
GEOPHYSICAL SURVEY REPORT

Project

**Geophysical survey to characterise the conditions
of North Promenade, Barmouth**

Location

Barmouth

Client

YGC

Head Office
Unit 1 Link Trade Park
Penarth Road
Cardiff CF11 8TQ
United Kingdom

Telephone: +44 (0)2920 700127
www.terradat.co.uk



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Project Geophysicist: J Hamlyn PhD MSc BSc (Hons)



Reviewer: C Bird BSc (Hons) FGS



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Figure 3 – GPR Line 2 example radargrams

Figure 4 – Feature location plan **(also provided as a .dxf file)**

Appendix

Appendix 1- GPR Background information

1 EXECUTIVE SUMMARY

A geophysical survey was commissioned by Ymgynghoriaeth Gwynedd Consultancy (YGC) of North Promenade, Barmouth. The survey aimed to investigate the current condition of the subsurface with particular respect to the location and characterisation of shallow voids.

The promenade currently comprises a pre-cast concrete wave recurve wall at the top of a stone-faced revetment that slopes toward the beach, at the toe of the revetment, is a concrete step over a vertical sheet piled wall. A footpath and Marine Parade Road are located behind the wave wall, with secondary and tertiary sea walls positioned on either side of the road. The survey area is approximately 1.2 km long included a 2 m swath of the footpath, the toe of the revetment and specific locations within Marine Parade road.

Ground Penetrating Radar (GPR) data were acquired across the area of interest using 1 m spaced parallel survey traverses. However, the toe of the revetment became inaccessible after a chainage of ~620 m (from the northernmost extent of the promenade) due to the presence of beach materials.

Along the footpath and within Marine Parade Road, each radargram was inspected for the presence of three features that may indicate voiding and structural defects; high amplitude reflectors, isolated diffraction hyperbolae and zones of increased signal penetration. All the features of interest have been digitised and presented on a feature plan, also submitted in .dxf format. Data acquired across the middle and northern sections of the promenade do not appear to have the same volume or distribution of observable features as identified in the south. This could be caused by a difference in the construction or conductivity of the fill material beneath the footpath. The lack of observed features may also indicate that the structure is in reasonable condition in these areas.

The radar data acquired along the revetment toe inconsistently displays a high amplitude reflector approximately ~0.2 to ~0.3 m bgl. This may be caused by 'steps' within the structure that were encased in concrete during a phase of refurbishment, or at these locations, voiding/washout is present between different ages of concrete.

An intrusive investigation of all examples of the identified features is highly recommended. The acquisition of cores will allow calibration of the results of the geophysical survey.

2 INTRODUCTION

This report describes a geophysical survey of North Promenade, Barmouth. It was commissioned by Ymgynghoriaeth Gwynedd Consultancy (YGC), part of Cyngor Gwynedd Council, and was designed to investigate the current condition of the subsurface with particular respect to the location and characterisation of shallow voids. The survey work was conducted between the 2nd and the 4th of February 2021.

2.1 Site description and history

Barmouth North Promenade is situated along the west coast of Snowdonia, adjacent to Barmouth town, Gwynedd. The area of interest is approximately 1.2 km long, stretching from the most northern extent of the promenade to the beginning of the dunes in front of the Min-Y-Mor Hotel (Figure 1).

According to documentation provided by the Client, a sea defence was originally built in the early 1930s. Subsequently, several phases of refurbishment to maintain the integrity of the structure have been required, with works carried out in every decade between 1954 and 1984. The local council began regularly inspecting the structure in 1996 and began a rolling programme of minor repairs. In March 2020, the northernmost end of the promenade collapsed requiring urgent reconstruction.

The sea defence structure currently comprises a pre-cast concrete wave recurve wall at the top of a stone-faced revetment that slopes toward the beach, at the toe of the revetment is a concrete step over a vertical sheet piled wall. A footpath and Marine Parade Road are located behind the wave wall, with secondary and tertiary sea walls positioned on either side of the road. The survey areas comprised a 2 m swath of the footpath, a single GPR profile along the toe of the revetment and specific locations within Marine Parade road (see Plate 1 and Figure 1).

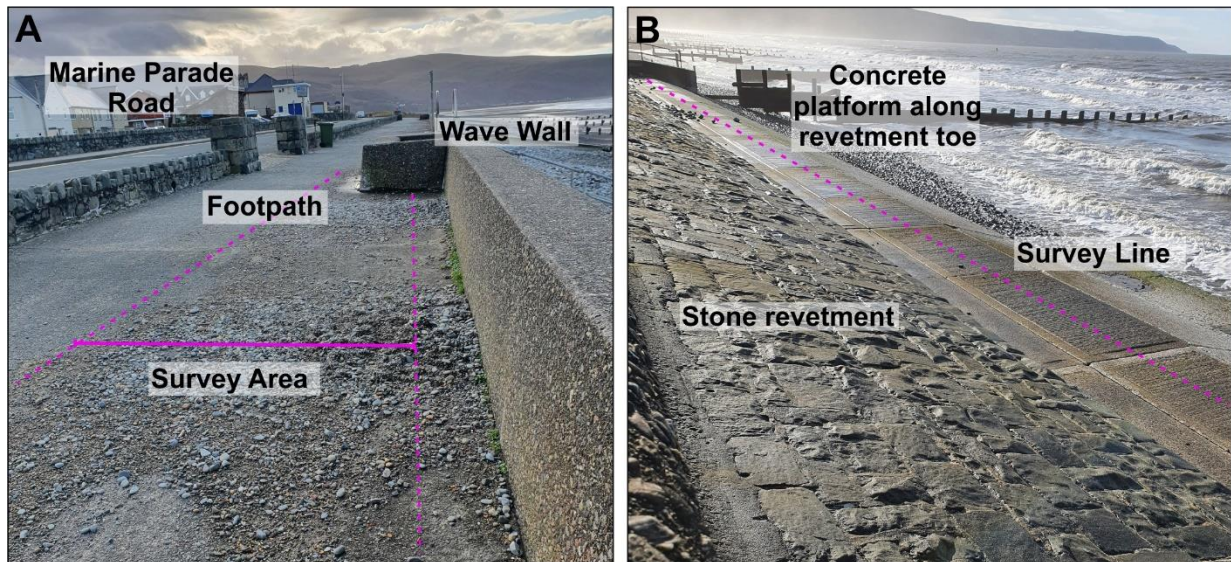


Plate 1: Site conditions and survey area. **A)** Footpath along promenade and wave wall at the top of the sea defence structure, Marine Parade Road in background. **B)** Sea defence structures showing stone revetment, concrete toe and position of the survey line along the toe of the revetment.

2.2 Geological setting

British Geological Survey (BGS) mapping indicates that the headland adjacent to the promenade comprises sandstones and mudstones of the Harlech Grits Group. The superficial deposits are mapped as Blown Sand and undifferentiated Coastal Zone deposits. However, the geophysical survey is unlikely to image the natural geology beneath the promenade. Historical drawings provided by the Client suggest that sand was used to infill between the original ground level and base of the promenade, which is assumed to be saturated with seawater.

2.3 Survey objectives

The survey aims to investigate the current shallow condition of the structure and identify shallow voiding along two prescribed survey traverses

2.4 Survey design

Given the nature of the structure under investigation, it was decided to use **Ground Penetrating Radar (GPR)** to provide detailed cross-sectional images that can be used to identify anomalous areas of GPR response related to voiding, the presence of engineered structures or sub-surface boundaries. Figure 1 shows the locations of the individual GPR profiles.

2.5 Quality control

The geophysical data were collected in line with normal operating procedures as outlined by the instrument manufacturer and TerraDat company policy. On completion of the survey, the data was downloaded from the survey instrument onto a computer and backed up appropriately. The acquired data set was initially checked for errors that may be caused by instrument noise; low batteries, positional discrepancies, etc. and any field notes were either written up or incorporated in the initial data processing stage. The data set is then processed using the standard processing routines and once completed; the resulting plots are subject to peer review to ensure the integrity of the interpretation. Our quality control standards are BS EN ISO 9001: 2015 certified.

3 SURVEY DESCRIPTION

The survey was conducted using Ground Penetrating Radar (GPR). The results are presented in the form of data plans and cross-sections, indicating the location and physical characteristics of identified anomalous features together with a text description and interpretive plots. Background information for the survey method is provided in the appendices, and descriptions of the actual survey work carried out on site are provided in the sections below.

Due to spring tides and rough seas, it was not possible nor safe to survey the promenade during the two hours before and after high tide. All survey work was conducted during periods of relatively low tide.

3.1 Topographic survey and data positioning

The GPR data were collected under the control of a Topcon Hiper Pro RTK GPS system. A series of three parallel 1 m spaced traverses were acquired along the footpath. However, only one traverse could be acquired along the toe of the revetment, and this is labelled 'GPR Line 2'. Where the Client had specified additional individual profiles within Marine Parade Road, a series of traverses were acquired parallel to the structure (see Figure 1).

3.2 Ground penetrating radar survey (GPR)

3.2.1 GPR survey - field activity

An Utsi Electronics TriVue radar system with shielded 250MHz, 500MHz and 1GHZ antennae was used to acquire the radar data along a series of 1 m spaced parallel traverses. These

survey lines covered all accessible areas within the area specified by the Client. However, GPR Line 2 became inaccessible after a chainage of ~620 m (from the northernmost extent of the promenade) due to the presence of beach materials (Plate 2).



Plate 2: Data acquisition on-site. **A)** Utsi TriVue GPR system during data collection along the footpath. **B)** GPR Line 2 became inaccessible after a chainage of ~620 m (from northernmost extent of the promenade).

3.2.2 GPR survey – data processing

The data processing was carried out using *GPR-SLICE* software. A series of editing and gain functions are applied to the radargrams to enhance features with the depth axis calculated using a nominal velocity correction of 0.1 m/s (the approximate velocity for concrete). Additional processing routines (e.g. background removal, deconvolution, FK filtering, migration, etc.) are applied to improve the coherency of the reflection events and remove any multiple reflections and diffractions. This results in a series of depth corrected radargrams, which emphasise key features/responses. Visual analysis of all the acquired radargrams has been carried out, and anomalous responses have been identified, digitised and transposed to an anomaly location plan.

4 RESULTS

The locations of the GPR profiles are shown in **Figure 1**. Each GPR cross-section was visually analysed for any anomalous features; examples of these are presented in **Figure 2 and 3**. The interpretive plot in Figure 4 shows the locations of identified anomalous responses. **Figure 4** has also been provided in digital CAD format (7328_Barmouth_feature_locations_v2.DXF) in OSGB coordinates.

Example data from the 500 MHz and 1GHz channels are presented as they show high-quality GPR data to depths of ~0.5 and ~1.5 m, respectively. The maximum depth of penetration is relatively shallow, likely caused by the presence of saline water within and beneath the structure creating a conductive medium that significantly attenuates the transmitted radar wave.

4.1 Promenade footpath and Marine Parade Road

The interpretations made within this section are based on the historical drawings provided by the Client and on TerraDat's experience of surveying similar sea defence structures. Plate 3 is a cross-section of the structure beneath both the footpath and the road. As can be seen, both the path and roadway comprise a ~0.2 m concrete slab over a sand fill. However, it is not clear how the recurve wave wall, added in the early 1970s, is 'keyed-in' to the structure and therefore the GPR profiles acquired close to the wall may observe thicker concrete.

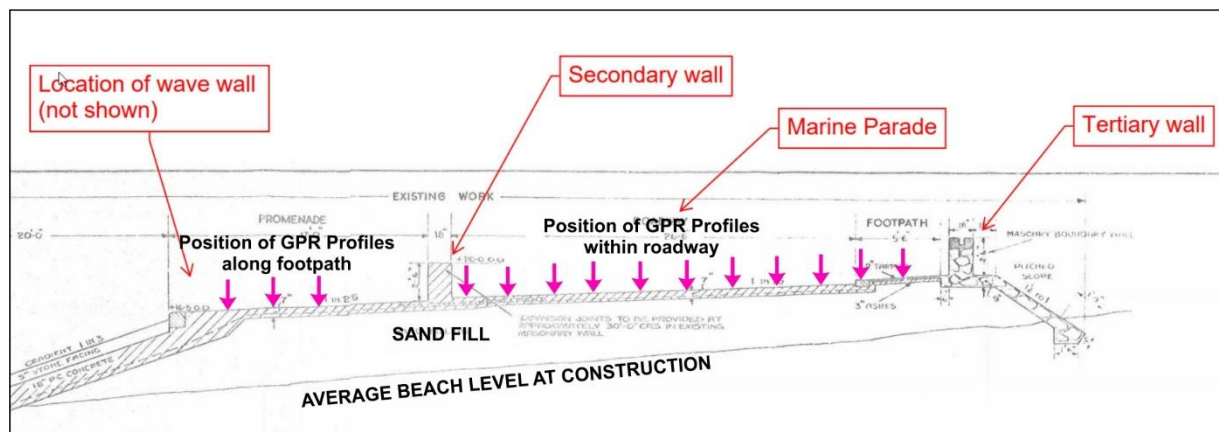


Plate 3. Historical drawing provided by the Client showing the current construction of the footpath and roadway.

4.1.1 Interpretation rationale

At this site, identification of voiding relies on the juxtaposition of different GPR responses and the ability to observe them. Each radargram was inspected for the presence of three features; high amplitude reflectors, isolated diffraction hyperbolae and zones of increased signal penetration. Each is outlined in detail below with examples from the acquired data set.

1) High amplitude reflectors, which may also dip or ‘sag’ along their length. High amplitude reflectors may be caused by laterally extensive air gaps between the concrete slab and the underlying fill. Dipping or sagging reflectors may suggest that a horizon is no longer supported due to loss of material below and may represent subsidence. See the example data in Plate 4 below.

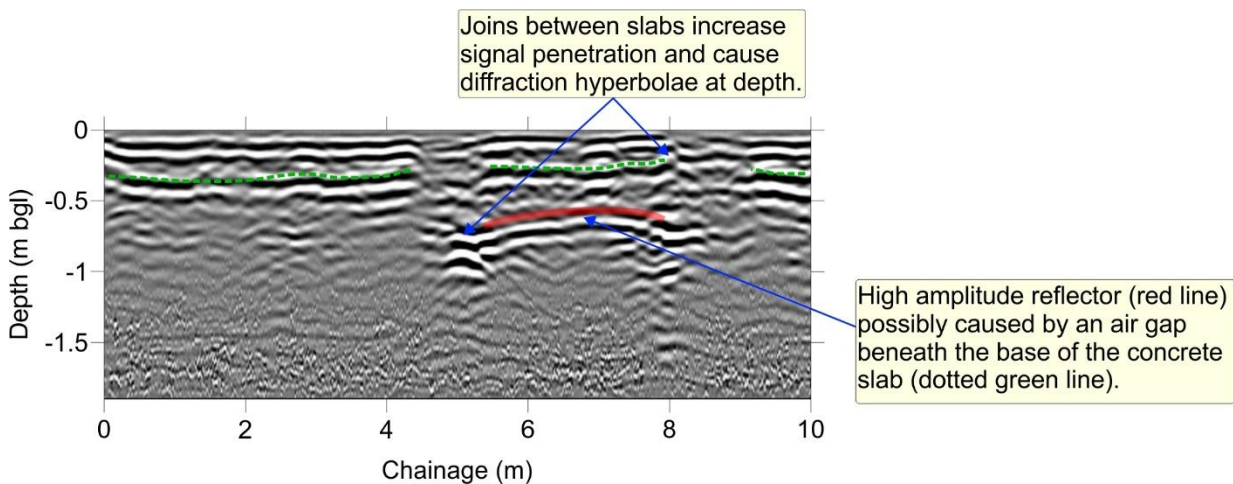


Plate 4: Example GPR data of a high amplitude reflector which may be indicative of voiding.

Example data extracted from the 500 MHz antenna data set.

2) Diffraction hyperbolae caused by a ‘point source’, a short feature of significantly different dielectric properties. For example, a spherical void; however, these are also caused by other discrete features such as boulders or utilities. See the example in Plate 5.

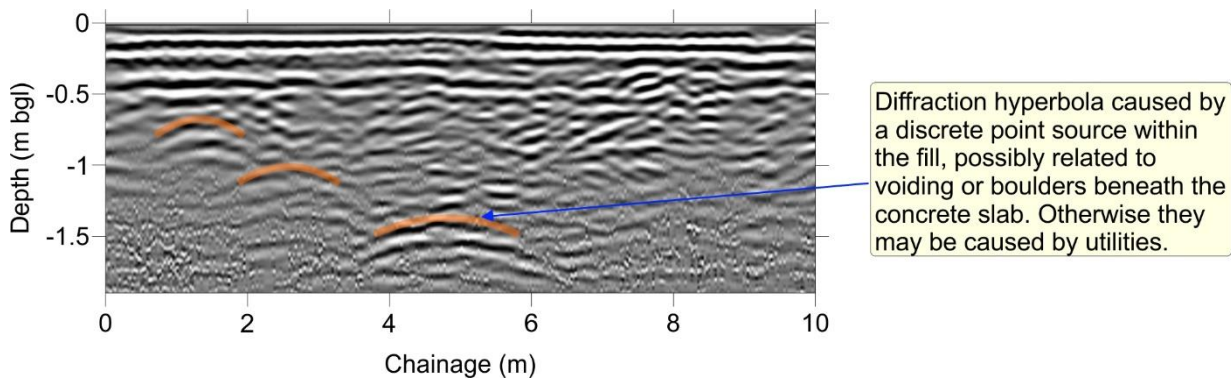


Plate 5: Example GPR data of an isolated diffraction hyperbola which may be indicative of a void. Example data extracted from the 500 MHz antenna data set.

3) Zones of increased signal penetration, areas where a large amount of the GPR signal is reflected. This is caused by granular or aerated fill and potentially voiding. See the example below in Plate 6. At some locations regularly spaced zones of increased signal penetration are observed and relate to the presence of joints between slabs, the presence of isolated zones of high-amplitude response beneath the joints may be indicative of localised voiding associated with them.

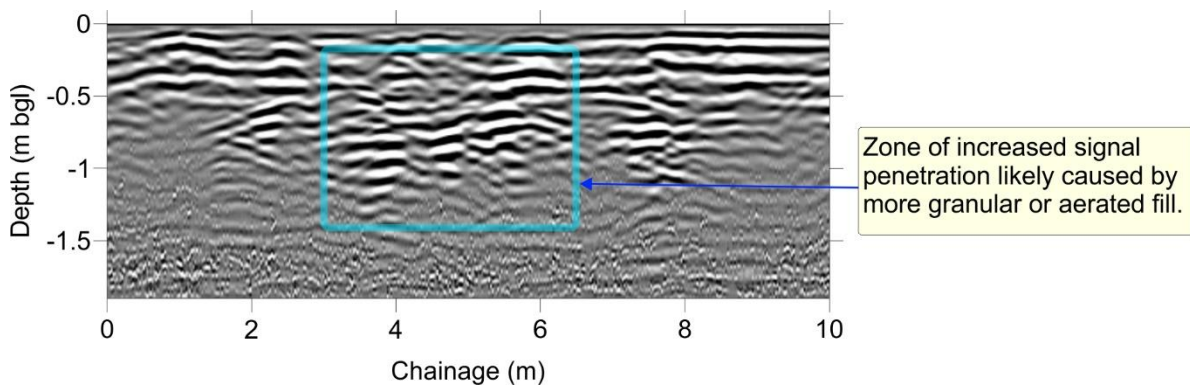


Plate 6: Example GPR data showing characteristic data from the site. Example data extracted from the 500 MHz antenna data set.

4.1.2 Example radargrams (Figure 2)

Each radargram was inspected to identify the features discussed in Section 4.1.1. Where these features are observed, the locations have been digitised and are shown in Figure 4. Figure 2 displays example radargrams showing some of these features and are discussed below. All the radargrams presented derive from the 500 MHz antenna. The coordinates of discussed features are given in Table 1.

The radargrams in Figure 2 are presented as they provide a representative subset of the features that are observed across the structure. They do not represent all the features that have been digitised and presented on the plot in Figure 4. Generally, the signal penetration is deeper and more features are observed in the south of the survey area than in the north.

Radargram 203 was acquired along the footpath in the south of the survey area, where the data has a good signal penetration to 1.5 m bgl. Regularly spaced zones of increased signal penetration (shown in dark blue) relate to the presence of joints between slabs, the presence of isolated zones of high-amplitude response beneath the joints may be indicative of localised voiding associated with them, one such feature has been noted as **F2**. The locations of such features are shown on Figure 4. Laterally continuous, high amplitude reflectors are occasionally also observed (**F2a**). High amplitude reflectors are also observed away from the broader zones of increased signal penetration, e.g., **F2b**. An isolated diffraction is also observable and may be caused by a void, boulder or utility (**F2c**).

Radargram 215 was also acquired along the footpath in the south of the survey area. This profile shows several broad areas of increased signal penetration and multiple high amplitude reflectors at approximately 1 m bgl (**F2d to i**).

Data acquired across the middle and northern sections of the promenade do not appear to have the same volume or distribution of observable features as identified in the south. This could be caused by a difference in the construction or conductivity of the fill material beneath the footpath. The lack of observed features may also indicate that the structure is in reasonable condition in these areas. An intrusive investigation is recommended to characterise the nature of the underlying fill material here and help advise the likely interpretation.

Example radargram 245 shows significant signal attenuation beneath the concrete slab. This is thought likely to be caused by increase conductivity of the fill material beneath the slabs and may reflect an increase in the clay content of the fill material (this location coincides with the presence of a historical stream) or fill material saturated by saline water.

Radargram 308 shows an example of data acquired across Marine Parade Road. The road appears to be underlain by reinforced slabs (as indicated by the numerous shallow diffraction hyperbolae) and some of the voiding-related features discussed previously are observed (**F2j and k**). It should be noted that the signal penetration increases with distance away from the

shoreline, which is thought likely caused by a decrease in the saturation of the fill or an increase in more granular fill with distance from the sea.

To better interpret the data, an intrusive investigation of all examples of the identified features is highly recommended. The acquisition of cores will allow calibration of the results of the geophysical survey, after which the interpretations within this report can be refined.

4.2 GPR Line 2 (Toe of Sea Defence)

The Client has provided documentation that includes a historical cross-section outlining several phases of construction of the sea defence (Plate 7A), and the interpretation of GPR Line 2 has been made in conjunction with this information. The structure in the 1970s comprised a pre-cast concrete wave recurve wall with a stone blockwork revetment sloping toward the beach, at the toe of the revetment was a series of pre-cast concrete steps over a sheet-piled wall (Plate 7B). Since the 1970s, the structure has undergone a series of refurbishments, including encasing of the original steps with further concrete to create a wide flat 'platform', along which GPR Line 2 was acquired (Plate 7C).

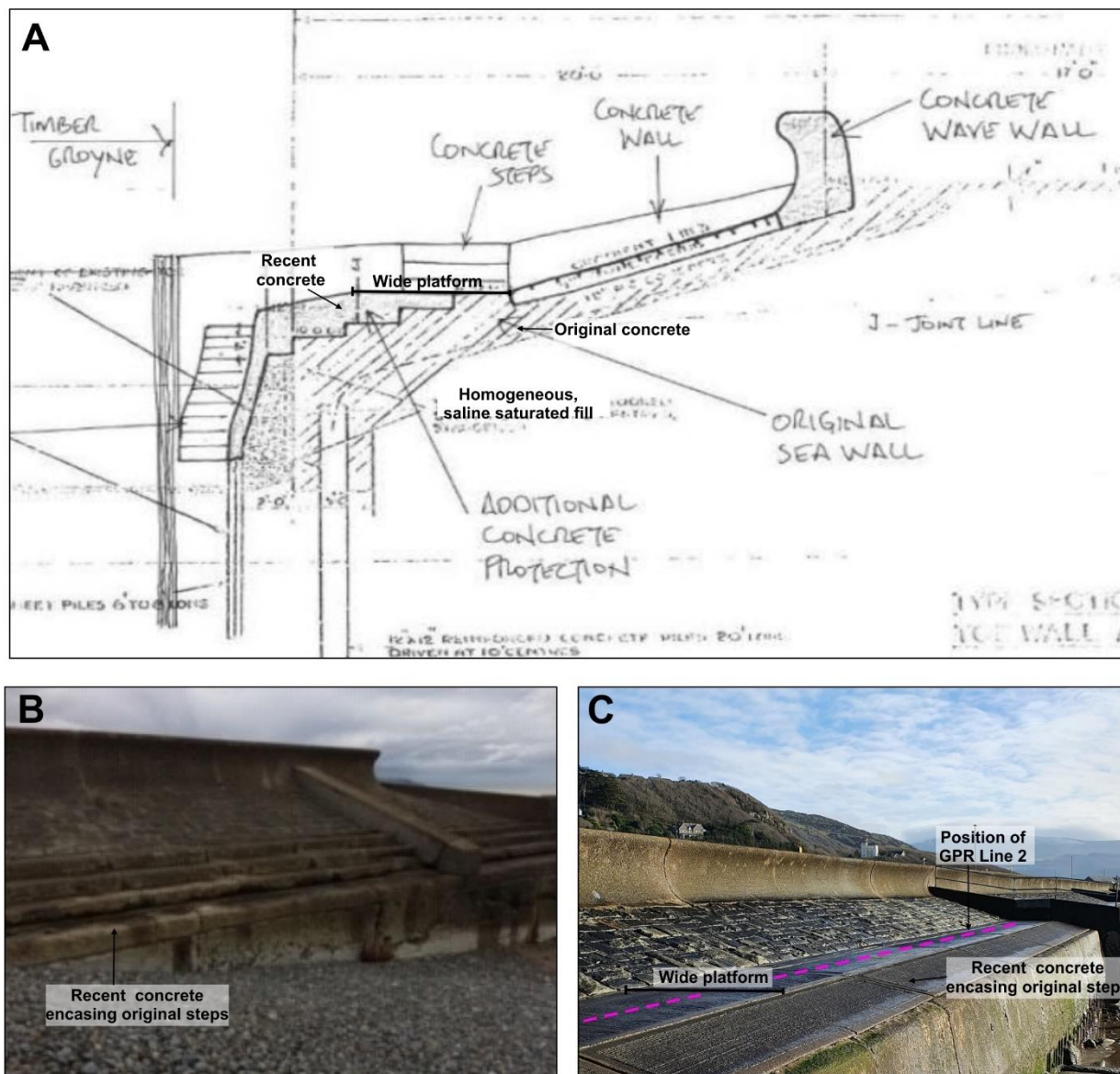


Plate 7. A) Historical drawing provided by the Client showing the current construction of the sea defence. **B)** Historical photo provided by the Client showing the sea wall prior to more recent refurbishment, including the encasing of the concrete steps. **C)** Photo showing the current condition of the structure as surveyed in this report.

The height between the last concrete step and the beach varies along the length of the promenade. At the northern end, it is approximately 3 m above beach level but becomes buried beneath beach material at a chainage of ~620 m (from the northern extent of the promenade). *Please note:* it was not possible to survey GPR Line 2 where it traversed along the original sea wall shown in the historical photo in Plate 5B, it is believed that this section of the wall is now buried beneath beach material.

4.2.1 Interpretation rationale

The cross section in Plate 5A suggests that beneath the location of GPR Line 2 should be more recent concrete covering an original series of steps (also made of mass concrete), below which is homogenous fill (sand) likely saturated with seawater.

The radargrams collected along GPR Line 2 inconsistently display a high amplitude reflector approximately ~0.2 to ~0.3 m bgl (an example is highlighted in red on Plate 8). There are two possible interpretations for this:

- 1) The line of GPR 2 is located close to the edge of a step and occasionally crosses from an upper to a lower step.
- 2) Or, at these locations, voiding/washout is present between different ages of concrete, creating a high amplitude reflector.

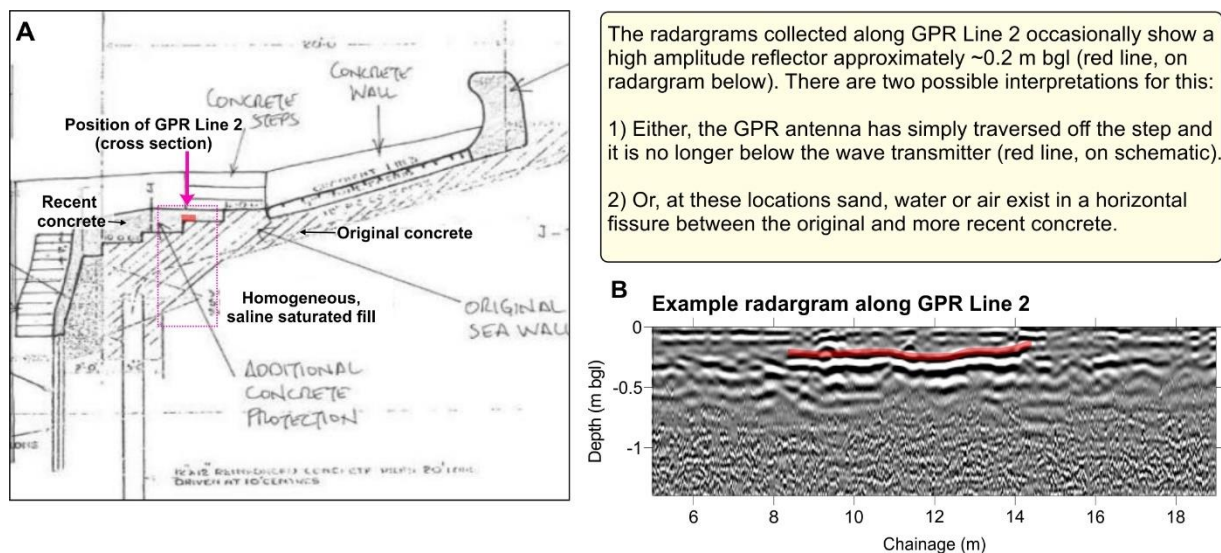


Plate 8. A) Historical drawing provided by the Client showing the current construction of the sea defence with respect to the position of GPR Line 2. **B)** Example data acquired along GPR Line 2.

Below a depth of 0.7 m, the radar signal appears to be largely attenuated, likely caused by the presence of conductive material, at this site it is likely seawater saturated fill. The locations at which a high amplitude reflector exists at ~0.2 m bgl have been digitised and presented in figure 4. It is recommended that where the reflector is both observed and absent is investigated intrusively to allow an informed interpretation of the feature.

4.2.2 Example radargrams (Figure 3)

Each radargram was inspected for the shallow high amplitude reflector discussed in Section 4.3.1. Where this feature is observed, the locations have been digitised and are shown in Figure 4. Figure 3 displays example radargrams showing this reflector (highlighted in red) and further isolated features which may be of significance, and these are discussed below.

Radargram 280 shows an example of data acquired by the 500 MHz antenna. The shallow intermittent reflector discussed previously is highlighted in red. However, a short deeper reflector is also observed at ~0.7 m bgl and highlighted in purple (**F3a**). At this depth, it is thought that the base of the original concrete steps overlies the saline saturated fill, where a high amplitude reflector is observed, there may be an air gap between the base of the concrete and the fill. Where this deeper reflector is observed it has been digitised and shown in Figure 4.

Feature **F3b** is a short, dipping, high-amplitude reflector. This feature occurs along what may indicate the presence of a historical surface (step), break or inclination in this surface may indicate damage to the structure.

Radargrams 278 and 280 show the intermittent character of the shallow reflector, and it is recommended that this is investigated intrusively to determine if this feature is caused by horizontal delamination along with the different phases of construction and refurbishment or is an artefact of the acquisition over the buried step.

4.3 Composite results plan (Figure 4)

Figure 4 presents the extents and locations and approximate depths of the numerous GPR response types, which may be related to potential voiding across the survey area. It is recommended that representative areas of highlighted GPR response are relocated on-site using a survey-grade RTK GPS and investigated intrusively. Figure 4 has also been provided in digital CAD format (7328_Barmouth_feature_locations.DXF) in OSGB coordinates.

The coordinates of the specific features discussed in the report are given in Table 1.

Feature ID	Location (OSGB)*
F2a	260729.23E 316146.95N
F2b	260722.87E 316157.10N
F2c	260720.08E 316161.73N
F2d	260633.91E 316368.81N
F2e	260636.92E 316360.88N
F2f	260638.37E 316357.15N
F2g	260641.91E 316348.05N
F2h	260643.03E 316344.99N
F2i	260649.09E 316329.30N
F2j	260315.57E 317143.30N
F2k	260315.99E 317142.46N
F3a	260459.41E 316785.41N
F3b	260393.28E 316946.18N

* Location coordinates given are either at the peak amplitude of the highlighted feature, or the centre of the spatial extents.

Table 1 - Summary of significant features observed.

5 CONCLUSIONS

Footpath and Marine Parade Road

- GPR has proved to be a very effective way of non-intrusively investigating the footpath and Marine Parade Road to a depth of the survey area to a depth of ~1.5 m bgl. However, signal penetration is deeper in the south than in the north.
- Data acquired in the north and middle of the survey area have fewer and more sporadic features of interest than in the south. This could be caused by a difference in the construction or conductivity of the fill material beneath the footpath. The lack of observed features may also indicate that the structure is in reasonable condition in these areas.
- The construction drawings provided by the Client have proved crucial to the interpretation of the GPR data.
- All radargrams were inspected for the presence of three features that may indicate voiding or structural defects; high amplitude reflectors, isolated diffraction hyperbolae and zones of increased signal penetration. Eleven such features have been discussed in detail within this report and their coordinates are given. All features observed have been provided in a .dxf file in OSGB coordinates.
- An intrusive investigation of all examples of the identified features is highly recommended. The acquisition of cores will allow calibration of the results of the geophysical survey, after which the interpretations within this report can be refined.

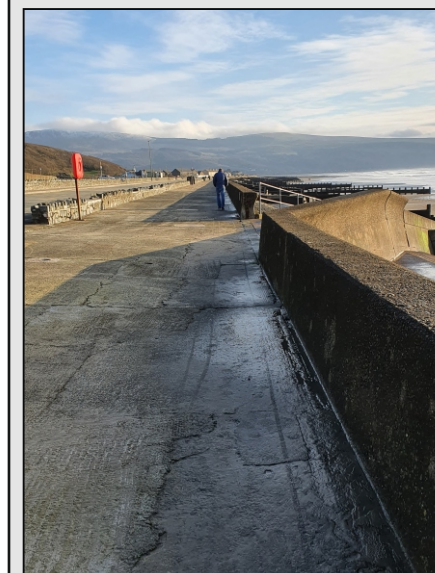
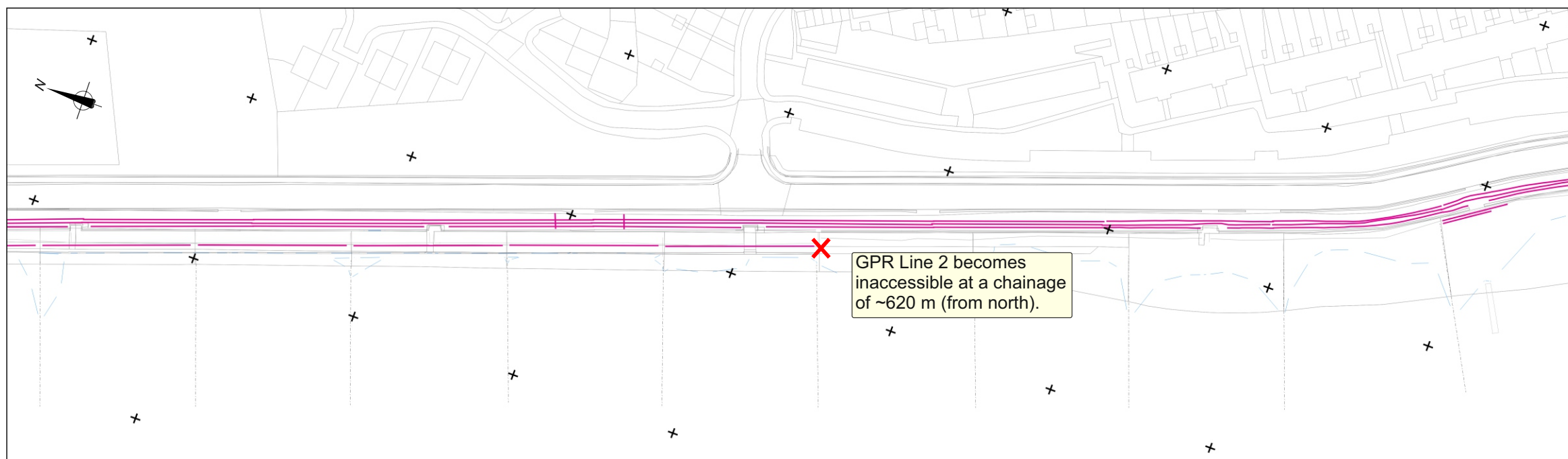
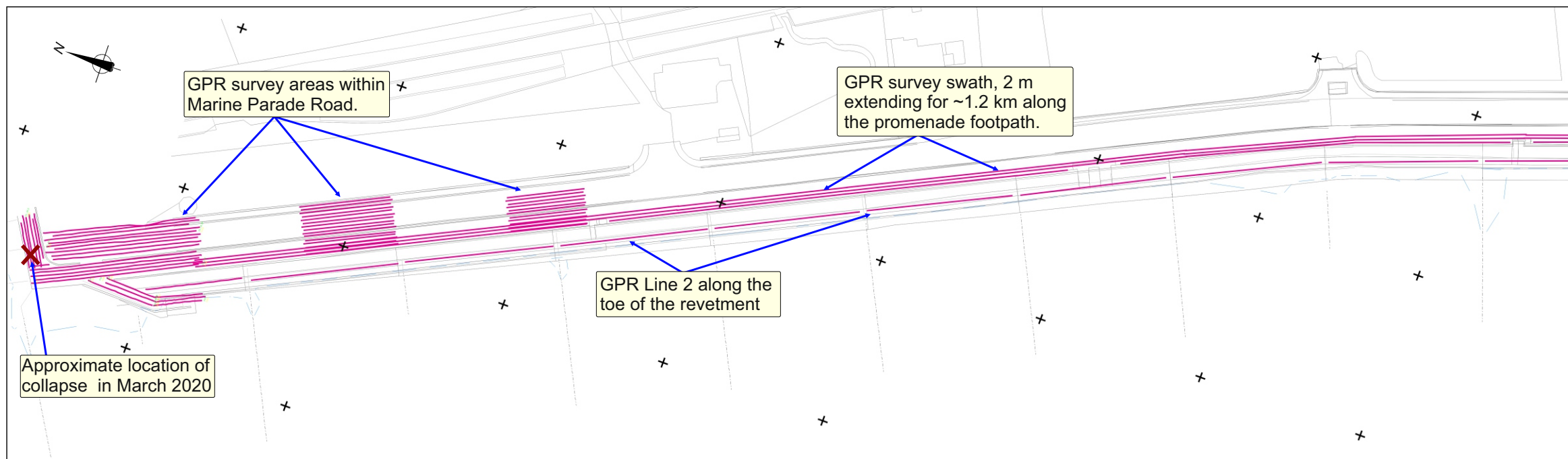
GPR Line 2 (toe of revetment)

- GPR has proved to be a very effective way of non-intrusively investigating the toe of the revetment to ~0.7 m bgl. The signal penetration is relatively shallow, likely caused by the presence of conductive material, at this site it is likely seawater saturated fill.
- The construction drawings provided by the Client have proved crucial to the interpretation of the GPR data.
- Along GPR Line 2, a high amplitude reflector approximately ~0.2 to ~0.3 m bgl is intermittently observed. This is either caused by the edge of a shallow step which is currently encased in concrete following a phase of refurbishment or at these locations, voiding/washout is present.
- It is recommended that where the reflector is both observed and absent is investigated intrusively to allow an informed interpretation of the feature.

Disclaimer

This report represents an opinionated interpretation of the geophysical data. It is intended for guidance with follow-up invasive investigation. Features that do not produce measurable geophysical anomalies or are hidden by other features may remain undetected. Geophysical surveys complement invasive/destructive methods and provide a tool for investigating the subsurface; they do not produce data that can be taken to represent all of the ground conditions found within the surveyed area. Areas that have not been surveyed due to obstructed access or any other reason are excluded from the interpretation.

FIGURES



View looking south along the promenade.

SCALE



KEY

- GPR Profiles
- Simplified base map (provided by Client)
- Termination of GPR Line 2 due to beach debris
- Approximate location of March 2020 collapse

NOTES

- 1: GPR Profiles on map provided by the Client.

Project:

Barmouth Promenade

Title:

SURVEY LOCATION PLAN



Tel: +44 (0) 2920 700127

Web: www.terradat.co.uk

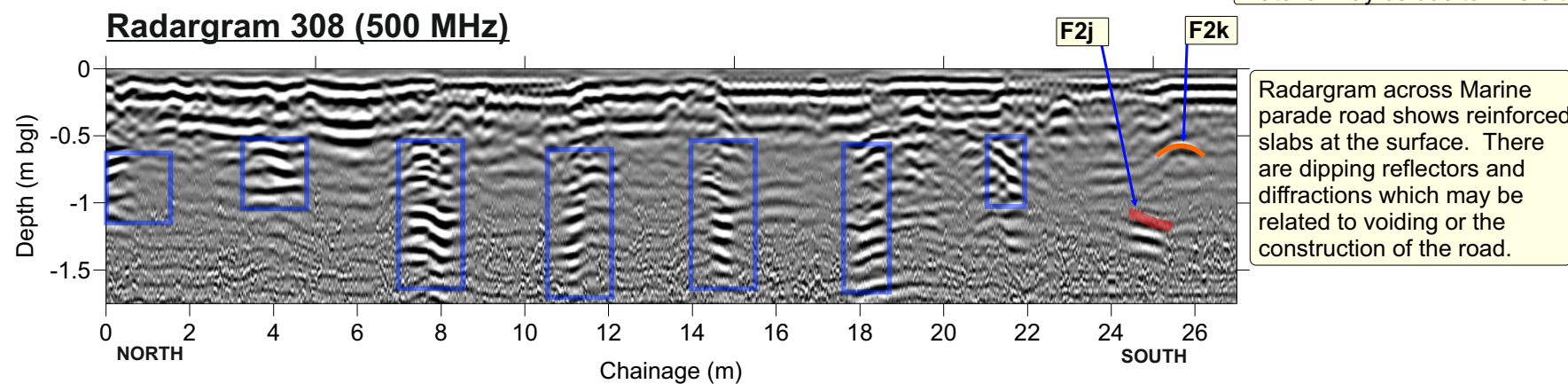
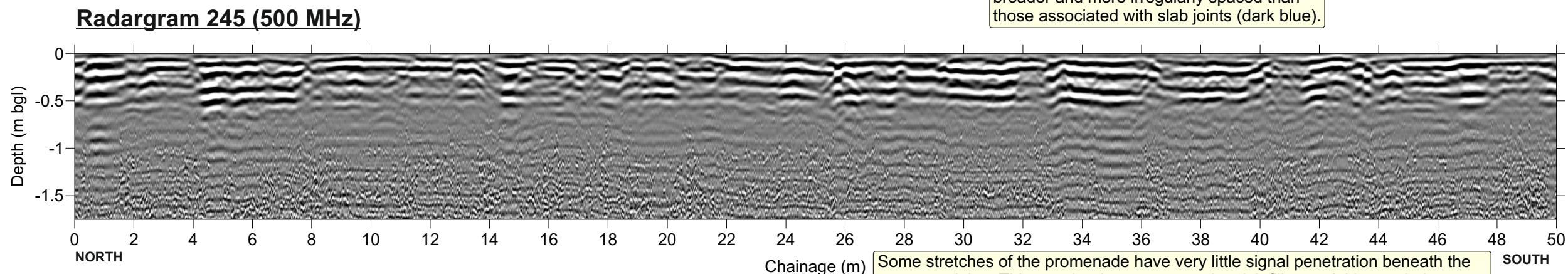
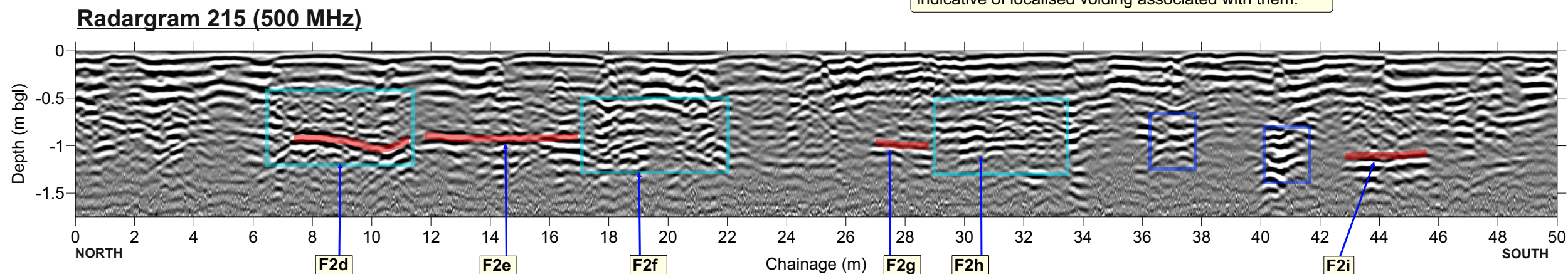
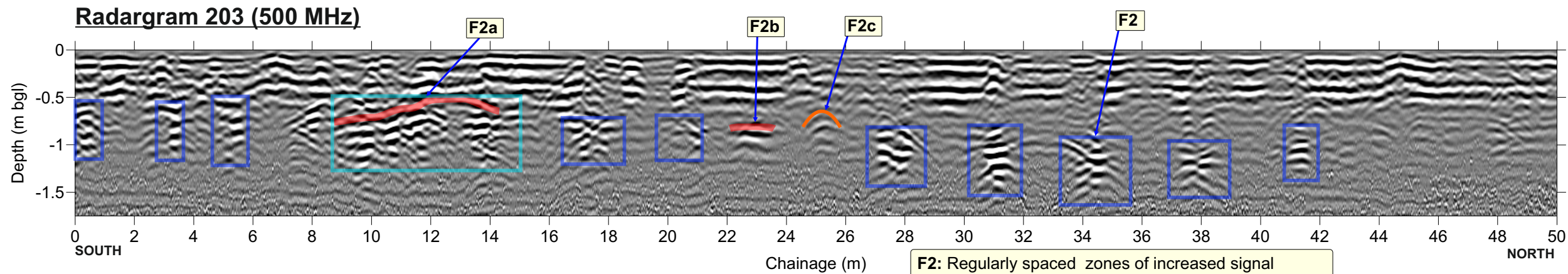
Email: web@terradat.co.uk

Scale: 1:1500 @ A3

Drawn by/Ref: JH/7328/2

Date: 9th February 2021

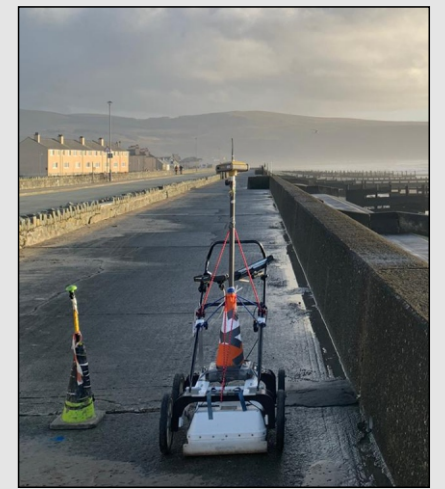
FIGURE 1



F2a, b, e,g,i and j: High amplitude reflectors possibly caused by air gaps in the made ground beneath the concrete slabs. In some cases these are coincident with zones of increased signal penetration.

F2c and k: Diffraction hyperbolae potentially caused by small isolated voids in the subsurface.

F2d, f, and h: Zones of increased signal penetration possibly caused by more granular, aerated fill. In some areas they are coincident with high amplitude reflectors.



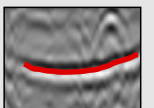
Data collection along footpath

COLOUR SCALE



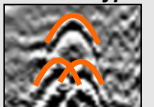
GPR KEY

Reflection event



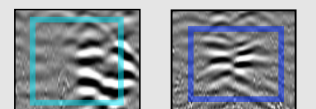
High amplitude reflectors may be caused by air gaps between the concrete slab and fill. Dipping or sagging reflectors may suggest that a horizon is no longer supported due to loss of material below and may represent subsidence.

Diffraction hyperbolae



A diffraction hyperbolae curve usually indicates a 'point' source, such as a void, buried service or an edge feature.

Increased Signal penetration



Areas where a large amount of the GPR signal is reflected. This is caused by granular or aerated fill and potentially voiding (light blue). Regularly spaced zones of increased signal penetration (dark blue) relate to the presence of joints between slabs, the presence of isolated zones of high-amplitude response beneath the joints may be indicative of localised voiding associated with them.

NOTES

- 1: Radar data processed assuming a subsurface velocity of 0.1m/ns.
- 2: See Figure 4/DXF for plan of radargram locations.

Project:

Barmouth Promenade

Title:

**FOOTPATH AND ROADWAY
EXAMPLE RADARGRAMS**



Tel: +44 (0) 2920 700127

Web: www.terradat.co.uk

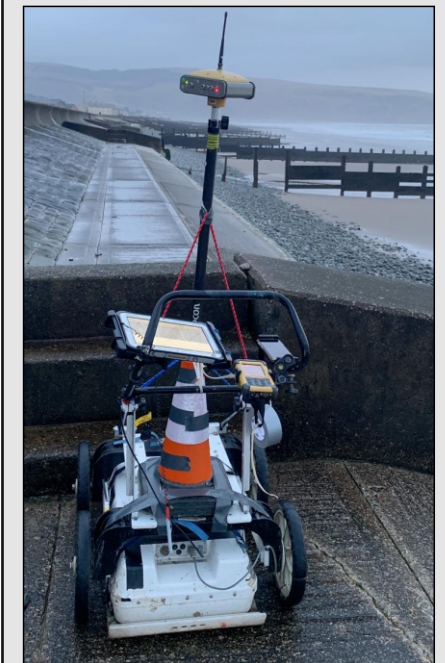
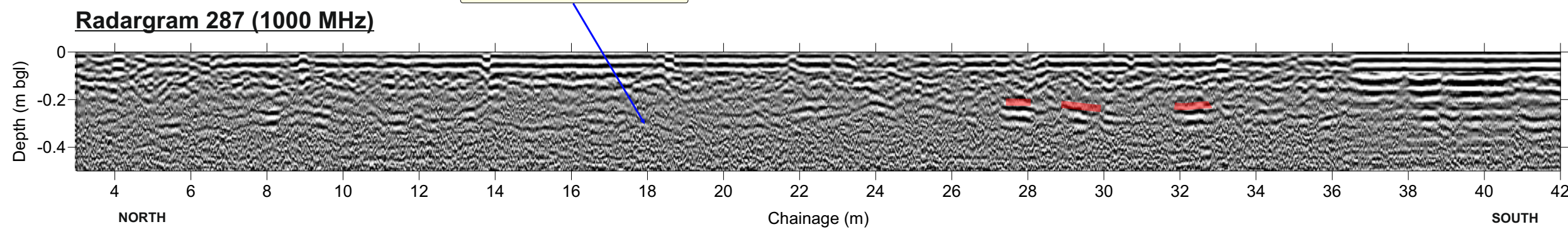
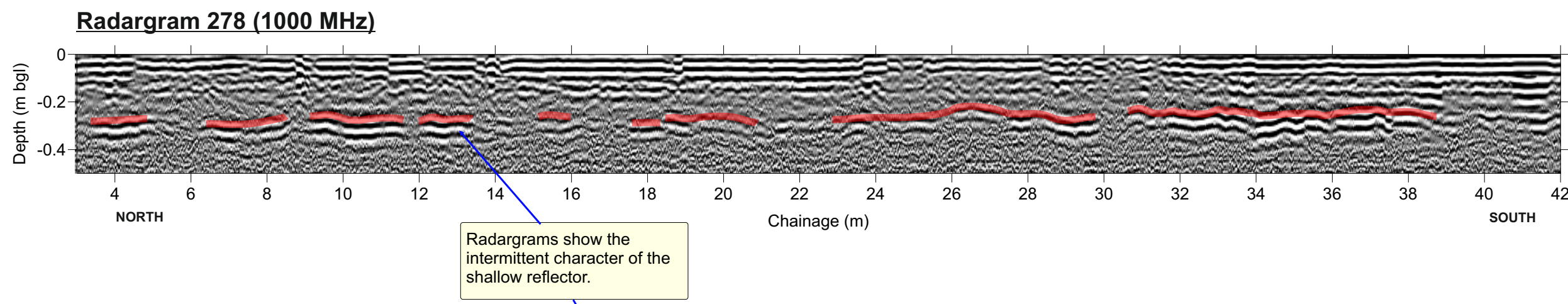
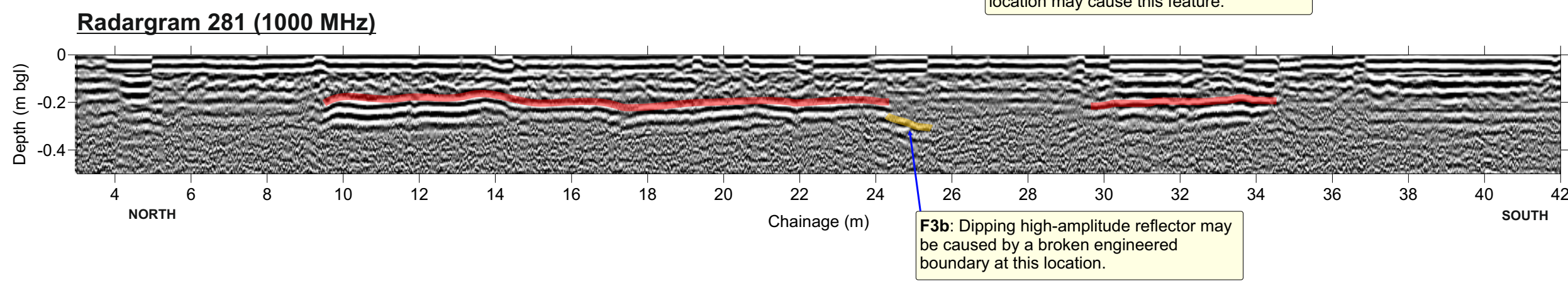
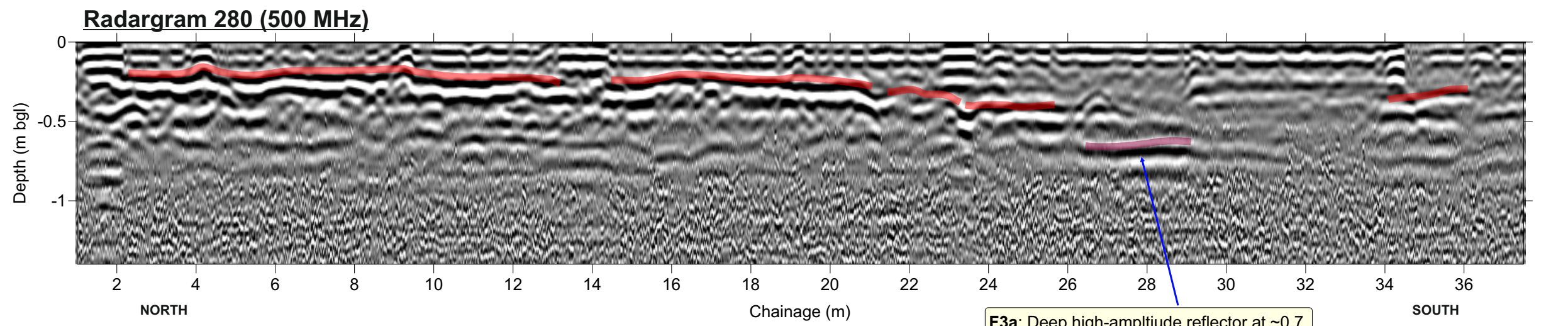
Email: web@terradat.co.uk

Scale:

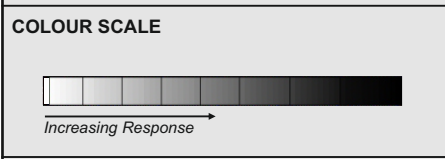
Drawn by/Ref: JH/7328/2

Date: 15th February 2021

FIGURE 2



Data collection along GPR Line 2



- GPR KEY**
- Shallow, intermittent, high-amplitude reflector.
 - Deeper high-amplitude reflector.
 - Dipping reflector.

NOTES

1: Radar data processed assuming a subsurface velocity of 0.1m/ns.
2: See Figure 4/DXF for plan of radargram locations.

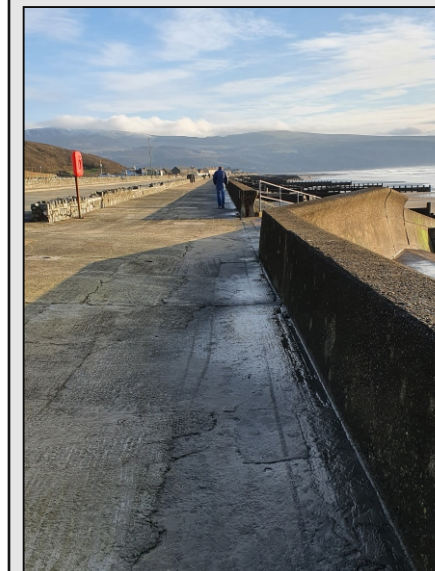
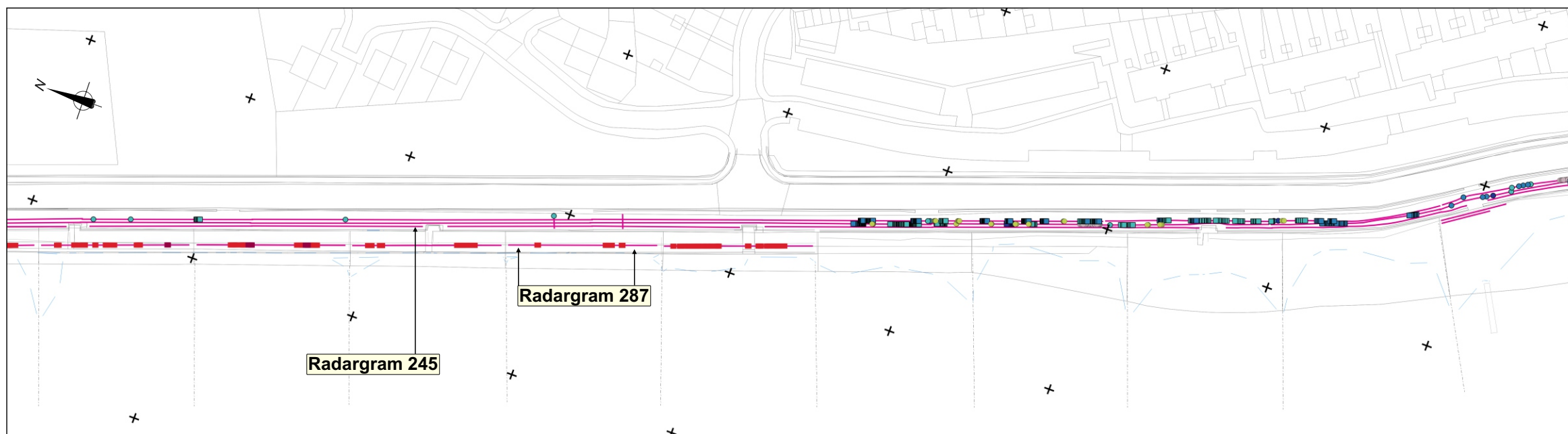
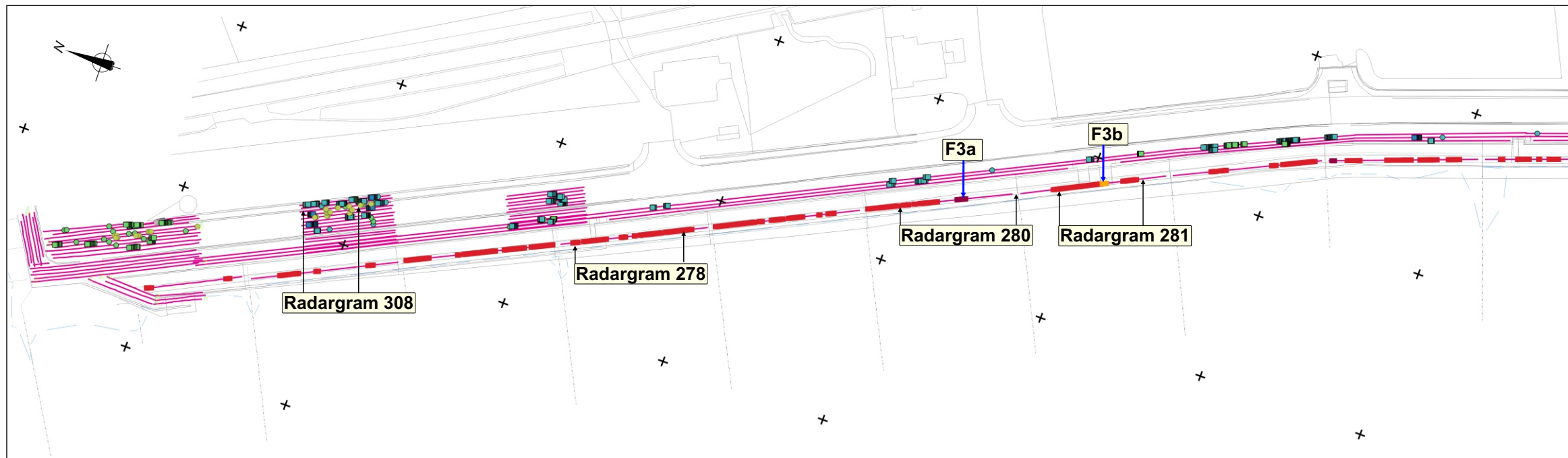
Project: **Barmouth Promenade**

Title: **GPR Line 2
EXAMPLE RADARGRAMS**

TERRA DAT down to earth geophysics
Tel: +44 (0) 2920 700127
Web: www.terradat.co.uk
Email: web@terradat.co.uk

Scale:
Drawn by/Ref: JH/7328/3
Date: 9th February 2021

FIGURE 3



View looking south along the promenade.

SCALE



KEY

- GPR Profiles
- Simplified base map (provided by Client)

Footpath and roadway

- ■ 0 to 0.3 m diffraction hyperbola/reflector
- ■ 0.3 to 0.7 m diffraction hyperbola/reflector
- ■ 0.7 to 1.1 m diffraction hyperbola/reflector
- ■ 1.1 to 1.5 m diffraction hyperbola/reflector

- Zones of increased signal penetration
- Zones of increased signal penetration beneath joints

GPR Line 2

- Location of shallow reflector ~0.2 m bgl
- Location of dipping reflector ~0.2 to 0.4 m bgl
- Location of deep reflector ~0.7 m bgl

NOTES

- 1: Features on map provided by the Client.
- 2: Also available in dxf format.

Project:

Barmouth Promenade

Title:

FEATURE LOCATION PLAN



Tel: +44 (0) 2920 700127

Web: www.terradat.co.uk

Email: web@terradat.co.uk

Scale: 1:1500 @ A3

Drawn by/Ref: JH/7328/4

Date: 12th February 2021

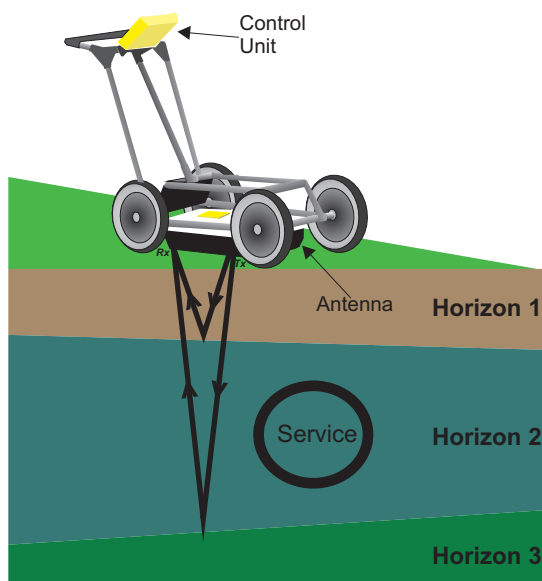
FIGURE 4

APPENDICES

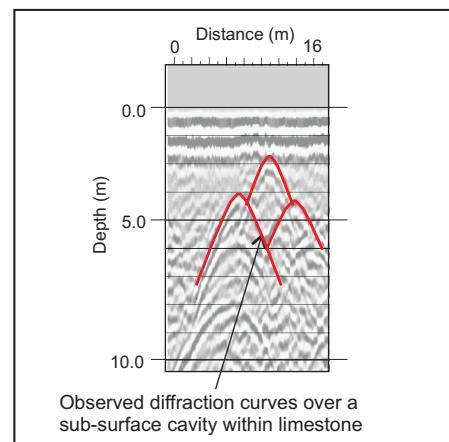
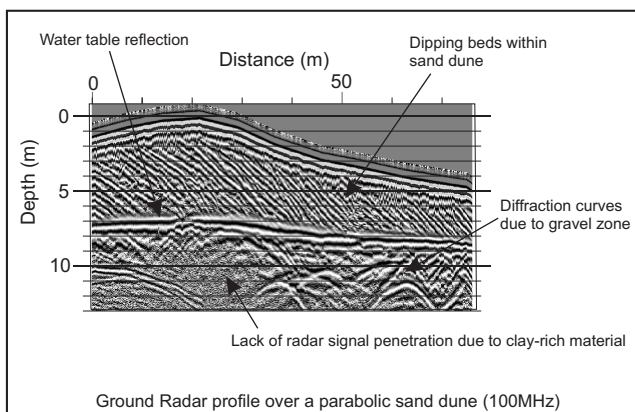
Appendix - Ground Penetrating Radar (GPR)

A Ground Penetrating Radar (GPR) survey involves one or two people either continuously towing a radar system or taking readings at very closely spaced intervals along selected traverse lines. GPR systems use a pulsed electromagnetic (radio wave) transmitted via a tuned frequency antenna that can penetrate soils, rock, concrete, and many other natural and man-made materials. Reflection events from geological or hydrological boundaries between sufficiently contrasting materials are recorded via a receiver antenna. A time-depth cross-section (radargram) of the shallow subsurface is constructed as the radar system is moved along a survey line. The radargram can be depth calibrated to enable detailed interpretation given known or measured velocities for the materials being investigated. While viewing relatively raw radar data can prove useful in the field there are numerous processing routines that can be employed to significantly improve the results. Final sections are presented showing annotated features of interest with apparent depth calibration.

General principle of Ground Radar



GPR Survey in progress



In order to improve the quality of the recorded radar data, a number of processing routines can be applied to the data using dedicated software (REFLEX). The final radar sections are converted to depth by applying a conversion velocity, which is usually based on an average velocity value for the local sediments. Without any additional calibration the measured depth to a particular feature is likely to be resolved within a 20% error margin depending on the local velocity structure.

Constraints:

The main limitations affecting radar surveys are the presence of conductive materials near surface (e.g., clay and water) which reduce penetration, and blocky material which scatters signal.