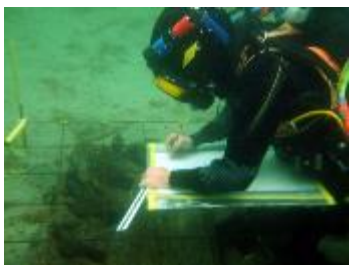
Appendix 12.1

Marine Archaeological Geophysical Survey Report

Marine Geophysical Survey
Arklow Waste Water Marine Outfall
Arklow, Co. Wicklow
16R0219

Marine Geophysical Survey
Arklow Waste Water Marine Outfall
Arklow, Co. Wicklow
16R0219

25 October 2017

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CONTENTS

Abbreviations

ADCO	The Archaeological Diving Company Ltd
CD	Chart Datum
DCHG	Department of Culture, Heritage and the Gaeltacht
E	Easting
EIS	Environmental Impact Statement
IH	Irish Hydrodata Ltd
N	Northing
NGR	National Grid Reference
NMS	National Monuments Service
SMR	Sites and Monuments Record
UAIA	Underwater Archaeological Impact Assessment

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Executive Summary

The Archaeological Diving Company Ltd (ADCO) was appointed by Irish Archaeological Consultancy Ltd on behalf of Irish Water to carry out a marine geophysical survey and archaeological interpretation of the seabed offshore of Ferrybank townland at Arklow, Co. Wicklow, to inform the Arklow Sewerage Scheme, Marine Outfall.

Site survey was carried out in 07 April 2017 by Irish Hydrodata Ltd under licence 16R0219 granted to the report author, and the primary data and project mapping was made available for archaeological interpretation.

The marine geophysical survey included the corridor for the proposed marine outfall pipeline, and the locations of 10 grab sample locations extending to the north, east and south of the outfall corridor.

The following surveys were conducted across the survey area: side-scan sonar; magnetometry and sub-bottom profile.

The known archaeological record is informed by the Sites and Monuments Record and the Historic Shipwreck Inventory. There are no known archaeological sites within the development area.

The marine geophysical survey was comprehensive and thorough.

A series of anomalies were detected but none are determined to be clearly archaeological in nature.

The pipeline installation will require excavation of a trench along the route of the outfall and this will be a direct impact on the seabed.

The report finds no archaeological constraint to the project proceeding.

Consideration should be given to inspecting those side-scan sonar anomalies that lie within the development area of the proposed outfall and its wayleave, to confirm and/or resolve their archaeological risk. These comprise anomalies ss2 tyres; ss3 rock(?); ss6 metal(?); ss 10 rock(?); ss12 rock(?).

Archaeological monitoring of the sea-bed and related disturbance works during construction is recommended, with the proviso to resolve fully any material of archaeological interest recovered at that point.

Recommendations are subject to the approval of the Depart of Culture, Heritage and the Gaeltacht (DCHG).

1.0 Introduction

The Archaeological Diving Company Ltd (ADCO) was appointed by Irish Archaeological Consultancy Ltd on behalf of Irish Water to carry out a marine geophysical survey and archaeological interpretation of the seabed offshore of Ferrybank townland at Arklow, Co. Wicklow, to inform the Arklow Sewerage Scheme, Marine Outfall (Figure 1).

Site survey was carried out in 07 April 2017 by Irish Hydrodata Ltd under licence 16R0219 granted to the report author, and the primary data and project mapping was made available for archaeological interpretation.

The marine geophysical survey included the corridor for the proposed marine outfall pipeline, and the locations of ten grab sample locations extending north, east and south of the outfall corridor, as tabulated in Table 1 (Figure 2).

Item	ING E	ING N
Terminus of Outfall	326270	173350
Grab Sample 1	326305	173346
Grab Sample 2	326302	173100
Grab Sample 3	325891	173272
Grab Sample 4	326546	173349
Grab Sample 5	326358	173590
Grab Sample 6	326227	172545
Grab Sample 7	326582	174095
Grab Sample 8	327070	173343
Grab Sample 9	326248	171312
Grab Sample 10	327106	175165

Table 1: Location of outfall terminus, and grab sample sites. Source: Project drawings.

The weather was good and the survey team managed to get the pipeline route corridor and the grab sample locations surveyed.

2.0 Proposed Development

The proposed marine outfall is part of the wider waste water treatment project for Arklow. The marine portion of the outfall will measure 1000m in length, with an additional 520m of pipe being laid as open cut. The outfall will extend East-Northeast from the foreshore in Ferrybank townland, north of the mouth of the Avoca River (Figure 2).

3.0 Receiving Environment

The focus on this section relates to the known archaeological and cultural heritage assets of the foreshore and related marine environment within which the outfall will be placed.

There are no recorded archaeological features close to or on the foreshore, which is today surfaced in rock armour coastal protection works. These effectively bury the original shoreline, which the First Edition Ordnance Survey map (*c.* 1840) records as a small delta that formed part of the Avoca River's estuary (Figure 3). The map indicates a series of sand bars and lobes through which the river meandered before entering the sea. The present-day river mouth is a former channel of the delta that lay to the south and has been enhanced. The estuarine land to the north was reclaimed since the late 1800s and assumed its present character already by the mid-1900s. There is no indication on the First Edition Ordnance Survey map of manmade features on the foreshore indicative of cultural heritage assets, such as paths, fishtraps, or boatwrecks.

The Historic Shipwreck Inventory maintained by the National Monuments Service is the most comprehensive archival record of shipwreck events recorded around the Irish coast since records were maintained systematically from the mid-1700s. The Inventory records locations where ships were noted as wrecking as well as locations where wreckage has been found. The former constitutes the larger collection of records and serves to provide a sense of the nature and intensity of wrecking events along a particular stretch of coastline. The latter provides the best indication of actual wreckage at a particular location since it is based on the recorded presence of wreckage. These events on the Wicklow coast included in the published volume of the Shipwreck Inventory.[1] The contents can be updated with the results of the Geological Survey of Ireland's ongoing inshore surveys known as the INFOMAR survey.[2]

[1] Karl Brady, *Shipwreck inventory of Ireland: Louth, Meath, Dublin and Wicklow*, Government Publications Office, Dublin, 2009, pp 450–471.
[2] http://www.infomar.ie/data/Google.php

While there are more than 173 recorded wrecking events associated with Arklow, the Avoca River and the Arklow Coast, there are no known or recorded wrecksites within the development area. The closest known wrecksites lie to the east, further out to sea, and these four instances are all sites identified by marine geophysical survey (Figure 4). The closest site to the proposed outfall lies 3.1km southeast of the outfall terminus.

4.0 Methodology

The requirements for archaeologically-led marine geophysical survey in Ireland are set by the National Monuments Service, and these are presented as Appendix A. The present survey sought to meet and exceed these requirements, by increasing the number of survey lines and running them closer together to ensure detailed coverage. Irish Hydrodata Ltd (IH) carried out the survey work. The following methodology was to be employed:

- 20m line spacing E/W + 100m line-spacing N/S for side-scan sonar, magnetometry, sub-bottom profiling and bathymetry.
- Marine Mammal Observer.
- Positioning of the survey vessel achieved using Trimble Ag132 DGPS (Fig. 2.1) with OMNISTAR corrections, to provide sub-meter horizontal accuracies. Positioning on Irish National Grid.
- Tidal data recorded at Arklow, the data to be used for reduction of bathymetric data to datum.
- The shallow parts of the survey area were surveyed at around HW to ensure that the complete survey area is covered
- The survey was carried out at a line spacing of 20m in the East-West direction and at 100m line spacing in the North-South direction for the outfall location, and smaller detailed grids for each of the grab sample locations.
- IH's licensed survey vessel was used for the work. The vessel is a 21' launch with cabin and is fully equipped with safety equipment including in-hull echosounder transducers.
- Bathymetric data was acquired using a Knudsen 320M simultaneous dual frequency (33kHz, 210kHz) precision survey echosounder. Speed of sound in water was measured using an Odom Hydrographics Inc. 'Digibar'. Depth data was reduced to OD Malin Head or other agreed datum. The survey was managed using the latest version of the hydrographic survey software package 'Hypack'. Survey lines were run at 20m line spacing parallel to the proposed pipeline route. Data was acquired at a rate of about one depth every 0.3m along the survey lines. The bathymetry was reduced to datum and was provided to the client in digital form as an AutoCAD drawing.

- An L^3-Klein System 3000 simultaneous dual frequency digital side-scan sonar system was employed for the side-scan sonar survey. This system operates at 100kHz and 500kHz simultaneously, thereby providing a greater possibility of detecting objects and providing a clear image of the seabed. Data from both frequencies is logged digitally using 'SonarPro' software and either or both datasets can be interpreted during post-processing. Data is logged in both SDF and XTF formats. Survey lines were steamed at 20m line spacing parallel to the proposed pipeline route within the survey area. The shallow water regions were surveyed at high water to maximise the coverage within the survey area. The side-scan range was to be set to 50m or 37.5m port and starboard to ensure better than 100% overlap and good data beneath the towfish. Data was to be post-processed using 'SonarPro' and 'SonarWizMap' software. Data was to be interpreted and a general indication of seabed type e.g. sand, rock etc. will be provided. Any obstructions, either man-made or natural were to be identified. The results would be provided as a chart in AutoCAD format and in hardcopy format. The original side-scan data without slant-range correction was provided to ADCO to assess the archaeological potential. All other data needed for archaeological assessment such as trackplots etc. provided.
- A Geometrics G881 marine magnetometer was employed for this aspect of the survey. The G-881 system is particularly well suited for the detection and mapping of all sizes of ferrous objects. It is an extremely high resolution Caesium vapour, small size, system for professional surveys. The G-882 is focused for operation in small boat, shallow water surveys. The magnetometer survey carried out simultaneously with the sidescan sonar survey and over the same planned survey lines. Data was post-processed using 'Hypack' software. Data was interpreted and the locations of all anomalies plotted. The results were provided as a chart in AutoCAD format.
- A Datasonics chirp sub-bottom profiling system was to be employed. Survey lines will be steamed at 20m line spacing parallel to the proposed pipeline. Data was post-processed using 'Coda Geokit' 'software. Data was interpreted to produce vertical profiles along each survey line perpendicular to the coast. The results were provided as profiles in AutoCAD drawing format.
- A Hobo water level recorder was deployed at a suitable location adjacent to the survey area for the duration of the field works, to record tidal levels.

5.0 Observations

5.1 Survey Grid

The survey grid was a rectangular-shaped area that extended 1000m offshore aligned with the proposed outfall, and measured 250m across (Figure 5, see IH project drawings for more detail in Appendix B). Within the grid was a series of seven East-West long survey lines that were spaced 35m apart, with variations up to 40m apart due to survey-boat movement. A series thirteen shorter cross lines spaced approximately 70m apart were set at right angles to the long lines. The survey grid covered fully the proposed cone-shaped footprint for the outfall and its 50m wayleave, and extended beyond the limits of that footprint. It reached within 30m of the rock-armoured shoreline, and would have accessed the tow of the rock armour that covers the natural shoreline.

For each of the Grab Sample (GS) locations outside the outfall corridor, a 100m x 100m survey box was constructed centred on the GS coordinate. A series of three East-West and three North-South survey lines spaced approximately 40m apart was run over each box (see IH project drawings for detail in Appendix B).

The result is a sequence of very comprehensive survey grids for the project that exceeds the requirements for marine geophysical survey for archaeological purposes in Ireland (see Appendix A).

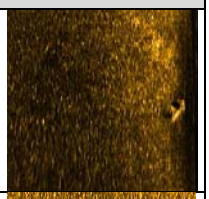
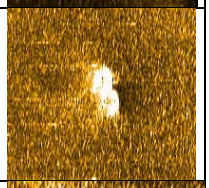
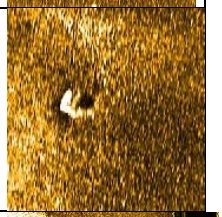
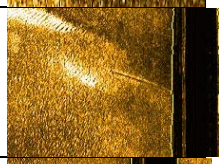
5.2 Side-scan sonar

Side-scan sonar detects the seabed surface and is an excellent means of discerning natural topographical variations as well as more discrete features that can be man-made in origin, such as shipwrecks, debris and even timber features such as fishtraps and pier fragments.

The seabed across the areas surveyed is predominantly a coarse sand. Inshore, a smooth sand is predominant (Plate 1) with some presence of sand ripples. As one proceeds seawards, a more varied surface is presented, suggesting spreads of sand and perhaps silt and some stone (Plate 2). This in turn is replaced with a series of Northwest-Southeast oriented low linear arrangements of silty sand (Plate 3). At the proposed terminus of the outfall, immediately to the north, there appears to be an expanse of shingle or a light shoaling (Plate 4). This seascape is seen again in the various Grab Sample locations, while the more distant Grab Sample locations appear to be in locations of featureless flat sand (Plates 5–7).

A series of fifteen anomalies appear in the side-scan sonar data. These are presented in Table 2, and Figure 5. The majority are most probably rocks and are small-scale anomalies (approximately 1m in length) but stand out from the ambient seascape and as such are presented as anomalies. Two such are observed in the GS locations

(ss14 in GS4, and ss15 in GS5). There are several non-natural anomalies as well (anomalies ss4, ss5, ss7, ss8, ss11, ss13). These non-natural anomalies are all identified to the north of the outfall route. None of them appear to be obvious shipwreck remains.

Ref	Anomaly	Latitude N	Longitude W	ITM E	ITM N	ING E	ING N	Image
ss1	Rock? 1.9m long	52:47.8111	06:08.4873	725334	673380	325411	173341	
ss2	Two conjoined tyres, 1.6m diameter each	52:47.7525	06:08.4401	725389	673274	325465	173234	
ss3	Rock? 1.5m long	52:47.7442	06:08.4707	725355	673256	325431	173216	
ss4	Cable? 12m+ long	52:47.8101	06:08.4192	725410	673380	325486	173340	
ss5	Feature, 8.6m long, 1.3m wide, 0.3m high	52:47.8141	06:08.3275	725512	673390	325588	173350	
ss6	Metal? (see mg7) 1.9m long	52:47.7601	06:08.3046	725541	673291	325618	173251	
ss7	Pier head, 16.3m long, 4m wide	52:47.6355	06:08.2863	725568	673061	325645	173022	
ss8	Feature 18m long of two x 7.1m-long linear elements, 2.1m wide, 0.3m high	52:47.8178	06:08.2909	725554	673399	325631	173359	

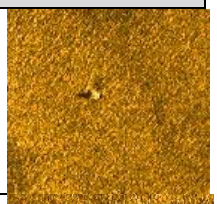
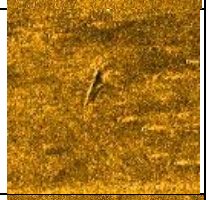
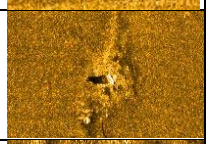
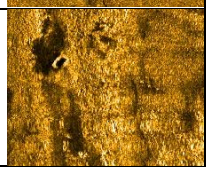
Ref	Anomaly	Latitude N	Longitude W	ITM E	ITM N	ING E	ING N	Image
ss9	Rock? 1.1m long	52:47.8400	06:08.0119	725866	673448	325943	173408	
ss10	Rock? 3m long	52:47.8159	06:07.7742	726135	673410	326212	173371	
ss11	Feature, linear, 7m long	52:47.8269	06:08.2035	725651	673418	325728	173378	
ss12	Rock? 2.5m long	52:47.7356	06:08.0452	725834	673254	325911	173214	
ss13	Feature, linear, 4.3m long	52:47.8235	06:08.0410	725834	673415	325912	173376	
ss14	Rock? 2m long, 0.6m high	52:47.8088	06:07.4498	726499	673407	326577	173367	
ss15	Rock? 2m long, 1.8m wide	52:47.9133	06:07.6530	726266	673592	326343	173552	

Table 2: List of side-scan sonar anomalies detected in the primary data sets.

5.4 Magnetometry

Magnetometry is a technique used to determine variations in the earth's magnetic field. The technique measures variations in nano tesla (nT) measurements. It can discern natural changes across large areas that reflect topographic differences associated with underlying rock formations. It can also detect cultural features that have a metal content. While side-scan sonar presents a swathe of data across the surface, magnetometry records data immediately beneath the device, so it only gathers information directly underneath it. This means that line-spacing at 50m apart (the recommended spacing in the NMS guideline) can miss material within the two lines surveyed. This constraint is addressed by running survey lines more closely

together, as has been done in the present survey. In contrast to side-scan sonar, magnetometry can also detect buried features. It is therefore a key tool used for identifying archaeological remains, where the variation in nano tesla will typically form localised defined spikes and troughs.

The magnetometry data acquired across the survey areas reflects a series of localised variations but they are for the most part small-scale variations and are not sharply defined. The grab sample locations reveal no such variations. A series of sixteen variations occur within the main outfall survey area, and are presented in Table 3 and Figure 5.

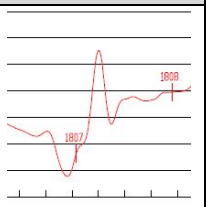
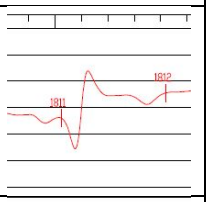
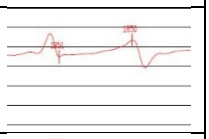
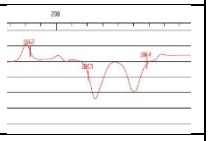
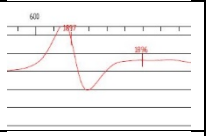
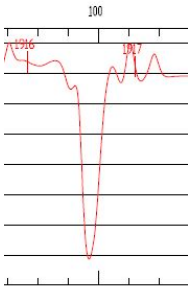
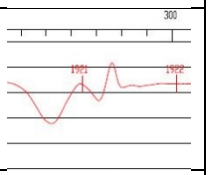
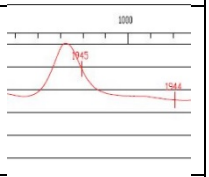
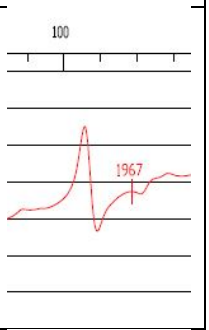
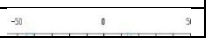
While the majority of the magnetic anomalies are small in scale, displaying variations in the order of 20nT or so, two anomalies are more striking. Anomaly mg9 shows a variation of more than 120nT, which is striking. The anomaly is located inshore within the wayleave area to the north of the proposed outfall; there is no corresponding side-scan sonar anomaly in this location, so it suggests that the source of the magnetic anomaly is buried.

Anomaly mg12 is perhaps the next most striking localised variation, with a difference of 50nT. This is a less intensely recorded feature. Anomaly mg12 is located within the central area of the proposed outfall, close inshore.

There is a spatial aspect to the distribution of magnetometry anomalies, where the majority are located inshore (Figure 5). This is in keeping with an expectation of localised debris. As with the side-scan sonar anomalies, magnetometry anomalies lie north of the outfall footprint, but many in this instance occur within the outfall area: mg1–mg7, mg12, mg15 and mg16. Anomalies mg8–mg10 lie within the wayleave area.

There is one close overlap with the side-scan sonar anomalies: mg7 and ss6 occupy the same position, and this suggests that ss6 retains a metal content. However, the variation is small scale and this might instead indicate that the metal content is low and/or that it is a rock with a magnetic content that is different from the ambient material.

Perhaps of greater interest is the near-correspondence between the linear feature ss5 and mg14, which lie 14m apart. The magnetic signature is strong, and this supports the suggestion that ss5 retains a metal content and, as its shape suggests, it is most likely manmade in origin.

Ref	Fix	Latitude N	Longitude W	ITM E	ITM N	ING E	ING N	Image
mg1	1807	52:47.8111	06:08.4873	725334	673380	325411	173341	
mg2	1811							
mg3	1850							
mg4	1851							
mg5	1862							
mg6	1863							
mg7	1864							
mg8	1897							
mg9	1917							
mg10	1921							
mg11	1945							
mg12	1967							
mg13	1992							

Ref	Fix	Latitude N	Longitude W	ITM E	ITM N	ING E	ING N	Image
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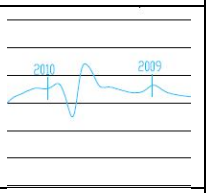
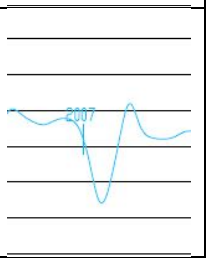
mg15	2010							
mg16	2007							

Table 3: List of magnetometry anomalies detected in the primary data sets.

5.5 Sub-bottom profile

Sub-bottom profiling presents an image of the layers underneath the seabed surface. It can distinguish sedimentary layers from bedrock, and it can highlight the presence of cuts or channels within the sedimentary levels. In common with magnetometry, sub-bottom profiling gathers information from directly underneath the device; it does not have the swathe or range capability of side-scan sonar. From an archaeological perspective, sub-bottom profiling can highlight the presence of substantial buried remains, such as shipwreck, but it does require the remains to be significant in size to be clear in the data.

The data acquired for the present project does not reveal obvious material of archaeological interest. In general, the deposits below the surface sand continue in depth with no significant variation. There are some troughs indicated in the data sets, which are too large to be man-made and are probably former channels, perhaps related to the inshore delta area of the estuary that is recorded on the First Edition Ordnance Survey maps (Plate 8). On the long survey lines, East-West, the profile data reveal the gentle slope seawards from the shoreline, and the presence of perhaps an underlying level of till deposit, which is revealed as a horizontal line within the buried deposit (Plate 9).

5.6 Conclusions

The marine geophysical survey has been comprehensive and thorough. It has observed the same areas of seabed from multiple directions, ensuring 100% coverage of the development area, and deploying a range of instruments to assess the potential of the seabed to retain cultural heritage assets. While a number of anomalies have been detected, there is no clear indication of archaeologically significant remains, either within the development areas, or on the seabed adjoining these areas.

6.0 Impacts

6.1 Construction design

The pipeline installation will require excavation of a trench along the route of the outfall and this will be a direct impact on the seabed. Construction of the outfalls would include works from both the land and sea. It is expected that several vessels may be required during the construction of the outfalls. Prior to the pipeline installation, the trench (in which the outfall is to be laid) would be excavated along the route of the outfall. The seabed material would be removed to achieve the required depth and slope of the trench. The trenching would be carried out through the use of dredging barges that would be either anchored to the sea bed or jacked up using steel piles. It is anticipated that the excavated material would be left to the side of the trench and naturally disperse.

6.2 Marine geophysical anomalies

The following side-scan sonar anomalies lie within the proposed development area and are therefore subject to direct impact from the outfall works:

- ss2 tyres; ss3 rock(?); ss6 metal(?).

The following side-scan sonar anomalies lie within the proposed wayleave adjacent to the outfall area and are therefore subject to impact from the outfall works:

- ss 10 rock(?); ss12 rock(?).

The following side-scan sonar anomalies lie within the proposed Grab Sample survey areas and may therefore be subject to impact from the associated sampling works:

- ss 14 rock(?); ss15 rock(?).

All other side-scan sonar anomalies lie outside the development area and are therefore outside any impact area associated with the outfall scheme.

The following magnetometry anomalies lie within the outfall area:

- mg1–mg7, mg12, mg15 and mg16,

Anomalies mg8–mg10 lie within the wayleave area.

Apart from mg7, none of these other magnetometry anomalies overlap with side-scan sonar anomalies; it is therefore likely that the magnetic anomalies lie buried and the source of the anomaly is only likely to be revealed during construction, if at all.

7.0 Recommendations

The report finds no archaeological constraint to the project proceeding.

7.1 Pre-construction recommendations

While no clearly identifiable archaeological features were detected within the development area, consideration should be given to inspecting those side-scan sonar anomalies that lie within the development area of the proposed outfall and its wayleave. These comprise anomalies ss2 tyres; ss3 rock(?); ss6 metal(?); ss 10 rock(?); ss12 rock(?).

Such inspection would be conducted by an archaeological dive team operation Surface Supplied Diving Equipment in accordance to the Diving at Work regulations, and under licence from the National Monuments Service to conduct archaeological Dive Survey and Detection Device surveys at each location. The work will help to resolve whether the anomalies retain archaeological interest.

7.2 Construction phase recommendations

Archaeological monitoring licensed by the National Monuments Service at the Department of Culture, Heritage and the Gaeltacht is recommended, with the proviso to resolve fully any material of archaeological interest recovered at that point.

7.3 Management recommendations

Appoint an experienced maritime archaeologist to advise the project team on archaeological and cultural heritage matters during construction; to acquire any consents required to conduct the work; and to supervise and direct the archaeological measures outlined above in Section 7.1 and 7.2.

THE TIME SCALE for the construction phase should be made available to the archaeologist, with information on where and when the various elements and ground disturbances and dredging will take place.

SUFFICIENT NOTICE. It is essential for the developer to give sufficient notice to the archaeologist/s in advance of the construction works commencing. This will allow for prompt arrival on site to undertake additional surveys and to monitor ground disturbances. As often happens, intervals may occur during the construction phase. In this case, it is also necessary to inform the archaeologist/s as to when ground disturbance works will recommence.

DISCOVERY OF ARCHAEOLOGICAL MATERIAL. In the event of archaeological features or material being uncovered during the construction phase, it is crucial that any machine work cease in the immediate area to allow the archaeologist/s to inspect any such material.

ARCHAEOLOGICAL MATERIAL. Once the presence of archaeologically significant material is established, full archaeological recording of such material is recommended. If it is not possible for the construction works to avoid the material, full excavation would be recommended. The extent and duration of excavation would be a matter for discussion between the client and the licensing authorities.

ARCHAEOLOGICAL TEAM. It is recommended that the core of a suitable archaeological team be on standby to deal with any such rescue excavation. This would be complimented in the event of a full excavation. The team should include provision for an archaeological dive team, in the event that discoveries are made underwater during dreding.

SECURE SITE OFFICES and facilities should be provided on or near those sites where excavation is required.

SECURE WET AND DRY STORAGE for artefacts recovered during the course of the monitoring and related work should be provided on or near those sites where excavation is required.

ADEQUATE FUNDS to cover excavation, post-excavation analysis, and any testing or conservation work required should be made available.

MACHINERY TRAFFIC during construction must be restricted as to avoid any of the selected sites and their environs.

SPOIL should not be dumped on any of the selected sites or their environs.

PLEASE NOTE: All of the above observations and conclusions are based on the archaeological information and information supplied for the Arklow Sewerage Scheme, marine outfall provided. Should any alteration occur, further assessment would be required.

Recommendations are subject to the approval of the National Monuments Service at the Department of Culture, Heritage and the Gaeltacht.

9.0 Acknowledgements

ADCO acknowledges the assistance of Faith Bailey, IAC in preparing for this work, and Irish Hydrodata Ltd for carrying out the marine geophysical survey. The survey data was interpreted archaeologically by Dr Niall Brady, who has also written the report. ADCO figures are prepared by Niall Brady and completed by Rex Bangerter.

Appendix A: Draft requirements for a geophysical survey for archaeological purposes

The Underwater Archaeology Unit, Department of the Environment, Heritage and Local Government (now the DCHG):

General:

Geophysical survey is usually required as part of an underwater archaeological assessment. The results of the geophysical survey should therefore form part of the overall archaeological assessment report. This report should comprise of the following:

- Introduction/Summary of requirement for survey and brief background to proposed work/development including who is undertaking the proposed works and any reference numbers, detection device licence numbers, date of report, etc.
- Details of equipment and personnel used, including qualifications.
- Details of survey methodology.
- Site location map showing proposed development/works.
- Survey grid superimposed on location map.
- Impact Statement detailing the possible impact of the proposed works on known or potential underwater archaeology.
- Historical and Archaeological section detailing background to area to be impacted. This should included (where relevant) consultation with the National Shipwreck Inventory for the area, Ports and Harbours Archive and Record of Monuments and Places, all held by the National Monuments Service of the Department of the Environment, Heritage and Local Government; Topographical Files of the National Museum of Ireland; Local sources and printed material such as books on shipwrecks, local journals and histories, etc.
- Track plots of the geophysical survey over the survey area.
- Raw geophysical data on CD to be included at end of report with details of software used.
- List of any anomalies identified and images of the anomalies with positions.
- Recommendations as to further archaeological mitigation requirements for the proposed works.

- Section 2(2) of the 1987 (Amend.) National Monuments Act states that it is prohibited to use without the consent of the Minister for Department of the Environment, Heritage and Local Government any detection devices in any place '*for the purpose of searching for archaeological objects'.* It is therefore necessary for any geophysical survey to be licenced by the National Monuments Service of the Department of the Environment, Heritage and Local Government. Application forms are available from the licensing section of the Department of the Environment, Heritage and Local Government, Dún Scéine, Harcourt Lane, Dublin 2.

- It should be noted that all sites should be dealt with on an individual basis. As such, each site will have its own specific requirements. Therefore a method statement should be attached to the application when applying for the survey licence. A copy of this method statement should also be forwarded to the office of the Underwater Archaeology Unit, Floor 2, 4-5 Harcourt Road, Dublin 2 so that the proposed methods are in line with the necessary requirements.

Specifications for geophysical survey undertaken for archaeological purposes:

Side-scan sonar:

- For archaeological purposes the side-scan sonar should have an operational frequency of 410/500 khz.
- Side-scan should be set at 50m survey line spacing
- If this is narrower then it should be corrected
- This should not be slant-range corrected
- There should be 100% coverage of sites and therefore overlap of areas may be required.

Magnetometer:

- A magnetometer should always be used in tandem with side-scan sonar
- Proton or caesium magnetometer should be used with 50m side spacing
- This should be used with DGPS

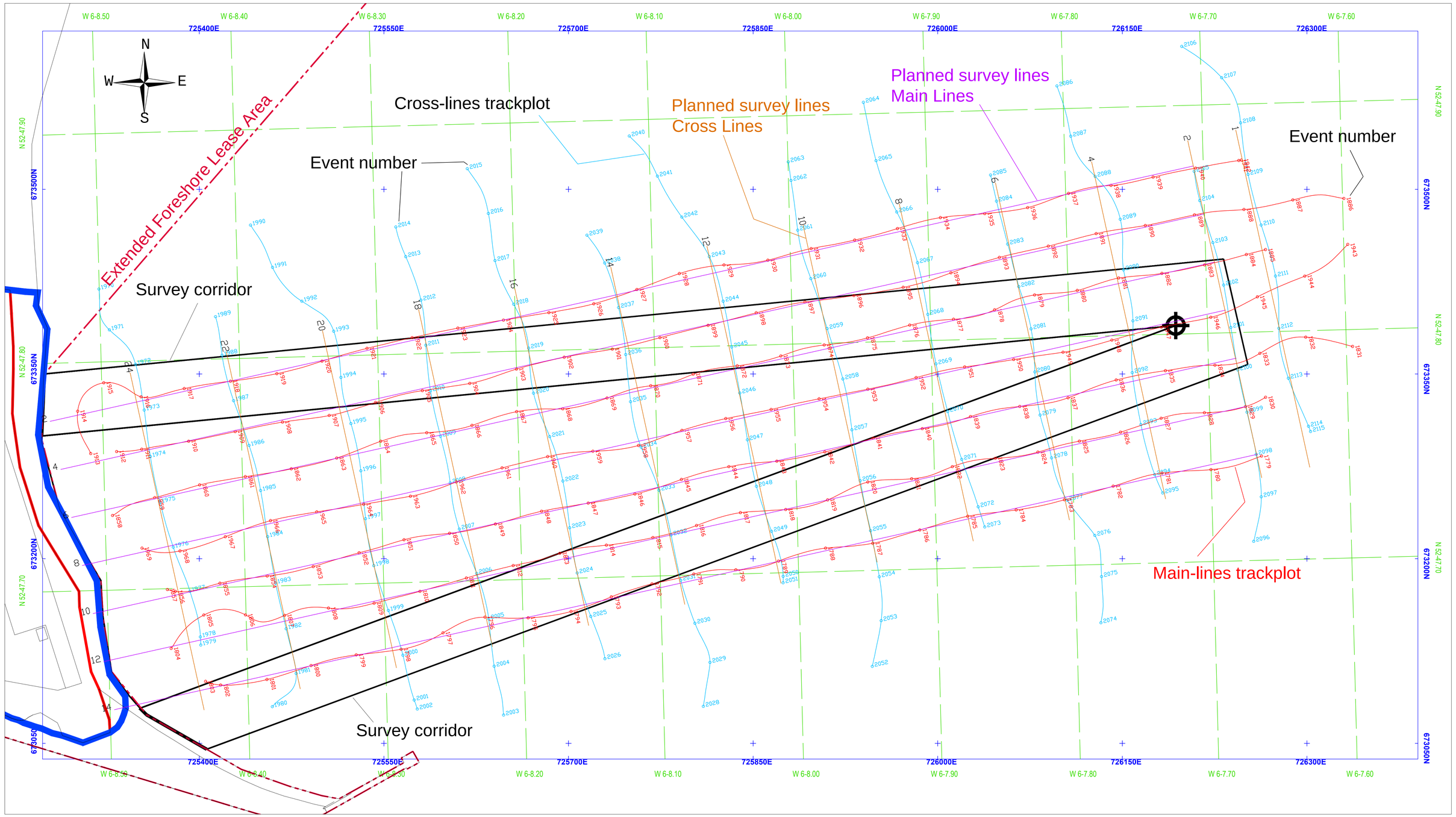
Sub-bottom profiler (optional):

- If using a sub-bottom profiler then the Chirp system is the preferred one as this gives the best resolution
- This should be used in conjunction with DGPS.

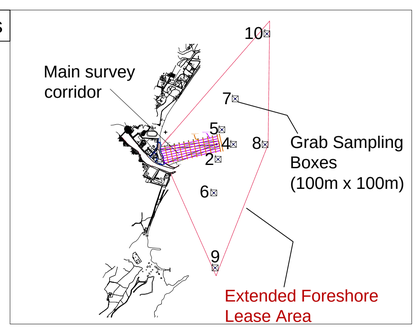
General:

- Co-ordinates should preferably be given in National Grid references but supported by latitude and longitude
- Track plots should also be recorded and included in the archaeological assessment report
- Track plots should be superimposed onto a locational chart
- All geophysical survey should be carried out by suitably qualified personnel. Preferably they should also have underwater archaeological experience. If this is not possible then the results must be viewed and interpreted by a qualified archaeo-geophysicist, details of whom should be included with the method statement accompanying the Detection Device licence application.
- A copy of the original Raw data/traces as well as the interpreted results of the geophysics should be sent to the Underwater Archaeology Unit of Department of the Environment, Heritage and Local Government or should be included with the Underwater Archaeological Assessment Report. Further archaeological mitigation may be required once the data has been reviewed.

Appendix B: Irish Hydrodata project drawings



Overview of survey areas



Notes:

1. Magnetic data was acquired using a Geometrics G882 magnetometer.
2. Positioning was by Trimble Ag DGPS.
3. The survey is mapped on Irish Transverse Mercator (ITM).

A layback of 20m has been applied to the trackplot. The event marks are at the location of the magnetometer towfish.

The magnetometer profiles are shown in Drgs. 1271-17-01A to 1271-17-01D.

Rev.	Date	Purpose of revision	Drawn	Chkd	Appr'd
A	11-04-17	For discussion	TB	JW	JW

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing.

0m 15m 30m 45m 60m 75m 150m

SCALE: 1 : 1500

Consulting Engineers: BYRNELOOBYARUP

Client: ervia

Project: **Arklow Wastewater Treatment Plant**

Drawing Title: Archaeological Marine Geophysical Survey Magnetometer Survey Trackplot in Outfall Corridor

Survey date: April 7th 2017

Archaeological Consultants: ADCO (The Archaeological Diving Company Ltd)

Surveyed by: IRISH HYDRODATA Ltd., Ballygarvan, Co Cork. T12 HD5Y

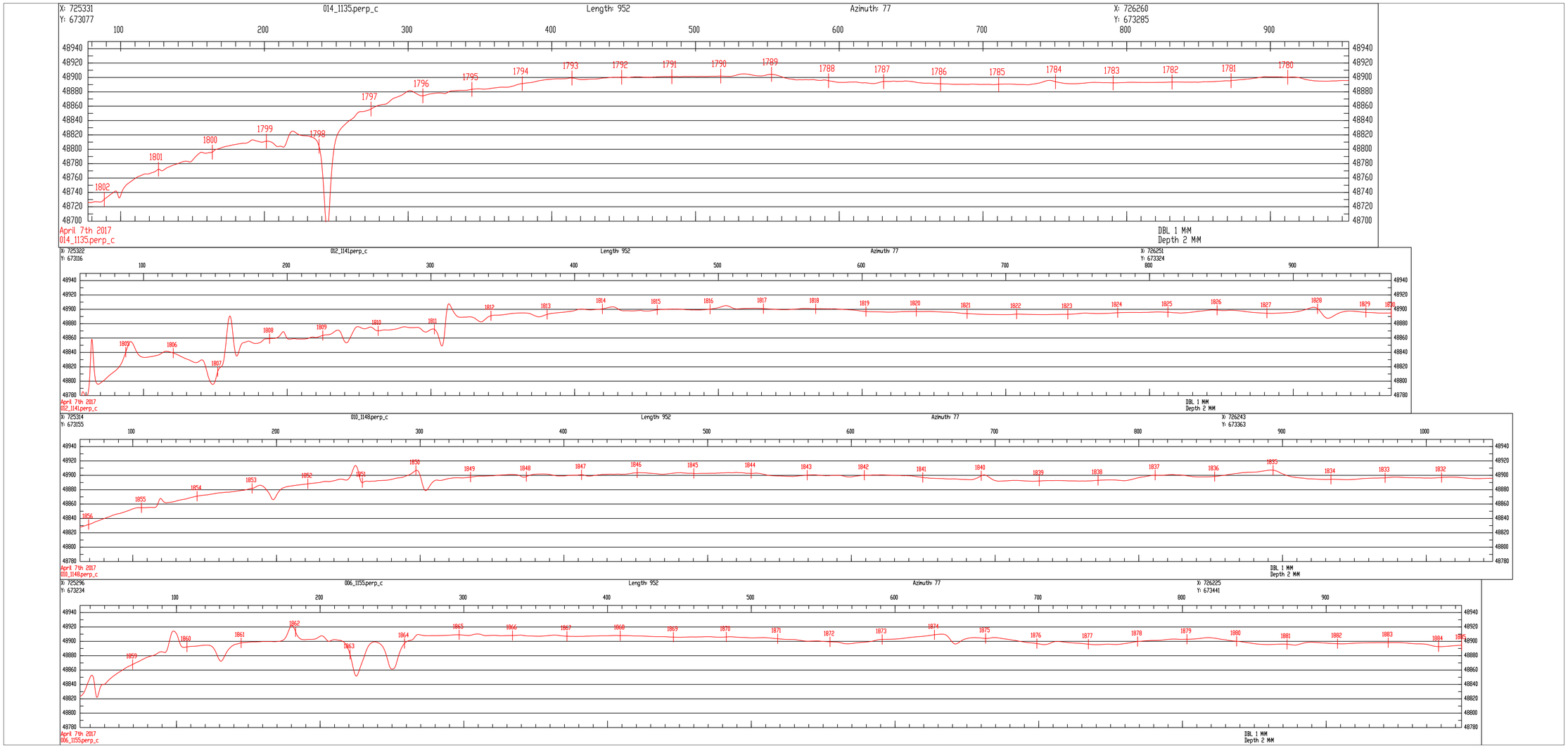
Drawing Status: For Discussion

Scale @ A1: 1:1500 — DO NOT SCALE

Job No.: 1271-17

Drawing No.: 1271-17-01 — Rev.: A

Outfall Corridor - Magnetometer Profiles - Main Lines 006, 010, 012, 014



Notes:

1. Magnetic data was acquired using a Geometrics G882 magnetometer.
2. Positioning was by Trimble Ag DGPS.
3. The survey is mapped on Irish Transverse Mercator (ITM).

A layback of 20m has been applied to the trackplot. The event marks are at the location of the magnetometer towfish.

The magnetometer trackplot is shown in Drg. 1271-17-01.

Scales
Horiz. 1:1500
Vert. 1:3000

Rev.	Date	Purpose of revision	Drawn	Chkd	Appr'd
A	11-04-17	For discussion	TB	JW	JW

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing.

0m 15m 30m 45m 60m 75m 150m
SCALE: 1 : 1500

Consulting Engineers
BYRNELOOBYARUP

Client
ervia

Project
Arklow
Wastewater Treatment Plant

Drawing Title
Archaeological Marine Geophysical Survey
Magnetometer Profiles in Outfall Corridor
Main Lines 6,10,12,14

Survey date: April 7th 2017

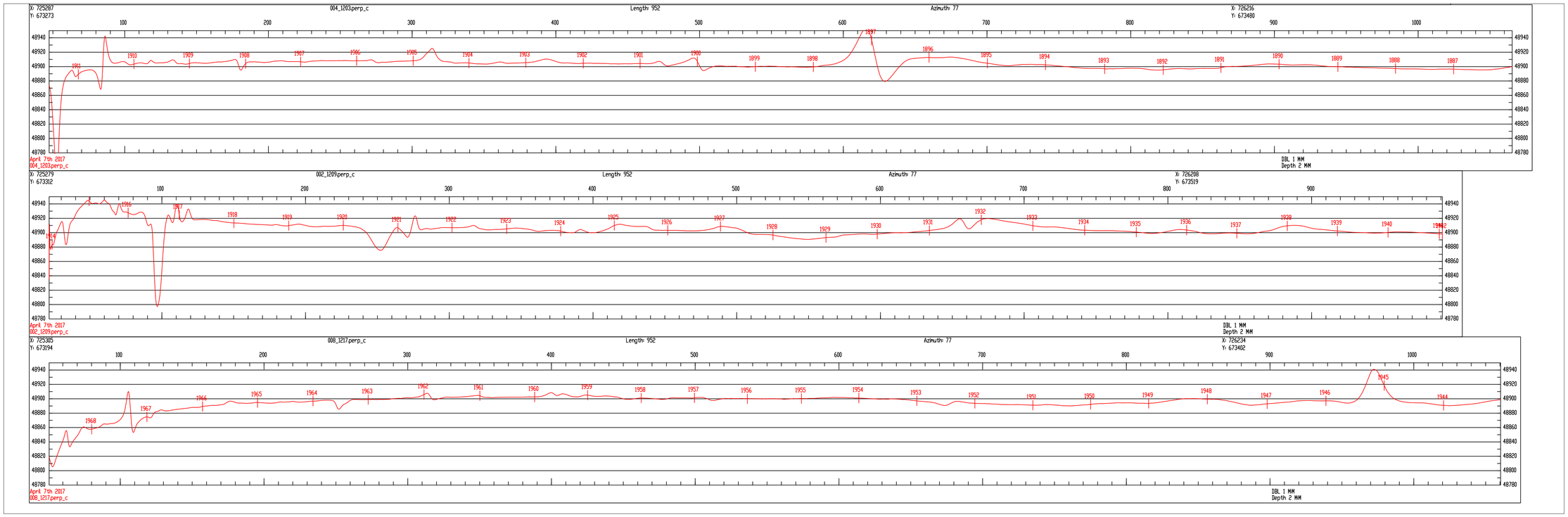
Archaeological Consultants
THE ARCHAEOLOGICAL DIVING COMPANY LTD ADCO

Surveyed by
IRISH HYDRODATA Ltd.
Ballygarvan, Co Cork.
T12 HD5Y

Drawing Status: For Discussion

Scale @ A1	1:1500	DO NOT SCALE
Job No.	1271-17	
Drawing No.	1271-17-01-A	Rev. A

Outfall Corridor - Magnetometer Profiles - Main Lines 002, 004, 008



Notes:

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2. Positioning was by Trimble Ag DGPS.
3. The survey is mapped on Irish Transverse Mercator (ITM).

A layback of 20m has been applied to the trackplot. The event marks are at the location of the magnetometer towfish.

The magnetometer trackplot is shown in Drg. 1271-17-01.

Rev.	Date	Purpose of revision	Drawn	Chkd	Appr'd
A	11-04-17	For discussion	TB	JW	JW

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0m 15m 30m 45m 60m 75m 150m

SCALE: 1 : 1500

Consulting Engineers: BYRNELOOBYARUP

Client: ervia

Project: **Arklow Wastewater Treatment Plant**

Drawing Title: Archaeological Marine Geophysical Survey Magnetometer Profiles in Outfall Corridor Main Lines 2,4,8

Survey date: April 7th 2017

Archaeological Consultants: THE ARCHAEOLOGICAL DIVING COMPANY LTD. SPECIALISTS IN LAND AND UNDERWATER ARCHAEOLOGY — ADCO

Surveyed by: **IRISH HYDRODATA Ltd.**
Ballygarvan, Co Cork.
T12 HD5Y

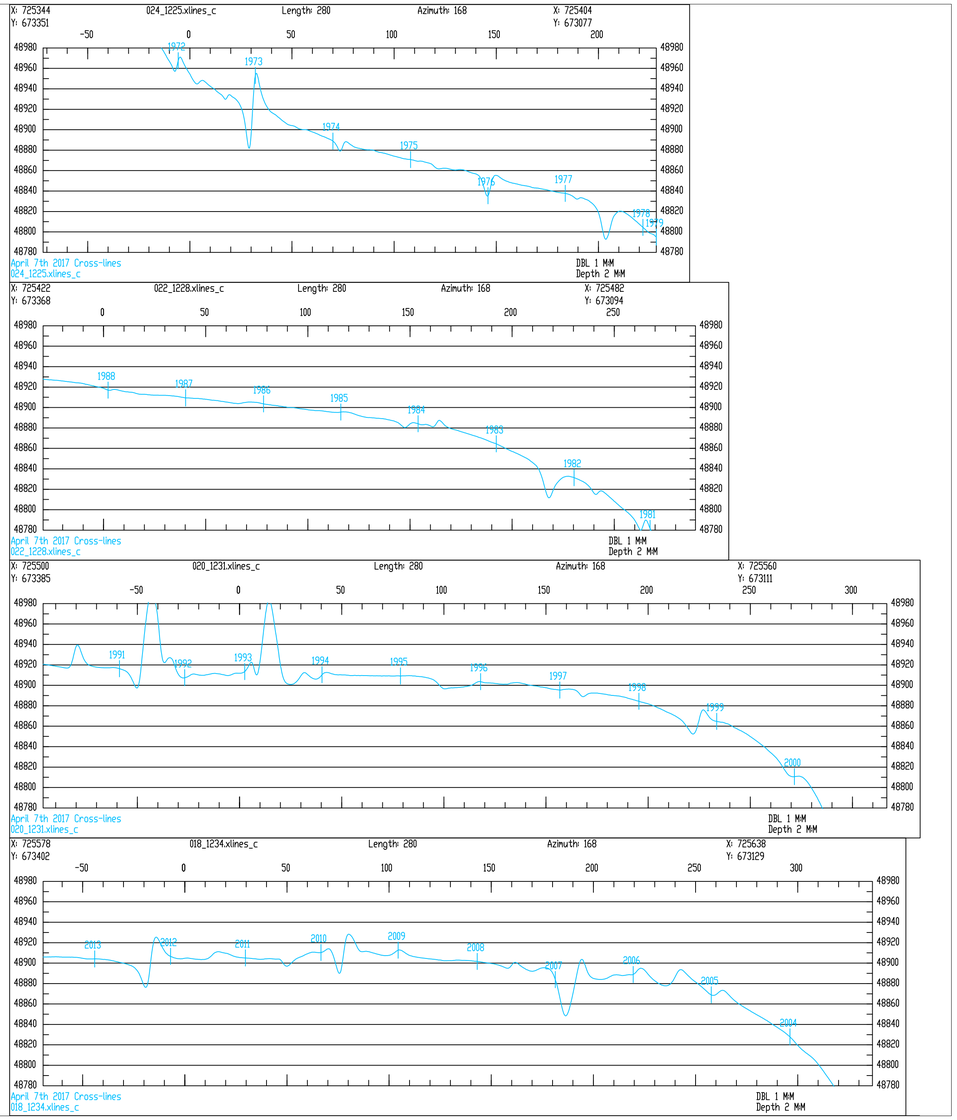
Drawing Status: For Discussion

Scale @ A1: 1:1500 — DO NOT SCALE

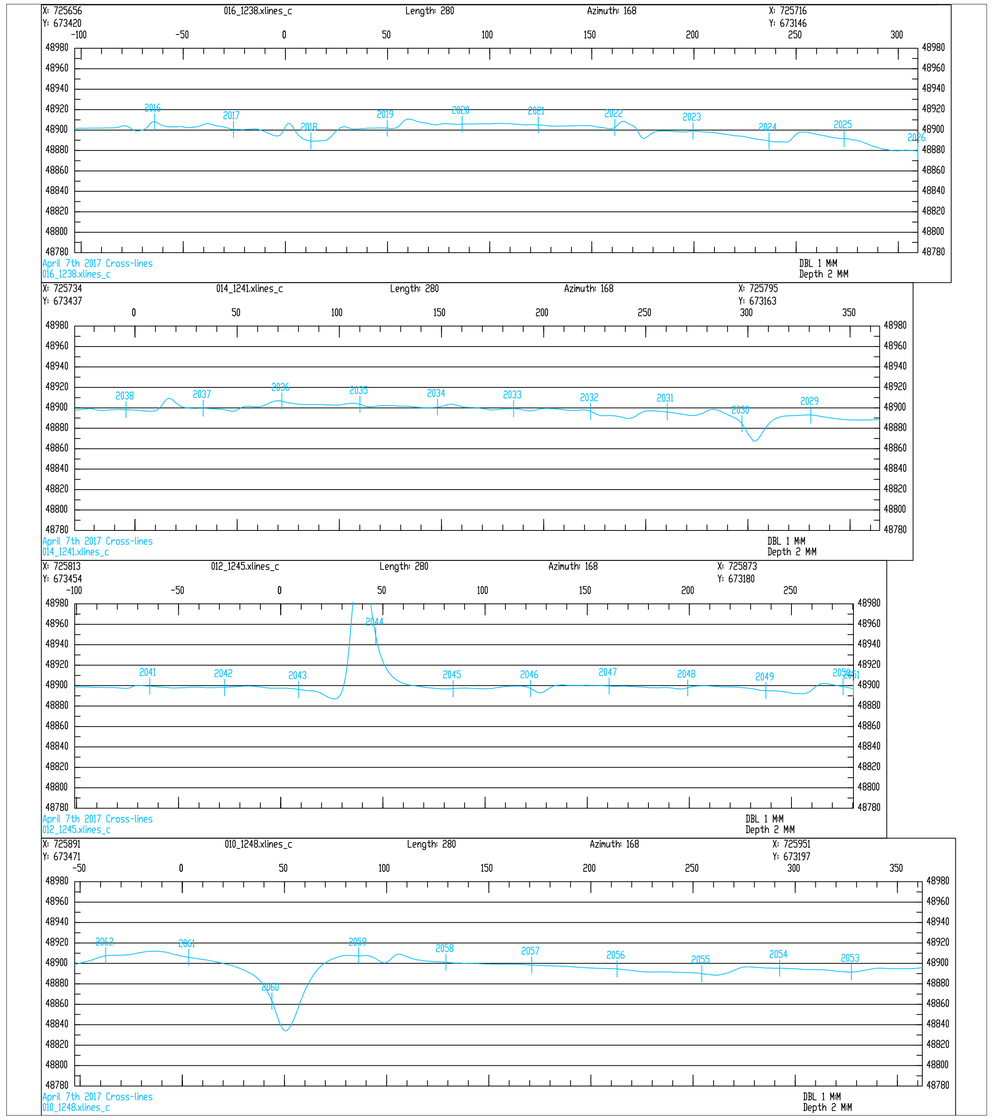
Job No.: 1271-17

Drawing No.: 1271-17-01-B — Rev.: A

Outfall Corridor - Magnetometer Profiles
Cross Lines 018, 020, 022, 024



Outfall Corridor - Magnetometer Profiles
Cross Lines 010, 012, 014, 016



Notes:

1. Magnetic data was acquired using a Geometrics G882 magnetometer.
2. Positioning was by Trimble Ag DGPS.
3. The survey is mapped on Irish Transverse Mercator (ITM).

A layback of 20m has been applied to the trackplot. The event marks are at the location of the magnetometer towfish.

The magnetometer trackplot is shown in Drg. 1271-17-01.

Rev.	Date	Purpose of revision	Drawn	Chkd	Appr'd
A	11-04-17	For discussion	TB	JW	JW

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing.

0m 15m 30m 45m 60m 75m 150m

SCALE: 1 : 1500

Consulting Engineers: BYRNELOOBYARUP

Client: ervia

Project: **Arklow Wastewater Treatment Plant**

Drawing Title: Archaeological Marine Geophysical Survey Magnetometer Profiles in Outfall Corridor Cross Lines 010 to 024 @2

Survey date: April 7th 2017

Archaeological Consultants: THE ARCHAEOLOGICAL DIVING COMPANY LTD SPECIALISTS IN LAND AND UNDERWATER ARCHAEOLOGY ADCO

Surveyed by: **IRISH HYDRODATA Ltd.**
Ballygarvan, Co Cork.
T12 HD5Y

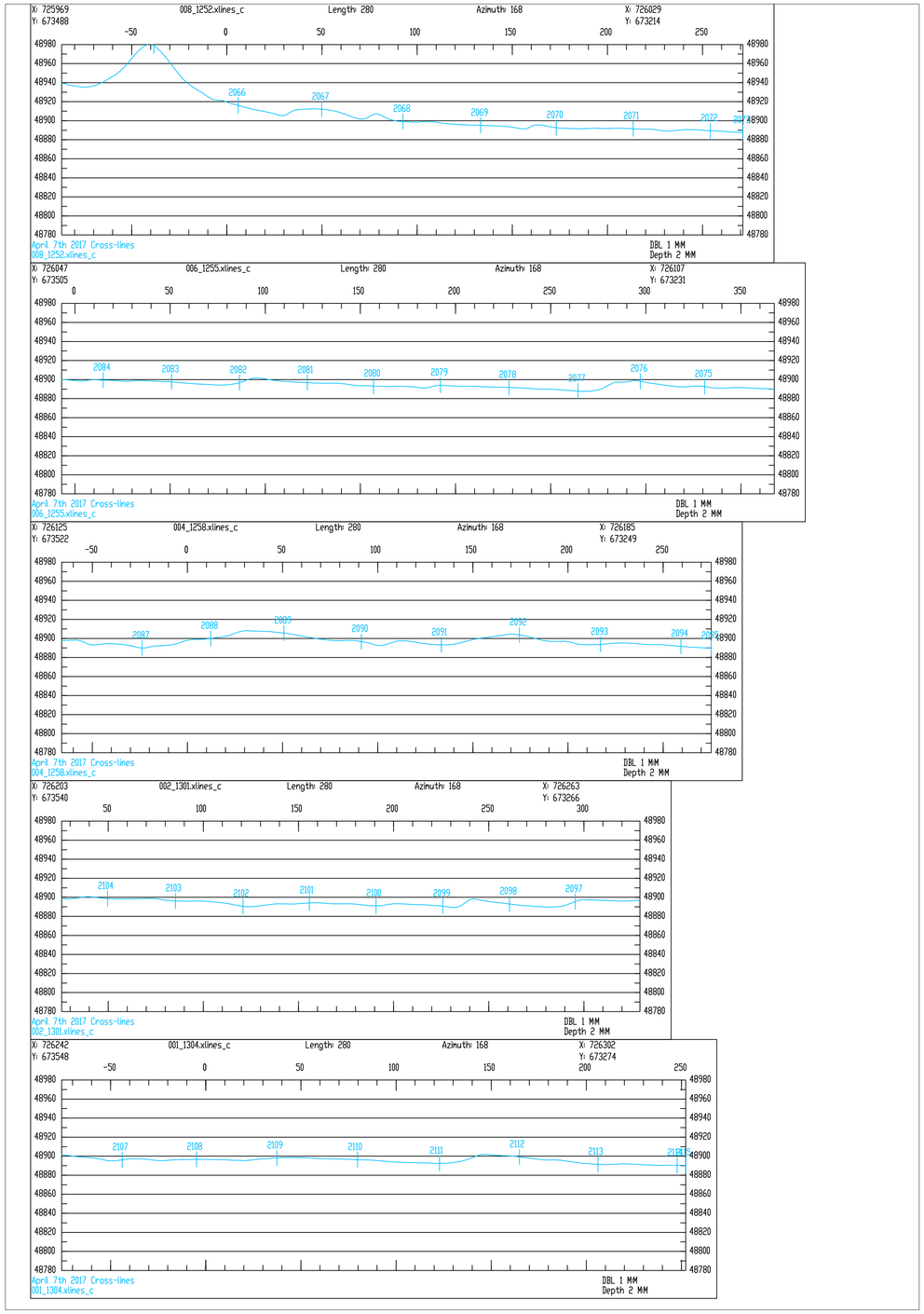
Drawing Status: For Discussion

Scale @ A1: 1:1500 — DO NOT SCALE

Job No.: 1271-17

Drawing No.: 1271-17-01-C — Rev.: A

Outfall Corridor - Magnetometer Profiles
Cross Lines 001, 002, 004, 006, 008



Notes:

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2. Positioning was by Trimble Ag DGPS.
3. The survey is mapped on Irish Transverse Mercator (ITM).

A layback of 20m has been applied to the trackplot. The event marks are at the location of the magnetometer towfish.

The magnetometer trackplot is shown in Drg. 1271-17-01.

Rev.	Date	Purpose of revision	Drawn	Chkd	Appr'd
A	11-04-17	For discussion	TB	JW	JW

0m 15m 30m 45m 60m 75m 150m

SCALE: 1 : 1500

Consulting Engineers: BYRNELOOBYARUP

Client: ervia

Project: **Arklow Wastewater Treatment Plant**

Drawing Title: Archaeological Marine Geophysical Survey Magnetometer Profiles in Outfall Corridor Cross Lines 001 + (002 to 008) @2

Survey date: April 7th 2017

Archaeological Consultants: THE ARCHAEOLOGICAL DIVING COMPANY LTD CONSULTANTS IN LAND AND UNDERWATER ARCHAEOLOGY — ADCO

Surveyed by: **IRISH HYDRODATA Ltd.**
Ballygarvan, Co Cork.
T12 HD5Y

Drawing Status: For Discussion

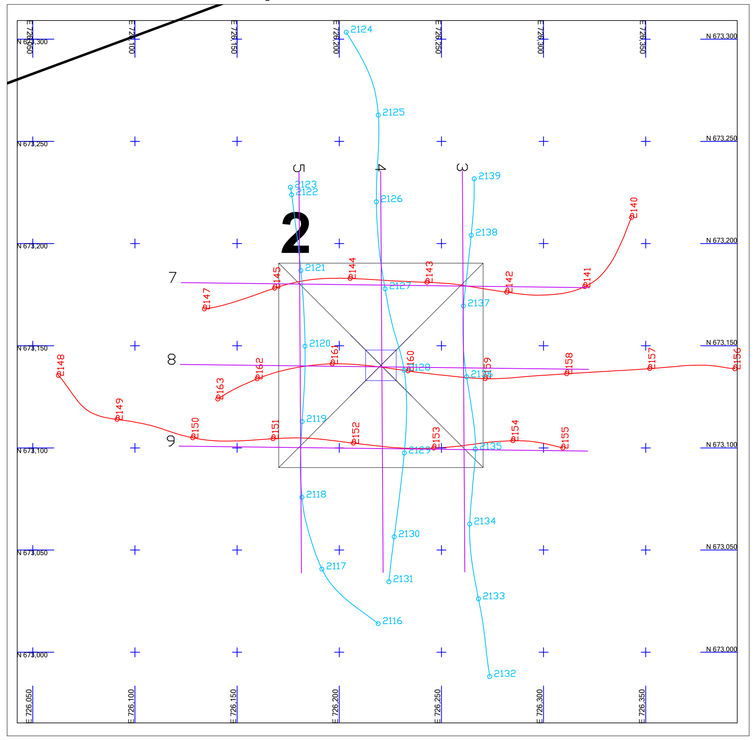
Scale @ A1: 1:1500 — DO NOT SCALE

Job No.: 1271-17

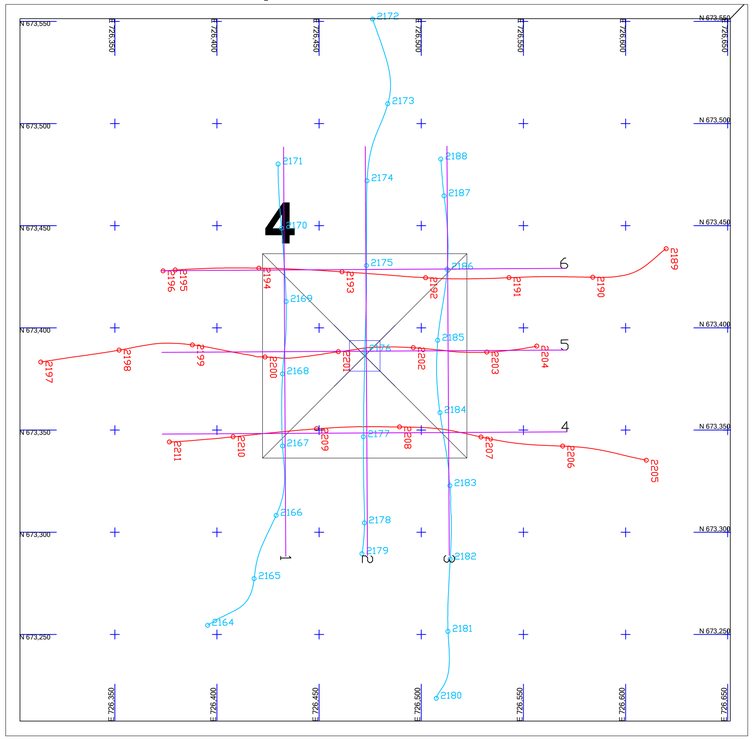
Drawing No.: 1271-17-01-D

Rev.: A

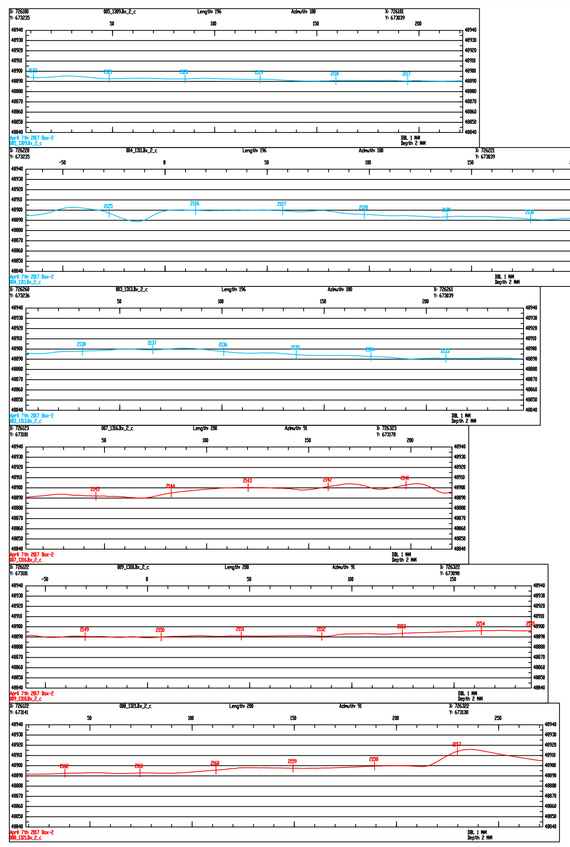
Box 2 - Trackplot



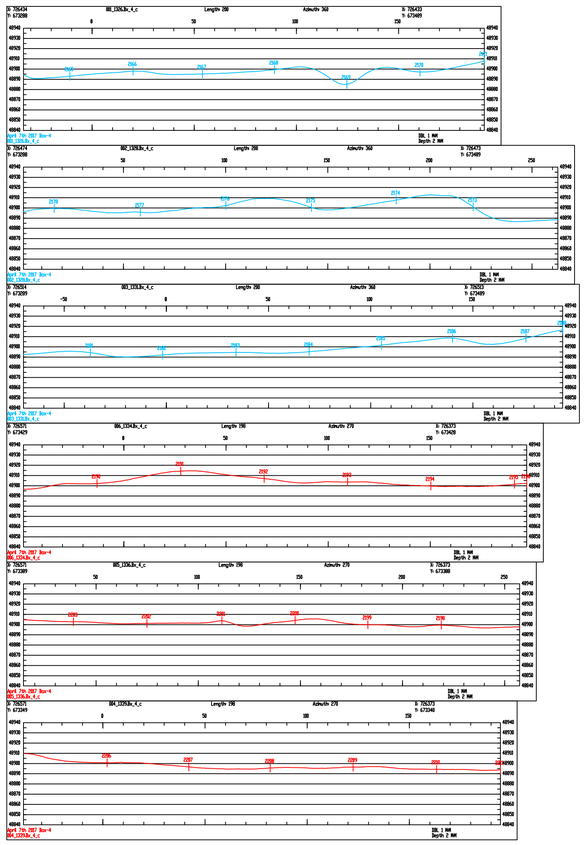
Box 4 - Trackplot



Box 2 - Magnetometer profiles



Box 4 - Magnetometer profiles



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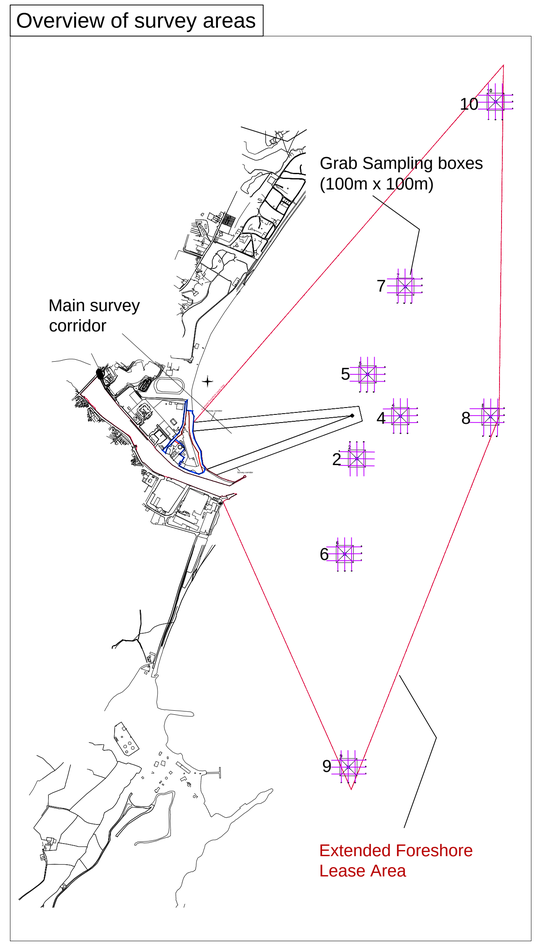
Overview of survey areas



Notes:

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3. The survey is mapped on Irish Transverse Mercator (ITM).

A layback of 20m has been applied to the trackplot. The event marks are at the location of the magnetometer towfish.

Survey date: April 7th 2017

0m 15m 30m 45m 60m 75m 150m

HORIZ. SCALE: 1 : 1500

Rev.	Date	Purpose of revision	Drawn	Chkd	Appr'd
A	11-04-17	For discussion	TB	JW	JW

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing.

Project

Arklow
Wastewater Treatment Plant

Drawing Title

Archaeological Marine Geophysical Survey
Magnetometer Survey Trackplot & Profiles
in Grab Sampling Boxes 2 and 4

Consulting Engineers: BYRNE LOOBY ARUP

Client: ervia

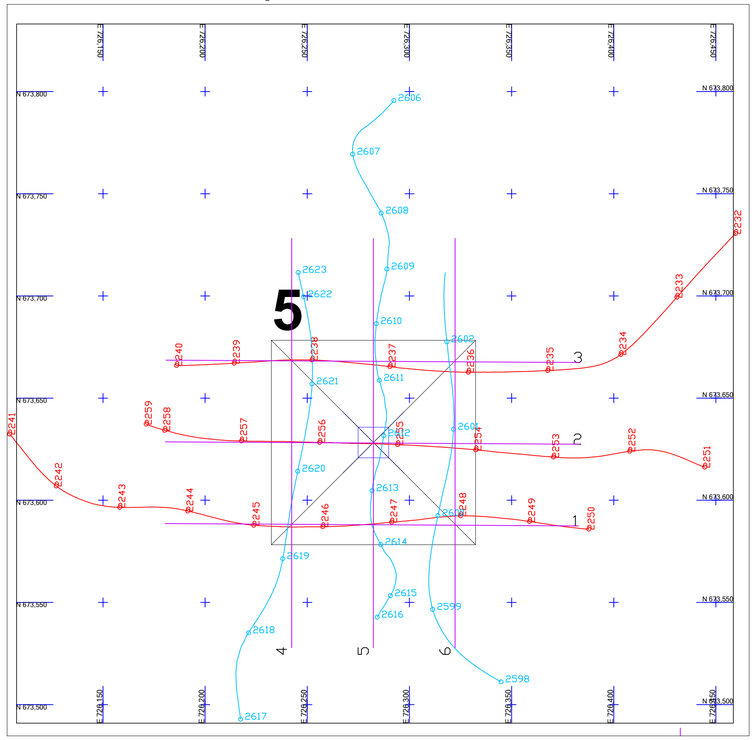
Archaeological Consultants: THE ARCHAEOLOGICAL DIVING COMPANY LTD SPECIALISTS IN LAND AND UNDERWATER ASSESSMENT — ADCO

Surveyed by

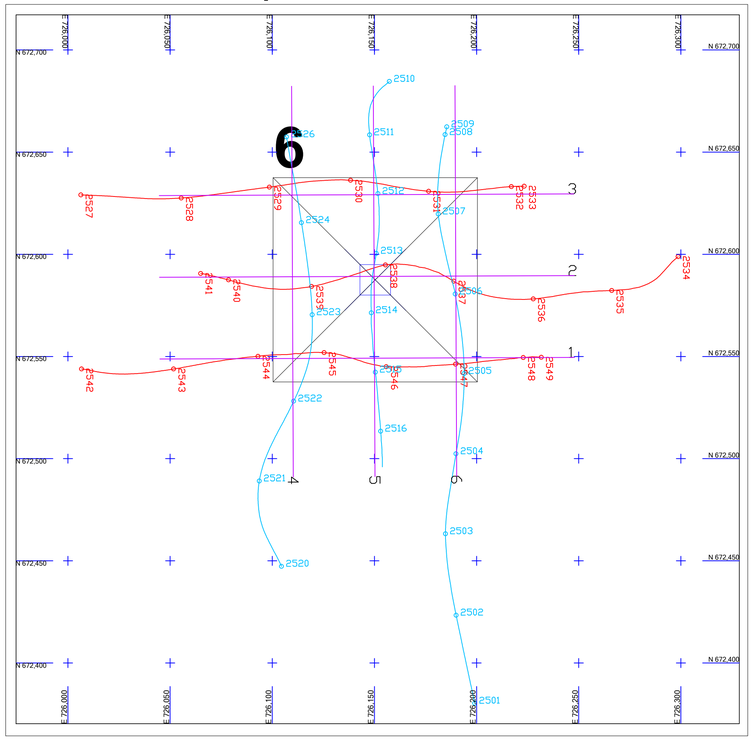
IRISH HYDRODATA Ltd.
Ballygarvan, Co Cork.
T12 HD5Y

Drawing Status	For Discussion
Scale @ A1	1:1500 — DO NOT SCALE
Job No.	1271-17
Drawing No.	1271-17-02-A — Rev. A

Box 5 - Trackplot

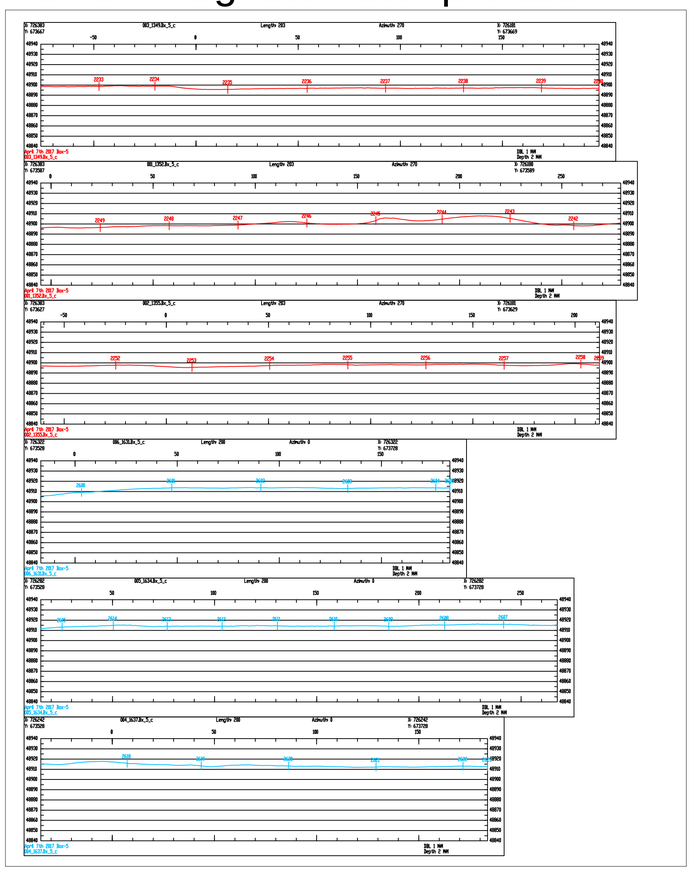


Box 6 - Trackplot



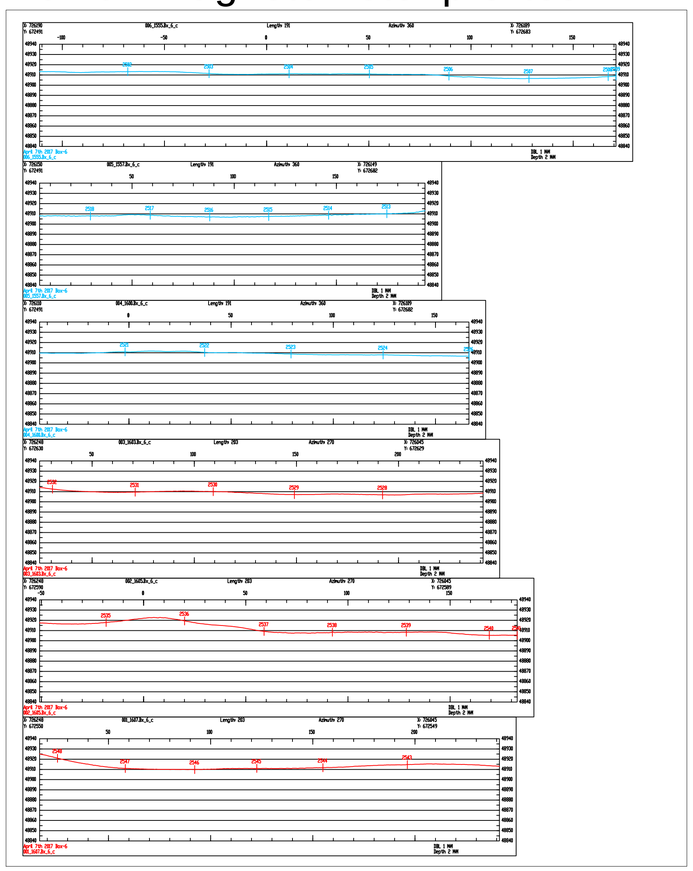
Overview of survey areas

Box 5 - Magnetometer profiles



Scales
Horiz. 1:1500
Vert. 1:3000

Box 6 - Magnetometer profiles



Notes:

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A layback of 20m has been applied to the trackplot. The event marks are at the location of the magnetometer towfish.

Survey date: April 7th 2017

0m 15m 30m 45m 60m 75m 150m

HORIZ. SCALE: 1 : 1500

Rev.	Date	Purpose of revision	Drawn	Chkd	Appr'd
A	11-04-17	For discussion	TB	JW	JW

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing.

Project

Arklow
Wastewater Treatment Plant

Drawing Title

Archaeological Marine Geophysical Survey
Magnetometer Survey Trackplot & Profiles
in Grab Sampling Boxes 5 and 6

Consulting Engineers: BYRNE LOOBY ARUP

Client: ervia

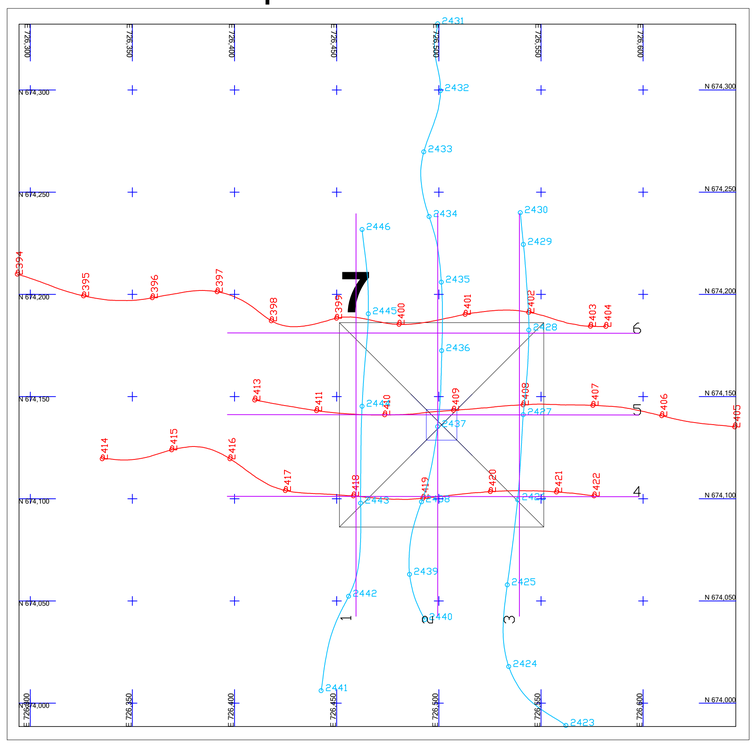
Archaeological Consultants: THE ARCHAEOLOGICAL DIVING COMPANY LTD SPECIALISTS IN LAND AND UNDERWATER ASSESSMENT — ADCO

Surveyed by: **IRISH HYDRODATA Ltd.**
Ballygarvan, Co Cork.
T12 HD5Y

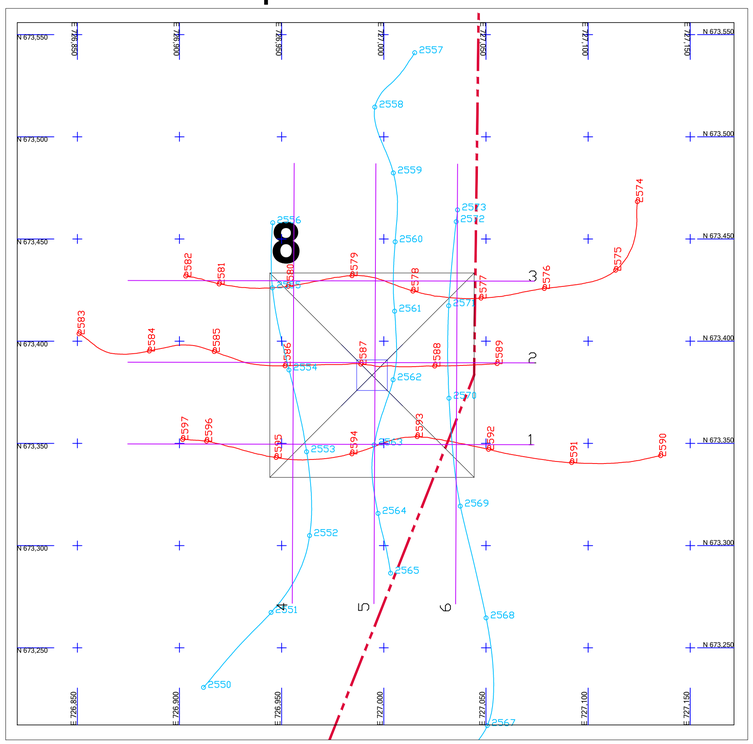
Drawing Status: For Discussion

Scale @ A1	1:1500	DO NOT SCALE
Job No.	1271-17	
Drawing No.	1271-17-02-B	Rev. A

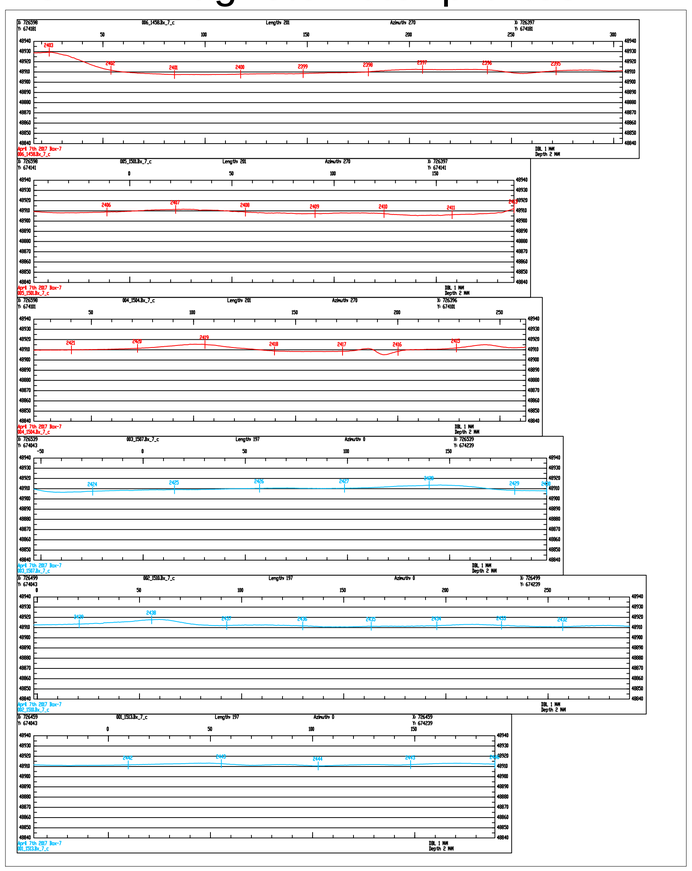
Box 7 - Trackplot



Box 8 - Trackplot



Box 7 - Magnetometer profiles



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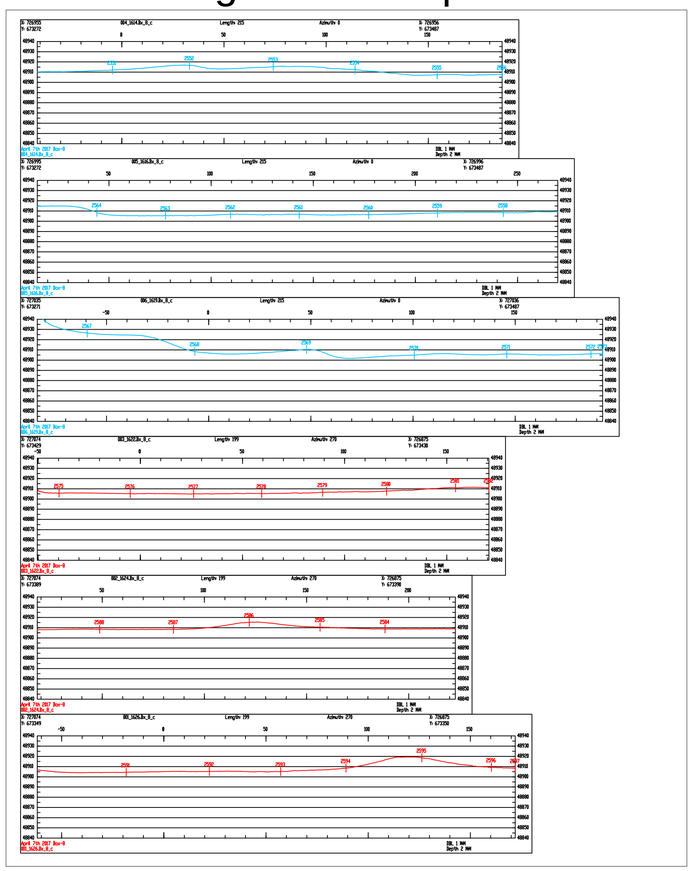
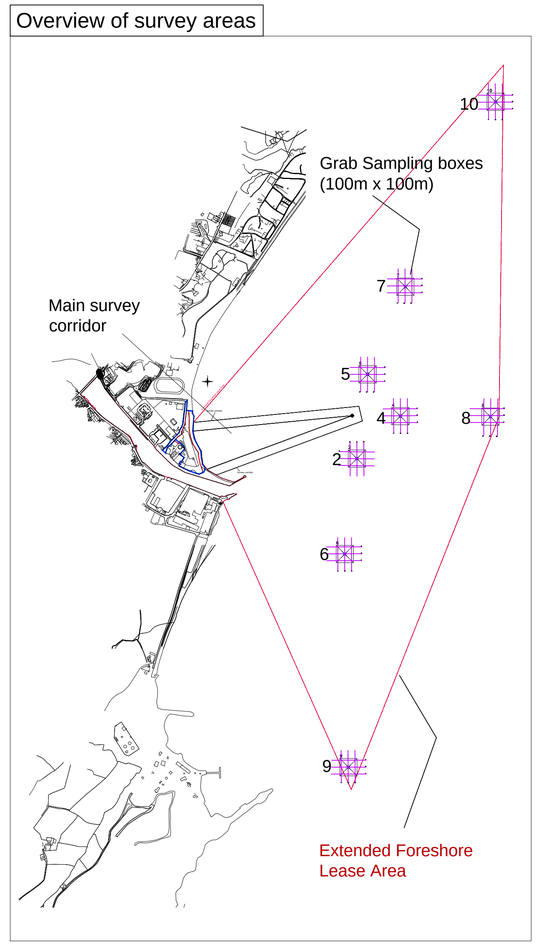
Box 8 - Magnetometer profiles



Overview of survey areas



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3. The survey is mapped on Irish Transverse Mercator (ITM).

A layback of 20m has been applied to the trackplot. The event marks are at the location of the magnetometer towfish.

Rev.	Date	Purpose of revision	Drawn	Chkd	Appr'd
A	11-04-17	For discussion	TB	JW	JW

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing.

Project

Arklow
Wastewater Treatment Plant

Drawing Title

Archaeological Marine Geophysical Survey
Magnetometer Survey Trackplot & Profiles
in Grab Sampling Boxes 7 and 8

Survey date: April 7th 2017

0m 15m 30m 45m 60m 75m 150m

HORIZ. SCALE: 1 : 1500

Consulting Engineers: BYRNE LOOBY ARUP

Client: ervia

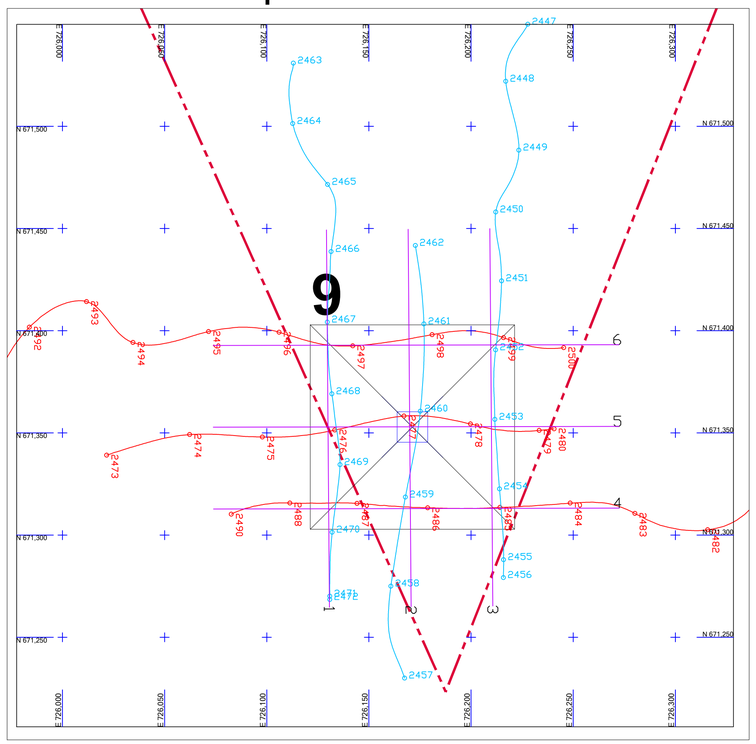
Archaeological Consultants: THE ARCHAEOLOGICAL DIVING COMPANY LTD SPECIALISTS IN LAND AND UNDERWATER ASSESSMENT — ADCO

Surveyed by: IRISH HYDRODATA Ltd.
Ballygarvan, Co Cork.
T12 HD5Y

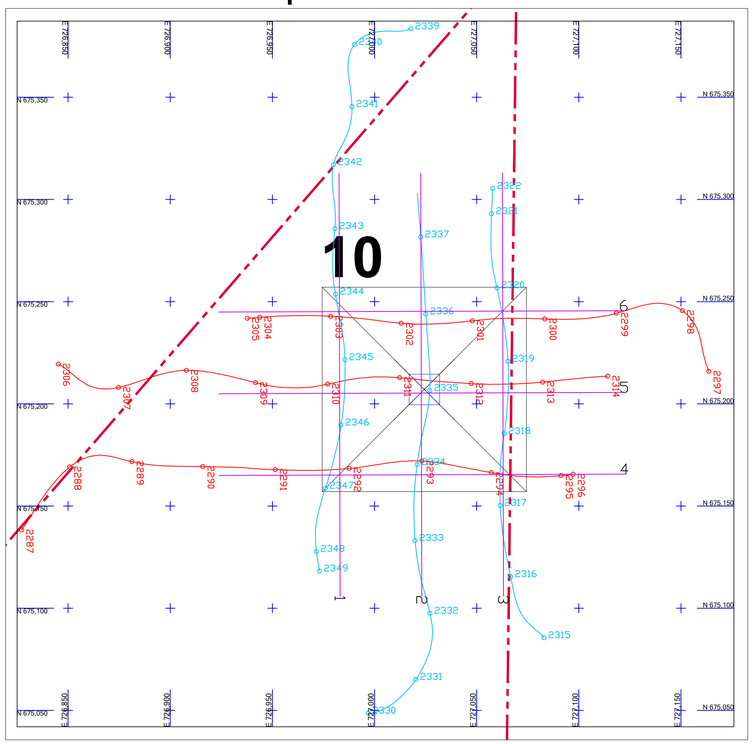
Drawing Status: For Discussion

Scale @ A1	1:1500	DO NOT SCALE
Job No.	1271-17	
Drawing No.	1271-17-02-C	Rev. A

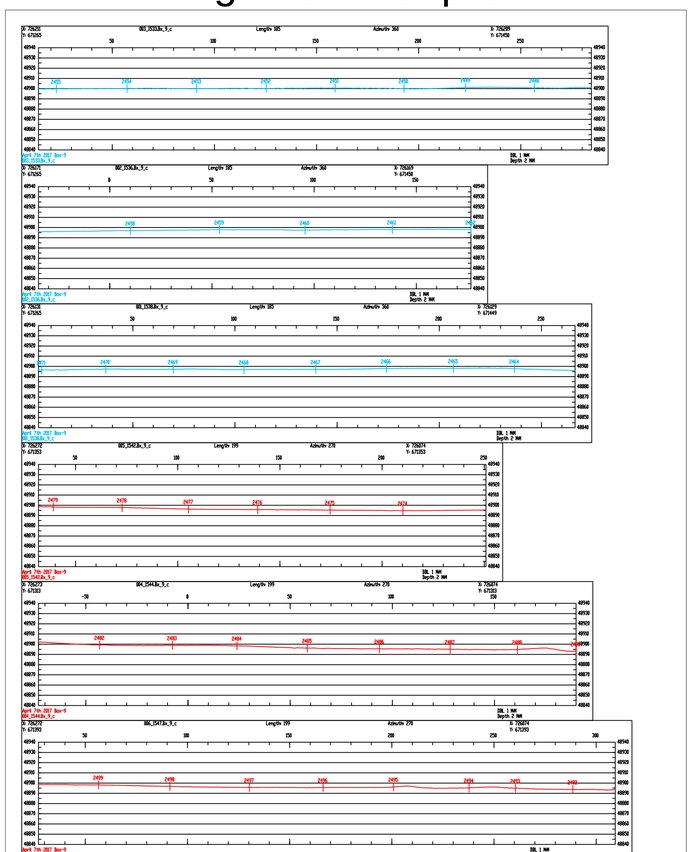
Box 9 - Trackplot



Box 10 - Trackplot

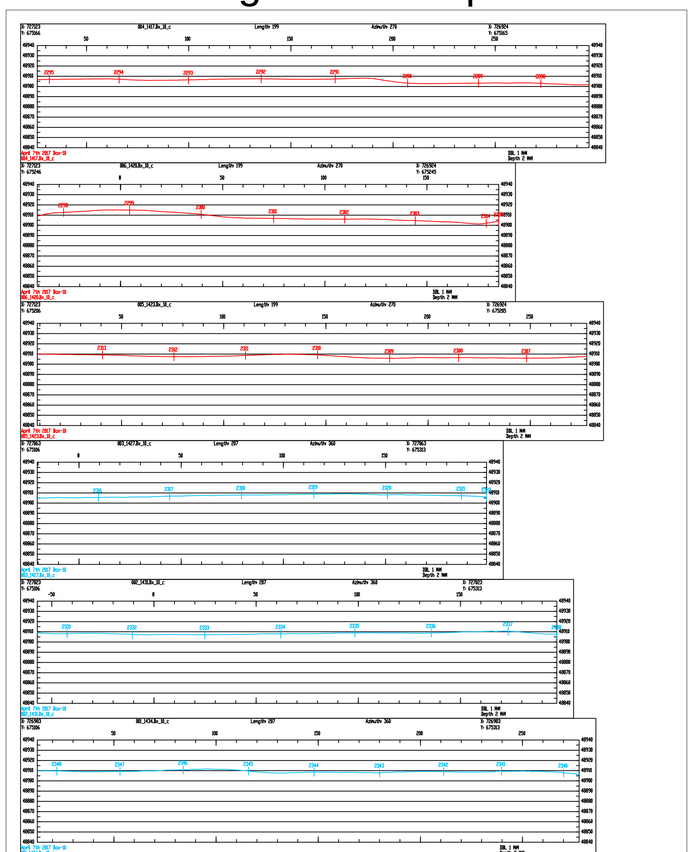


Box 9 - Magnetometer profiles



Scales
Horiz. 1:1500
Vert. 1:3000

Box 10 - Magnetometer profiles



Overview of survey areas

Notes:

1. Magnetic data was acquired using a Geometrics G882 magnetometer.
2. Positioning was by Trimble Ag DGPS.
3. The survey is mapped on Irish Transverse Mercator (ITM).

A layback of 20m has been applied to the trackplot. The event marks are at the location of the magnetometer towfish.

Survey date: April 7th 2017

0m 15m 30m 45m 60m 75m 150m

HORIZ. SCALE: 1 : 1500

Rev.	Date	Purpose of revision	Drawn	Chkd	Appr'd
A	11-04-17	For discussion	TB	JW	JW

Project

Arklow
Wastewater Treatment Plant

Drawing Title

Archaeological Marine Geophysical Survey
Magnetometer Survey Trackplot & Profiles
in Grab Sampling Boxes 9 and 10

Consulting Engineers: BYRNE LOOBY ARUP

Client: ervia

Archaeological Consultants: THE ARCHAEOLOGICAL DIVING COMPANY LTD SPECIALISTS IN LAND AND UNDERWATER ASSESSMENT — ADCO

Surveyed by: **IRISH HYDRODATA Ltd.**
Ballygarvan, Co Cork.
T12 HD5Y

Drawing Status: For Discussion

Scale @ A1	1:1500	DO NOT SCALE
Job No.	1271-17	
Drawing No.	1271-17-02-D	Rev. A

ADCO

Client
IAC Ltd./ Irish Water

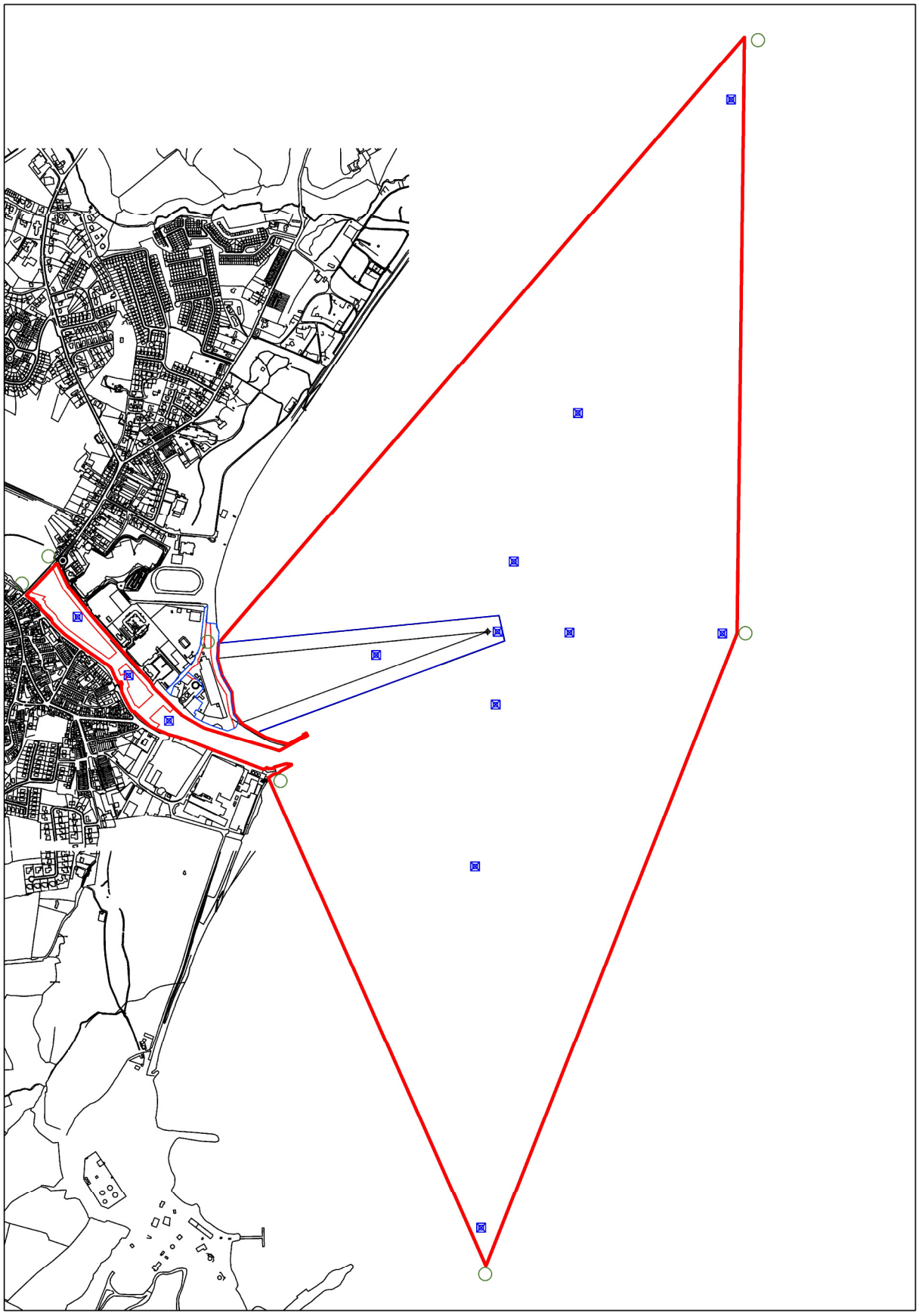
Notes
Source: OSi Discovery Series (1:50,000) Mapping

Site boundary of proposed development

A4

Title
Figure 1- Location Map showing site boundary of proposed Arklow Sewerage Scheme and associated Marine Outfall.

Project	Job/Exc No.	Compiled by	CAD reference	Date	Scale	Drawing No.
Arklow Sewerage Scheme, Marine Outfall- Geophysical Survey	16R0219	R.Bangerter	Arklow2016	31.07.17	1:50,000	Figure 1



ADCO

Client
IAC Ltd./ Irish Water

Notes
Source: ArcGIS mapping

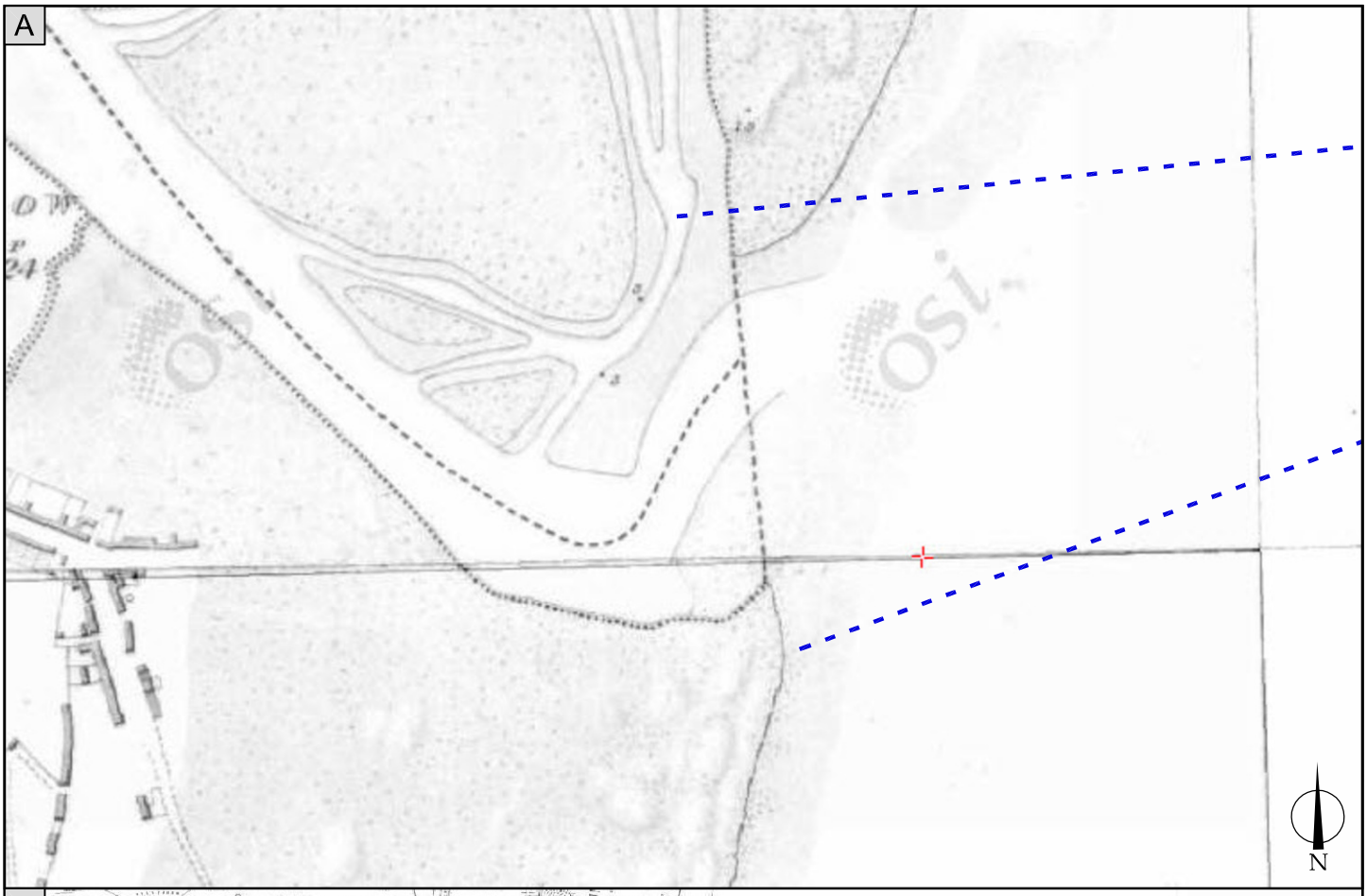
Site Boundary — Marine Outfall Location

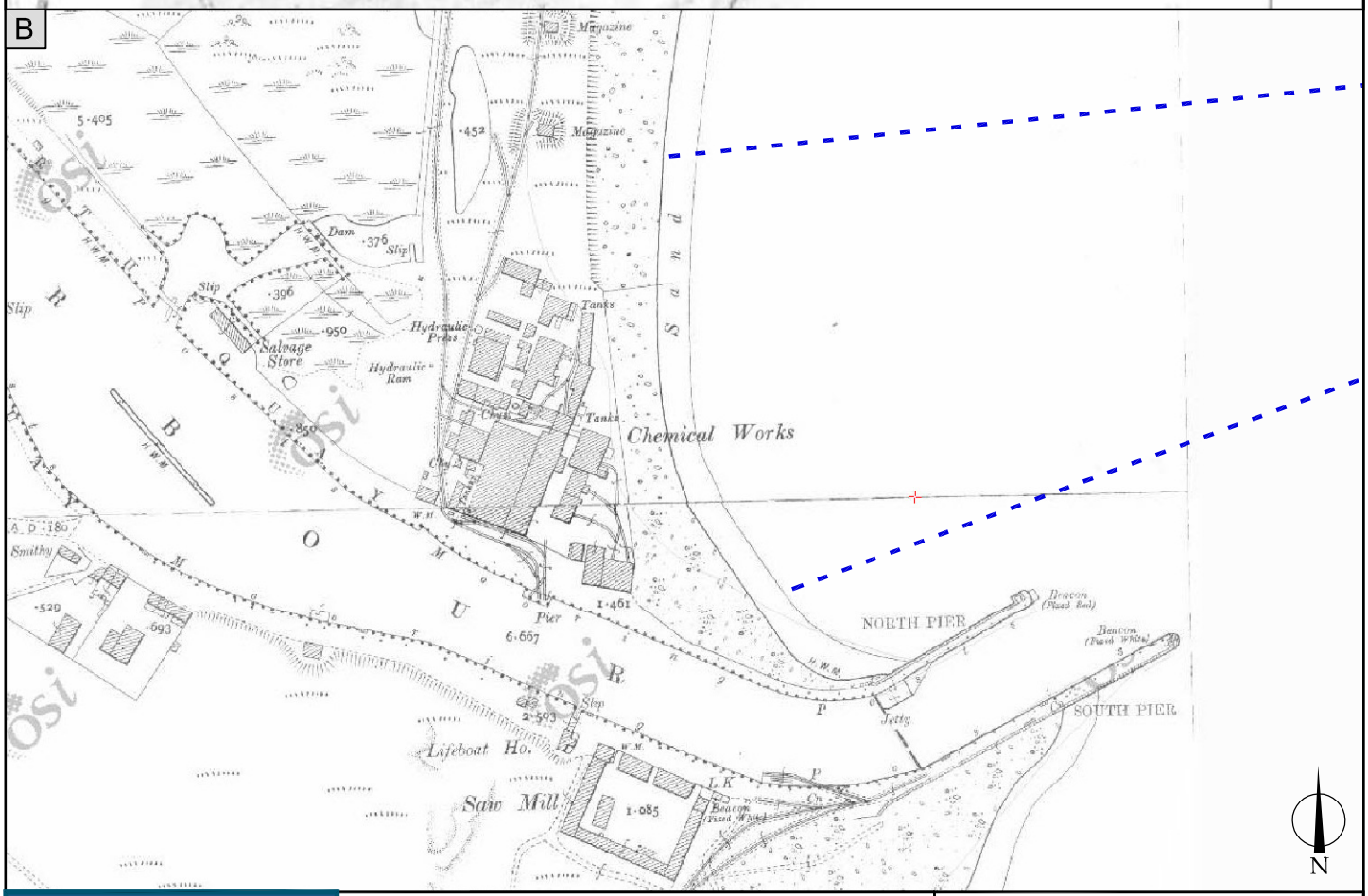
Grab Sample location

A4

Title
Figure 2- Location map showing Marine Outfall and Grab Sample positions.

Project	Job/Exc No.	Compiled by	CAD reference	Date	Scale	Drawing No.
Arklow Sewerage Scheme, Marine Outfall- Geophysical Survey	16D0219	R.Bangerter	Arklow2016	31.07.18	1:3500	Figure 2





ADCO

Client
IAC Ltd./ Irish Water

Notes
Source: OSi Historic Map Archive
Approximate landfall location of proposed marine outfall

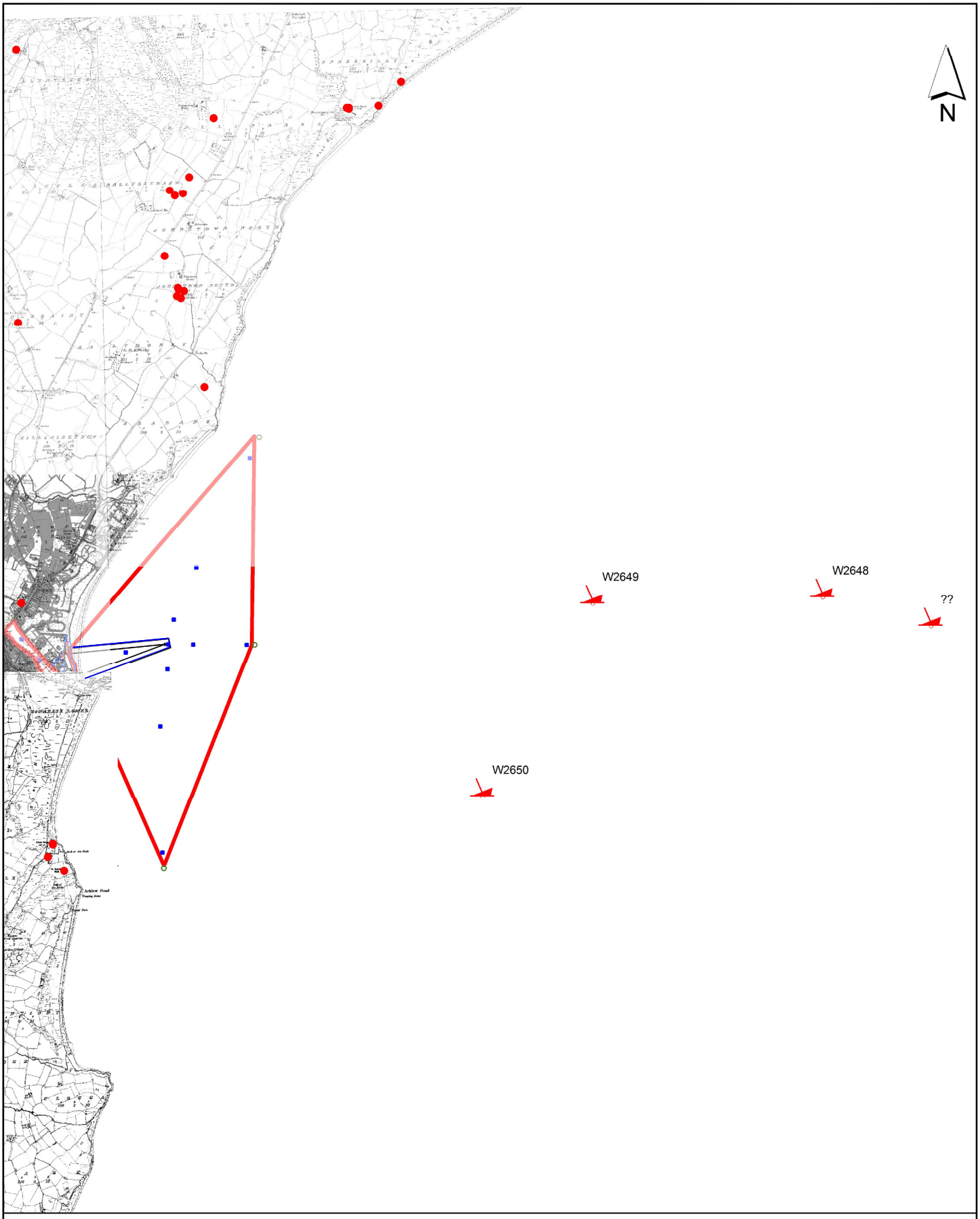
A4

Title
Figure 3-

A). Extract from OS Fist Edition map (*c.* 1840) showing the coastline adjacent to the proposed marine outfall.

B). Extract from OS 25-inch map (*c.* 1910) showing the coastline adjacent to the proposed marine outfall.

Project	Job/Exc No.	Compiled by	CAD reference	Date	Scale	Drawing No.
Arklow Sewerage Scheme, Marine Outfall- Geophysical Survey	16D0219	R.Bangerter	Arklow2016	37.07.17	1:5000	Figure 3



Sites listed in the Historic Shipwreck Inventory [DCHG]

Sites listed in the RMP [DCHG]

ADCO

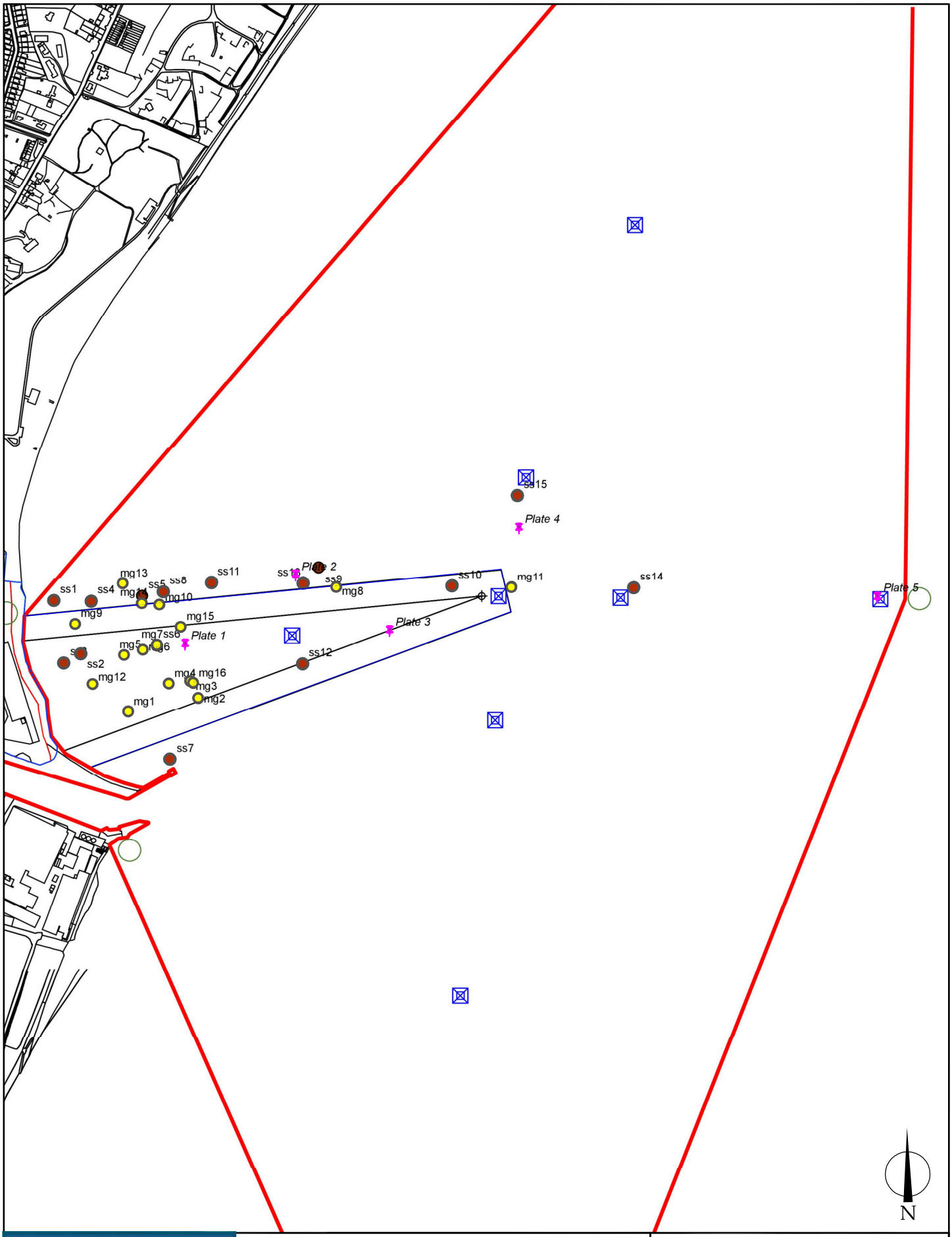
Client
IAC Ltd./ Irish Water

Notes
Source: ArcGIS mapping
Site Boundary
Marine Outfall Location
Grab Sample location

A4

Title
Figure 4- Map showing development location and known archaeological sites in the wider area.

Project	Job/Exc No.	Compiled by	CAD reference	Date	Scale	Drawing No.
Arklow Sewerage Scheme, Marine Outfall- Geophysical Survey	16D0219	R.Bangerter	Arklow2016	31.07.18	1:3500	Figure 4



ADCO

Client
IAC Ltd./ Irish Water

Notes
Source: ArcGIS mapping

- Site Boundary
- Marine Outfall Location
- Grab Sample location
- Side-scan Sonar Anomaly
- Magnetometer Anomaly
- Selected Plate location

A4

Title
Figure 5- Map showing area surveyed and archaeological observations.

Project	Job/Exc No.	Compiled by	CAD reference	Date	Scale	Drawing No.
Arklow Sewerage Scheme, Marine Outfall- Geophysical Survey	16D0219	R.Bangerter	Arklow2016	31.07.18	1:10,000	Figure 5

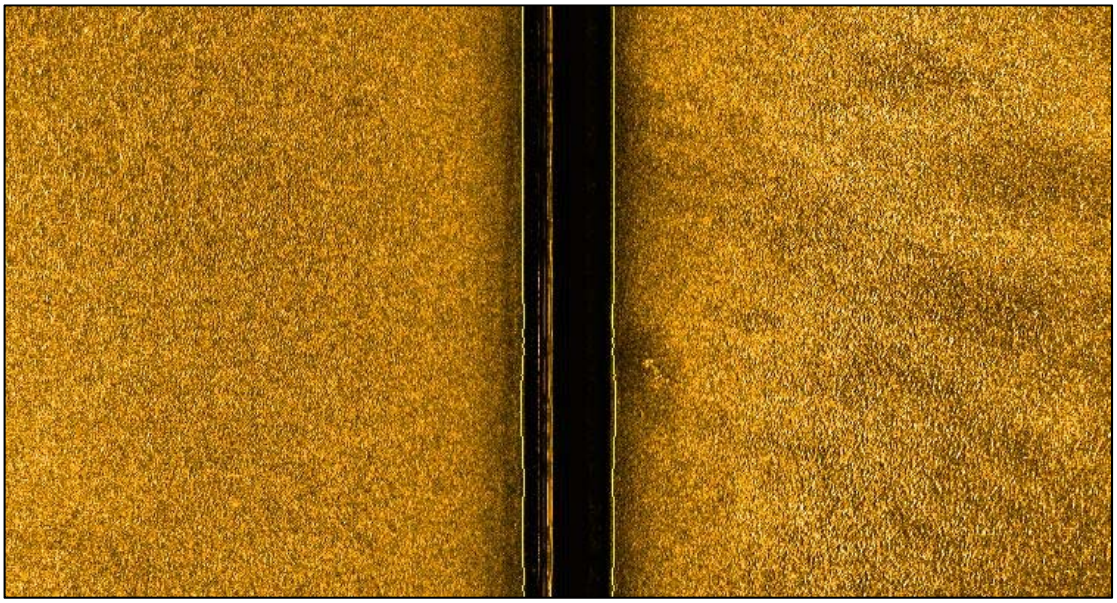


Plate 1: Scan-scan sonar data trace showing typical image of featureless sandy seabed surface across the inshore section of the survey area.

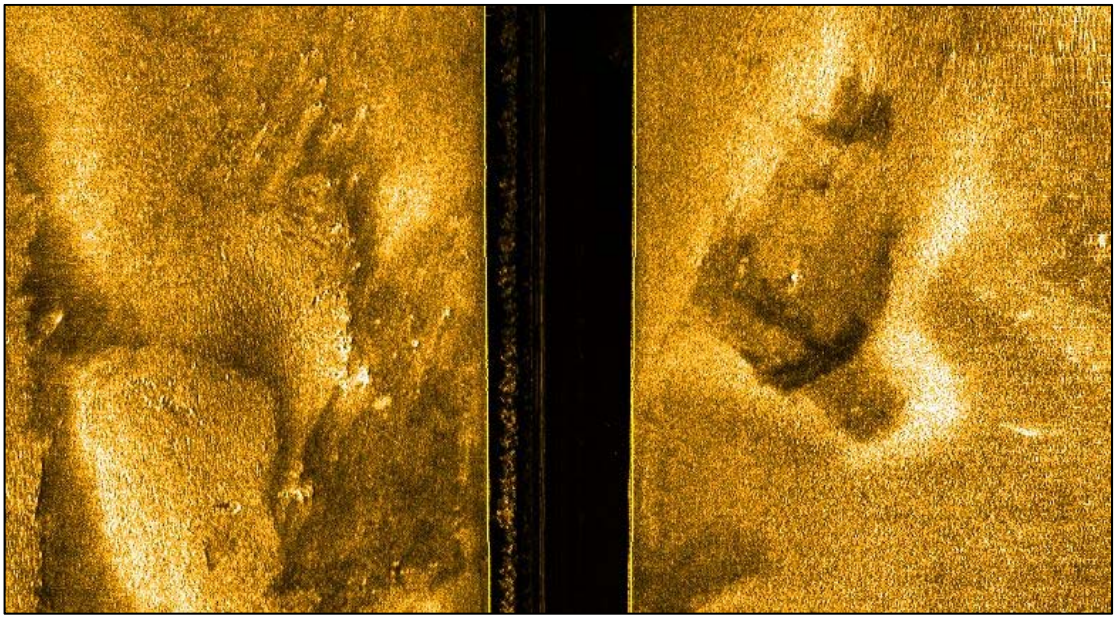


Plate 2: Scan-scan sonar data trace showing typical image of sand and silt patches that cover the seabed surface across the middle section of the survey area .

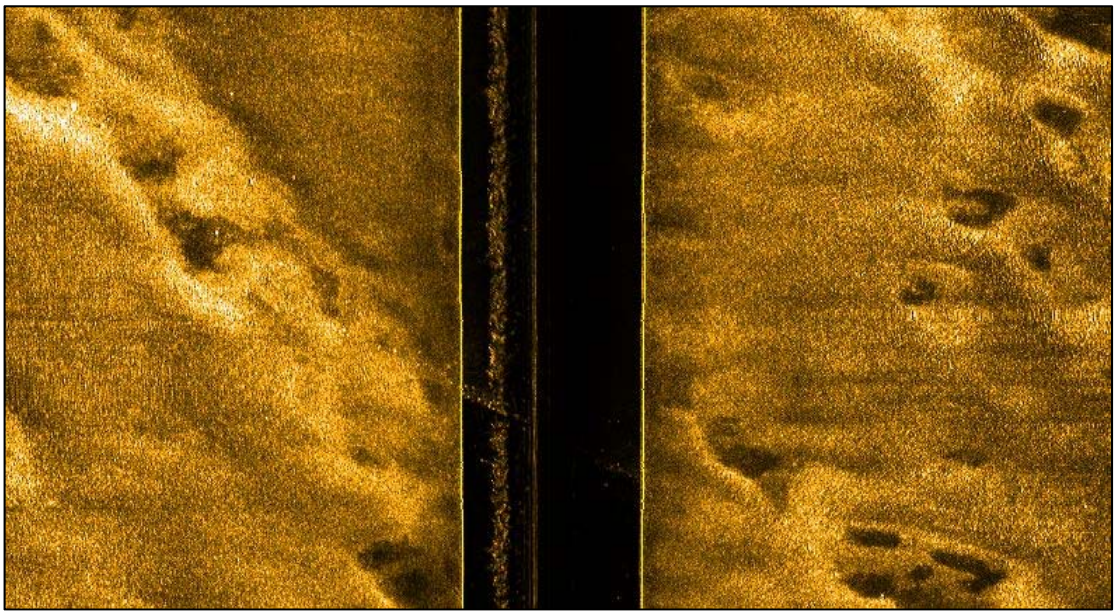


Plate 3: Scan-scan sonar data trace showing typical image of outer sections of the seabed surface within the survey area, showing an East-West alignment of sand/silt formations.

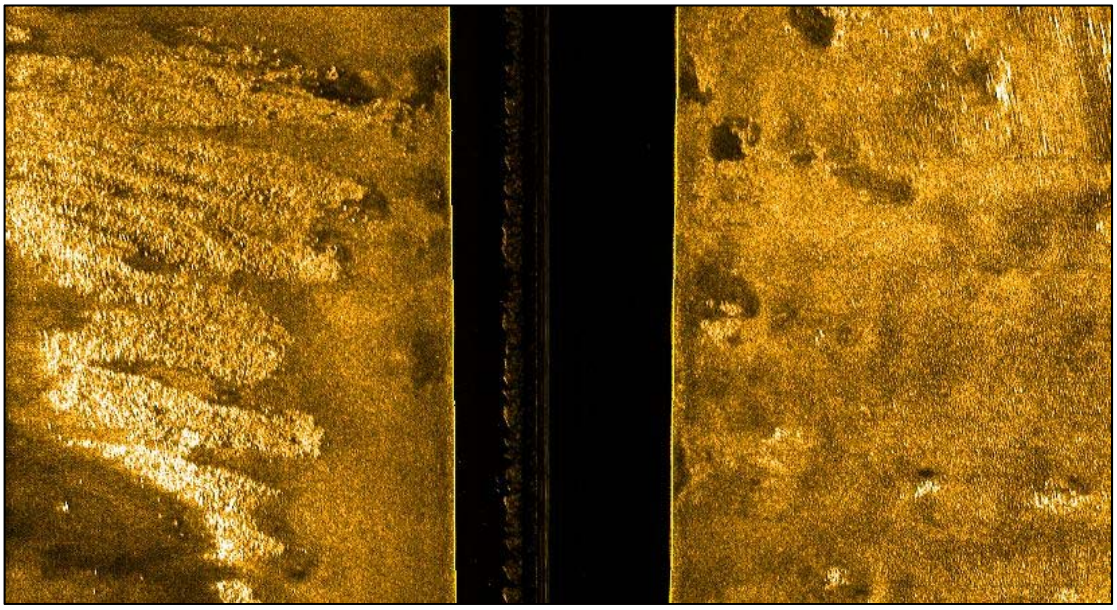


Plate 4: Scan-scan sonar data trace showing image of seabed surface at the terminus location of the proposed outfall, highlighting an area of shingle/cobble to the north.

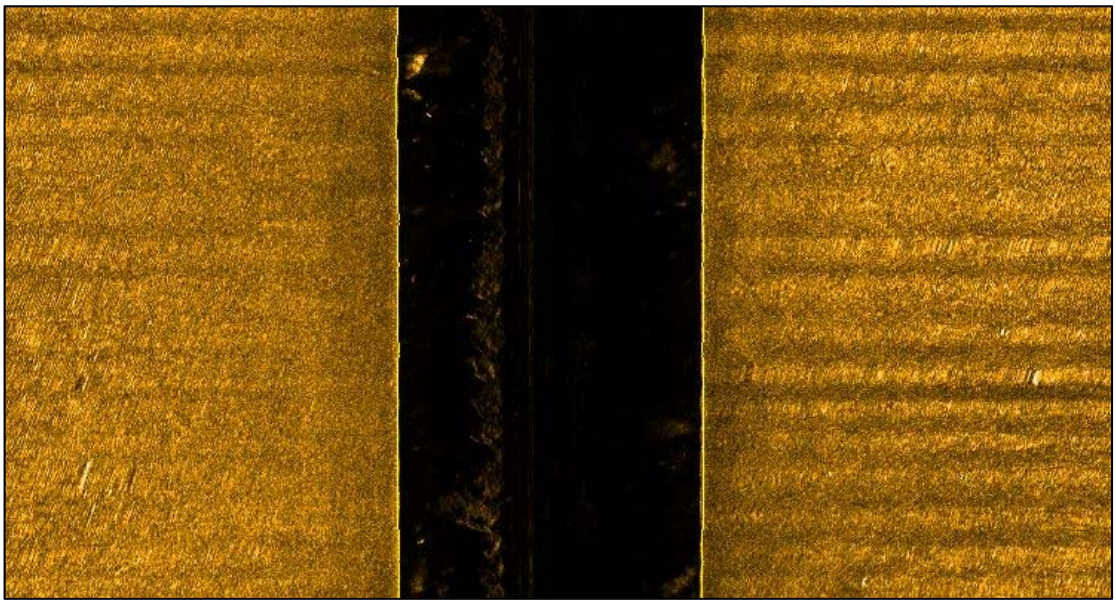


Plate 5: Scan-scan sonar data trace showing typical image of featureless seabed surface within the area of GS8.

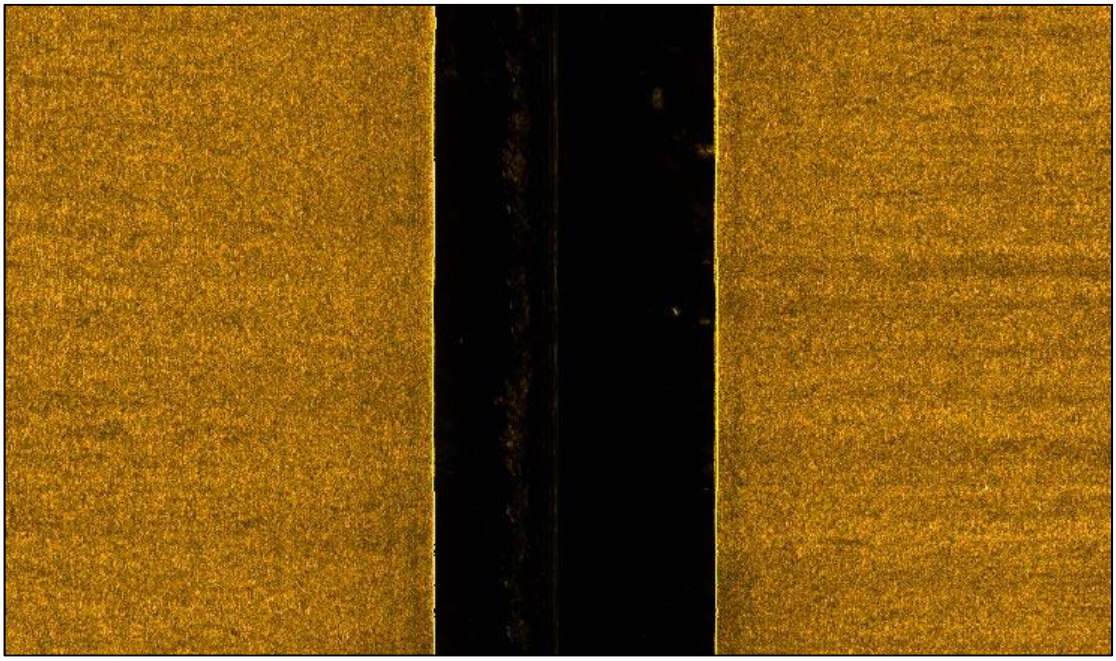


Plate 6: Scan-scan sonar data trace showing typical image of featureless seabed surface within the area of GS9.

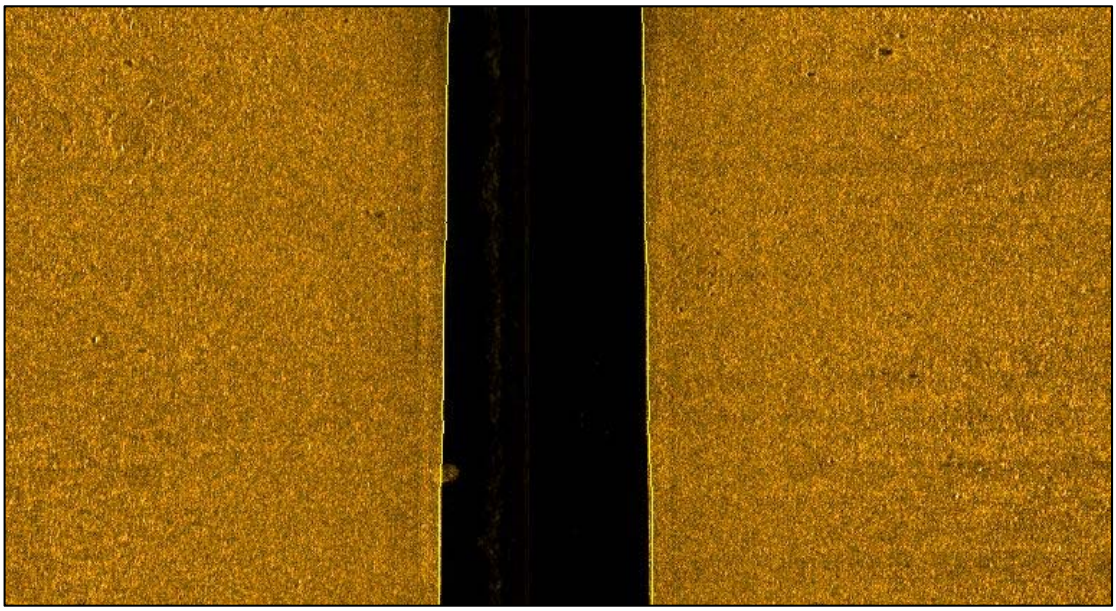


Plate 7: Scan-scan sonar data trace showing typical image of featureless seabed surface within the area of GS10.

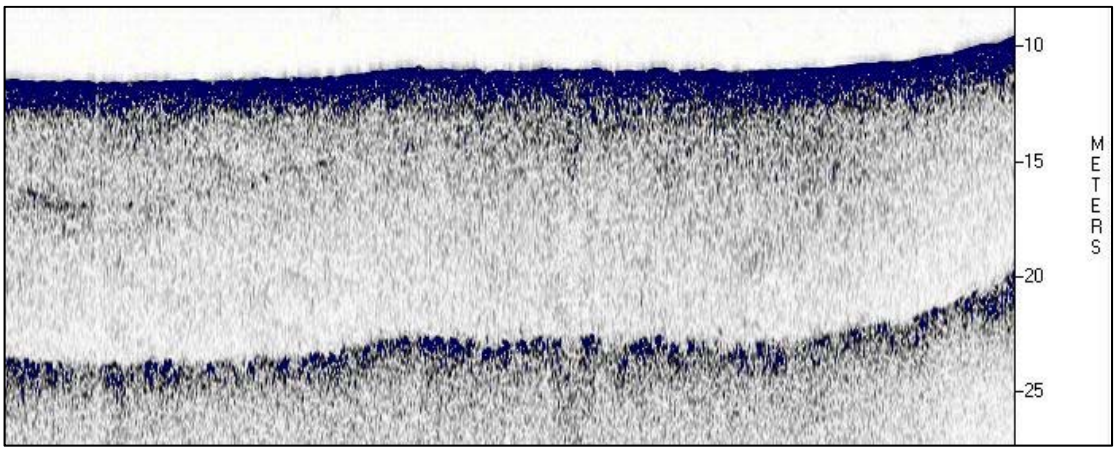


Plate 8: Sub-bottom profile in GS5, at Ping 52900. The image shows a trough feature under the seabed sand. The trough is approximately 6m in maximum depth and extends to 16m below sea level (based on scale to right), approximately.

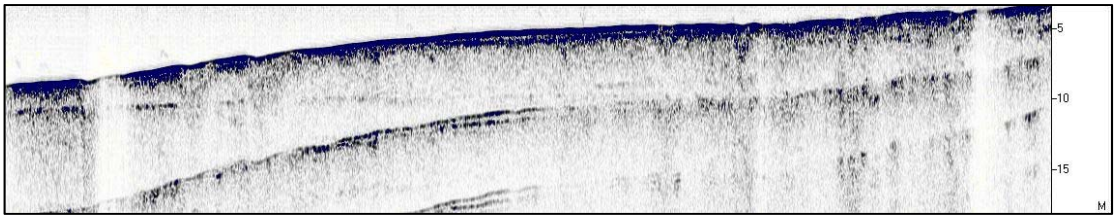


Plate 9: Sub-bottom profile along the main East-West survey lines, showing progressive drop in slope from the shoreline (right side of picture) seawards (left side of picture). The horizontal line apparent at approximately 9m below sea level might indicate the presence of a basal till underlying the covering sand.