Appendix 6B

Geophysical Survey Report (Marine)

Hydrographic Surveys Ltd.
The Cobbles, Crosshaven, Co. Cork.
Tel: +353 21 4831184 • Fax: +353 21 4831193
E-mail: info@hydrosurvey.com
www.hydrosurvey.com

Rossaveel Harbour Development

Proposed Deep Water Berth

Geophysical Survey

Report

No. P16004_GP_ Rp_D03

Client:

Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

REPORT CONTROL SHEET

Client	Department of Agriculture Food and the Marine					
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1. Introduction

1.1 Site Location and Description

Hydrographic Surveys Ltd. was requested by the Department of Agriculture Food and the Marine, to undertake a geophysical survey consisting of a sub bottom profiling and side scan sonar surveying at Rossaveel Harbour main channel, Co. Galway.

The main channel area at Rossaveel Harbour is characterised by exposed bedrock on its eastern extents with a concrete slipway and small buildings present. The western banks of the main channel consist of gently undulating topography.

Fieldwork was undertaken on the 19th and 20th January 2016 across the survey area (Fig1-1).

In accordance with legislation, a Marine Mammal Observer was employed for the duration of the marine seismic survey.

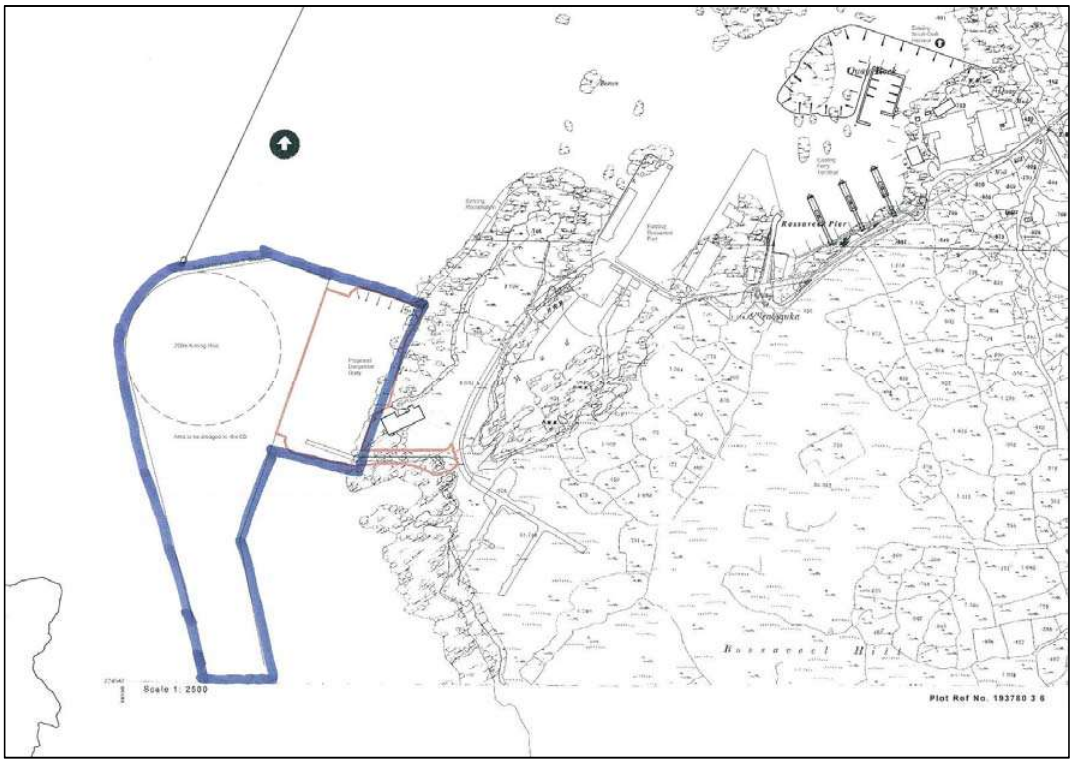


Figure 1-1: Extents of geophysical survey area shown as blue line

1.2 Survey Objectives

The survey objectives were to identify:

- Define the top of rock across the survey area
- Identify any obstructions on the surface
- Calculate volumes of overburden and bedrock requiring removal for the proposed development.

1.3 Site Geology

The Connemara area is characterised by glacial erosion resulting in many areas of exposed bedrock. Evidence of glacial deposition in the site area is present in the form or erratic and glacial till.

The Teagasc Soils Map shown in Fig 1-2 shows most of the area surrounding the site to be composed of bedrock outcrop (highlighted in grey). Small pockets of till derived from granite are present also (highlighted in red).

According to the general GSI 1:500k Geology Map the survey area is underlain by a granites and garnodiorites.

A more detailed map from the GSI 1:100k Geology map is given in Fig 1-3 and describes a number of bedrock formations surrounding the site.

The bedrock highlighted in Fig 1-3 in purple (GaBz) is classified as a Magma Mixing –Mingling Zone. This formation is present immediately to the west and east of the survey area and is described as a complex zone of dioritic enclaves.

The bedrock highlighted in dark red (GaLI) is classified as Lough Luggan Granite and is present to the south of the survey area. This formation is described as a pink-grey leucocratic granite.

The bedrock highlighted in pink (GaCt) to the east of the survey area is classified as the Costello Murvey Granite and is described as a medium coarse leucocratic syenogranite.

The bedrock highlighted in orange (GaCt) to the west of the survey area is classified as the Callowfinish Granite and is described as a monzogranite with small megacrysts.

All mapping as referred to above can be accessed at the following web address:

http://dcenr.maps.arcgis.com/apps/MapSeries/?appid=a30af518e87a4c0ab2fbde2aaac3c228.

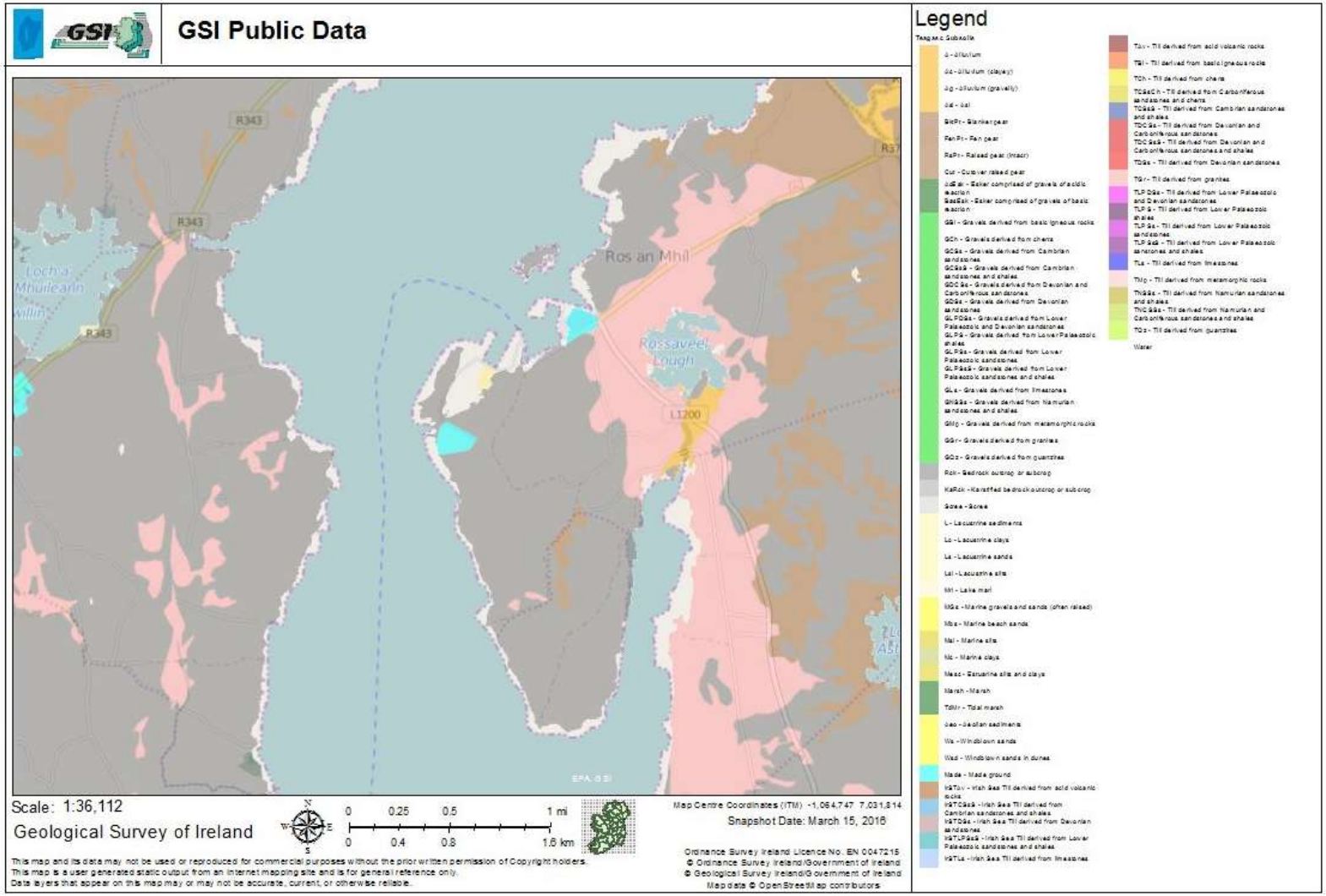


Figure 1-2: Teagasc soils Map of the survey area

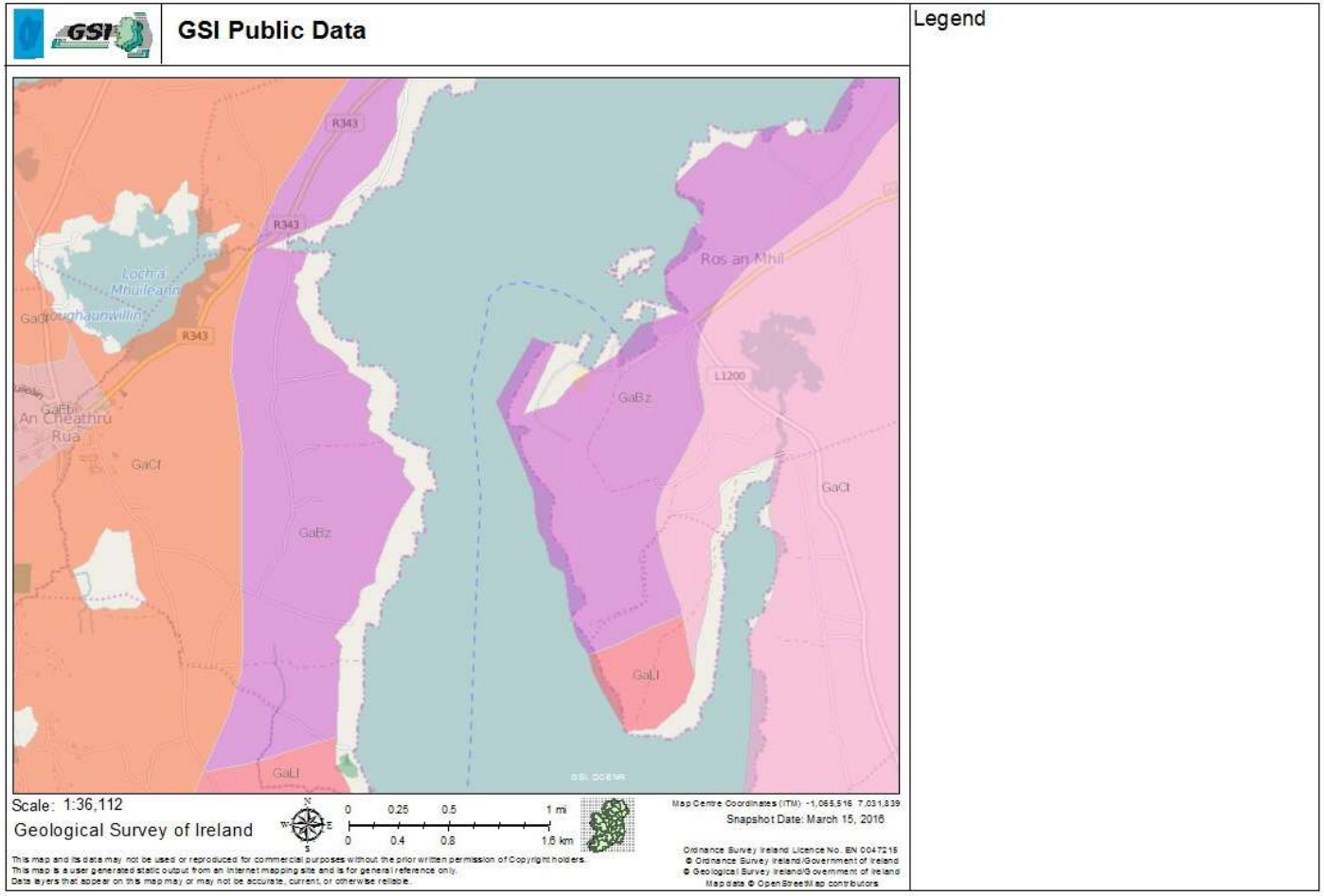


Figure 1-3: GSI 100k Bedrock Lithology.

1.4 Site Investigation

The site investigation carried out by Fugro Ltd. in 2001 was provided to HSL to assist in the interpretation of the acquired data. This survey involved geotechnical marine investigation conducted using a jack-up platform. A total of 81 no. boreholes were sunk utilising cable tool percussive boring and wireline rotary coring techniques.

It was reported by the Department of Agriculture Food and Marine to HSL that the reported datum levels within the Fugro boreholes had known and unknown errors. It was reported to HSL that;

1. The 0.2m adjustment to change from Poolbeg datum to Chart Datum was applied incorrectly giving an error of 0.4m. Fugro levels being low by 0.4m.
2. There are other random errors in the Fugro levels.

The table (Table 4-1) on the following page details the difference between the current survey and the Fugro borehole levels with and without the 0.4m shift. The table details differences in ground level and bedrock level.

From the table it can be seen that 20 of the 31 boreholes (65%) are within ± 0.35cm. Boreholes where difference between Fugro reported bedrock levels and bedrock levels reported by the current survey was greater than 0.35cm were E24, E26, E39, E40, E42, E47, E48, E50, E51, E61, E63.

Where appropriate the proven bedrock levels form the site investigation results were compared against the interpreted bedrock levels from the current survey and used to aid in the geophysical interpretation.

1.4.1 Superficial Deposits

The superficial deposits in the current survey area is broken down into the following strata;

Sand and Gravel Deposits

Sand and gravel deposits composed of mainly shell fragments were present throughout the current survey area to a maximum thickness of 1.63m (BH E40). Where these deposits were present they were mainly seen to directly overlay the granitic bedrock.

Clay and Silt Deposits

Gravelly very sandy CLAY deposits were present only on borehole E26 in the current survey and was present to a thickness of 0.55m. This clay layer is underlain by 0.75m of clayey very sandy GRAVEL in turn underlain by GRANITE bedrock.

1.4.2 Bedrock

Weathered bedrock occurred in many boreholes and was composed of granitic gravels and boulders. The weathered horizon ranged in thickness from 0.25m to 4.1m.

Competent bedrock was composed of granite.

BH	Easting	Northing	Rock Level reported by Fugro Boreholes (CD)	Rock Level reported by Fugro Boreholes (CD) - 0.4m	Rock Level reported by current survey (CD)	Difference original	Difference original (with 0.4m shift)	Ground Level reported by Fugro Boreholes (CD)	Ground Level reported by Fugro Boreholes (CD) - 0.4m	Ground Level reported by current survey (CD)	Difference original	Difference original (with 0.4m shift)
E23	95149.7	224735.7	5.88	5.48	5.81	0.07	-0.33	5.54	5.14	5.27	0.27	-0.13
E24	95159.8	224885.6	7.80	7.40	7.05	0.75	0.35	7.35	6.95	6.95	0.40	0.00
E25	95162.0	224947.7	7.25	6.85	7.04	0.21	-0.19	6.89	6.49	6.66	0.23	-0.17
E26	95166.6	225007.2	8.19	7.79	6.79	1.40	1.00	6.89	6.49	6.43	0.46	0.06
E27	95172.8	225066.7	6.55	6.15	5.94	0.61	0.21	5.65	5.25	5.44	0.21	-0.19
E37	95295.8	225118.3	6.94	6.54	6.71	0.23	-0.17	6.94	6.54	6.66	0.28	-0.12
E38	95237.1	225122.0	7.31	6.91	7.10	0.21	-0.19	7.31	6.91	6.69	0.62	0.22
E39	95231.0	225063.6	9.58	9.18	7.87	1.71	1.31	9.08	8.68	7.56	1.52	1.12
E40	95399.6	225050.9	6.16	5.76	7.11	-0.95	-1.35	4.53	4.13	5.15	-0.62	-1.02
E41	95289.2	225055.7	8.00	7.60	7.65	0.35	-0.05	8.00	7.60	7.50	0.50	0.10
E42	95318.6	225053.2	8.88	8.48	6.54	2.34	1.94	8.66	8.26	6.34	2.32	1.92
E43	95288.0	225016.0	8.57	8.17	8.20	0.37	-0.03	8.22	7.82	7.79	0.43	0.03
E44	95317.4	225014.6	8.64	8.24	7.91	0.73	0.33	7.84	7.44	7.17	0.67	0.27
E45	95284.7	224974.8	9.29	8.89	8.72	0.57	0.17	8.49	8.09	8.13	0.36	-0.04
E46	95314.0	224974.3	7.95	7.55	7.40	0.55	0.15	7.70	7.30	7.18	0.52	0.12
E47	95283.4	224936.8	9.89	9.49	8.85	1.04	0.64	8.65	8.25	8.05	0.60	0.20
E48	95312.7	224934.4	8.56	8.16	7.47	1.09	0.69	7.46	7.06	7.12	0.34	-0.06
E49	95281.6	224896.3	8.34	7.94	7.68	0.66	0.26	7.89	7.49	7.51	0.38	-0.02
E50	95309.1	224895.5	8.91	8.51	8.02	0.89	0.49	7.57	7.17	7.02	0.55	0.15
E51	95276.7	224859.3	8.94	8.54	8.90	0.04	-0.36	8.44	8.04	7.91	0.53	0.13
E52	95306.3	224853.7	7.65	7.25	6.93	0.72	0.32	6.90	6.50	6.71	0.19	-0.21
E54	95366.0	224993.2	6.17	5.77	5.61	0.56	0.16	5.47	5.07	5.09	0.38	-0.02
E56	95393.9	224948.5	4.44	4.04	3.88	0.56	0.16	3.64	3.24	3.25	0.39	-0.01

E57	95362.0	224912.0	5.25	4.85	4.92	0.33	-0.07	4.65	4.25	4.21	0.44	0.04
E58	95356.6	224869.6	5.61	5.21	4.87	0.74	0.34	4.46	4.06	4.22	0.24	-0.16
E59	95355.4	224837.2	5.02	4.62	4.46	0.56	0.16	4.57	4.17	4.20	0.37	-0.03
E60	95351.6	224792.5	4.07	3.67	3.72	0.35	-0.05	3.92	3.52	3.64	0.28	-0.12
E61	95303.7	224804.0	9.06	8.66	6.81	2.25	1.85	8.66	8.26	6.29	2.37	1.97
E62	95299.4	224755.4	7.59	7.19	7.06	0.53	0.13	6.99	6.59	6.58	0.41	0.01
E63	95280.1	224731.0	9.33	8.93	8.48	0.85	0.45	8.73	8.33	7.92	0.81	0.41
E69	95325.0	225116.2	7.56	7.16	6.88	0.68	0.28	7.38	6.98	6.86	0.52	0.12

Table 4-1: Comparison between bedrock levels and ground level of Fugro boreholes and current sub bottom profiling / bathymetric survey results

2. Findings

2.1 Sub Bottom Profiling Survey

The geophysical survey was a non-invasive process and involved the interpretation of readings made from the ground surface through the water column.

A Knudsen Pinger Sub Bottom Profiler operating at a frequency of 3.5kHz was utilised during the survey. The instrument was mounted to the side of the survey vessel. A time varying gain was applied to the data during acquisition to maximise the return signal. Various frequency filters were used to improve the signal to noise ratio.

2.1.1 Survey Lines

Refer to **APPENDIX A: Drawing No. PH16004_01_D01** for the tracklines of the acquired seismic profiles. All survey lines were extended as close as possible to the edge of the survey area at high water however shallow water and protruding boulders around the concrete slip restricted the extent to which surveyeing was possible.

2.1.2 Reflector Descriptions

Data quality was very good with bedrock observable on all the acquired profiles. For much of the survey area the bedrock was at or very close to the surface. Where superficial deposits were present layering was not visible / present within the deposits.

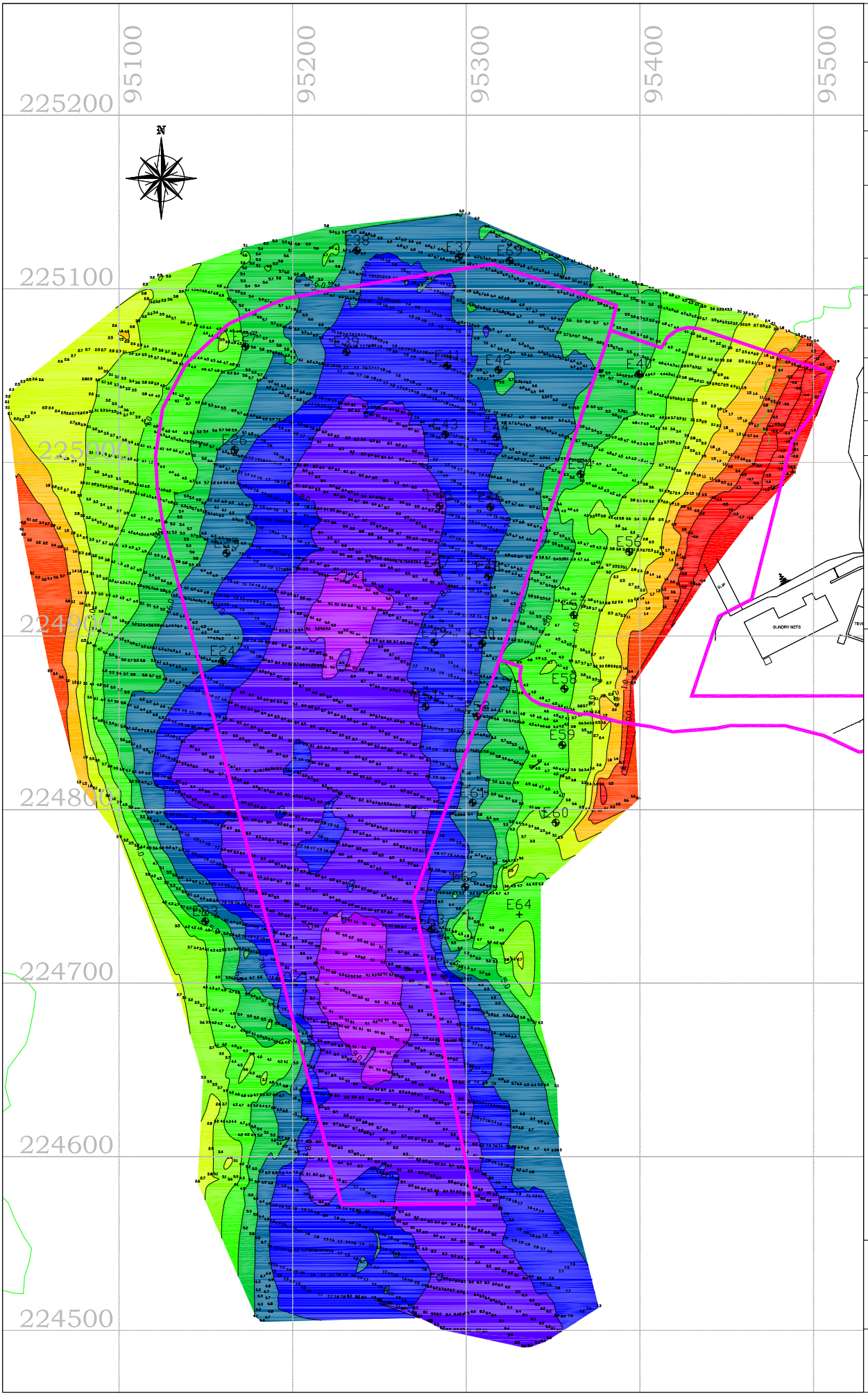
Top of rock elevation has been plotted to Chart Datum across the survey area in **APPENDIX A: Drawing No. PH16004_01_D02.** Cross sections have been produced in order to detail the nature of the bedrock across the navigation channel. These cross sections are provided in **A: Drawing No. PH16004_01_D03 and PH16004_01_D04.** For these cross sections boreholes have been overlayed where appropriate. Borehole numbers E39, E40, E42 and E61 were excluded from the cross section to very large discrepancies' in ground level and bedrock level.

This interpretative report is based on the existing knowledge of ground conditions, typical geophysical responses of known materials and the experience of the author.

3. APPENDIX A: DRAWINGS

The 5 No. drawings are summarised below. The digital AutoCAD 2010 is also attached as a 2D .dwg file. All drawings are to Irish National Grid.

Drawing Number		**Description**
PH16004_D01	Bathymetric Survey - Chart Datum	1:1000 at A1
PH16004_D02	Top of Rock – Chart Datum	1:1000 at A1
PH16004_D03	Side Scan Image of Survey Area	1:1000 at A1
PH16004_D04	Cross Section 1 & 2 (10x vert exaggeration)	V: 1:100, H:1:1000 at A1
PH16004_D05	Cross Section 3 & 4 (10x vert exaggeration)	V: 1:100, H:1:1000 at A1



SITE:

ROSSAVEEL HARBOUR, COUNTY GALWAY

Sheet Title:

Bathymetry reduced to Chart Datum

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JOB NUMBER:

PH16004_01

DRAWING NUMBER:

PH16004_01_D01

DRAWN BY:

Hugh Power

DATE(S) OF SURVEY:

19/01/2016

SCALE:	APPROVED:
1:1000 ON A1	J.B.J.

REVISION:

D02 - Issued 26/08/2016

Memoir

1. Constructed on Irish National Grid.
2. Horizontal control by D.G.P.S.
3. Soundings in metres and decimetres reduced to CD.

Legend

E27 Fugro Boreholes

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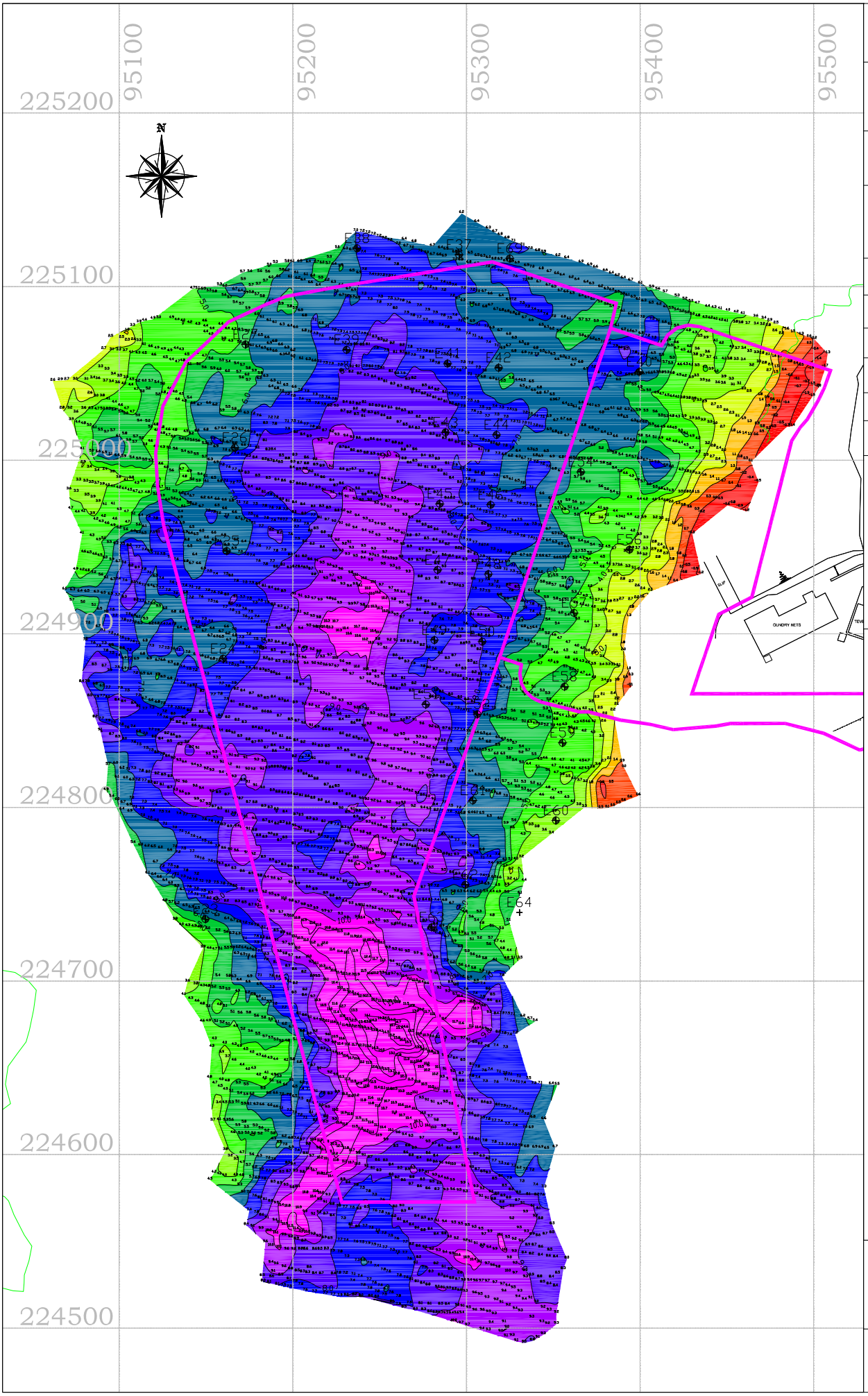

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ROSSAVEEL HARBOUR, COUNTY GALWAY

Sheet Title:

Seismic Reflector interpreted as Top of Rock reduced to Chart Datum

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DRAWING NUMBER:

PH16004_01_D02

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DATE(S) OF SURVEY:

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2. Horizontal control by D.G.P.S.
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Legend

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Side Scan Image of Survey Area

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Legend

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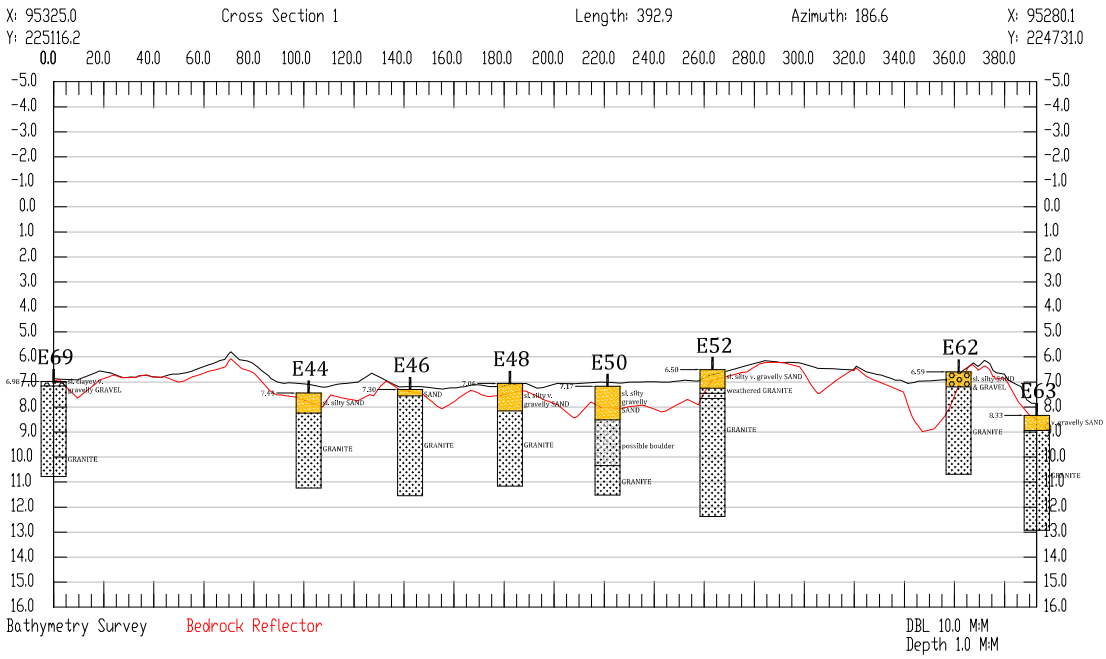
FIGURE 1: CROSS SECTIONS SCALE VERT 1:100 HORZ 1:1000 @ A1 (10X VERT EXAGERRATION)



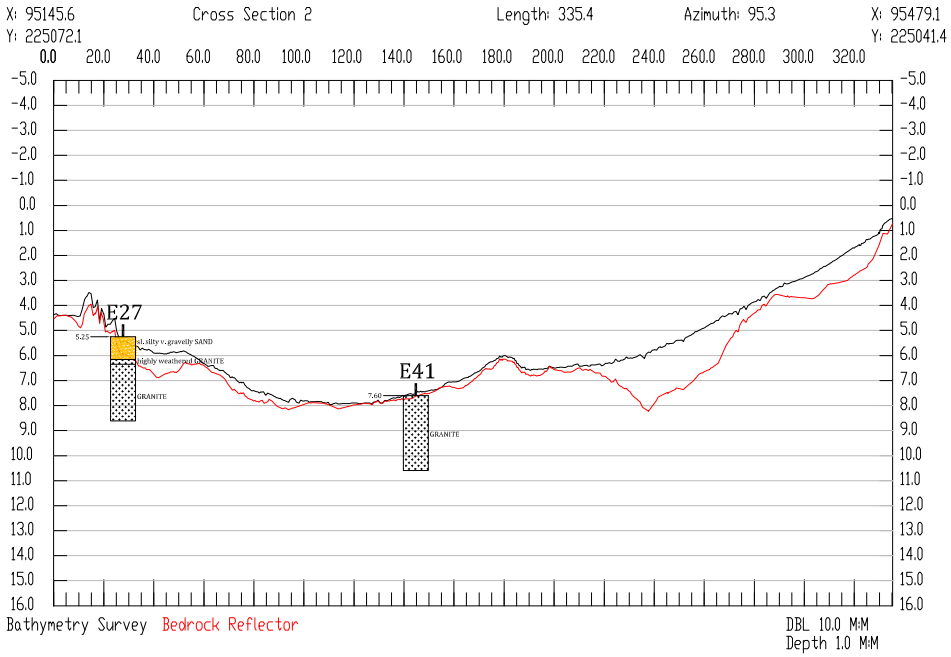
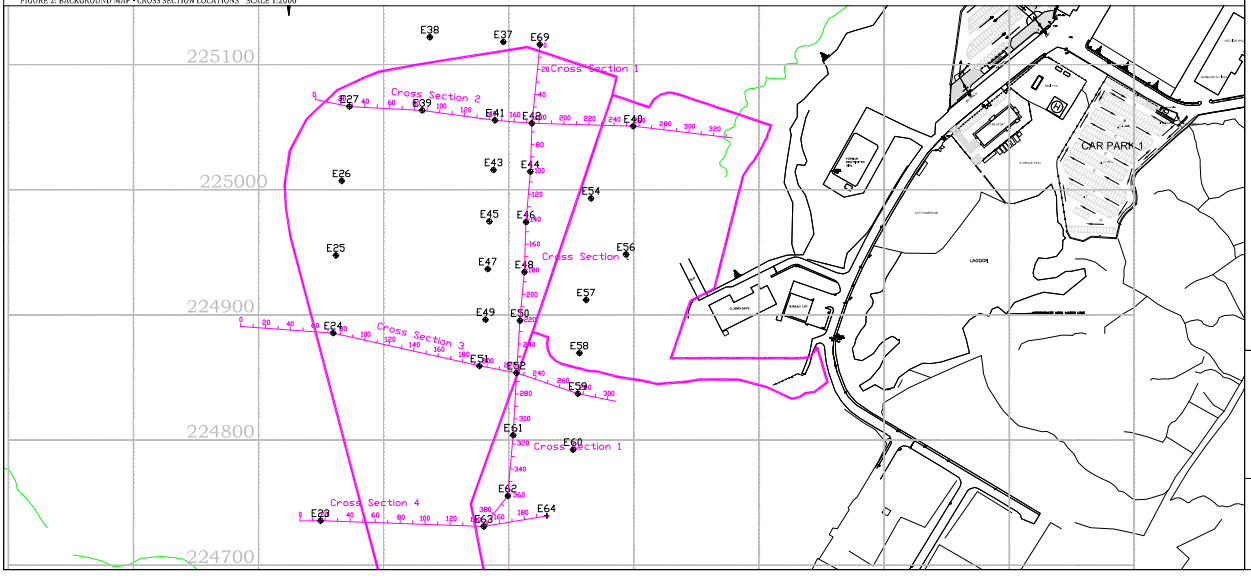


FIGURE 2: BACKGROUND MAP - CROSS SECTION LOCATIONS SCALE 1:2000



SITE:
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Sheet Title:
Cross Section 1 and 2

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DRAWING NUMBER:
PH16004_01_D04

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SCALE:
AS STATED ON A1

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J.B.J.

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1. Constructed on Irish National Grid.
2. Horizontal control by D.G.P.S.
3. All levels reduced to Chart Datum

Legend

E27 Fugro Boreholes

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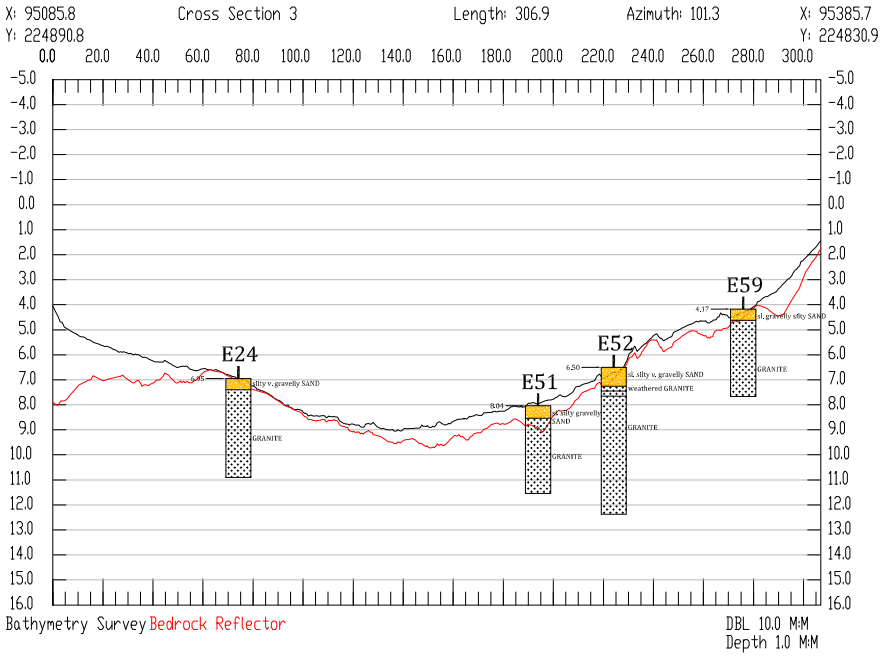
FIGURE 1: CROSS SECTIONS SCALE VERT 1:100 HORZ 1:1000 @ A1 (10X VERT EXAGERRATION)



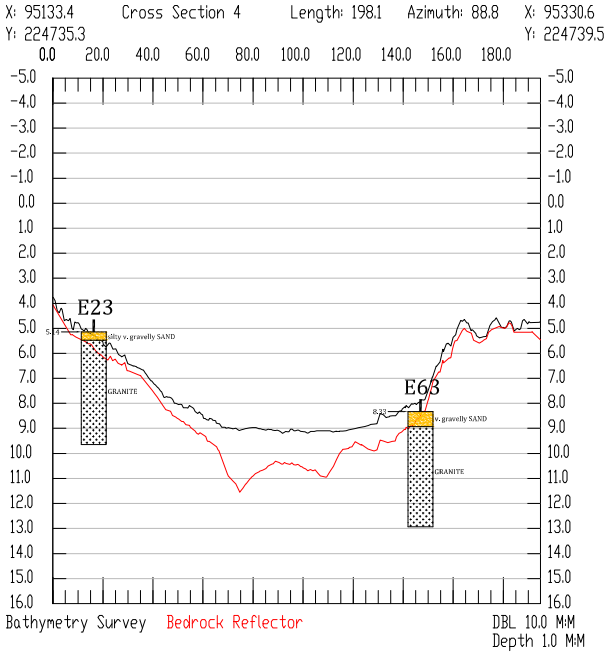
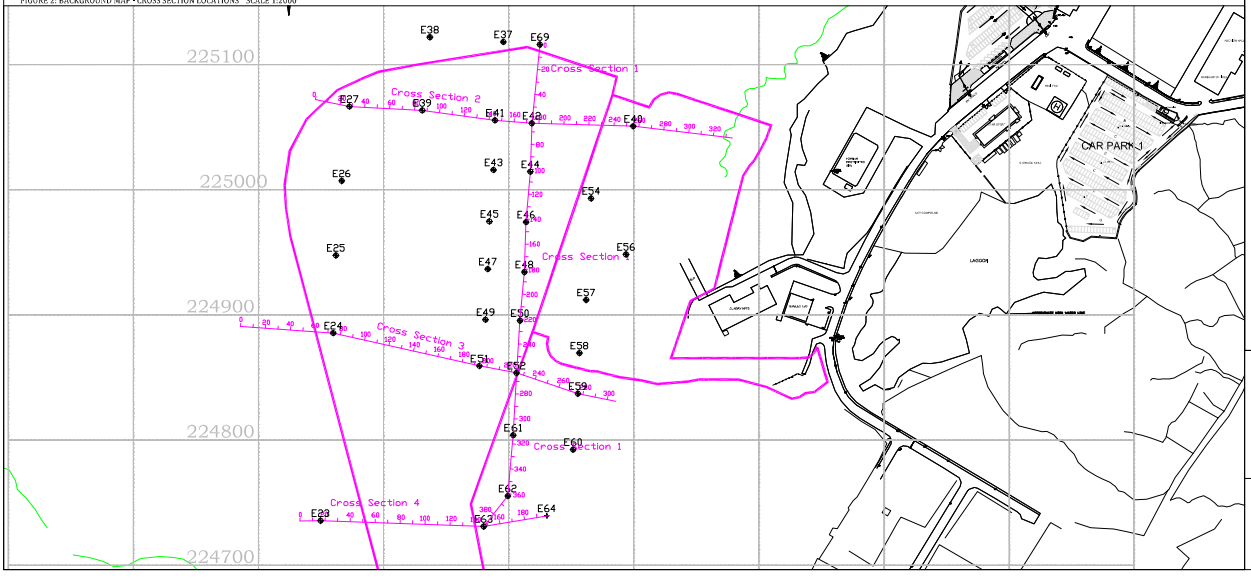


FIGURE 2: BACKGROUND MAP - CROSS SECTION LOCATIONS SCALE 1:2000



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Crosshaven
Co. Cork
t: +353 21 4831184
e: info@hydrosurvey.com

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4. APPENDIX B: SURVEY METHODOLOGY

4.1 Bathymetric Survey

4.1.1 Horizontal Control

Horizontal control for the survey was provided by a Trimble DGPS receiver with broadcast differential signal corrections from monitoring stations. The navigation system was interfaced to Hypack survey software for logging and for online guidance. The unit has a sub-metre horizontal positioning accuracy. On-line transformation of WGS'84 Latitude and Longitude to Irish National Grid took place within the survey programme. All plotting of data was to Irish National Grid.

4.1.2 Vertical Datum

All levels were reduced to Chart Datum. Tidal variations were recorded at Rossaveel Pier. Tidal heights were recorded every 5 minutes for the duration of the survey. Tidal heights were recorded at an established TBM and levels reduced to Datum.

4.1.3 Depth Sounding

The 215 Navisound dual frequency digital echo-sounder was used, to record seabed levels in both digital and analogue format. The echo sounder has a resolution of 0.01m and was calibrated on site by the bar-check method. A bar check was undertaken prior to and on completion of the survey. The sounder was interfaced with the dGPS via Hypack 2015 survey software thereby providing a digital record with related position fixes.

4.2 Sub Bottom Profiling

4.2.4 Horizontal Control

Horizontal control for the survey was provided by a Trimble DGPS receiver with broadcast differential signal corrections from monitoring stations. The navigation system was interfaced to Hypack survey software for logging and for online guidance. The unit has a sub-metre horizontal positioning accuracy. On-line transformation of WGS'84 Latitude and Longitude to Irish National Grid took place within the survey programme. All plotting of data was to Irish National Grid.

4.2.5 Sub Bottom Profiler Fieldwork

Sub-bottom information was obtained using a Knudsen Pinger acquisition system. This system included two separate interchangeable projectors, a low frequency 3.5kHz projector (ideally suited for hard sand sea bed) and a 15kHz projector (ideal for soft mud sediments). For this survey the 3.5kHz projector was installed on the instrument. The 3.5kHz uses a default bandwidth of 6 kHz.

A pulse width rate of 0.2ms was used for the duration of the survey period.

The Knudsen Pinger was a theoretical range resolution of 7.5cm for a typical frequency sweep assuming a speed of sound of 1500m/s. Signal sediment penetration is greatly dependant on external factors, primarily local sediment characteristics and to a lesser extent water depth.

4.2.6 Sub Bottom Profiler Processing and Interpretation

All seismic reflection profiles were processed in CODA Octopus sub-bottom profiling processing software. The sea-bed and interpreted reflectors were digitised in the CODA Octopus software.

Before digitising of reflectors, a number of processing methods were applied to the seismic data including water velocity correction, low and high band pass filter and data stacking.

5. REFERENCES

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