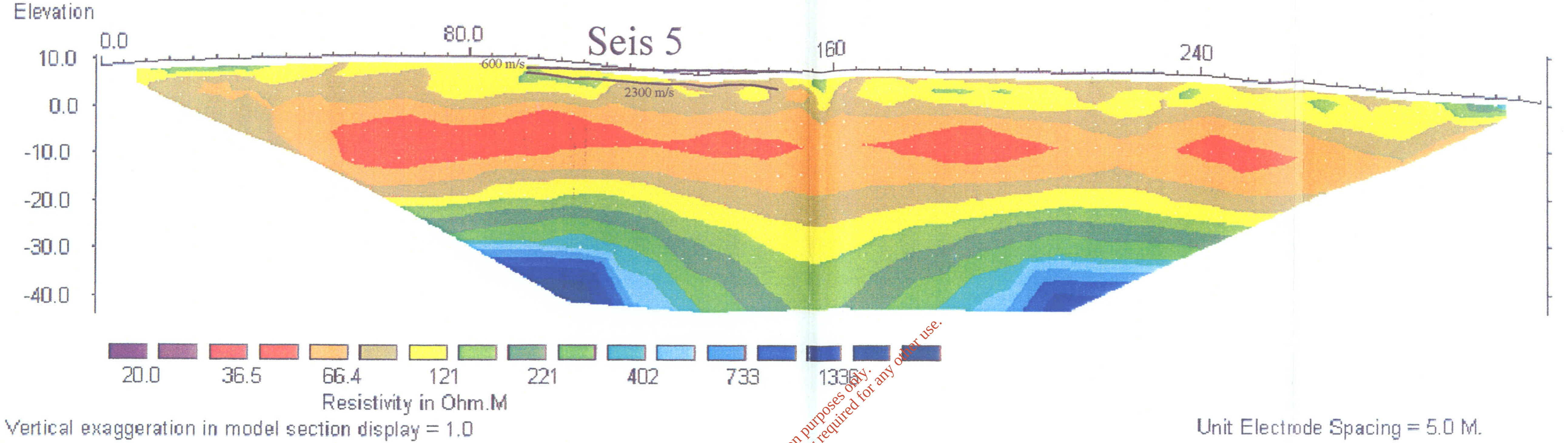
2D-Resisitivity Profile 4

Measured Data



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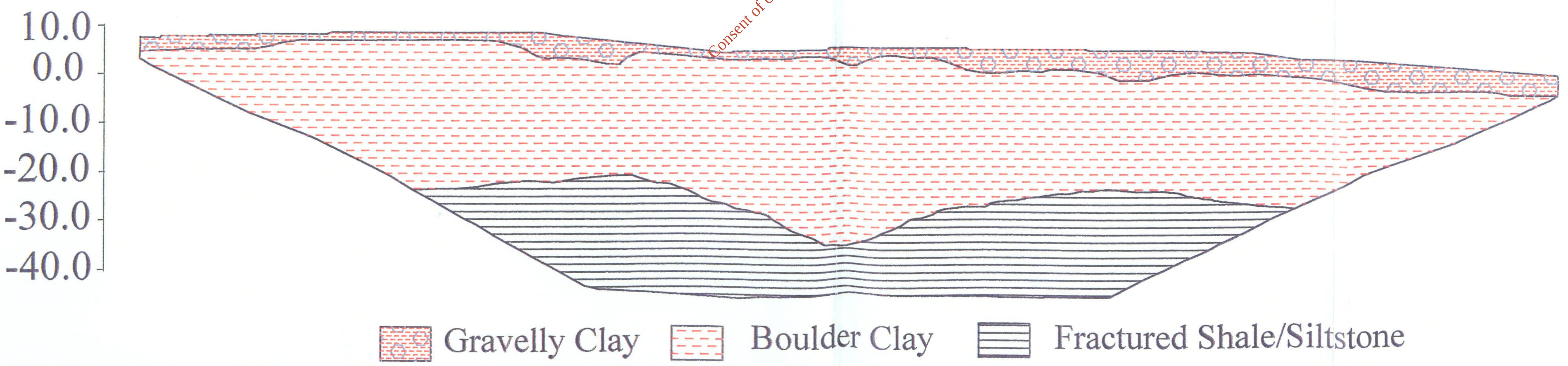

BMA GeoServices Ground Engineering Consultants. Comhairleoirí Cré-Innealtóireachta. BMA, Strawhall Business Park, Athy Road, Carlow, Ireland. Phone: 353-503-34488 Mobile: 087-2477923 Fax: 353-503-34490 E-mail: bmacarlow@bma.ie	Notes: Notes	Drawn: Philip Dowling Scale: 1/1000 Date: May 2003 Checked: Ruth Staunton Based On:	Title: SECTION 4 INTERPRETATION 2D-RESISITIVITY PROFILE 4	Job: CORRANURE LANDFILL, Co. CAVAN	Client: M.C. O`SULLIVAN & CO. LTD.

Revision Details	Issue	By	Date	Rev
Revision Details	Issue	By	Date	Rev
Revision Details	Issue	By	Date	Rev
Revision Details	Issue	By	Date	Rev

Drg No: 1229/R4

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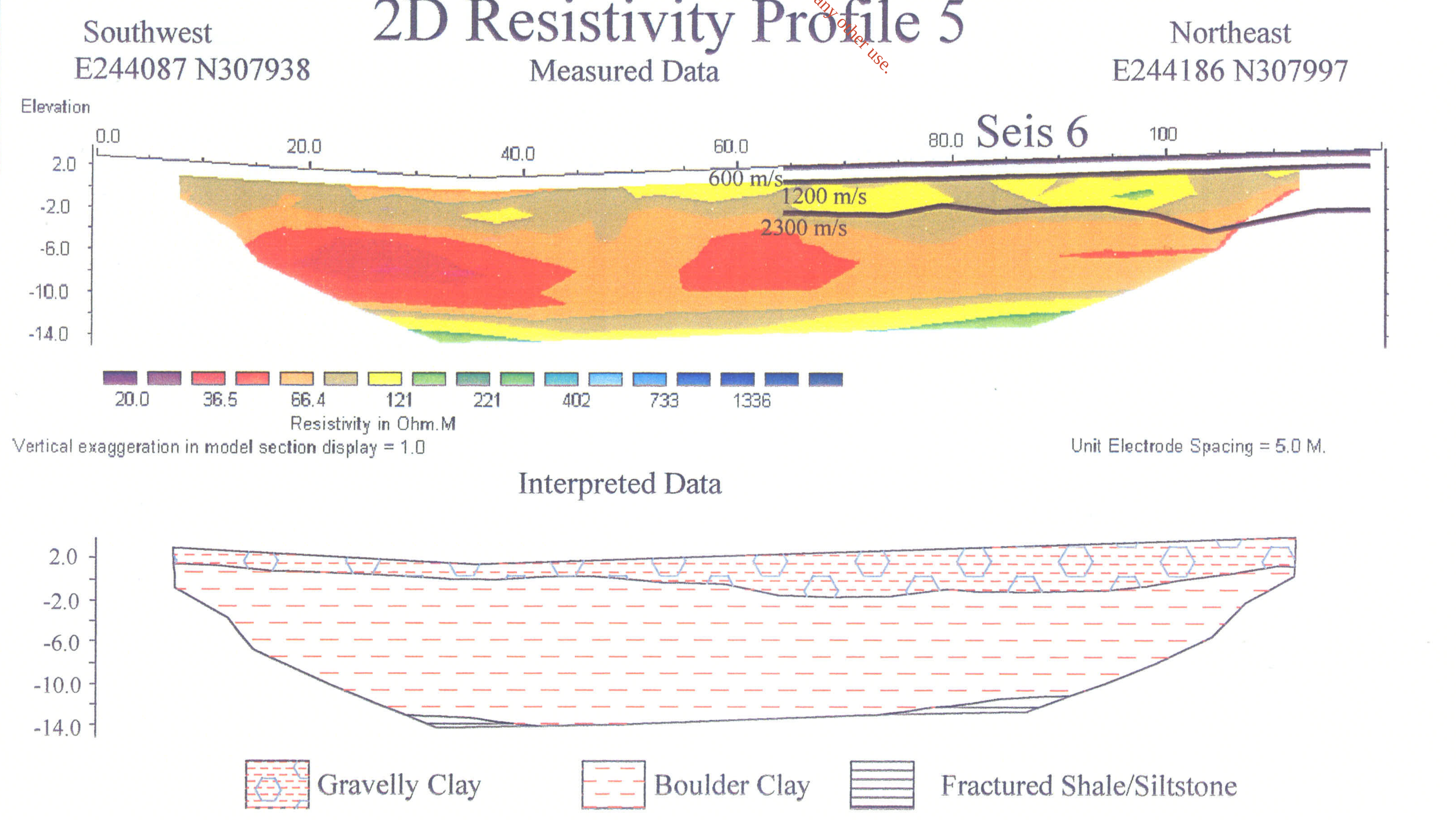
2D Resistivity Profile 5



Notes:	Drawn: Philip Dowling Scale: 1 / 500 Date: May 2003 Checked: Ruth Staunton Based On:	Title: SECTION 5 INTERPRETATION OF 2D RESISTIVITY PROFILE 5	Job: CORRANURE LANDFILL, Co. CAVAN	Client: M.C. O'SULLIVAN & CO. LTD.

Drg No: 1229/R5

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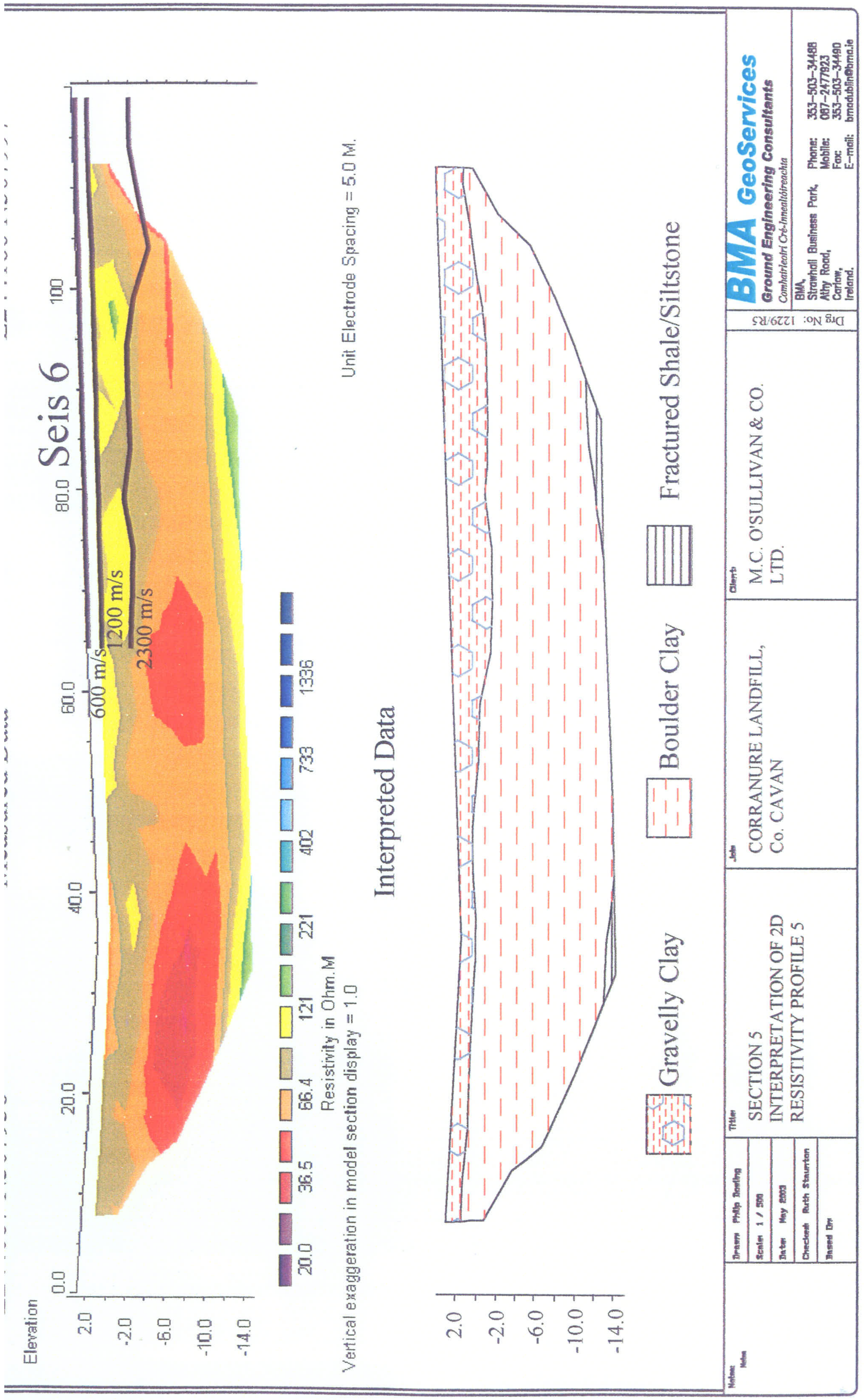

Appendix I Geophysical Methodology.

A1. Methods Used

- A1.1 EM31 Ground Conductivity
- A1.2 2D-Resistivity Profiling
- A1.3 Seismic Refraction

A2. Equipment Used

- A2.1 EM31 Ground Conductivity
- A2.2 2D-Resistivity Profiling
- A2.3 Seismic

A3. Field Procedure

- A3.1 EM31 Ground Conductivity
- A3.2 2D-Resistivity Profiling
- A3.3 Seismic

A4. Data Processing

- A4.1 EM31 Ground Conductivity
- A4.2 2D-Resistivity Profiling
- A4.3 Seismic

Appendix I Geophysical Methodology.

A2. Equipment Used

A2.1 EM31 Ground Conductivity

The equipment used was an EM-31 conductivity meter and data logging system. The instrument does not require ground contact and can be operated by one person.

A2.2 2D-Resistivity Profiling

The Geopulse TIGRE resistivity meter, a multi-core cable with 32 takeouts and 32 stainless steel electrodes were deployed and used to measure the resistivity sections. For one of the profiles, a multi-core cable with 64 takeouts and 64 stainless steel electrodes were used.

The RES2DINV software was used for processing and viewing the data immediately after the survey (Campus Geophysical Instruments, 1997).

A2.3 Seismic Refraction

The seismic data was recorded using a 12-channel Geometrics Smartseis signal enhancement seismograph with a seismic cable and 12 vertical geophones. The seismic source was a hammer and a striking plate.

A2. Equipment Used

A2.1 EM31 Ground Conductivity

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A2.3 Seismic Refraction

The seismic data was recorded using a 12-channel Geometrics Smartseis signal enhancement seismograph with a seismic cable and 12 vertical geophones. The seismic source was a hammer and a striking plate.

Table A3.3: Seismic Refraction locations

SPREAD No.	SPACING (m)	LENGTH (m)	AZIMUTH -	NOMINAL DEPTH (m)
1	5	55	NW-SE	15
2	5	55	NW-SE	15
3	5	55	SW-NE	15
4	5	55	NW-SE	15
5	5	55	NW-SE	15
6	5	55	SW-NE	15

Table A3.3: Seismic Refraction locations

SPREAD No.	SPACING (m)	LENGTH (m)	AZIMUTH -	NOMINAL DEPTH (m)
1	5	55	NW-SE	15
2	5	55	NW-SE	15
3	5	55	SW-NE	15
4	5	55	NW-SE	15
5	5	55	NW-SE	15
6	5	55	SW-NE	15

A4.3 Seismic Refraction

The data were processed as follows:

(i) 'First breaks' were picked on the field records and traveltime plots constructed for each spread.

(ii) Seismic velocity phases were picked on each traveltime plot and the thickness of each velocity unit was calculated using the intercept - time method (Redpath, 1973).

The data processing was carried out using the "FIRSTPIX' and "GREMIX" computer programs (Interpex, 1997, 1998). The traveltime graphs, depth sections and velocity graphs for each spread are contained in Appendix II.

Approximate errors for velocities are estimated to be +/- 10%. Errors for the calculated layer thickness are of the order of +/-20%. Possible errors due to the "hidden layer" and "velocity inversion" effects may also occur (Soske, 1959).

A4.3 Seismic Refraction

The data were processed as follows:

(i) 'First breaks' were picked on the field records and traveltime plots constructed for each spread.

(ii) Seismic velocity phases were picked on each traveltime plot and the thickness of each velocity unit was calculated using the intercept - time method (Redpath, 1973).

The data processing was carried out using the "FIRSTPIX' and "GREMIX" computer programs (Interpex, 1997, 1998). The traveltime graphs, depth sections and velocity graphs for each spread are contained in Appendix II.

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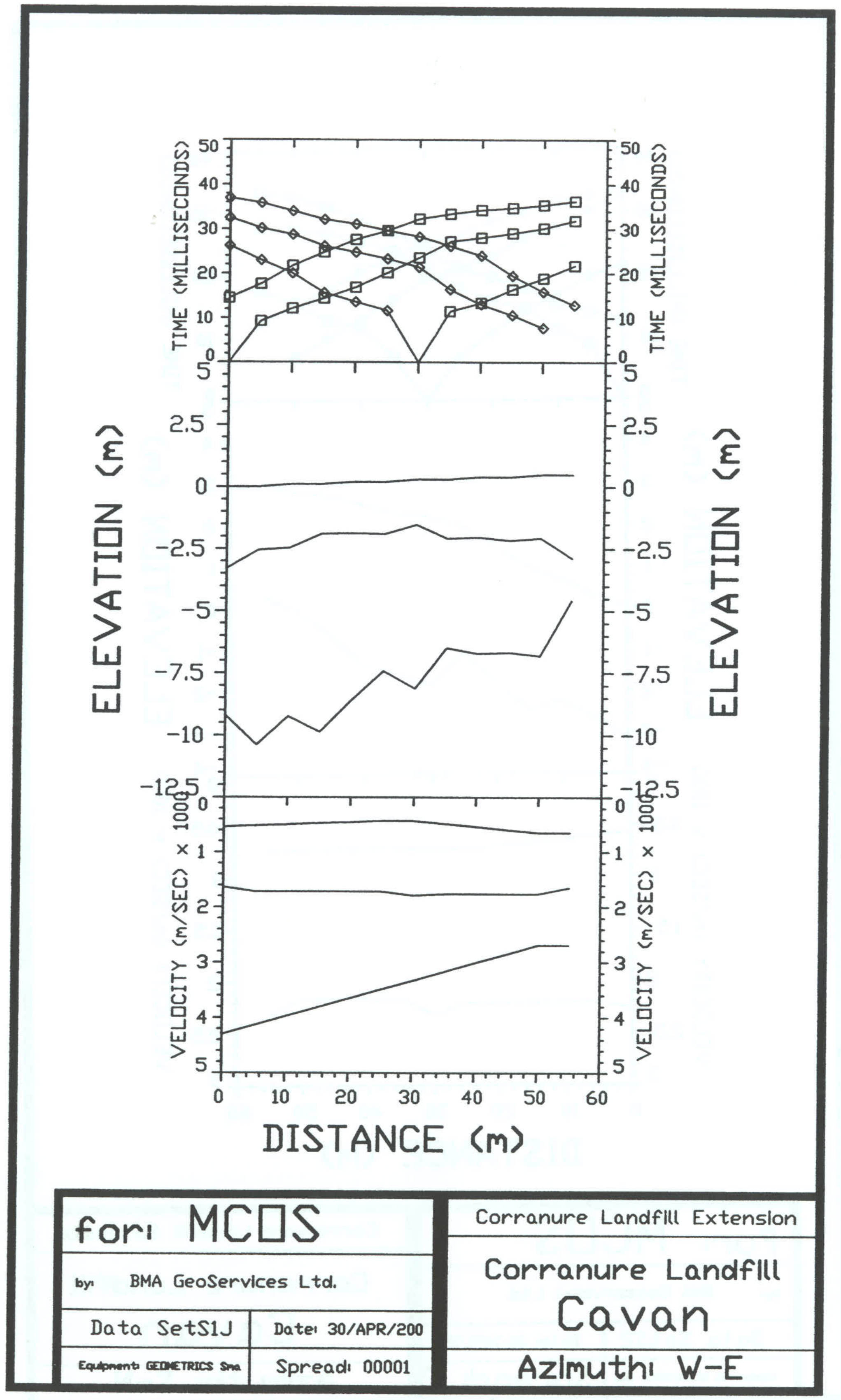

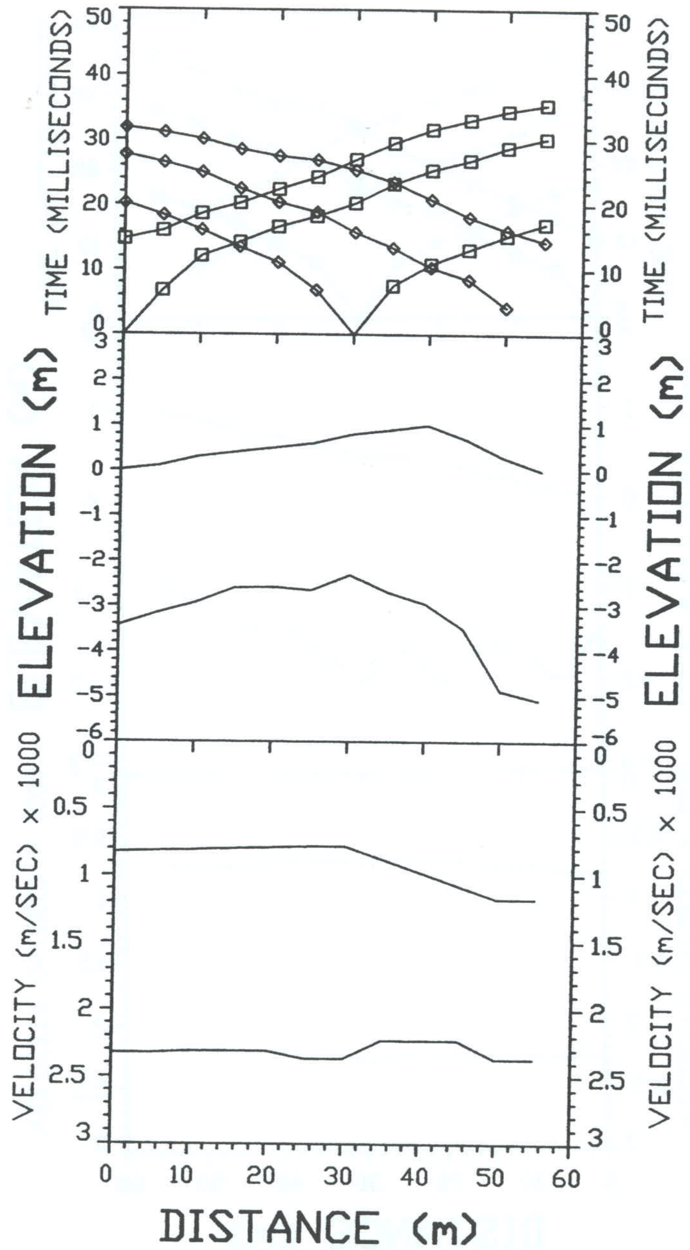

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by: BMA GeoServices Ltd.	Corranure Landfill Cavan
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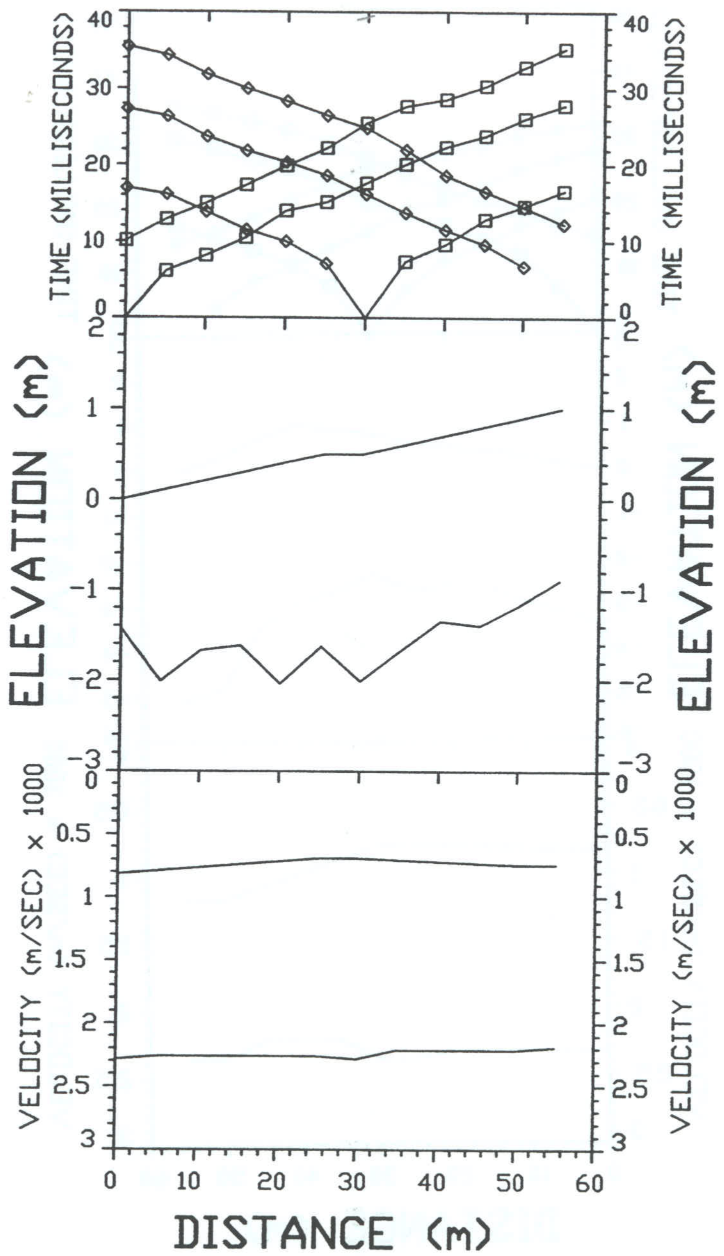

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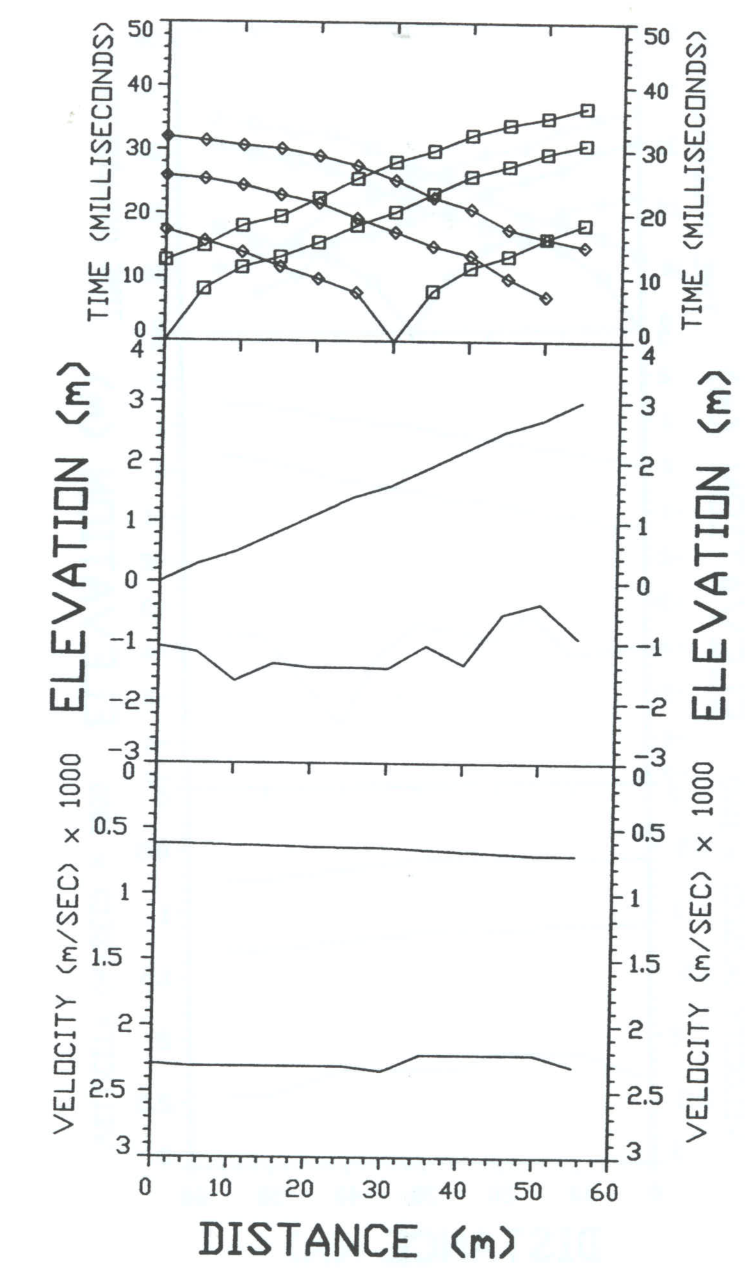

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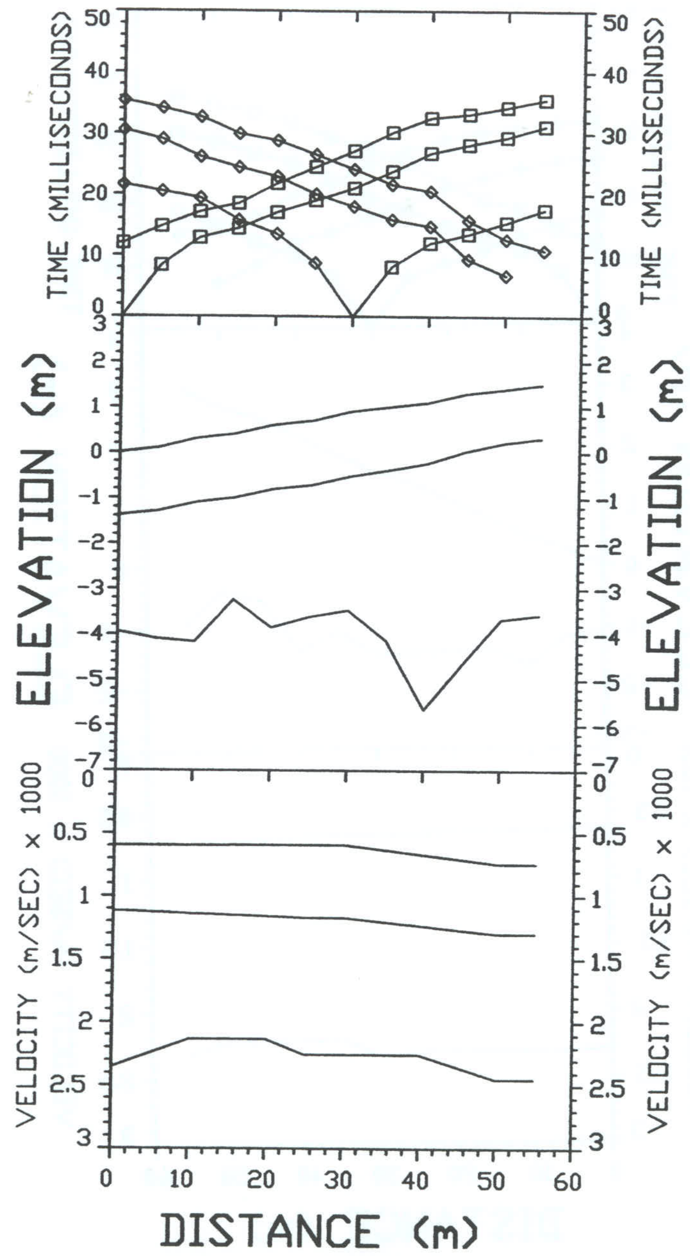

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by: BMA GeoServices Ltd.	Corranure Landfill Cavan
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Equipment: GEOMETRICS Sms / Spread: 6	Azimuth: W-E

Geophysical Geotechnical Environmental

Report

Amendment to Geophysical Survey for a proposed extension to Corranure Landfill, Co. Cavan.

for

M.C. O'Sullivan & Co. Ltd.

PRIVATE AND CONFIDENTIAL

BMA GEOSERVICES LTD
8 STRAWHALL BUSINESS PARK
ATHY ROAD, CARLOW
CO. CARLOW
REG. NO. 171945

AUTHOR	CHECKED	JOB NUMBER	DATE
Philip Dowling	Dr. Ruth Staunton	1229	August 2003

FOREWORD

Geophysical surveying is an indirect, non-invasive process and involves interpretation of readings made at the ground surface in terms of likely subsurface conditions. This interpretation is based on the existing knowledge of ground conditions, typical geophysical responses of known materials and the experience of the author. **Direct investigation is recommended to confirm the findings of this report**. This report has been prepared by BMA GeoServices in line with best current practice and with all reasonable skill, care and diligence within the limitations imposed by the survey technique applied and the resources devoted to it by agreement with the client. The client should take the interpretative basis for any conclusions or opinions contained therein into account in any future use of this report.

TABLE OF CONTENTS

1. Summary

- BMA Geoservices, Geophysical Consultants, were requested by M. C. O'Sullivan & Co. Ltd., to carry out a geophysical survey of a proposed landfill extension at Corranure. The findings of this survey were issued in a report entitled "Geophysical Survey for a proposed extension to Corranure, Co. Cavan".
- This report contains the interpretation of 2 additional Resistivity Profiles conducted at Corranure Landfill, on the 1st August 2003.
- This report details geophysical interpretation, which uses information, gleaned from boreholes drilled in the current landfill in 1998 for the study conducted by BMA and also the Geophysical Survey conducted by BMA in May 2003.
- The interpretation of the results of the 2D-Resistivity profiling (Sections 6-7) may be summarised as follows:

Interpretation	Thickness (m)	Resistivity (ohm-m)	Estimated Stiffness/ Rock Quality*	Excavatability
Gravelly Clay	< 5	100 - 300	Soft	Diggable
Boulder Clay	15 - 20	30 - 100	Soft-Firm	Diggable
Fractured Siltstone/Shale Bedrock	-	> 100	Strong	Break - Blast

- The two Resistivity Profiles, 6 and 7, are consistent with previous geophysical data and are particularly similar to Profiles 1 and 2, which are parallel to Profiles 6 and 7. The Profiles are interpreted to consist of fractured shale/siltstone overlain by a thick sequence of boulder clay and gravelly clay. The average depth to bedrock is 15 – 20 m.
- Depths to bedrock of 15 – 20 m have been verified from borehole data from the south of the site, in the current landfill, from the report carried out by BMA in 1998.
- Borehole data also confirms the presence of a top layer of gravelly clay, the boulder clay and the fractured nature of the siltstone/shale bedrock.
- The low resistivities from the 2D resistivity profiles for the bedrock are possibly due to fracturing of the bedrock

2. Introduction

BMA Geoservices, Geophysical Consultants, were requested by M. C. O'Sullivan & Co. Ltd., to carry out a geophysical survey for a proposed landfill extension at Corranure, Co. Cavan. This survey was completed in May 2003. On 1st August 2003 two additional Resistivity Profiles were carried out.

Objectives

- The aim of the Corranure Landfill Project is to outline and investigate by non-destructive geophysical methods the suitability of the site for a proposed extension to the existing landfill in the area.
- This amendment to the previous report aims to give further detail in the south of the site at Corranure, in order to determine variations in overburden type and thickness and determine depth to bedrock and variation in bedrock type.

Methodology

- 2D-resistivity profiles to estimate the overburden thickness and variation in rock type with depth.
- Integration of borehole data into the geophysical interpretation.

The locations of the geophysical readings are shown on Map 1. Maps were provided by M. C. O'Sullivan & Co. Ltd.

Site Description and Geological Setting

Corranure Landfill lies approximately 2 km to the northeast of Cavan Town. The geological bedrock map (Geology of Monaghan-Carlingford, sheet 8, 1997) indicates that Northern Belt Ordovician rocks underlie the site. The northern belt in this area consists of the Red Island Formation, which consists of green to grey, medium to coarse-grained greywackes with subordinate shales.

The survey area, which is the proposed extension to the landfill, lies to the north of the existing landfill and encompasses an area of approximately 8 hectares. Ground elevation varies from 92 to 119 mOD, with the average elevation at approximately 105 mOD Ground conditions vary from well to poorly drained. The predominant ground condition is poorly drained boggy ground. Reeds and rushes are common, particularly in the northern half of the site. A series of ditches randomly dissect the area.

3. Results

This section integrates the geophysical results with the available geological data together with the borehole data. The interpretation is based on the available factual information, typical geophysical responses of known materials and the experience of the author. The interpreted 2D-Resistivity sections are shown at the end of this report.

2D-Resistivity

The 2D-Resistivity profiles are consistent with previous resistivity data. Profiles 6 and 7 run parallel to Profiles 1 and 2 on the previous survey, and show similar results. The recorded resistivities range from less than 30 ohm-m to approximately 300 ohm-m. Three layers have been interpreted on each 2D-resistivity profile. The resistivity data may be summarised as follows:

Resistivity (ohm-m)	Interpretation
100 - 300	Gravelly Clay
30 – 120	Boulder Clay
> 100 (below 15m depth)	Fractured Shale/Siltstone

Integrated Interpretation

The 2D-Resistivity information indicates three layers are present. The top layer is interpreted to be gravelly clay. This is underlain by a thick sequence of boulder clay, which is in turn underlain by shale/siltstone bedrock.

The gravelly clay layer varies from 2 - 5 m in thickness. The thickness of the boulder clay varies from 15 – 20 m. Depth to bedrock is interpreted to be between 15 and 20 m.

Information from borehole analysis indicates that the low resistivities of the bedrock are possibly due to fracturing of the bedrock.

The combined geophysical properties from all geophysical data collected, can be summarised as follows:

Interpretation	Thickness (m)	Resistivity (ohm-m)	Estimated Stiffness/ Rock Quality*	Excavatability
Gravelly Clay	> 5	100 - 300	Soft	Diggable
Boulder Clay	15 - 20	30 - 100	Soft-Firm	Diggable
Fractured Siltstone/Shale Bedrock	-	> 100	Strong	Break - Blast

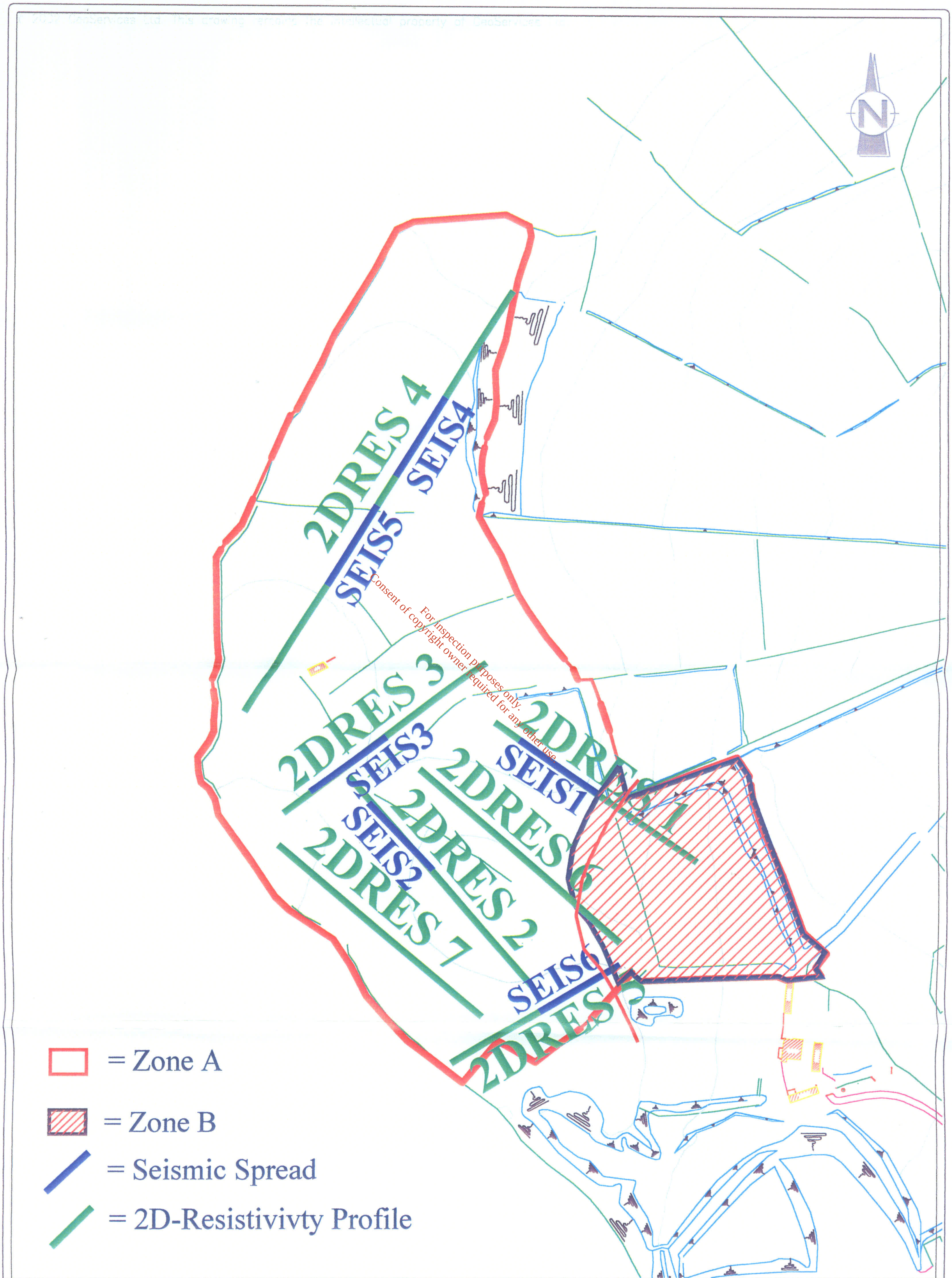
*Estimates of soil stiffness and rock quality are based on the measured geophysical properties.

4. References

Campus Geophysical Instruments, 1997: User Manual for computer program RES2DINV, Birmingham, England.

Geraghty, M., 1997: Geology of Monaghan-Carlingford.

Soske, J.L. 1959 The blind zone problem in engineering geophysics, *Geophysics, 24*, pp359-36



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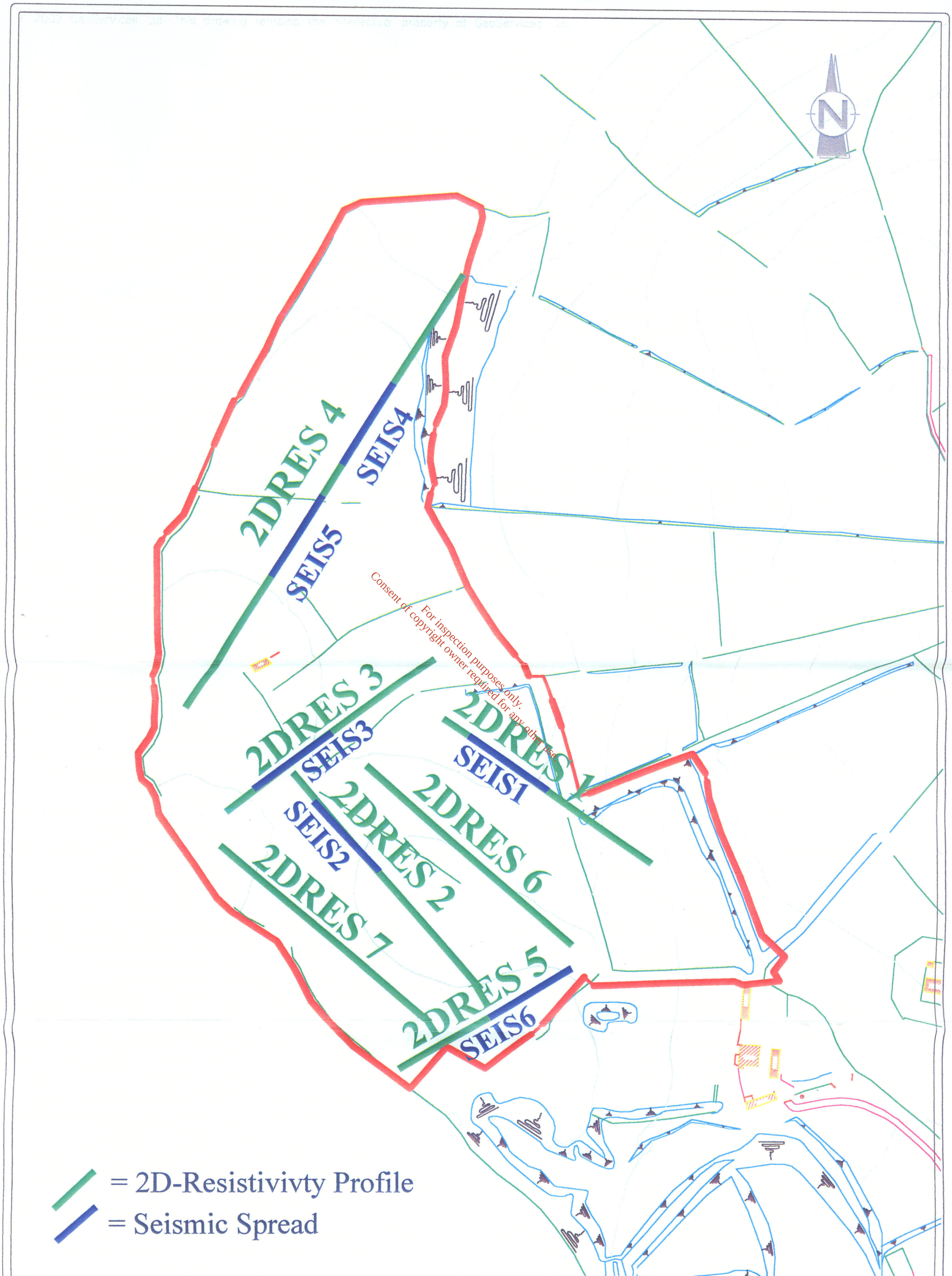

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Date: August 2003				
Checked: Ruth Staunton				
Issued Dr:				

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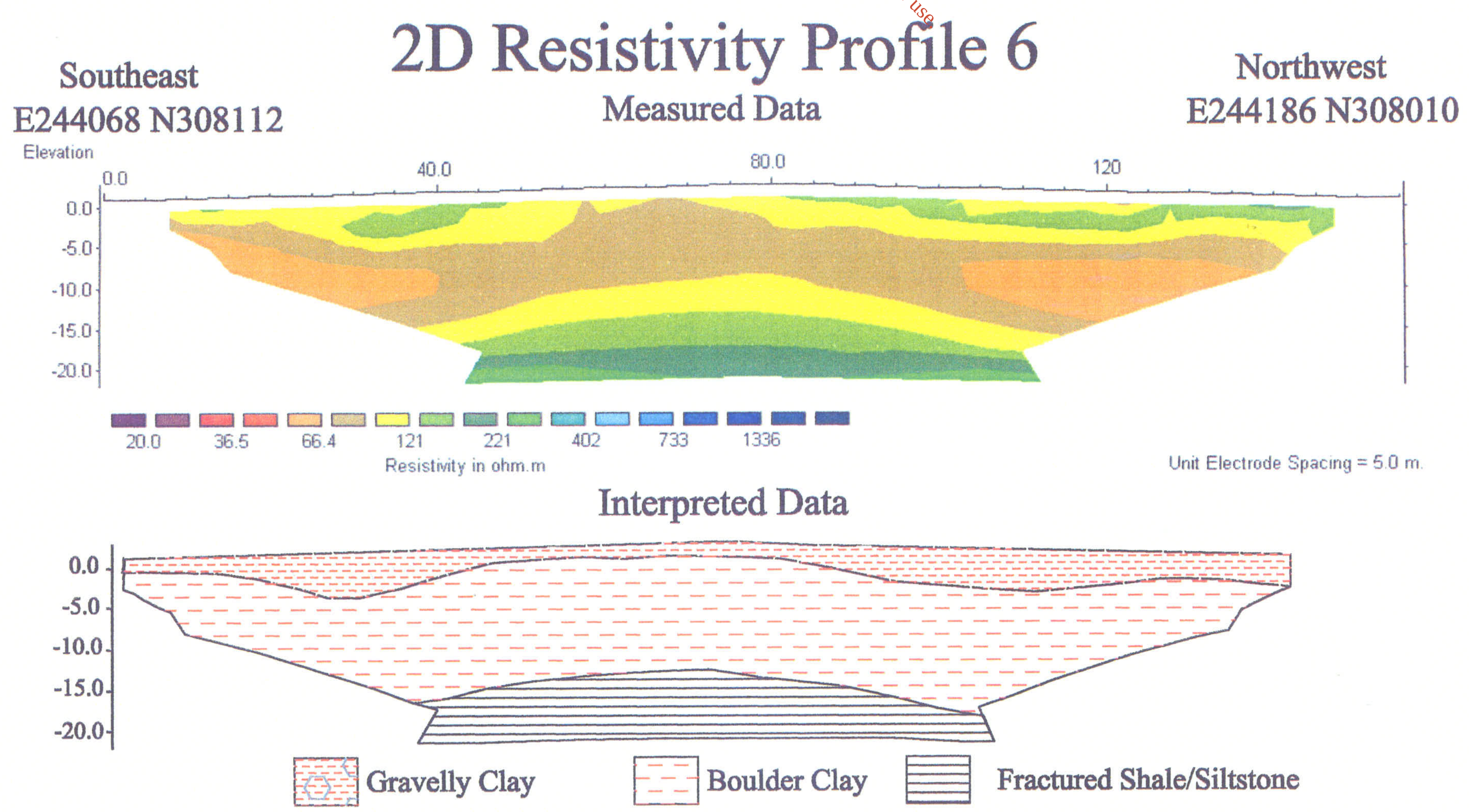

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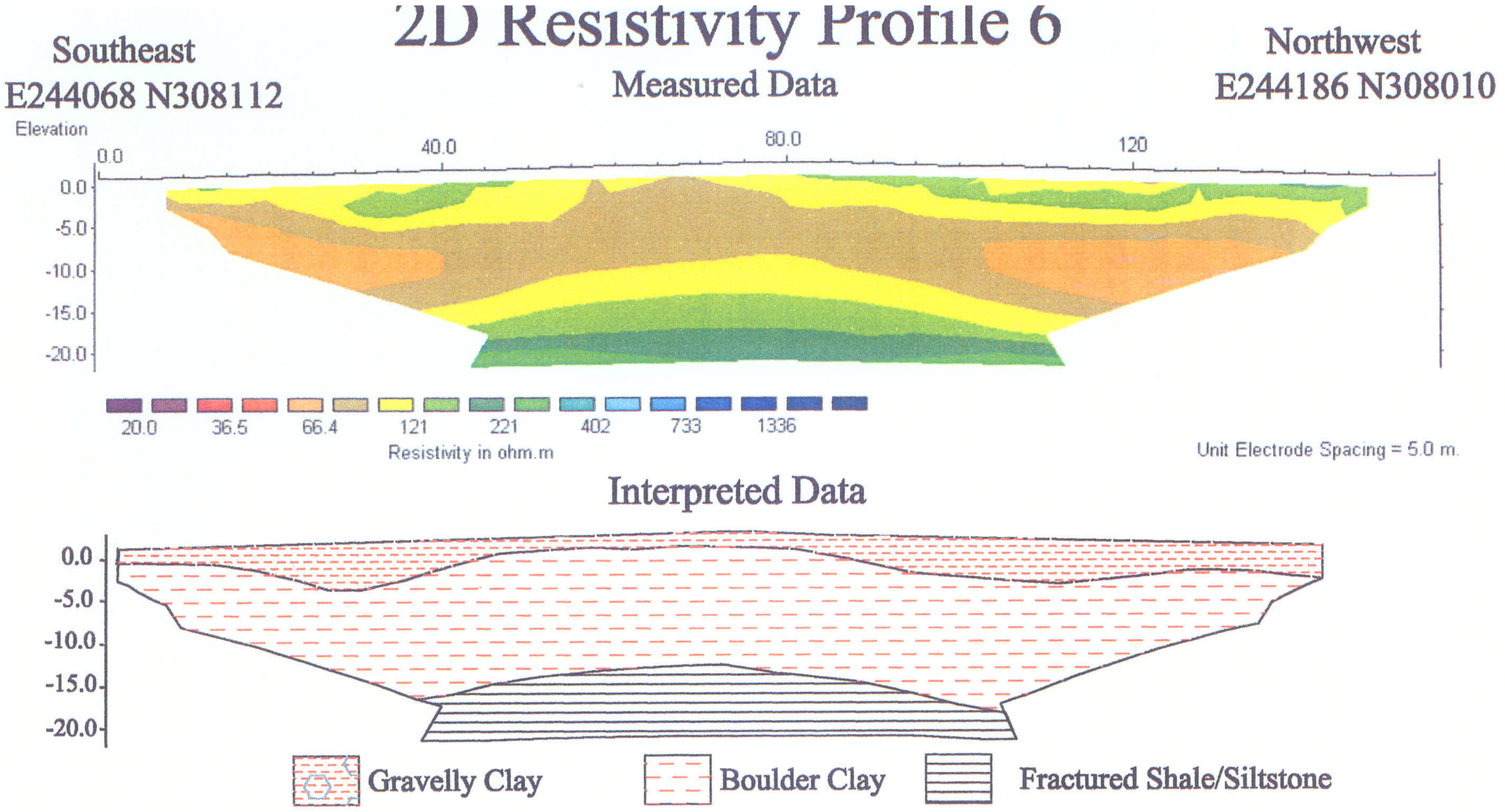
2D Resistivity Profile 6



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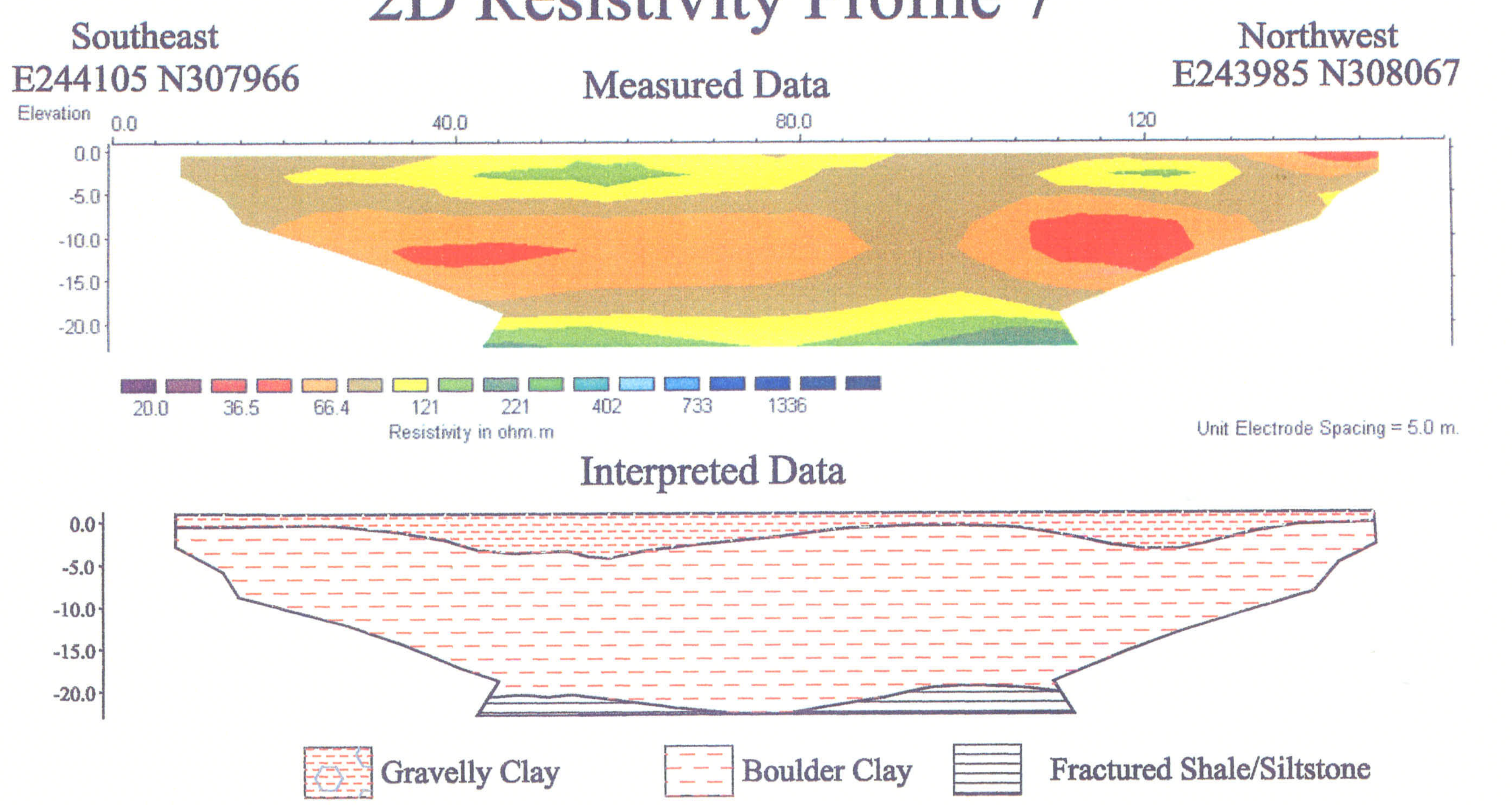
2D Resistivity Profile 7



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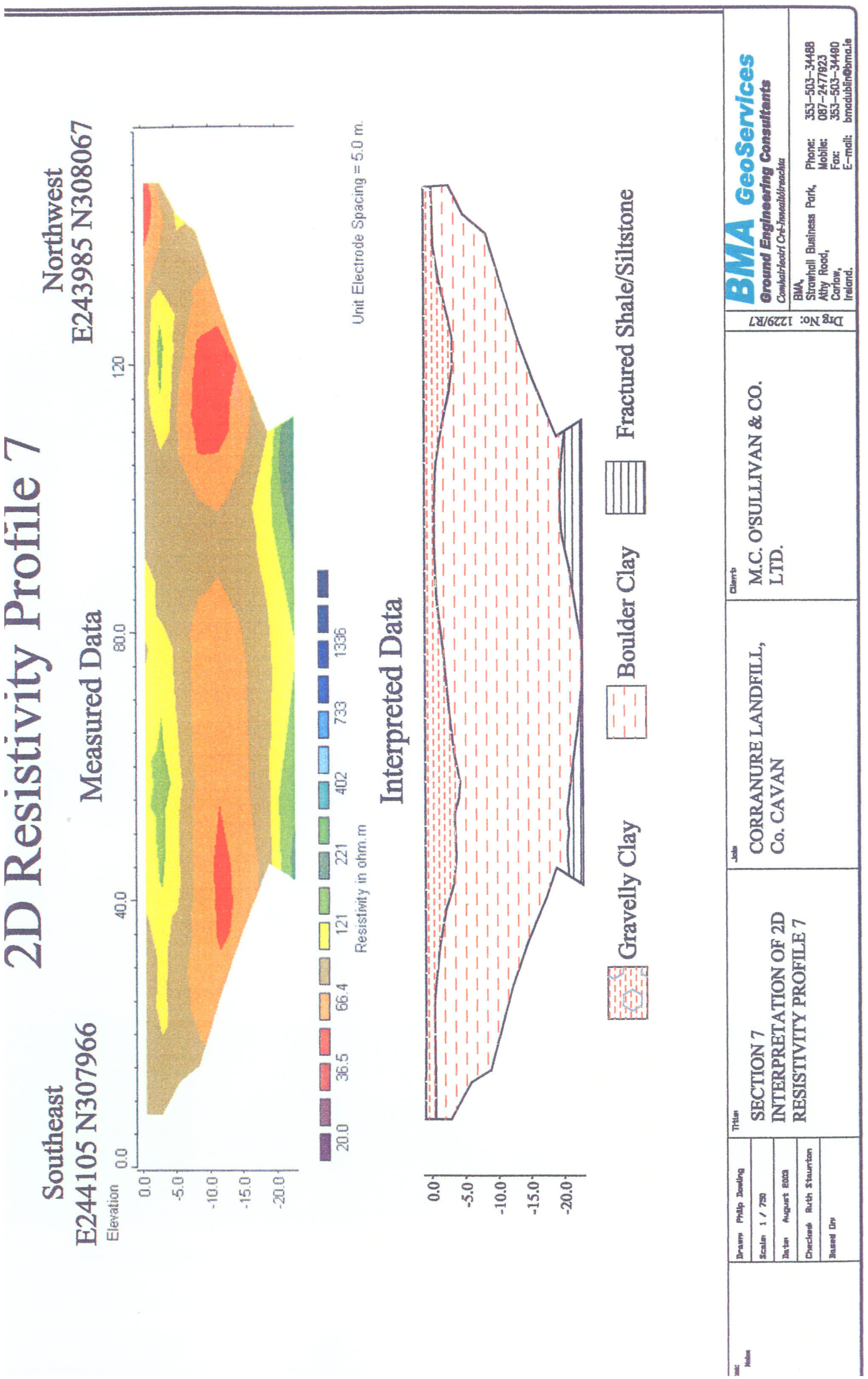

Appendix I Geophysical Methodology.

A1. **Methods Used**

A1.1 2D-Resistivity Profiling

A2. **Equipment Used**

A2.1 2D-Resistivity Profiling

A3. **Field Procedure**

A3.1 2D-Resistivity Profiling

A4. **Data Processing**

A4.1 2D-Resistivity Profiling

Appendix I Geophysical Methodology.

A1. Methods Used

A1.1 2D-Resistivity Profiling

A basic measurement technique in resistivity work is the Wenner array, whereby four electrodes are planted along a line in the ground and a current is introduced through the two outer electrodes. The potential difference across the two inner electrodes is then measured and the resistance (physical unit: Ohm) is determined as the quotient of the potential and the current. All measurements are made with a resistivity meter.

To obtain the resistivity (physical unit: Ohm * m), which is a quantity independent of test conditions and characteristic for different soils and liquids, the following formula is applied:

Resistivity = 2 * Pi * Spacing * Resistance

In 2D-Resistivity a large number of resistivity measurements are taken both laterally and vertically in order to map changes in material types in these directions. This is achieved in a very efficient way by connecting a series of electrodes to the resistivity meter and using a computer to control the process of data collection and storage.

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A2. Equipment Used

A2.1 2D-Resistivity Profiling

The Geopulse TIGRE resistivity meter, a multi-core cable with 32 takeouts and 32 stainless steel electrodes were deployed and used to measure the resistivity sections. For one of the profiles, a multi-core cable with 64 takeouts and 64 stainless steel electrodes were used.

The RES2DINV software was used for processing and viewing the data immediately after the survey (Campus Geophysical Instruments, 1997).

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The RES2DINV software was used for processing and viewing the data immediately after the survey (Campus Geophysical Instruments, 1997).

A3. Field Procedure

The locations of the geophysical measurements were recorded using GPS and are shown on Map 1.

A3.2 2D-Resistivity Profiling

A total of 5 2D-Resistivity profiles were carried out across the survey area. The profiles were located to <5m accuracy using GPS.

The recording parameters for each profile are listed below.

Table A3.2: 2D-Resistivity Profile locations

	NO. OF ELECTRODES	SPACING (m)	LENGTH (m)	AZIMUTH -	NOMINAL DEPTH (m)
2DRES 6	32	5	155	SE-NW	20
2DRES 7	32	5	155	SE-NW	20

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The locations of the geophysical measurements were recorded using GPS and are shown on Map 1.

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2DRES 6	32	5	155	SE-NW	20
2DRES 7	32	5	155	SE-NW	20

A4. Data Processing

A4.1 2D-Resistivity Profiling

The field data were stored in computer files and converted within the TIGRE resistivity meter. The resulting files were loaded into RES2DINV (Campus Geophysical Instruments, 1997), where an inversion with up to 5 iterations of the measured data was carried out for each profile to obtain a 2D-Depth model of the resistivities.

These 2D-Resistivity models and interpreted geology are displayed on Sections 1 - 5. The horizontal axis shows the distance along the profile, while the depth (b.g.l.) is indicated at the sides. Constant contour intervals and colour codes have been used for Sections 1 - 5.

Note: Care should be taken when using these sections. The data displayed is real physical data that can be measured with a high repeatability, but transforming resistivities directly into geological layers requires interpretation of the geophysical results.