstification by chemical solution of rock. These processes would result in the generation of voids in the originally compact rock as well as the build up of silt, clay, sand, water and weathering products. This results in the reduction of the resistivity. The infill of the rock with overburden material often prevents subsidence of the ground level, though voids may become activated by excavation or change of drainage during excavation.

The clean limestone indicated by the highest resistivities can contain small voids caused by karstification, especially as an epikarst layer at the top of the rock. These would be predominantly small, hollow and above the water table, otherwise they would show as a lower resistivity. The initial study by Minerex Environmental Ltd. shows that visible possible karst features were found at CH8,800 – 8,900 and possible dolines at CH10,000 – 10,200. In both these areas, clean limestone in addition to some weathered/fractured/broken/karstified limestone is relatively close to the surface

The examined area is liable to karstification and targeted drilling into the zones will have to be carried out in order to determine the exact nature of the rock and type of karstification.

4 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are made:

- The resistivities along the line of the survey indicate several zones with each being characterised by its own distinctive subsurface geology. The recorded resistivity values suggest that the area may be cross-cut by a suite of dipping faults.
- The bedrock type and presence of faults may be determined by a targeted drilling programme. The resistivity sections are displayed against chainage and were recorded along the centreline. Therefore the locations for targeted drilling can be selected from the drawings.
- There is a potential for karstified rock along the whole examined chainage. The type of karstification is likely to change from an epikarst like shallow pattern in clean limestone to thick layers of weathered/broken/fractured/karstified limestone. These types will follow the zones shown by the resistivities.
- The 2D-Resistivity has shown a varied geological pattern and consideration should be given to carry out a survey along the whole length of the road scheme at an early stage in the main site investigation. This will lead to further targeted boreholes.
- Some allowance for seismic refraction surveying in the main site investigation is recommended as this method determines the top of strong rock. This is particularly useful in cut areas, but also in the interpretation of rock and overburden type in other areas.

This interpretation should be reviewed once borehole data becomes available.

5 REFERENCES

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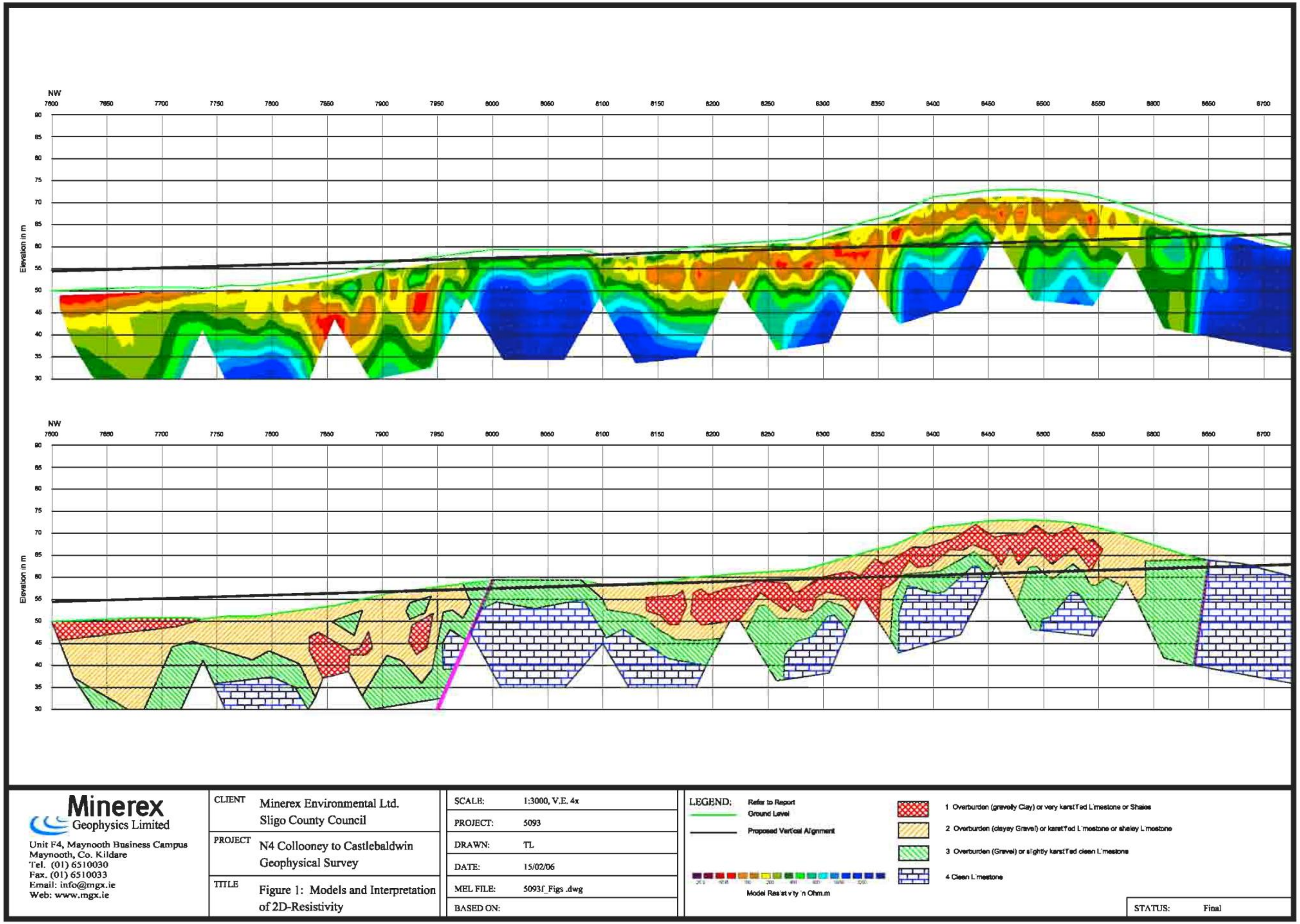
5. Minerex Environmental Ltd, 2006. Hydrogeological Impact Assessment of the Proposed N4 Realignment: Castlebaldwin to Collooney. Rev. 1 – Incomplete Draft (WIP).


NW
Elevation in m
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CLIENT Minerex Environmental Ltd.
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PROJECT N4 Collooney to Castlebaldwin
Geophysical Survey
TITLE Figure 1: Models and Interpretation of 2D-Resistivity
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DATE: 15/02/06
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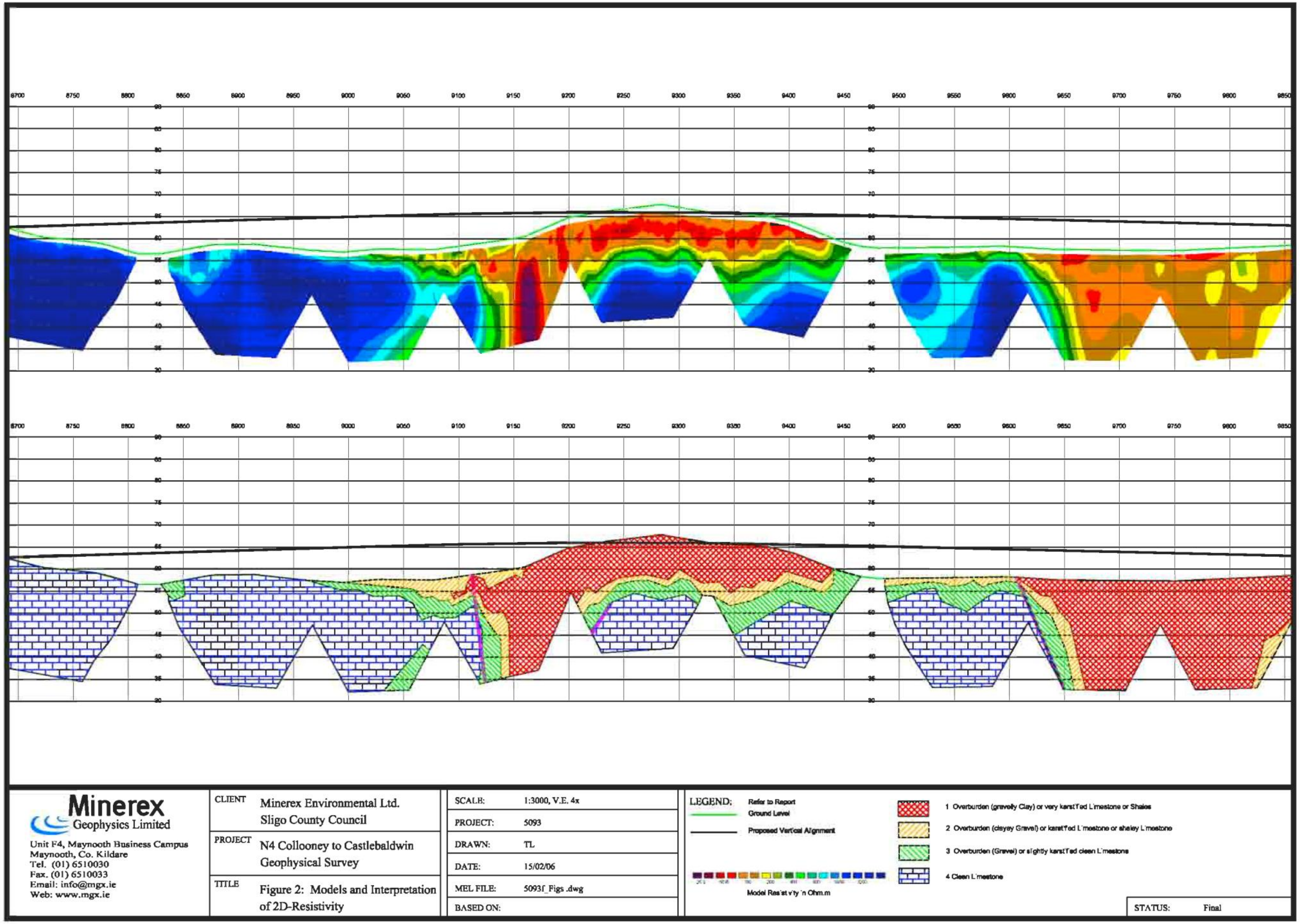
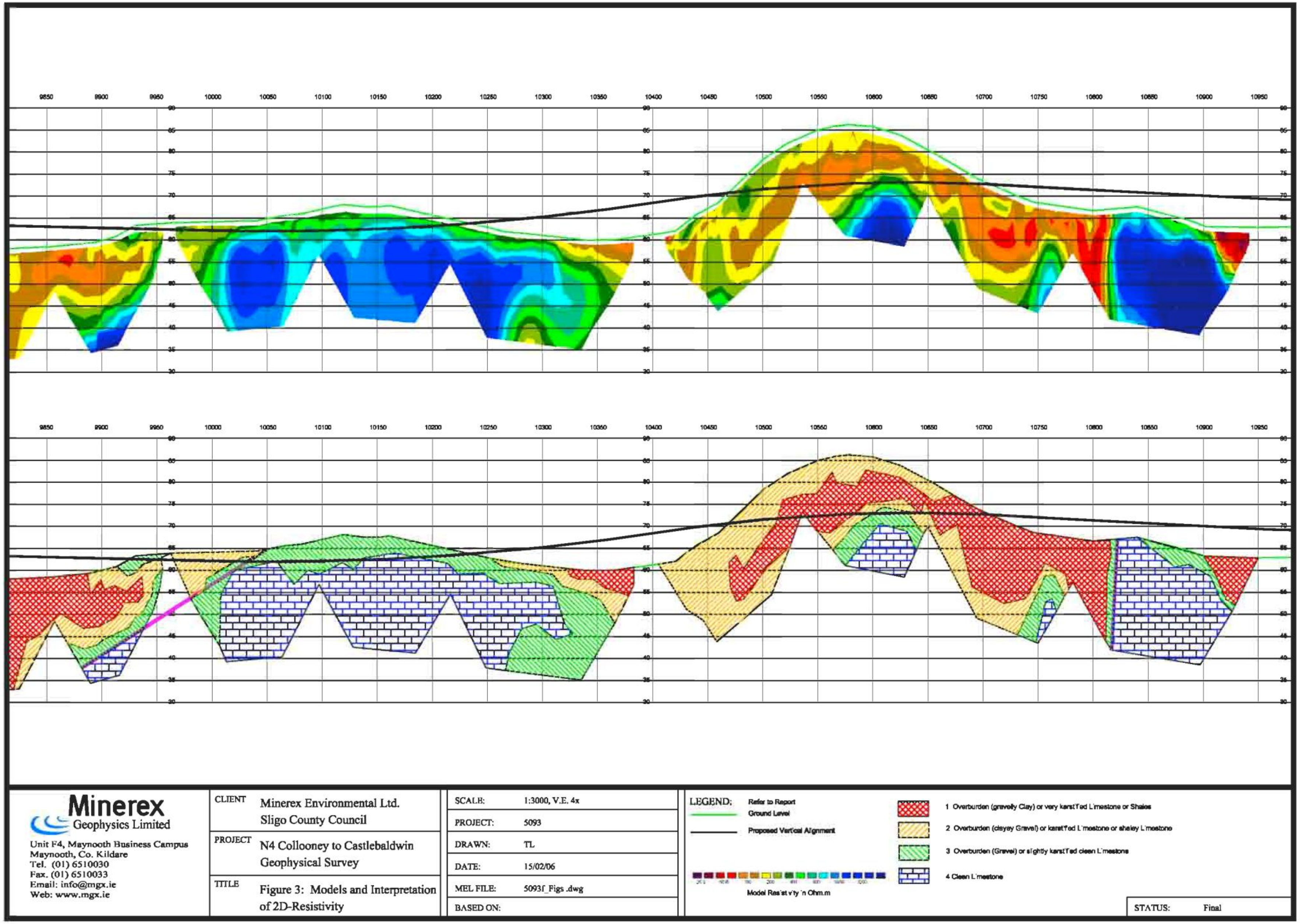
LEGEND: Refer to Report
Ground Level
Proposed Vertical Alignment
Model Resistivity in Ohm.m
1 Overburden (gravelly Clay) or very karstified Limestone or Shales
2 Overburden (clayey Gravel) or karstified Limestone or shaley Limestone
3 Overburden (Gravel) or slightly karstified clean Limestone
4 Clean Limestone
STATUS: Final

Appendix 13.1





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CLIENT Minerex Environmental Ltd. Sligo County Council
PROJECT N4 Collooney to Castlebaldwin Geophysical Survey
TITLE Figure 3: Models and Interpretation of 2D-Resistivity
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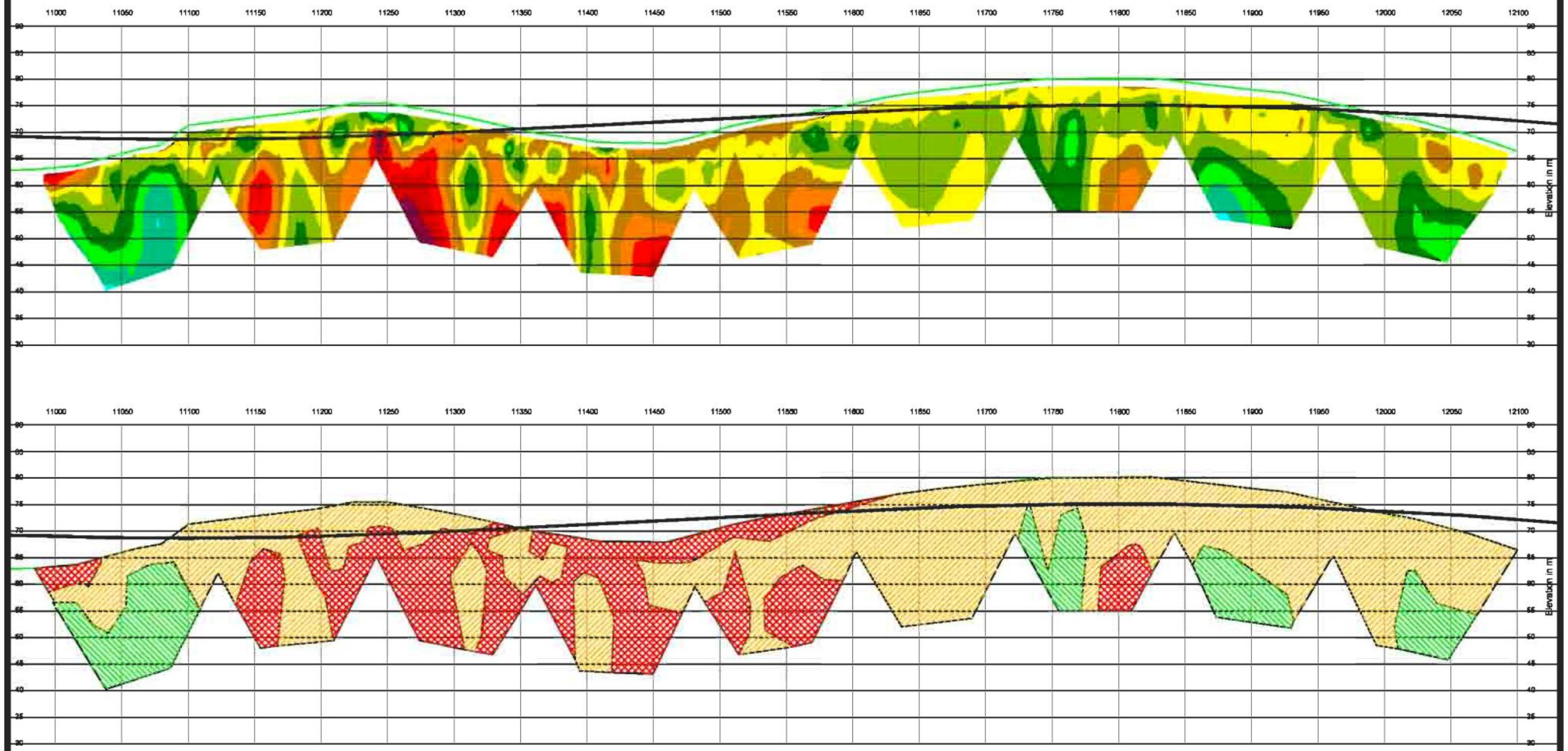

Minerex Geophysics Limited Unit F4, Maynooth Business Campus Maynooth, Co. Kildare Tel. (01) 6510030 Fax. (01) 6510033 Email: info@mgx.ie Web: www.mgx.ie	CLIENT: Minerex Environmental Ltd. Sligo County Council	SCALE: 1:3000, V.E. 4x	LEGEND: Refer to Report
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		DRAWN: TL	Proposed Vertical Alignment
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		BASED ON:	2 Overburden (clayey Gravel) or karstified Limestone or shaley Limestone
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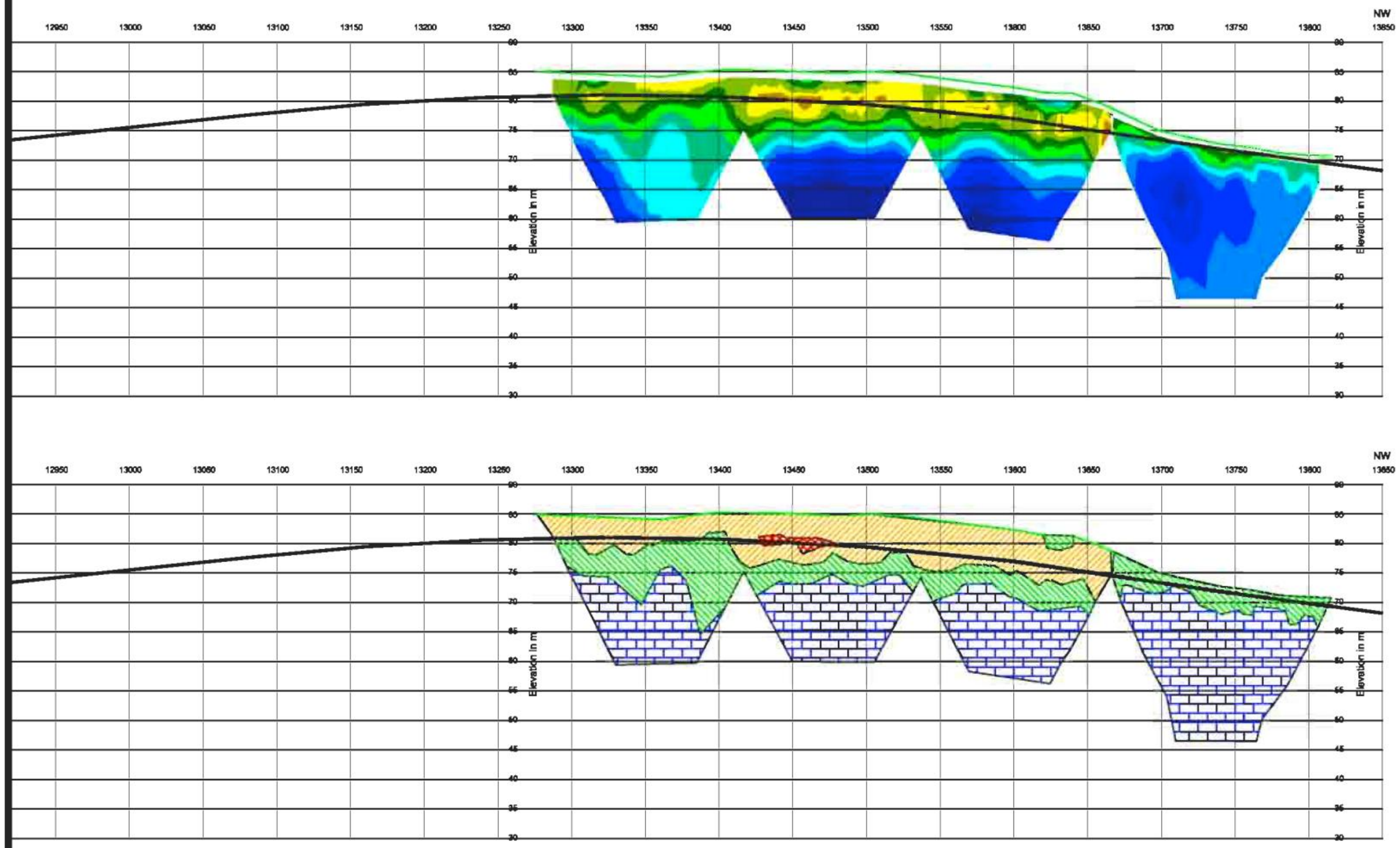
			STATUS: Final



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CLIENT	Minerex Environmental Ltd. Sligo County Council
PROJECT	N4 Collooney to Castlebaldwin Geophysical Survey
TITLE	Figure 5: Models and Interpretation of 2D-Resistivity

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BASED ON:	

LEGEND: Refer to Report

Ground Level

Proposed Vertical Alignment

Model Resistivity in Ohm.m

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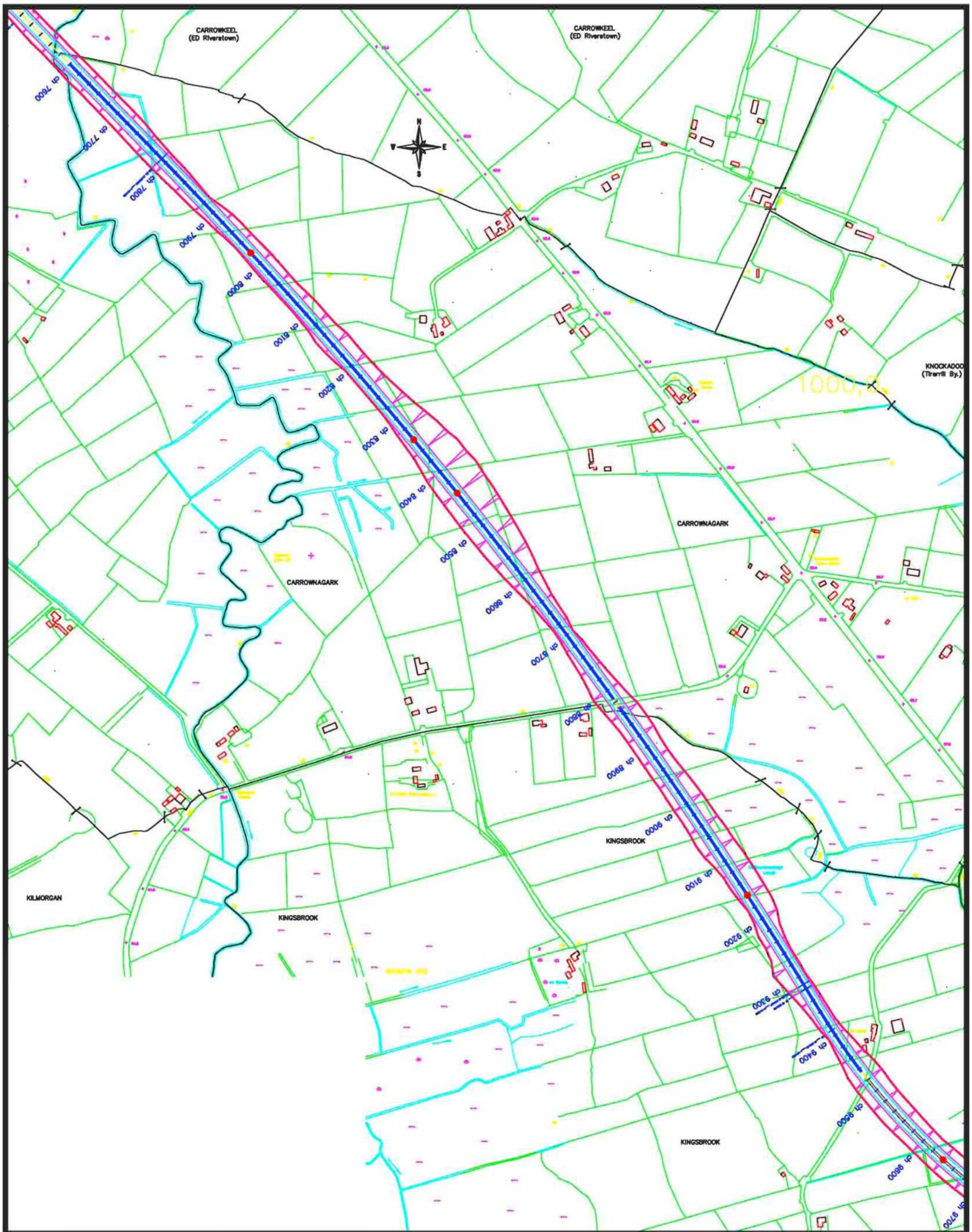

Minerex Geophysics Limited Unit F4, Maynooth Business Campus Maynooth, Co. Kildare Tel. (01) 6510030 Fax. (01) 6510033 Email: info@mgx.ie Web: www.mgx.ie	CLIENT: Minerex Environmental Ltd. Sligo County Council PROJECT: N4 Collooney to Castlebaldwin Geophysical Survey TITLE: Map 1: Geophysical Survey Location Map	SCALE: 1:5000 at A3 PROJECT: 5093 DRAWN: HK DATE: 23/01/06 MGX FILE: 5093f_Maps.dwg BASED ON:	LEGEND: (Refer to Report) 2D-Resistivity Profile Proposed Borehole STATUS: Final

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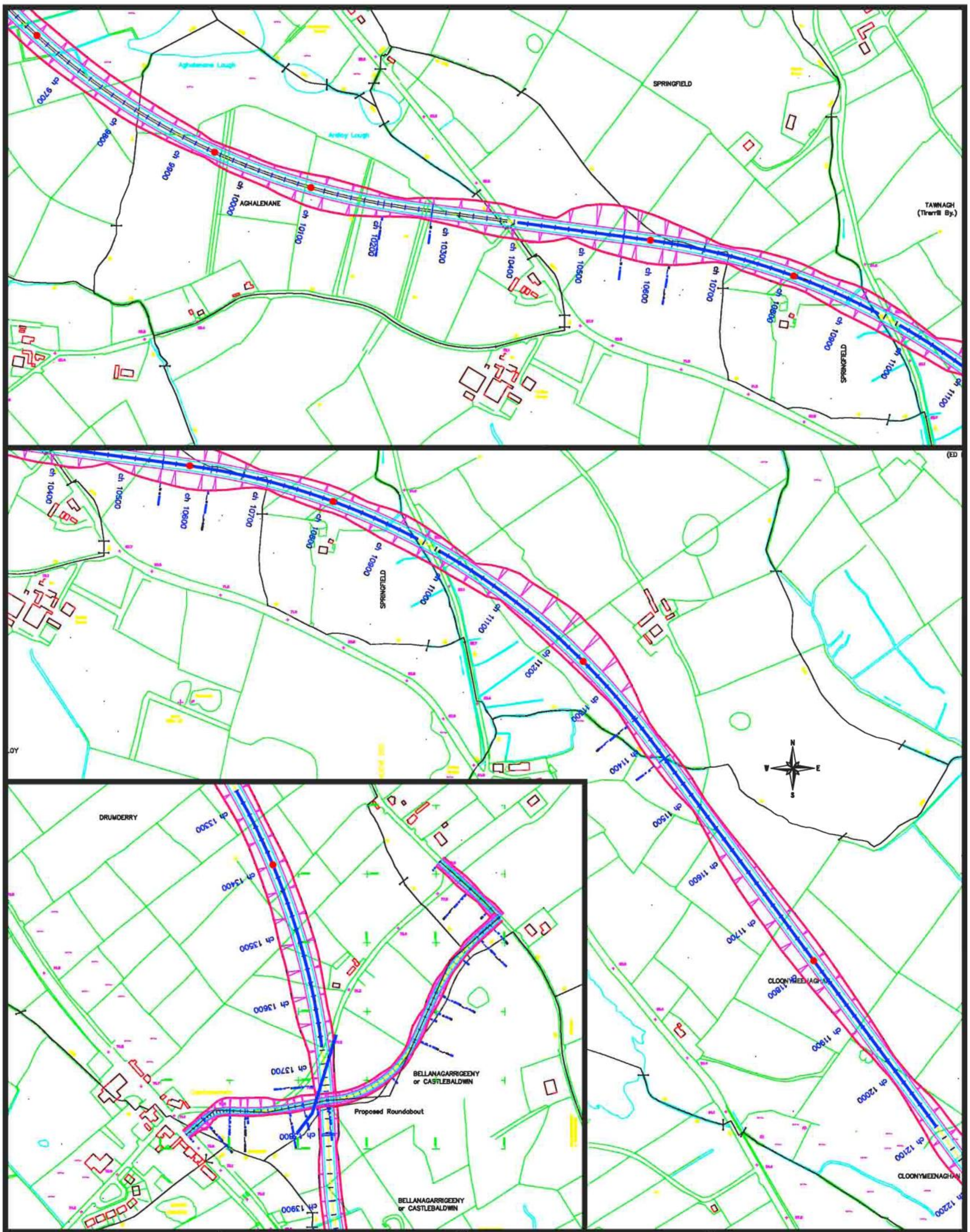

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CLIENT	Minerex Environmental Ltd. Sligo County Council
PROJECT	N4 Collooney to Castlebaldwin Geophysical Survey
TITLE	Map 2: Geophysical Survey Location Map

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PROJECT:	5093
DRAWN:	HK
DATE:	23/01/06
MGX FILE:	5093f_Maps.dwg
BASED ON:	

LEGEND: (Refer to Report)
2D-Resistivity Profile
Proposed Borehole

STATUS: Final