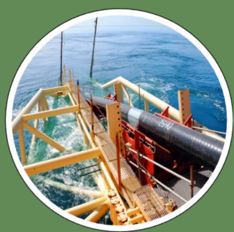
GREENLINK
MARINE ENVIRONMENTAL IMPACT ASSESSMENT REPORT- IRELAND

APPENDIX A - G

P1975_R4500_RevF2
July 2019

Greenlink Interconnector
- connecting the power markets in Ireland and Great Britain



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APPENDIX A

Meetings held with Irish stakeholders to inform Proposed Development & EIAR

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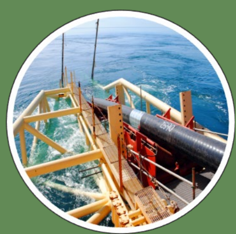

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Stakeholder	Date	Meeting Objective
National Parks & Wildlife Service (NPWS)	09 Dec 2015	Introduction to Greenlink. Discussion of potential landfall options and environmental sensitivities of the sites. Discussed environmental studies to be used to inform route development and EIAR. Joint onshore & offshore meeting. NPWS provided habitat maps for Hook Head. NPWS noted that preference would be to avoid external cable protection on Reef habitats.
Port of Waterford Company	09 Mar 2016	Introduction to Greenlink. Port noted that Duncannon channel gets dredged 3 times a year. Requested any cable route up the Estuary avoids shipping channel and is to be routed as close to headland / coast as possible
NPWS	13 Mar 2018	GIL provided update on Greenlink programme. Discussed potential route through Hook Head SAC ahead of cable route survey.
Port of Waterford Company	14 Mar 2018	GIL provided update on Greenlink programme. Port provided updated on activities. Reiterated concerns (previously communicated via email correspondence) about Boyce's Bay route.
Department of Housing, Planning & Local Government (DHPLG) - Foreshore Unit	14 Mar 2018	GIL provided update on Greenlink programme. Provided update on survey programme and discussed survey Foreshore Licence. Discussed screening & scoping for EIAR.
Bord Iascaigh Mhara (BIM)	14 Jun 2018	Joint meeting hosted by Greenlink Fisheries Liaison Officer (FLO). Objective to discuss the planned survey works for commencement late summer / early autumn 2018 ahead of the formal presentation to and meeting with local fishermen.
South East Regional Inshore Fisheries Forum (SERIFF)		
Irish South and East Fish Producers Organisation (IS&EFPO)		
Irish South and West Fish Producers Organisation (IS&WFPO)		
BIM, SERIFF, IS&EFPO, IS&WFPO, 45 local fishermen	14 Jun 2018	Joint meeting hosted by Greenlink Fisheries Liaison Officer (FLO). Objective to provide local fishermen with overview of project and discuss the planned survey works for commencement late summer / early autumn 2018.
NPWS	01 Aug 2018	Meeting focused on Greenlink Irish Onshore route but included exchange of information relevant to the Proposed Development
BT	21 Sep 2018	Meeting to discuss crossing of Celtic and ESAT1 telecoms cables. Discussed BTs concerns regarding cable paralleling.
DHPLG - Foreshore Unit	17 Jan 2019	Pre-application meeting for Greenlink Foreshore Licence application. GIL provided update on project programme and scope of Proposed Development. Provided update on results of cable route survey. Discussed EIAR scoping responses. Discussed EIAR content and agreed Campile Estuary should be included in application. Emphasised historic and tourism sensitivities at Baginbun and the nature conservation sensitivities at Baginbun and Campile Estuary.
IS&WFPO	17 Jan 2019	GIL provided update on Greenlink programme and presented information on how interconnector cables are installed. Discussed contents of EIAR and agreed risk of snagging should be scoped in to EIAR. Raised concerns regarding whether cable burial risk assessment has considered frequency and intensity of scallop dredging and how temporary exclusion zones are communicated during installation.
SERIFF	17 Jan 2019	Joint meeting. GIL provided update on Greenlink programme and presented information on how interconnector cables are installed. Discussed contents of EIAR and agreed risk of snagging should be
BIM		

Stakeholder	Date	Meeting Objective
		scoped in to EIAR. Information provided on fisheries and herring fishery in particular.
Irish Ferries	04 Feb 2019	Telephone meeting to inform Navigation Risk Assessment and discuss route of Pembroke to Rosslare ferry and potential for interaction with installation operations.
NPWS	07 Feb 2019	GIL provided update on project programme and result of cable route survey. Discussed scoping response, HDD at Baginbun and scope of Natura Impact Statement.

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APPENDIX B

Competent Experts Table

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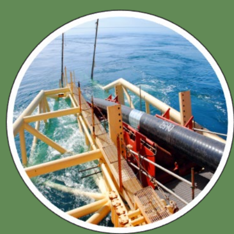

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Contributor	Company	Chapters	Qualifications	Experience (years)
Anna Farley	Intertek EWCS	All Chapters and Appendices	BSc (Hons) Marine Geography	16
Dr Nicholas Morley	Intertek EWCS	6	PhD Aquatic Chemistry; BSc Oceanography	22
Jillian Hobbs	Intertek EWCS	9, Technical Appendix C	BSc (Hons) Geology Associate member of the Institute or Environmental Management and Assessment	16
Dr Andrew Page	Intertek EWCS	3, 4, 13, Technical Appendix C	PhD Marine Geology and Geochemistry; M.Sc. Exploration Geophysics; B.Sc. Honours: Applied Geology	14
Paula Daglish	Intertek EWCS	10, Technical Appendix D	BSc (Hons) Maritime Environmental Science, Associate member of the Institute or Environmental Management and Assessment	14
Kerri Gardiner	Intertek EWCS	2, 5, 7, 8, 11	MSc Marine Resource Development and Protection; BSc Physical Geography	8
Helene Soubies	Intertek EWCS	10, Technical Appendices C & D	MSc Environmental Mapping; BSc Geography	6
Christopher Carroll	Intertek EWCS	4, 13	Geological Oceanography BSc (Hons) Member of the Institution of Engineering & Technology	6
Louis Dumenil	Intertek EWCS	13	MSc Hydrodynamic and Ocean	6
Matthias Thomsen	Intertek EWCS	7, Technical Appendix C	PhD Marine Ecology, Master of Science (Integrated BSc & MSc) Marine Biology	1
Rebecca Gay	Intertek EWCS	14	BSc (Hons) Geology-Petroleum Geology, MSc Civil Engineering	1
Christopher Goode	Intertek EWCS	GIS	MSc in Water and Environmental Engineering, MEng in Civil Engineering	6
Paul Evans	Intertek EWCS	6	PhD "Hydrodynamic characteristics of Macrotidal Straits and implications for tidal stream turbine deployment, M.Sc. Coastal Engineering, B.Sc. (Hons) Marine Geography, MCIWEM, C.WEM, C.Env, C.Sci, British Standards Institution (BSI) Committee Member	11
Dr Emma Rendle	Resilient Coasts	6	PhD Marine Science and Engineering; MSc Applied Marine Science; BSc Honours Marine Biology and Oceanography.	12
Dr Michael Walsh	Cotswold Archaeology	15, Technical Appendix G	PhD in maritime archaeology MA in maritime archaeology BA in archaeology and ancient history Member of the chartered institute for archaeologists (MCIfA) Visiting research fellow, University of Southampton	25 years in archaeology 12 years in commercial archaeology (concurrent)
Dr Michael Grant	Coastal and offshore archaeological research services (University of Southampton)	As above	PhD in physical geography; MSc in geoarchaeology; BSc in oceanography with physical geography; Enterprise fellow, University of Southampton	13 years
Zoe Arkley	Cotswold Archaeology	As above	BSc in archaeological and forensic sciences Associate of CIfA (ACIfA)	7 years

Contributor	Company	Chapters	Qualifications	Experience (years)
Claire Griffiths	MarineSpace	13	MSc Applied Marine Science	8
Jonny Lewis	MarineSpace	13	MSc Applied Hydrobiology	20
Rachel Crabtree	MarineSpace	Technical Appendix E –	MRes Marine Biology	6
Iain Warner	MarineSpace	Technical Appendix E	MSc Coastal Zone Management	11
Ian Reach	MarineSpace	Technical Appendix E	BSc Marine Biology with Fish Biology. Professional Member of the Marine Biological Association UK Chair of the Marine Aggregates Environmental Impact Assessment Working Group Advisor to: International Council on the Exploration of the Seas Working Group on Marine Systems; Atlantic Ocean Research Alliance Support Action (AORA-CSA) North Atlantic Ecosystem Approach Group; Pelagic Advisory Council	27
Rhianna Roberts	MarineSpace	16	BSc Zoology	3
Sam Strutton	MarineSpace	16	BSc Oceanography with Physical Geography	10
Ian Reach	MarineSpace	16	(As above)	27

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APPENDIX C

Underwater Sound Modelling

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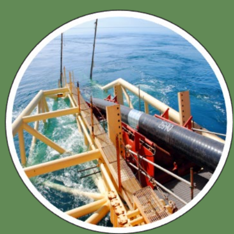

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1. Introduction

1.1 *Objective*

One of the most important environmental concerns related to the installation, operation (including maintenance and repair) and decommissioning of Greenlink is the potential effects of underwater sound. Sound inputs to the marine environment will be generated by vessel movements, sand wave preparation (pre-sweeping), cable trenching, rock placement and if required, unexploded ordnance (UXO) detonations.

To determine the zone of influence for each activity (the spatial extent over which the activities are predicted to have an effect on the receiving environment) an assessment has been conducted which combines literature review with underwater sound modelling. This Technical Appendix presents the findings of the assessment. It has informed the EIA process and assessment of significant effects presented in Chapter 8 – Fish and Shellfish and Chapter 10 – Marine Mammals and Reptiles.

1.2 *Underwater sound*

Sounds in the ocean originate from natural causes such as earthquakes, rainfall, and animal noises; and anthropogenic activities such as shipping, fishing activities, seismic survey, research activities, sonars and recreation activities. As sound waves travel through water, they spread, dissipate and reflect off the sea surface and seabed. The local oceanographic conditions will affect the path of the sound in the water column, how much sound is transmitted, and the levels received by the receptor at distance from the source. Variables such as water depth, source and receiver depths, temperature gradients, salinity, seabed ground conditions and many other factors can affect received levels.

Although some sound sources can be identified, the sources of others cannot, and they are considered part of the background noise. How a receptor is affected by a change in underwater sound is linked to the current exposure levels and associated background noise.

1.2.1 Background sound

Measurements on anthropogenic sounds were recorded to quantify background noise levels in the UK, as part of the European Union (EU) Marine Strategy Framework Directive (MSFD) (Merchant et al. 2016). These were taken across locations in the Celtic Sea, southern North Sea (SNS) and northern North Sea (NNS). Recordings were taken at four frequency ranges (63Hz, 125Hz, 250Hz and 500Hz). Noise levels in the Celtic Sea ranged from 99.9dB (500Hz) to 102.9dB re1μPa (250Hz) (RMS[1]) (Merchant et al. 2016). These levels are lower on average than the NNS and SNS, noting that only one location was recorded in the Celtic Sea in comparison to ten in the NNS. Little is known on ambient sound levels in the vicinity of Greenlink

[1] The EU MSFD recommends the use of root mean square (RMS) noise levels as environmental indictor.

development. Background sound levels in the vicinity of the project will influence how marine species react to the introduction of new sound as part of the installation and then maintenance of the marine cable.

1.2.2 Sound categories

Underwater sound is classified between two distinct types: impulsive and continuous (i.e. non-pulse).

Impulsive sound is defined as a discrete or a series of events, for example an explosion or a seismic airgun (Southall et al. 2007). Produced impulsive sounds are generally transient and brief; peak sound pressure has a rapid rise and a rapid decline (NMFS 2018). Single pulse sound results from a single event, such as UXO detonation and pile strike (Southall et al. 2007). A repetition of pulses is considered as a multiple pulse sound source and is a series of discrete acoustic events within a 24hr period, for example a seismic survey (Southall et al. 207).

Continuous events, such as shipping noise, produce non-pulse sound and are generally broadband, narrowband or tonal. Continuous sound can either be intermittent or continuous within a 24hr period (NMFS 2018). Cable installation activities include trenching, rock placement, pre-sweeping and the use of thrusters for dynamically positioning (DP) on vessels; all of which produce continuous sound over a period of 24hrs.

2. Receptor Sensitivity to Underwater Sound Changes

2.1 Introduction

Research has largely focused on effects of underwater sound on marine mammals, but in the last few years evidence of effects in other species such as fish (Popper *et al*. 2014), crustaceans (Solan *et al*. 2016, Tidau and Briffa 2016) and zooplankton (McCauley *et al*. 2017) have been reported.

2.2 Marine mammals

Both cetaceans and pinnipeds have evolved to use sound as an important aid in navigation, communication and hunting (Richardson *et al*. 1995). It is generally accepted that exposure to anthropogenic sound can induce a range of behaviour effects to permanent injury in marine mammals. Loud and prolonged sound above background levels is considered to be noise and may have an effect on marine life. This may mask communicative or hunting vocalisations, preventing social interactions and effective hunting.

High intensity noises such as from seismic survey, explosions and pile driving can cause temporary or permanent changes to animals' hearing if the animal is exposed to the sound in close proximity and, in some circumstances, can lead to the death of the animal (Richardson *et al*. 1995). Where the threshold of hearing is temporarily damaged, it is considered a temporary threshold shift (TTS), and the animal is expected to recover. If there is permanent damage (permanent threshold shift (PTS)) where the animal does not recover, social isolation and a restricted ability to locate food may occur, potentially leading to the death of the animal (Southall *et al*. 2007).

Behavioural disturbance from underwater sound sources is more difficult to assess than injury and is dependent upon many factors related to the circumstances of the exposure (Southall *et al*. 2007, NMFS 2018). An animal's ability to detect sounds produced by anthropogenic activities depends on its hearing sensitivity and the magnitude of the noise compared to the amount of natural ambient and background anthropogenic sound. In simple terms for a sound to be detected it must be louder than background and above the animal's hearing sensitivity at the relevant sound frequency.

Behavioural responses caused by disturbance may include animals changing or masking their communication signals, which may affect foraging and reproductive opportunities or restrict foraging, migratory or breeding behaviours; and factors that significantly affect the local distribution or abundance of the species. An animal may swim away from the zone of disturbance and remain at a distance until the activities have passed. Behavioural disturbance to a marine mammal is hereafter considered as the disruption of behavioural patterns, for example: migration, breeding and nursing.

2.3 Sea turtles

Sea turtles are known to be able to detect (Ridgway et al. 1969, Bartol et al. 1999, Bartol & Ketten 2006) and respond to acoustic stimuli (Lavender et al. 2014, Martin et al. 2012, O'Hara & Wilcox 1990, DeRuitter & Doukara 2012), which they may use for navigation, prey location, predator avoidance as well as general environmental awareness (Piniak et al. 2016). Sea turtles have adapted their hearing for use underwater. It is likely that their body serves as a receptor while the turtle is underwater (Lenhardt 1983, 1985).

Electrophysiological and behavioural studies have demonstrated that sea turtles are able to detect low-frequency sounds both underwater and in air (Piniak et al. 2016). Sea turtles respond to aerial sounds between 50 and 2000 Hz and vibrational stimuli between 30 and 700 Hz, with maximum sensitivity values recorded between 300 and 500 Hz for both sounds (Ridgway et al. 1969).

Green turtles respond to underwater signals between 50 Hz to 1600 Hz, with maximum sensitivity between 200 and 400 Hz (Piniak et al. 2016). These values are similar to findings by Bartol & Ketten (2006).

Similarly, adult Loggerhead sea turtle responded to underwater stimuli between 50 and 800 Hz with best sensitivity at 100 Hz using behavioural response techniques, while between 100 and 1131 Hz with best sensitivity between 200 and 400 Hz when using AEP techniques (Martin et al. 2012).

Overall, the biological significance of hearing in sea turtles remains poorly understood, but as low-frequency sound is most prevalent and travels the farthest in the marine environment there may be some advantage to sea turtles in specializing in low-frequency sound detection. It is therefore believed that acoustic sound may provide important environmental cues for sea turtles (Piniak et al. 2016).

Popper et al. (2014) provide sound exposure guidelines for injury to sea turtles.

2.4 Fish

In general, most fish hear well in the range within which most energy from anthropogenic noise sources is emitted, i.e. relatively low frequency sound below 1 kHz, with peak perception between approximately 100-400 Hz.

Several features of a fish's anatomy, life cycle and habitats will determine the potential effects of sound on fish. Popper et al. (2014) classified sensitivity of fish species to underwater sound based on the presence or absence of swim bladder; the otolith organ acts as a particle motion detector and where linked to the swim bladder, converts sound pressure into particle motion, which is detected by the inner ear. Specialist hearing species include species such as herring, sprat, twaite shad and allis shad.

Swim bladder are used by certain fish species for buoyancy control, hearing, respiration etc. Pressure changes for fish with a swim bladder, in particular from impulsive sound, can result in physiological trauma.

Popper et al. (2014) provide sound exposure guidelines for injury to fish, which have been used in the modelling presented in Table 3-3.

2.5 Crustaceans

Little is known about how crustacean species are impacted by underwater sound changes (Tidau and Briffa 2016). Recent studies identified that crustaceans, both freshwater and marine species, are likely to be impacted by underwater sound changes. Unlike fish species, crustaceans do not have an air-filled chamber; therefore, they are unlikely to detect sound pressure but can be sensitive to particle motion (Tidau and Briffa 2016).

Studies have considered the impact and the behavioural responses of crustaceans to airgun sounds. Results from these studies produced varied results. A field study on shrimp species and American lobster did not identify an avoidance behaviour while a behavioural response was identified during laboratory test (Andriguetto-Filho et al. 2005; Parry and Gason, 2006 in Tiday and Briffa 2016). A stress response to noise (airguns) was noticed (increase in food intake). Impacts of impulsive pile driving on Norway lobster showed a change in behaviour, as such reduced burrowing and mobility (Solan et al. 2016).

These studies identified a large array of responses to underwater sound pressure, from an increase in behaviour (for example an increase in food intake in lobsters), stress responses, slower or reduced behaviour, change in foraging habitats etc. The current knowledge on how these reactions are displayed however is based on a limited range of studies (Tidau and Briffa 2016).

2.6 Zooplankton

Zooplankton are highly mobile at small scales or across small scales (McManus & Woodson 2012, Bianco et al. 2014, Visser 2007); however, research suggest that they cannot move away from an approaching air gun array (i.e. an impulsive sound) produced during seismic surveys. Recent scientific evidence also suggests that low-frequency impulse sound leads to significant mortality to zooplankton populations (McCauley et al. 2017).

A decrease in zooplankton abundance was recorded during experimental air gun signal exposure when compared to the absence of air gun signal, as measured by sonar (~3–4 dB drop within 15–30 min) and net tows (median 64% decrease within 1 hour). In addition, this caused an increase in mortality for adult and larval zooplankton (McCauley et al. 2017). The impacts of air guns on zooplankton have been observed out to the maximum 1.2 km range sampled (McCauley et al. 2017).

Further studies on larval invertebrates also showed significant malformations to scallop veliger larvae from simulated air gun exposure (de Soto et al. 2013), while no impacts were detected on larval hatching success or viability immediately after hatchment for lobster eggs exposed to an air gun in the field (Day et al. 2016).

The knowledge of effects from underwater sound on zooplankton communities is very sparse with little scientific evidence, besides from recent research by McCauley et al. (2017) described above.

3. Results and Discussion

3.1 Marine mammals

3.1.1 Injury and disturbance thresholds

Effects of underwater sound changes range from injury through to disturbance. To calculate the zone of influence for both levels of effect, sound propagation calculations have been used to determine the range at which the received sound attenuates to levels below a defined threshold. The thresholds used in the calculations are explained below.

3.1.1.1 Injury thresholds

The assessment has used both the recently published American National Marine Fisheries Service (NMFS) (2018) thresholds for the onset of PTS and TTS and the thresholds defined by Southall *et al.* (2007). Both approaches separate marine mammals into five groups based on their functional hearing, namely: low-frequency cetaceans; mid frequency cetaceans; high frequency cetaceans; pinnipeds (Phocid) in water; and pinnipeds (Otariid) in water. Table 3-1 presents the species identified as present along the Greenlink route according to their functional hearing category.

Table 3-1 Marine mammal auditory bandwidth

Group	Low-frequency cetaceans	Mid-frequency cetaceans	High-frequency cetaceans	Pinnipeds (Phocid) in water	Otariid and other non-phocid marine carnivores in water
Generalised hearing range (NMFS 2018)	7Hz - 35kHz	150hz - 160kHz	275Hz - 160kHz	50Hz - 86kHz	60Hz - 39kHz
Species	Baleen whales	Most toothed whales, dolphins	Certain toothed whales, porpoises	True seals	Otter
Species observed along Greenlink route	Minke whale Humpback whale Fin whale	Short-beaked common dolphin Common bottlenose dolphin Stripped dolphin Risso's dolphin Atlantic white-sided dolphin White-beaked dolphin Long-finned pilot whale Killer whale	Harbour porpoise	Grey seal Harbour seal	Common otter

Source: NMFS (2018)

The thresholds for the onset of PTS and TTS, as published in NMFS (2018) and Southall *et al*. (2007), are provided in Table 3-2. These reflect the current peer-reviewed published state of scientific knowledge.

Table 3-2 Injury thresholds for marine mammals from impulsive (SPL, unweighted) and continuous (SEL, weighted) sound

Group	SPL (unweighted) - impulsive sound				SEL (weighted) - continuous sound			
	NMFS (2018)		Southall *et al*. (2007) *		NMFS (2018)		Southall *et al*. (2007)	
	PTS (dB re 1 µPa (peak))	TTS (dB re 1 µPa (peak))	PTS (dB re: 1 µPa (peak))	TTS (dB re: 1 µPa (peak))	PTS (dB re 1 µPa^2 s)	TTS (dB re 1 µPa^2 s)	PTS (dB re: 1 µPa^2-s)	TTS (dB re: 1 µPa^2-s)
Low-frequency cetaceans	219	213	230	224	199	179	198	183
Mid-frequency cetaceans	230	224	230	224	198	178	198	183
High-frequency cetaceans	202	196	230	224	173	153	198	183
Pinnipeds (Phocid) in water	218	212	218	212	201	181	186	171
Pinnipeds (Otariid) in water	232	226	-	-	219	199	-	-

Source: Southall *et al*. (2007); NMFS (2018)

Note: * Single pulse

3.1.1.2 Disturbance thresholds

NMFS has not yet published guidelines on behaviour thresholds due to the complexity and variability of the responses of marine mammals to anthropogenic disturbance.

For the purposes of this assessment the threshold for behavioural disturbance has been assessed as 160 dB rms (SPL - impulsive sound) and 120 dB rms (SEL - continuous sound) for all cetacean species (Gomez et al. 2016, BOEM 2017, NMFS 2018).

3.1.1.3 Modelling

Sound attenuates as it propagates through water and the local oceanographic conditions will affect both the path of the sound into the water column and how much sound is transmitted. An in-house geometric spreading calculation was used to determine the propagation of underwater sound from the activities. The spreading model assumes that sound is spread geometrically away from the source with an additional frequency-dependent absorption loss; it therefore provides conservative estimates. It also does not take into consideration the conditions within the area, such as bathymetry, water depth or sediment type and thickness.

Attenuation used in the geometric spreading calculation can be calculated using the equation below:

SPL = SL – 15log (R). In this equation:

SPL = sound pressure level

SL = source level

R = the distance from a source level (SL)

15 = attenuation value associated with spreading in shallow water, allowing for losses to the seabed.

This equation does not include any terms relating to frequency (MMO 2015).

The NMFS recently developed a spreadsheet tool to estimate at which range (or distances) PTS (permanent injury) could effect marine mammals (NMFS 2018). This spreading model considers weighting factor adjustments and frequency, as well as source level, as part of its calculation. It was used to confirm the PTS results obtained from the geometric spreading modelling. The NMFS (2018) spreadsheet does not provide values for TTS.

A literature review was performed to obtain the source levels to inform this assessment and modelling (results provided in Table 3-3). No project-specific data was available, and the literature review identified appropriate sound sources to use.

Nedwell et al. (2003) provided an unweighted source level for trenching operations during trenching at North Hoyle; this is assumed to be 178dB re µPa @ 1m. The trenching noise was considered to be a mixture of broadband noise, tonal machinery noise and transients. During trenching at North Hoyle, sound was recorded as highly variable, and assumed to be dependent on the physical properties of the particular area of seabed that was being cut at the time (Nedwell et al. 2003). There is no publicly available data providing sound exposure levels (SEL) associated with trenching operations. The source level provided in Nedwell et al. (2003) is unweighted; therefore, this has been compared against SPL (unweighted) thresholds from the NMFS (2018) and Southall et al. (2007).

Genesis Oil and Gas Consultants (2011) listed the sound levels of DP vessels; a worst-case 184dB B re 1 μPa @ 1m was used for the assessment below.

Studies showed that rock placement did not generate a noticeable rise in the level of underwater sound, compared to the presence of vessels (including those using dynamic positioning). This indicates the sound levels are dominated by the vessel noise and not the rock dumping activities (Nedwell and Edwards 2004). Wyatt (2008) recommended the use of 188dB (rms) 1μPa @1m, which was converted to 191dB (0-peak) 1μPa @1m.

Received sound by marine mammals from the geophysical survey are considered as near-continuous, rather than impulsive. However, there are no publicly available data on sound exposure levels (SEL) for the geophysical equipment. For the purpose of this assessment, sound pressure levels (SPL), which are more readily available, have been used instead to compare the sound levels of the geophysical equipment and borehole drilling against PTS and TTS thresholds (for near-continuous noise the thresholds are provided in SEL as this accounts for the time element as well as the noise level whereas impulsive just considers the noise).

Modelling results, i.e. the distances from the source at which sound levels will diminish to below the injury and disturbance thresholds, are summarised in Table 3-3.

Table 3-3 Summary of results – cable installation and geophysical survey

Auditory group	Threshold			Distance in metres at which threshold is exceeded						
				DP vessel *	Trenching **	Rock placement ***	Geophysical survey: Multibeam echosounder (MBES)*	Geophysical survey: Sidescan sonar (SSS)*	Geophysical survey: Sub-bottom profiling: chirper / pinger*	Geophysical survey: Sub-bottom profiling: boomer *
				SPL: 184dB dB re 1 µPa @ 1m Frequency: 63Hz	SPL: 178dB re 1 µPa @ 1 m Frequency: 125Hz	SPL(0-peak): 191dB re: 1µPa @1m Frequency: 10kHz	SPL: 232dB(rms)re 1µPa @1m (converted to 235 dB0-peak re 1µPa2-s) * Frequency: 95kHz	SPL: 226dB(rms) re 1µPa @1m (converted to 229 dB0-peak re 1µPa2-s) * Frequency: 114kHz	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) * Frequency: 1.5kHz	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) * Frequency: 2.5kHz
Low-frequency cetaceans	PTS (dB re 1 µPa (peak))	NMFS	219	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	15	5	Threshold not exceeded	Threshold not exceeded
		Southall *et al.*	230	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	2.6	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
	TTS (dB re 1 µPa (peak))	NMFS	213	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	40	13	Threshold not exceeded	Threshold not exceeded
		Southall	224	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	7	2.6	Threshold not exceeded	Threshold not exceeded
Mid-frequency cetaceans	PTS (dB re 1 µPa (peak))	NMFS Southall	230	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	2.6	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
	TTS (dB re 1 µPa (peak))	NMFS Southall	224	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	7	2.6	Threshold not exceeded	Threshold not exceeded
High-frequency cetaceans	PTS (dB re 1 µPa (peak))	NMFS	202	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	110	60	4.6	4.6
		Southall	230	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	2.6	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded

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Auditory group	Threshold			Distance in metres at which threshold is exceeded						
				DP vessel *	Trenching **	Rock placement ***	Geophysical survey			
							Multibeam echosounder (MBES)*	Sidescan sonar (SSS)*	Sub-bottom profiling: chirper / pinger*	Sub-bottom profiling: boomer *
				SPL: 184dB dB re 1 µPa @ 1m Frequency: 63Hz	SPL: 178dB re 1 µPa @ 1 m Frequency: 125Hz	SPL(0-peak): 191dB re: 1µPa @1m Frequency: 10kHz	SPL: 232dB(rms)re 1µPa @1m (converted to 235 dB0-peak re 1µPa2-s) * Frequency: 95kHz	SPL: 226dB(rms) re 1µPa @1m (converted to 229 dB0-peak re 1µPa2-s) * Frequency: 114kHz	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) * Frequency: 1.5kHz	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) * Frequency: 2.5kHz
	TTS (dB re 1 µPa (peak))	NMFS	196	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	180	110	11	11
		Southall	224	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	7	2.6	Threshold not exceeded	Threshold not exceeded
Pinnipeds (Phocid) in water	PTS (dB re 1 µPa (peak))	NMFS Southall	218	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	15	7	Threshold not exceeded	Threshold not exceeded
	TTS (dB re 1 µPa (peak))	NMFS Southall	212	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	40	15	Threshold not exceeded	Threshold not exceeded
Otter in water	PTS (dB re 1 µPa (peak))	NMFS	232	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	2	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded
	TTS (dB re 1 µPa (peak))	NMFS	226	Threshold not exceeded	Threshold not exceeded	Threshold not exceeded	4.6	2	Threshold not exceeded	Threshold not exceeded
All cetaceans	Disturbance (dB rms)	BOEM, NMFS	160	50	17	130	940	720	2,600	2,500

Source: Southall *et al.* (2007), Popper *et al.* (2014), BOEM (2017), NMFS (2018)

Source: * Genesis Oil & Gas Consultants (2011), ** Nedwell *et al.* (2003), *** Wyatt (2008), † Based on 734kg explosive (sea mine).

Note: Sound generated by vessel movement, pre-sweeping, trenching and rock placement is continuous. However, there is no publicly available data on SEL for these activities. Therefore, SPL input values and thresholds have been used to assess sound generated by these activities.

3.1.1.4 Zone of influence

The geometric spreading model results indicate that for activities which generate continuous (cable installation) or near-continuous (geophysical survey) sound:

- Cable installation activities (DP vessels, rock placement and trenching):
  - No cetaceans, pinnipeds or otters are at risk of permanent or temporary injury.
  - The zone of influence for disturbance is 130m (all cetaceans).
- Geophysical survey (multi-bean echosounder, side-scan sonar, sub-bottom profiler)
  - The zone of influence for permanent injury is 110m (high-frequency cetaceans).
  - The zone of influence for temporary injury is 180m (high-frequency cetaceans).
  - The zone of influence for disturbance is 2.6km (all cetaceans).
  - Otters are at risk of permanent injury within 2m of the source.
  - Otters are at risk of temporary injury within 4.6m of the source.

3.1.2 Activities generating impulsive sound

This section models and discusses the detonation of UXO. This activity, if required, would be undertaken during the installation phase, and potentially during operation (principally maintenance and repair).

3.1.2.1 Modelling

Should UXO be found, which require clearance by detonation, there would be a relatively large release of impulsive sound energy. Peak source levels would depend on the quantity and nature of explosive material.

A desk-based UXO risk assessment conducted for Greenlink by 1st Line Defence (2018), identified that of the UXO that could be present along the cable route, size would range from 14kg up to 794kg. British sea mines were considered as a worst-case, containing up to 794kg of explosives. It is important to note that the desk-based study has not identified the number or locations of UXOs but provides a review of the type most likely to occur.

The source level of explosives can be predicted if certain parameters are known, such as the weight of the charge (w) and depth of detonation. The SPL (0-peak) of the initial shock wave, the largest amplitude component, is given by the formulae:

SPL (0-peak) dB re1µPa @ 1m = 271 dB + 7.533(log)(w)

Using this equation and based on 794kg as the weight of charge, the worst-case SPL(0-peak) is 293dB re1µPa @ 1m.

The results from the equation have been compared to measured SPLs from UXO detonations. Genesis Oil and Gas Consultants (2011) summarise information collected by Nedwell *et al*. (2001) during explosive operations in support of wellhead decommissioning. Measurements of sound pressure levels were taken at two locations: the CSO Seawell in a standoff position 600-800m from the wellhead; and seabed mounted hydrophones at different ranges. Sound pressure levels were recorded for charge sizes between 36kg and 81kg at varying water depths (see Table 3-4).

If the formula is used to calculate the SPL (0-peak) for a 36kg charge it concludes a value of 283 dB re1μPa @ 1m. Assuming spherical spreading from the explosion, then the SPL will attenuate to 227 dB re1μPa @ 600m. This figure is 6dB higher than the measured SPL @ 650m recorded by Nedwell *et al*. (2001) presented in row 1 of Table 3-4 above, suggesting that the calculations using the formula are conservative.

Table 3-4 SPLs (0-peak) recorded from the detonation of explosive charges measured from the CSO Seawell adapted from Nedwell *et al*. (2001)

Range (m)	Charge size (kg)	Depth of hydrophone	Received level (0-Peak) dB re1μPa @ range
650	36	30	221 dB re1μPa @ 650m
650	36	25	222 dB re1μPa @ 650m
800	36	30	221 dB re1μPa @ 800m
575	45	30	211 dB re1μPa @ 575m
575	45	25	211 dB re1μPa @ 575m
600	45	40	213 dB re1μPa @ 600m
600	45	35	214 dB re1μPa @ 600m
600	45	30	214 dB re1μPa @ 600m
600	45	25	214 dB re1μPa @ 600m
650	45	40	216 dB re1μPa @ 650m
650	45	35	218 dB re1μPa @ 650m
650	45	40	218 dB re1μPa @ 650m
650	45	35	217 dB re1μPa @ 650m
650	45	40	221 dB re1μPa @ 650m
650	45	35	217 dB re1μPa @ 650m
650	45	40	221 dB re1μPa @ 650m
650	45	35	221 dB re1μPa @ 650m
650	45	30	218 dB re1μPa @ 650m
650	45	25	217 dB re1μPa @ 650m
75	45	116	227 dB re1μPa @ 75m
125	45	87	226 dB re1μPa @ 125m
200	45	110	225 dB re1μPa @ 200m
300	45	91	232 dB re1μPa @ 300m
300	45	84	230 dB re1μPa @ 300m

Range (m)	Charge size (kg)	Depth of hydrophone	Received level (0-Peak) dB re1μPa @ range
400	45	108	223 dB re1μPa @ 400m
600	73	30	220 dB re1μPa @ 600m
650	73	25	226 dB re1μPa @ 650m
600	81	30	220 dB re1μPa @ 600m
600	81	25	226 dB re1μPa @ 600m

Source: Genesis Oil and Gas Consultants (2011)

Table 3-5 presents the results of the modelling assuming a SPL(0-peak) of 293dB re: 1μPa @1m for a 794kg charge.

Table 3-5 Summary of results - UXO detonation (worst-case 794kg explosive detonation)

Auditory group	Threshold			Distance in km at which threshold is exceeded SPL(0-peak): 293dB re: 1μPa @1m * Frequency: 10kHz
Low-frequency cetaceans	PTS (dB re 1 μPa (peak))	NMFS	219	13
		Southall *et al.*	230	5.8
	TTS (dB re 1 μPa (peak))	NMFS	213	16
		Southall	224	8.6
Mid-frequency cetaceans	PTS (dB re 1 μPa	NMFS	230	5.8
		Southall		
	TTS (dB re 1 μPa (peak	NMFS	224	8.6
		Southall		
High-frequency cetaceans	PTS (dB re 1 μPa (peak	NMFS	202	23
		Southall	230	5.8
	TTS (dB re 1 μPa (peak	NMFS	196	27
		Southall	224	8.6
Pinnipeds (Phocid) in water	PTS (dB re 1 μPa (pea)	NMFS	218	13
		Southall *et al.*		
	TTS (dB re 1 μPa (peak	NMFS	212	17
		Southall *et al.*		
Otters in water	PTS (dB re 1 μPa (pea)	NMFS	232	5
	TTS (dB re 1 μPa (p))	NMFS	226	7.6
All cetaceans	Disturbance (db rms)	BOEM, NMFS	160	54

Source: Southall *et al.* (2007), Popper *et al.* (2014), BOEM (2017), NMFS (2018)

Source: * Calculated using Ulrick (1975) equation, using 794kg weight

3.1.2.2 Zone of influence

The modelling indicates that for UXO detonation which generates impulsive sound:

- High-frequency cetaceans are at risk of permanent injury within 23km of the source.
- High-frequency cetaceans are at risk of temporary injury within 27km of the sound source.
- Seal are at risk of permanent injury within 13km of the source.
- Seal are at risk of temporary injury within 17km.
- The zone of influence for permanent injury for otters is 5km.
- The zone of influence for temporary injury for otters is 7.6km.
- All cetaceans are at risk of disturbance within 54km of source.

3.2 Sea turtles

3.2.1 Continuous sound

A review of sound exposure on sea turtles by Popper *et al*. (2014) identified no existing data regarding the effect of continuous sound.

3.2.2 Impulsive sound – UXO detonation

There is little information on the effects of impulsive sound on marine turtles. Some studies identified that the use of explosives in the Gulf of Mexico for oil and activities resulted in the mortality or injury of some individuals, probably due to the quick change in pressure associated with detonations (Popper *et al*. 2014).

Modelling, using the same approach as for cetaceans, presented in Table 3-6 indicates that sea turtles are risk of mortality and potential mortal injuries within 6.2km.

Table 3-6 Summary of results for UXO - sea turtles

Auditory group	Threshold			Distance in km at which threshold is exceeded SPL(0-peak): 293dB re: 1μPa @1m * Frequency: 10kHz
Sea turtles	Mortality and potential mortal injury	Popper *et al.*	229 -234dB re 1 μPa (peak)	4.2 - 6.2

3.3 Fish

3.3.1 Continuous sound source

Popper *et al*. (2014) identified that there is no direct evidence of permanent injury to fish species from shipping and other continuous noise (such as the cable installation and near-continuous sound produced by geophysical equipment). The Oslo and Paris (OSPAR) Commission (2012) considered that the potential for likely significant effects to fish from cable installation activities is considered to be minor.

Different fish species react differently to sound. Behavioural responses may include small movement or escape responses, based on studies conducted in laboratories (The University of Rhode Island 2017).

Continuous sound is detectable by fish species, and it is possible that this could lead to masking. However, masking and behavioural changes in fish from continuous sound is currently unknown (Popper *et al*. 2014). It is unlikely that fish species will be significantly affected by sound changes during the cable installation activities.

3.3.1.1 Modelling

Modelling results, i.e. the distances from the source at which sound levels will diminish to below the injury and disturbance thresholds, are summarised in Table 3-7.

Table 3-7 Summary of continuous sound results - fish

		Threshold	Recoverable injury 173dB re 1 µPa†	TTS 161dB re 1 µPa†
Activity	Source	Frequency	Distance in metres at which threshold is exceeded	
DP vessel *	SPL: 184dB dB re 1 µPa @ 1m	Frequency: 63Hz	7	50
Trenching **	SPL: 178dB re 1 µPa @ 1 m	Frequency: 125Hz	2.6	16
Rock placement ***	SPL(0-peak): 191dB re: 1µPa @1m	Frequency: 10kHz	17	110
MBES*	SPL: 232dB(rms)re 1µPa @1m (converted to 235 dB0-peak re 1µPa2-s) *	Frequency: 95kHz	630	910
SSS*	SPL: 226dB(rms) re 1µPa @1m (converted to 229 dB0-peak re 1µPa2-s) *	Frequency: 114kHz	450	700
Chirper / pinger*	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) *	Frequency: 1.5kHz	350	2,200

		Threshold	Recoverable injury	TTS
			173dB re 1 µPa†	161dB re 1 µPa†
Activity	Source	Frequency	Distance in metres at which threshold is exceeded	
Boomer *	SPL: 208dB(rms) re 1µPa @1m (converted to 211 dB0-peak re 1µPa2-s) *	Frequency: 2.5kHz	350	2,200

Note: † Popper *et al*. (2014) provide thresholds in dB (rms) for recoverable injury and TTS. These have been derived in 0-peak. Recoverable injury threshold is 170dB rms for exposure of 48hrs and TTS threshold is 158dB rms for exposure of 14hrs.

3.3.1.2 Zone of influence

The geometric spreading model results indicate for activities which generate continuous (cable installation) or near-continuous (geophysical survey) sound:

- Cable installation (DP vessels, rock placement and trenching):
  - The zone of influence for fish recoverable injury is 17m.
  - The zone of influence for temporary injury for fish is 110m.
- Geophysical survey (multi-bean echosounder, side-scan sonar, sub-bottom profiler)
  - The zone of influence for fish recoverable injury is 630m.
  - The zone of influence for temporary injury for fish is 2,200m.

3.3.2 Impulsive sound – UXO

Underwater explosion produces a pressure waveform with rapid oscillations from positive pressure to negative pressure which results in rapid volume changes in gas-containing organs. Damage to visceral organs is most often the cause of fish mortality following exposure to underwater explosions. The most commonly injured organs are those with air spaces that are affected by the explosion’s shock wave passing through the body of the fish, these include the body cavity, the pericardial sack and gut, however injuries of the swim bladder are most common. The swim bladders are subject to rapid contraction and overextension in response to explosive shock waveforms. Species which do not possess a swim bladder or have small swim bladders are likely to be more resistant to noise generated from explosions (Keevin and Hempen 1997).

Popper *et al* (2014) also highlighted that there is no data on the effects of an explosion (such as UXO for example) on hearing or behaviour available. It is possible that a detonation can lead to temporary or partial loss of hearing at high sound levels, especially for fish species having a swim bladder which enhances sound detection. The time interval between explosions can also a key factor in fish species resilience to detonation (Popper *et al*. 2014).

If an UXO detonation is required, it is likely that any individual adult and juvenile fish present in vicinity of the explosion zone of influence will be injured or killed.

3.3.2.1 Modelling and zone of influence

Modelling, using the same approach as for cetaceans, presented in Table 3-8 indicates that fish are risk of mortality and potential mortal injuries within 6.2km.

Table 3-8 Summary of results for UXO - fish

Auditory group	Threshold			Distance in km at which threshold is exceeded SPL(0-peak): 293dB re: 1μPa @1m * Frequency: 10kHz
Fish	Mortality and potential mortal injury	Popper *et al.*	229 -234 dB re 1 μPa (peak)	4.2 - 6.2

3.4 *Crustaceans*

There is no threshold for the assessment of sound exposure for crustaceans (Tidau and Briffa 2016).

3.5 *Zooplankton*

There is no threshold for the assessment of sound exposure for zooplankton (Solan *et al*. 2016, McCauley *et al*. 2017).

4. Conclusion

4.1 *Zones of Influence*

The zones of influence to be used in the EIA process are summarised in the Tables below as follows:

- Table D4-1 - Continuous sound from cable installation;
- Table D4-2 – Continuous sound from geophysical survey (MBES, SBP, SSS); and
- Table D4-3 – Impulsive sound from UXO detonation (worst-case 794kg explosive).

Table 4-1 Zones of influence for continuous sound – cable installation

Species	Permanent Injury (PTS)	Temporary Injury (TTS)	Disturbance
Low-frequency cetaceans	Not exceeded	Not exceeded	130m
Mid-frequency cetaceans	Not exceeded	Not exceeded	130m
High-frequency cetaceans	Not exceeded	Not exceeded	130m
Seals in water	Not exceeded	Not exceeded	130m
Otters in water	Not exceeded	Not exceeded	130m
Fish (swim bladder used for hearing, primary pressure detection)	-	50m	-
Sea turtles	-	-	-
Zooplankton	-	-	-
Crustaceans	-	-	-

Table 4-2 Zones of influence used in EIA process for continuous sound – geophysical survey

Species	Permanent Injury (PTS)	Temporary Injury (TTS)	Disturbance
Low-frequency cetaceans	15m	40m	2,600m
Mid-frequency cetaceans	2.6m	7m	2,600m
High-frequency cetaceans	110m	180m	2,600m
Seals in water	15m	40m	2,600m
Otters in water	2m	4.6m	2,600m
Fish (swim bladder used for hearing, primary pressure detection)	-	2,200m	-
Sea turtles	-	-	-
Zooplankton	-	-	-
Crustaceans	-	-	-

Table 4-3 Zones of influence used in EIA process for impulsive sound – UXO detonation

Species	Permanent Injury (PTS)	Temporary Injury (TTS)	Disturbance
Low-frequency cetaceans	13km	16km	54km
Mid-frequency cetaceans	5.8km	8.6km	54km
High-frequency cetaceans	23km	27km	54km
Seals in water	13km	17km	54km
Otters in water	5km	7.6km	54km
All fish species	6.2km	-	-
Sea turtles	6.2km	-	-
Zooplankton	-	-	-
Crustaceans	-	-	-

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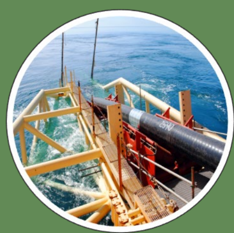
GREENLINK
MARINE ENVIRONMENTAL IMPACT ASSESSMENT REPORT- IRELAND

APPENDIX D

Herring Spawning and Sandeel Assessment

P1975_R4500_RevF1
July 2019

Greenlink Interconnector
- connecting the power markets
in Ireland and Great Britain



Greenlink
INTERCONNECTOR

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1. Introduction

This document presents work associated with analysing and mapping the potential spawning habitat resource for herring and sandeel species habitat in relation to the Greenlink Interconnector cable for both UK and Irish waters. The species considered are:

- Atlantic herring *Clupea harengus* Linnaeus, 1758;
- greater sandeel *Hyperoplus lanceolatus* Le Sauvage, 1824;
- Corbin's sandeel *H. immaculatus* Corbin, 1950;
- the lesser sandeel *Ammodytes tobianius* Linnaeus, 1758;
- Raitt's sandeel *A. marinus* Raitt, 1934; and
- the smooth sandeel *Gymnammodytes semisquamatus* Jourdain, 1879.

The work uses the methodology for the Atlantic herring preferred and marginal habitat resource mapping that was conducted and reported in MarineSpace *et al*. (2013a), using the same methods and types of data layers developed for the 2013 mapping exercise (Reach *et al*. 2013).

The same exercise is applied for sandeel preferred and marginal habitat mapping, using the resource mapping methodology (MarineSpace *et al*. 2013b), using the rationale developed by (Latto *et al*. 2013). The process for mapping sandeel habitat is the same as for Atlantic herring with the exclusion of the use of International Herring Larvae Survey (IHLS) data.

The 2013 reports are fundamental to the work presented in this report and should be referenced regarding processes associated with the rationale and detailed methodologies used. Where relevant, specific sections of the 2013 reports are cross-referenced to facilitate easy use and understanding of this report.

1.1 *Habitat Resource Parameterisation*

The habitat resource data used in the 2013 baseline mapping have been re-visited and updated with post-2012 data (where these are available). The revised baseline was developed in early January 2019, any relevant data available to that point have been considered and used to validate regional scale data.

1.1.1 *Spawning Ground Data*

The 2013 analyses used the spawning area data and maps from Coull *et al*. (1998) as one of the indicator layers used in the assessment. Subsequent to publication of the 2013 baseline report (MarineSpace Ltd *et al*. 2013a) new fish spawning analyses have been presented by Ellis *et al*. (2012).

Analysis of the Ellis *et al*. (2012) data and maps (by MarineSpace scientists) has demonstrated that the report brings no more useful resolution of data to the assessment compared to that already incorporated into the assessment from Coull *et al*. (1998). In explanation: the Atlantic herring spawning area maps presented in Ellis *et al*. (2012) replicate the Coull *et al*. (1998) spawning areas and then overlays a time series of IHLS data on top of these areas. The Reach *et al*. (2013) method also does this i.e. the 2013 baseline maps used the Coull *et al*. (1998) spawning areas and then mapped over these with the distribution of the IHLS data used in the assessment.

Therefore, in effect, the 2013 resource mapping exercise and this updated assessment are presenting the same data analysis used by Ellis *et al*. (2012) (e.g. Coull *et al*. (1998) spawning areas and IHLS data). The same extrapolation of spawning area is being presented, with the benefit that the data layers can be assessed separately. In fact, this method allows the incorporation of post-2011 IHLS data making it a more 'up-dateable' process than just relying upon the Ellis *et al*. (2012) data. For this reason, the data vintage score for the Coull *et al*. (1998) data is not adjusted and both these data and the updated IHLS data can be considered to present the same information as the Ellis *et al*. (2012) data.

1.1.2 Fishing Fleet and Vessel Monitoring System Data

At the time of the 2018 assessment only **Vessel Monitoring System (VMS) data** from 2013-2016 were available in addition to the 2002-2011 baseline assessed as part of the 2013 exercise (MarineSpace *et al*. 2013a, 2013b). This assessment therefore considers VMS data 2002-2016.

VMS data only provide differentiation between fishing locations by gear types, and therefore it is the gear types that have been used to inform habitat resource areas. As one gear type will target a number of species and not just Atlantic herring or sandeel spp., the probability of it informing spawning grounds or habitat is very low (see Section 1.2 of this report; Section 2.5 of MarineSpace *et al*., 2013a, 2013b and Appendix B of those reports).

However, pelagic gears are considered an indicator of Atlantic herring spawning areas; and demersal gears are an indicator of sandeel habitat as well as an indication of habitat damage and / or deterioration pressure footprints for both species groups.

The confidence in the VMS data remains the same as for the original 2013 assessments (low; MarineSpace *et al*. 2013a) (see Section 1.2).

Wales and Ireland Sea Fishing Atlas - The Sea Fishing Atlas for Wales was compiled by the then Countryside Council for Wales (CCW) (now part of Natural Resources Wales(NRW)) in 2010 from information collected between 2000 and 2005 from various sources including fishermen, fishery officers and fishery regulators, and other marine users.

The Cefas Inshore Fishing Activity – Trawling Activity – data layer remains the same as for the 2013 baseline assessment e.g. 2010-2012; as no updated data were identified to inform the revised assessment.

The data vintage score has been revisited and adjusted (down-scored) to reflect the age of the data as considered in the revised baseline assessment. However, the lowering of the confidence in data vintage score (from 3 down to 2) has not affected the overall data confidence associated with this data layer (see Section 1.2 of this report; Section 2.5 of MarineSpace *et al.* 2013a, 2013b and Appendix B of those reports).

1.1.3 Data used in the 2018 Baseline Assessment

The 2018 maps were produced by integrating the 2013 baseline data layers with the appropriate new data. Table 1-1 presents the data layers used to build the 2018 'heat' maps.

Table 1-1 Data layers used to produce the habitat resource 'heat' maps

Data classification	Data	Information
Atlantic herring		
Seabed Sediment	British Geological Survey	Herring **preferred** sediment polygon regions
Seabed Sediment	British Geological Survey	Herring **marginal** sediment polygon regions
Spawning Ground	Coull *et al.* (1998)[†]	Herring Spawning beds
Fishing Fleet	Marine Management Organisation (MMO) Vessel Monitoring System	2013-2016 for Pelagic Fishing Activity
Fishing Fleet	Natural Resources Wales (NRW)	Wales Sea Fishing Atlas data from 200-2005
Fishing Fleet	Cefas Inshore Fishing Activity	2010-2012 Trawling Activity
Sandeel species		
Seabed Sediment*	British Geological Survey	Sandeel **preferred** sediment polygon regions
Seabed Sediment*	British Geological Survey	Sandeel **marginal** sediment polygon regions
Spawning Ground	Coull *et al.* (1998)[†]	Sandeel Spawning
Fishing Fleet	MMO Vessel Monitoring System	2013-2016 for Demersal Fishing Activity
Fishing Fleet	NRW	Wales Sea Fishing Atlas data from 200-2005
Fishing Fleet	Cefas Inshore Fishing Activity	2010-2012 Trawling Activity
Fishing Fleet	Ellis *et al.* (2012)[¥]	High and low intensity fishing activity and relationship with spawning grounds

* adjusted Folk Classification; † Coull, K.A., Johnstone, R., and S.I. Rogers. 1998. Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd; [¥]Ellis J.R., Milligan S.P., Readdy L., Taylor N., and Brown M.J., 2012. Spawning and nursery grounds of selected fish species in UK waters. *Sci. Ser. Tech. Rep.*, Cefas Lowestoft, 147, 56 pp.

An additional datum layer was also used to 'sense check' the British Geological Survey (BGS) seabed surface sediment data:

- Particle Size Analysis (PSA) data collected from the Greenlink Interconnector route (MMT 2019).

The PSA data were analysed, classified and collated in relation to the 2013 Atlantic herring potential spawning habitat, and sandeel optimal habitat classifications, using the Folk (1954) sediment classification (Table 1-2; Figure 1-1; Table 1-3; Table 1-4; Figure 1-2)

Table 1-2 Description of Atlantic herring potential spawning habitat sediment classes

Preferred habitat sediment class	In the context of this methodology these are the sediment divisions / units represented by Gravel and sandy Gravel which Atlantic herring favourably select as part of their spawning habitat requirements. It should be noted that other physical, chemical and biotic factors contribute to the overall definition of potential spawning habitat
Marginal habitat sediment class	In the context of this methodology this is the sediment division / unit represented by gravelly Sand which Atlantic herring may select as part of their spawning habitat requirements. This sediment class has adequate sediment structure but is less favourable than preferred habitat
Unsuitable habitat sediment class	Seabed sediment classes which have inadequate sediment structure to be chosen by Atlantic herring for spawning grounds

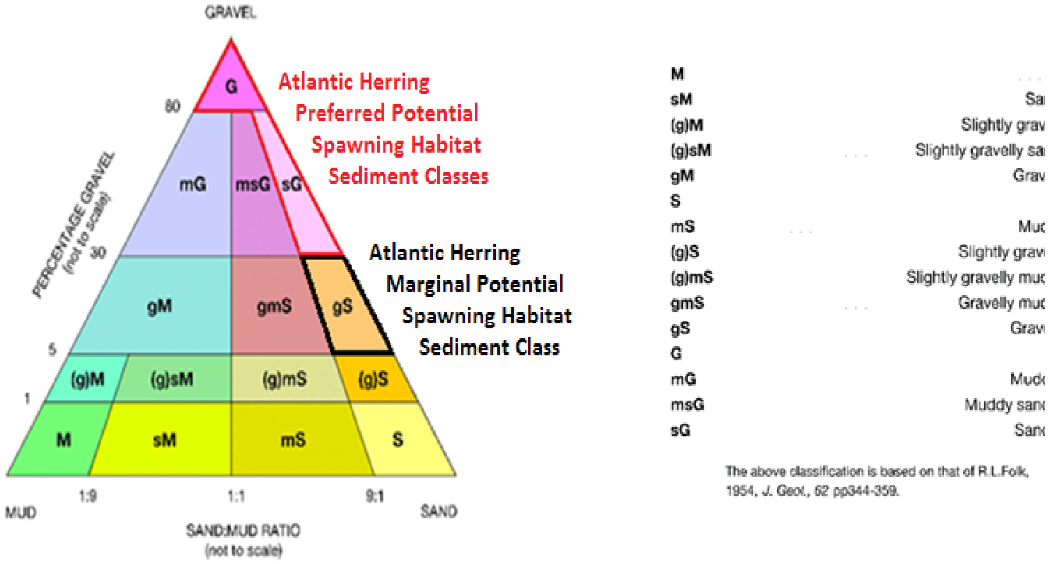
Source: Appendix A in MarineSpace Ltd *et al*. 2013a; Folk 1954

Table 1-3 The partition of Atlantic herring potential spawning habitat sediment classes

% Particle contribution (Muds = clays and silts <63 µm)	Folk sediment unit	Habitat sediment classification
<5% muds, >50% gravel	Gravel and part sandy Gravel	Preferred
<5% muds, >25% gravel	Part sandy Gravel and part gravelly Sand	Preferred
<5% muds, >10% gravel	Part gravelly Sand	Marginal
>5% muds, <10% gravel	Everything excluding Gravel, part sandy Gravel and part gravelly Sand	Unsuitable

Source: Appendix A in MarineSpace Ltd *et al*. 2013a; Folk 1954

Figure 1-1 The Folk sediment triangle with Atlantic herring preferred and marginal habitat sediment classes indicating potential spawning habitat



Note: It is important to note that the Folk (1954) sediment classes over-represent the suitability of an individual class to completely represent sediment habitat that will be used by Atlantic herring for spawning. This is due to the percentage of muds component within the sediment divisions. However, without a complete re-working of all the BGS data used in developing the 1:250,000 scale sediment maps a direct representation of the <5% muds (<63 µm) is not possible. The Marine Management Organisation (MMO) and MMO Regulatory Advisory Group (RAG) agreed that such an exercise is beyond the requirements of any specific EIA (as required under The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)). Therefore, the best-fit Folk sediment classification, presented in amended form as Figure 1-1, has been used to conduct the assessments within this report.

Source: Appendix A in MarineSpace Ltd *et al.*, 2013a; Folk 1954

Table 1-4 Description of sandeel species habitat sediment classes

Preferred habitat sediment class	In the context of this methodology these are the sediment divisions / units represented by Sand, slightly gravelly Sand and gravelly Sand which sandeel favourably select as part of their habitat requirements. It should be noted that other physical, chemical and biotic factors contribute to the overall definition of potential spawning habitat
Marginal habitat sediment class	In the context of this methodology this is the sediment division / unit represented by sandy Gravel which sandeel may select as part of their habitat requirements. This sediment class has adequate sediment structure but is less favourable than preferred habitat
Unsuitable habitat sediment class	Seabed sediment classes which have inadequate sediment structure to be chosen by sandeel

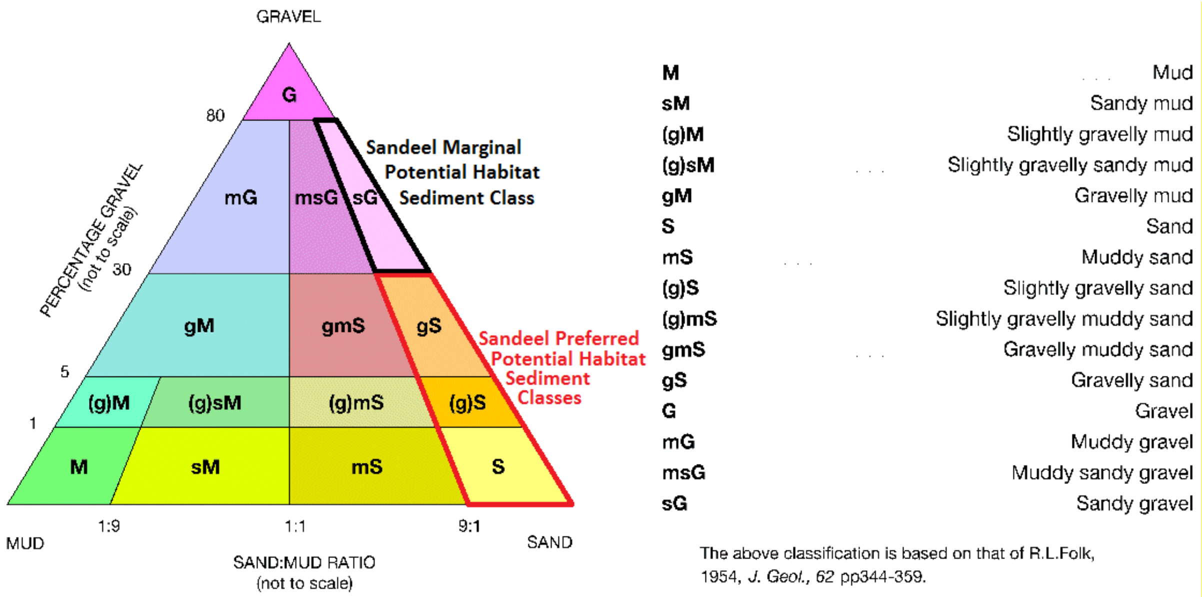
Source: Appendix A in MarineSpace Ltd *et al*. 2013b; Folk 1954

Table 1-5 The partition of sandeel species habitat sediment classes

% Particle contribution (Muds = clays and silts <63 µm)	Folk sediment unit	Habitat sediment classification
<1% muds, >85% Sand	Part Sand, part slightly gravelly Sand and part gravelly Sand	Preferred
<4% muds, >70% Sand	Part Sand, part slightly gravelly Sand and part gravelly Sand	Preferred
<10% muds, >50% Sand	Part gravelly Sand and part sandy Gravel	Marginal
>10% muds, <50% Sand	Everything excluding Gravel, part sandy Gravel and part gravelly Sand	Unsuitable

Source: Appendix A in MarineSpace Ltd *et al*. 2013b; Folk 1954

Figure 1-2 The Folk sediment triangle with sandeel species preferred and marginal habitat sediment classes



Source: Appendix A in MarineSpace Ltd *et al*. 2013b; Folk 1954

All data sets were acquired in a polygon format (area of spatial extent), rather than point, line or raster / gridded data, as this allowed them to be combined (union tool in GIS) and result in an overall assessment.

1.2 Data Confidence Assessment

All data were subjected to the data confidence assessment process developed in 2013 (Appendix B in MarineSpace Ltd *et al*. 2013a, 2013b). It is important to note that any data unchanged since used for the 2013 baseline were also re-assessed as data vintage is one of the confidence parameters assessed. All data were 'tagged' with the appropriate confidence score ready for 'heat' mapping.

The Total Normalised Atlantic herring or sandeel score is calculated by normalising the total weighted score for Atlantic herring to a range of 0-5, i.e. by dividing by the total possible score of 30 and multiplying by the range, 5. Whilst these values could have ranged 0-3 as with the rest of the scores, this did not allow enough variation between the datasets. A range of 5 was considered to show a suitable level of variation (very low = 1, low = 2, medium = 3, high = 4 and very high = 5). These individual data layer values were assigned to each shapefile attribute table ready to contribute towards the final combined confidence mapping layers.

The data confidence scores for each data layer are presented in Table 1-6.

Data vintage has been considered for those datasets not updated with additional data since the 2013 baseline was reported.

Table 1-6 Data layer confidence assessment scores

Atlantic herring		
Data classification	**Data**	**Confidence assigned to layer**
Seabed Sediment*	British Geological Survey – 'preferred' habitat	3
Seabed Sediment*	British Geological Survey – 'marginal' habitat	2
Spawning Ground	Coull *et al.* (1998)†	3
Fishing Fleet	Vessel Monitoring System	2
Fishing Fleet	Cefas Inshore Fishing Activity	2
Fishing Fleet	Wales and Ireland Fishing atlas	2
Sandeel species		
Data classification	**Data**	**Confidence assigned to layer**
Seabed Sediment*	British Geological Survey – 'preferred' habitat	4
Seabed Sediment*	British Geological Survey – 'marginal' habitat	2
Spawning Ground	Coull *et al.* (1998)†	3
Fishing Fleet	Vessel Monitoring System	2
Fishing Fleet	Cefas Inshore Fishing Activity	2
Fishing Fleet	Wales and Ireland Fishing atlas	2
Fishing Fleet	Ellis *et al.* (2012)¥ High Intensity	3
Fishing Fleet	Ellis *et al.* (2012)¥ Low Intensity	2

* adjusted Folk Classification; † Coull, K.A., Johnstone, R., and S.I. Rogers. 1998. *Fisheries Sensitivity Maps in British Waters*. Published and distributed by UKOOA Ltd; ¥Ellis J.R., Milligan S.P., Readdy L., Taylor N., and Brown M.J., 2012. Spawning and nursery grounds of selected fish species in UK waters. *Sci. Ser. Tech. Rep.*, Cefas Lowestoft, 147, 56 pp.

It is important to note that the BGS 1:250K seabed surface data have a different confidence score for Atlantic herring compared to sandeel species (Table 1-6).

As an overview, the Folk classification ties in better for sandeel species for preferred habitat type (Sand (S), slightly gravelly Sand((g)S), gravelly Sand (gS) and sandy Gravel (sG) than it does for preferred habitat for Atlantic herring Gravel (G) and sandy Gravel (sG) (see the Folk triangles in Figure 1-1 and Figure 1-2) due to sediment gradings within the Folk classifications. Further information is provided in Section 2.5.5 of both the 2013 Atlantic herring report and the 2013 sandeel report (MarineSpace et al. 2013a, 2013b).

1.2.2 Atlantic Herring

As per the method statement for Atlantic Herring, of the three Folk categories that represent potential spawning habitat sediment class (Gravel (G), sandy Gravel (sG) and gravelly Sand (gS)), **all of these over-represent the habitat divisions. This reduces the confidence**. Therefore, the matrix results are as follows:

Atlantic Herring Matrix	Folk category over represents = 0 (very low)	Folk category represents correctly = 2 (medium)
Folk category indicates marginal habitat sediment = 0 (very low)	gS = 0 (very low)	N/A
Folk category indicates preferred habitat sediment = 2 (medium)	G, sG = 1 (low)	N/A

The habitat can only have a very low or low assessment due to the Folk classification limitations.

1.2.3 Sandeel Species

As per the method statement for sandeel, of the four Folk categories that represent potential sandeel habitat sediment class (Sand (S), slightly gravelly Sand((g)S), gravelly Sand (gS) and sandy Gravel (sG)), **only the marginal habitat sediment sandy Gravel over-represent the habitat divisions. This reduces the confidence in the data layer**. In contrast a greater degree of confidence is placed in the preferred habitat sediments **as these are correctly represented by the Folk category**. Therefore, the matrix results are as follows:

Sandeel Matrix	Folk category over represents = 0 (very low)	Folk category represents correctly = 2 (medium)
Folk category indicates marginal habitat sediment = 0 (very low)	sG = 0 (very low)	N/A
Folk category indicates preferred habitat sediment = 2 (medium)	N/A	gS, (g)S, S = 2 (medium)

1.2.4 Atlantic Herring Potential Spawning Habitat: Confidence

Intervals of 4 were chosen to develop the categorisation of 'heat' associated with mapping i.e. 1-4, 5-8, 9-12. This ensures that any location with a single layer score of 5 (i.e. IHLS), is not included within the lowest category. Therefore, use of categories of multiples of 4 (e.g. as opposed to 5) allows greater differentiation.

The confidence scores result in a multi-layer range from 2-12 with: 2-4 = 'low' confidence; 5-8 = 'medium'; and 9-12 = 'high' confidence.

1.2.5 Sandeel Potential Habitat: Confidence

Intervals of 4 were chosen to develop the categorisation of 'heat' associated with mapping. The confidence scores result in a multi-layer range from 2-13 with: 2-5 = 'low' confidence; 6-9 = 'medium'; and 10-13 = 'high' confidence.

2. 'Heat' Mapping

Following the data confidence scoring, all data layers were analysed in GIS through multi-layer mapping i.e. the combination of overlapping data layers and the associated confidence score were used to produce the 'heat' maps. The combined confidence is the sum of all layers at any one location. This has been produced by simply adding the score for each layer to a total: the greater the number of overlapping data layers, the higher the probability that the seabed location represents potential habitat.

The 'heat' map is presented using BGS 1:250,000 seabed sediment base-maps. A comparison of those data and the site specific PSA sediment data has been undertaken to determine if the two datasets provide an analogous representation of seabed sediment character (see Section 2.6). The comparison also presents an opportunity to determine any locations where there is poor correlation or a significant separation in the BGS data and the PSA sediment data.

The 'heat map' shows the probability, for any seabed location, of the presence of Atlantic herring potential spawning habitat or sandeel habitat to be present, or for an area to support spawning activity. The maps can be produced at a range of scales from the seas-scale level (e.g. spawning population level) down to the licence area effect footprint scale.

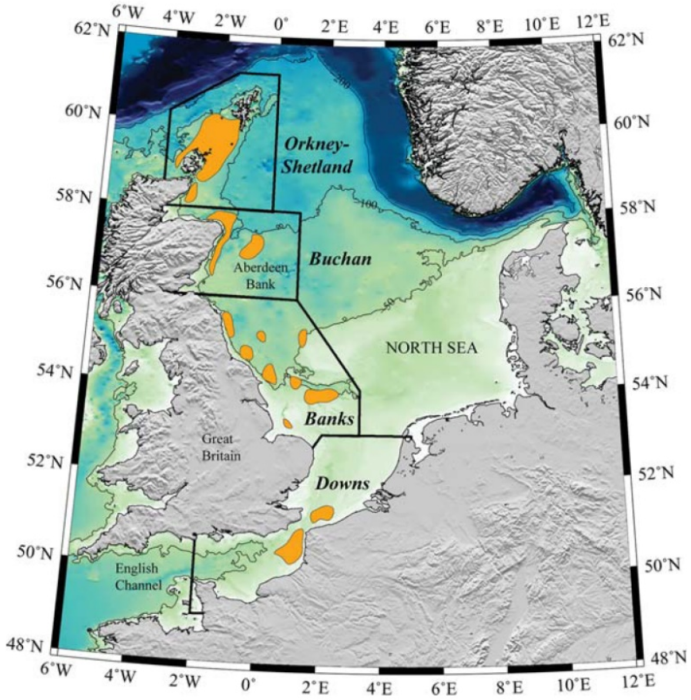
2.1 Atlantic Herring Spawning Population-scale Mapping Results

As previously identified in the 2013 assessments, there are four Atlantic herring spawning populations associated with UK waters in the North Sea and English Channel (Payne 2010; MarineSpace Ltd *et al*. 2013a; ICES 2017) (Figure 2-1):

- Orkney / Shetland;
- Buchan;
- Banks; and
- Downs.

Due to the geographic range of the Greenlink Interconnector route the mapping exercise for potential spawning habitat is not related to any of the main spawning populations within the UK. According to the Coull *et al*. (1998) data there is a small area of herring spawning near the coast of Freshwater West. The sandeel habitat mapping exercise relates to the same study area as the Atlantic herring, although it is not just concerned with mapping spawning habitat, but also habitat used all year round, for all life stages.

Figure 2-1 Distribution of Atlantic herring spawning populations recorded in UK Waters



Source: Payne, 2010; MarineSpace Ltd *et al.*, 2013a; ICES, 2017

In 2009 ICES (International Council for the Exploration of the Seas) adjusted the Irish Box (including ICES rectangles VIIa, VIIb, VIIf, VIIg, and VIIj) to the Biologically Sensitive Area (BSA) (ICES, 2009) Figure 2-2). The BSA includes Atlantic herring with the following statement regarding the importance of the area for the species:

"*Many inshore spawning sites and nursery areas* [are] *within the BSA although the BSA and associated management measures are unlikely to affect the species as controls mostly affect fishing further offshore*."

Figure 2-2 shows that the BSA lies to the north of the proposed Greenlink route. However, additional advice from ICES (2017), for Herring in Division VIIa South of 52° 30' N and VIIg,h,j,k (Celtic Sea and South of Ireland) states:

"*The stock SSB* [Spawning Stock Biomass] *is estimated to be declining and is estimated as 46 048 t. Mean F*[1] *(2-5 ring) in 2016 is estimated as being 0.40, having increased from 0.07 in 2009. Overall there had been a substantial decrease in F from 0.42 in 2004, but this is increasing again in recent years. Recruitment was good for several years with strong cohorts in 2005, 2007, 2009, 2010, 2011 and*

[1] F = Fecundity (egg-bearing capacity). Mean F = mean Fecundity metric related to adult female fish able to / with the potential to spawn. The term 'ring' relates to age of the fish. Post-egg and up to first year fish are 0-ringers. As the fish goes through annual seasons it lays down seasonal growth rings on the otolith (a statolith laid down in the ear) – 1 bold ring is 1 year old, 2 rings 2 years etc. Historical records show that generally female Atlantic herring reached maturation at around 4-5 years. However, due to fishing pressure etc. the females are tending to reach maturation at 2-3 years.

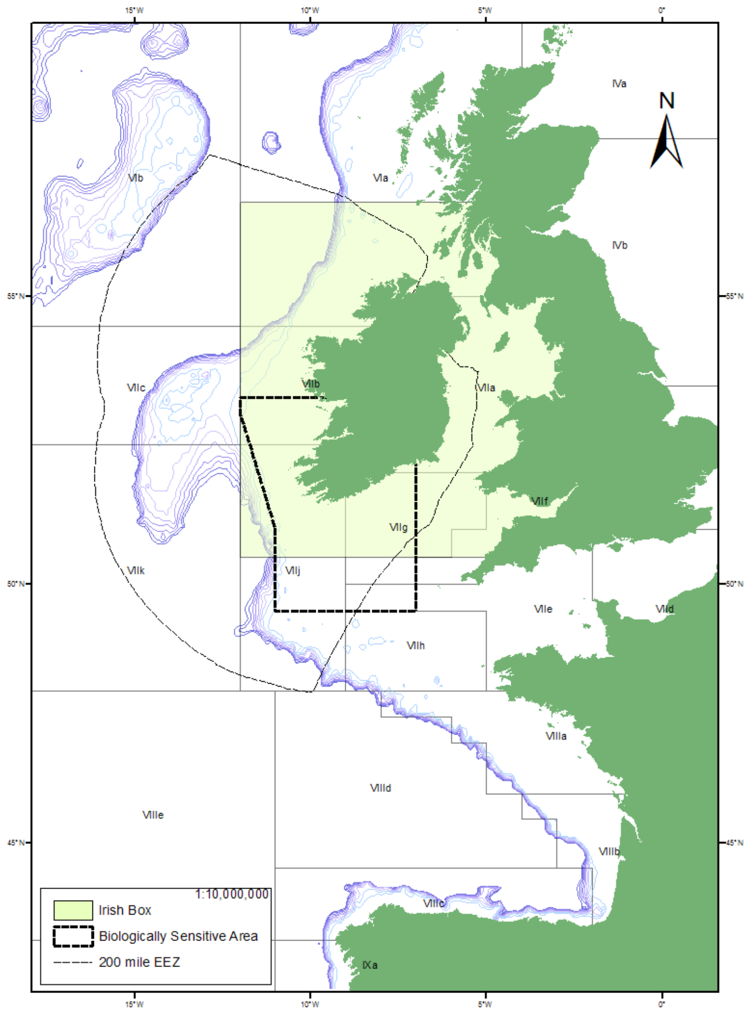
2012 having entered the stock. Recruitment has been lower in recent years, with an increase in 2016 with respect to 2015."

ICES HAWG (Herring Assessment Working Group) goes on to say:

"*At present there are no independent recruitment estimates... However, the acoustic survey age range has now been extended to include 1 ringers... This offers an independent estimate of recruits, and suggests a large increase in recruitment in recent years.*"

"*The state of the stock is not fully apparent from the results of the update assessment. Clearly, the stock has declined substantially from a high in 2012, as older cohorts disappeared and were not replaced - as recruitment has been below average since 2013. However the sudden change in fish behaviour as observed by the survey from 2014, with very differing availability of fish to the acoustic transducer, has meant that the assessment, following the Annex, cannot adequately track recent stock development* [fish recorded as swimming very close to the sea bottom]."

Figure 2-2 ICES Division VIIa South of 52° 30' N and VIIg,h,j,k (Celtic Sea and South of Ireland) and the Biologically Sensitive Area



Source: ICES (2009)

Finally, ICES HAWG (ICES, 2017) advises:

"Herring are an important prey species in the ecosystem and also one of the dominant planktivorous fish. The spawning grounds for herring in the Celtic Sea are well known and are located close to the coast. These spawning grounds may contain one or more spawning beds on which herring deposit their eggs. Individual spawning beds within the spawning grounds have been mapped and consist of either gravel or flat stone... Spawning grounds tend to be vulnerable to anthropogenic influences such as dredging, sand and gravel extraction, dumping of dredge spoil and waste from fish cages. There have been several proposals for extraction of gravel and to dump dredge spoil in recent years. Many of these proposals relate to known herring spawning grounds. ICES have consistently advised that activities that perturb herring spawning grounds should be avoided."

The Marine Institute, Fisheries Ecosystems Advisory Services (Ireland), cites that the smallest known spawning beds were found predominantly in the Celtic Sea, where nine beds were not larger than 0.1 km^2. The largest bed in the Celtic Sea was recorded as 36 km^2. In contrast spawning grounds recorded in the north and northwest of Irish waters, were considerably larger, with the largest being nearly 170 km^2, off north Donegal (O'Sullivan *et al*. 2013). However, for the larger spawning sites it is unclear whether they are contiguous beds, which seems unlikely given the specific spawning habitat requirements of Atlantic herring.

O'Sullivan et al. (2013) go on to say:

"[The 2012] *study is the first to show the locations of all herring spawning grounds in coastal waters of the Republic of Ireland. The results are based on extensive knowledge held within the fishing industry and validated with seabed data available from the national seabed survey programme. Larval modelling provides a first estimate of the spatial extent of larval dispersal fields from spawning beds which correspond with observed larval distributions from previous surveys. These results can be used for the purposes of marine spatial planning and to avoid negative impacts on herring spawning grounds. It is not possible to ascertain the contribution of individual spawning beds to recruitment of herring stocks. But to follow the precautionary approach it is necessary that all known beds are afforded maximum protection. The importance of herring as a forage fish…, and as a commercial resource…relies on favourable recruitment and the loss of spawning beds should to be avoided.*"

Figure 2-3 shows the distribution of known Atlantic herring spawning beds and grounds in Irish waters from the research conducted by O'Sullivan *et al*. (2013). It is apparent the known spawning habitat resources are distributed along the southern and western coastlines of the Republic of Ireland and off the northwestern coast of Northern Ireland.

Figure 2-3 Atlantic herring spawning beds

Source: O'Sullivan *et al.* (2013)

Table 2-1 presents the area of seabed associated with each of the 'heat' categories mapped with the available data. The area of 'high' confidence (9-12) 'heat' is used to set the greatest potential preferred spawning habitat available in the Welsh region. This value equates to 941.57 km^2 of 'high' 'heat' (2.66% of the total area of data used to delineate the potential Atlantic herring spawning area).

Table 2-1 The herring spawning population seabed area values

'Heat' (confidence) score	Category	Area (km^2)	Percentage of the Total Area of 'Heat' (%)
1 - 4	Low	16,410.73	46.36
5 - 8	Medium	9,997.94	28.25
9 - 12	High	941.57	2.66
All		35,396.07	77.27

The herring distribution and 'heat' map is presented in Figure 2-4. This sets the context of the herring spawning range within the Celtic Sea and the associated 'low', 'medium', 'high' and 'very high' confidence data for that population (along the Greenlink cable route).

In relation to this area of potential spawning habitat it is sensible to understand the status of the herring spawning populations, related fecundity and the 'space' required to maintain and support the total mass of spawning in any single year.

Atlantic herring spawning beds have quite specific characteristics. Due to data limitations and constraints the assessment has looked at data at a macro-scale. These data do not allow the necessary resolution to identify specific discrete and individual areas of seabed with the potential to act as Atlantic herring spawning beds. This is mainly because Atlantic herring spawning beds are typically small localised features[2].

2.1.2 Spawning Stock Biomass

Based on sources providing information on egg density at Atlantic herring spawning beds, number of eggs per female herring and the spawning stock biomass (SSB), it is possible to estimate a possible range for the total area of suitable spawning habitat for the Celtic Sea and South of Ireland Atlantic herring population (MarineSpace *et al*. 2013a). This can be compared to the values predicted in the mapping presented in this report and can contribute to the analysis of the effects on Atlantic herring in the wider context of the entire UK population. It should be noted that this is not a scientific attempt to quantify total Atlantic herring spawning habitat, but rather to allow order of magnitude comparisons of values predicted in two separate ways.

Given that SSB is likely to fluctuate over the 3 year period that the revised 2018 baseline will inform management decisions, the SSB value used in the revised assessment has been calculated as an average of the last 3 years of SSB data to help determine the total area of preferred habitat (ICES 2017).

The SSB values for the period 2014-2016 (inclusive) are presented in Table 2-2.

Table 2-2 Celtic Sea and South of Ireland Spawning Stock Biomass for the period 2014-2016

Year	SSB (tonnes)
2014	103,650
2015	69,979
2016	46,048
Mean Average	**73,226**

Source: ICES (2017)

[2] For example, a study undertaken by NOAA records size ranges of Atlantic spawning beds between 0.067 km^2 and 1.39 km^2 (Reid *et al*., 1999)

The mean average Celtic Sea and South of Ireland SSB for the period 2014-2016 is calculated as 73,226 tonnes or 73,226,000 kg (Table 2-2). Taking the average weight of an adult Atlantic Herring as 0.225 kg this would equate to a spawning population of approximately 325,448,889 fish[3]. According to Stratoudakis *et al.* (1998), on prime Atlantic herring spawning beds, egg densities were measured at 750,000-2,500,000 eggs per m^2. An adult female herring carries between 20-50,000 eggs[4]. A 28 cm female from the Downs stock produces around 42,000 eggs per year[5]. These values equate to anything between 15-125 female herring per m^2, or 30-250 adult fish per m^2 in total (assuming one male per spawning female). Taking a mean number of eggs per m^2, and a mean number of eggs per female, yields a mean number of 46 females per m^2, and a total of 92 fish per m^2. At these spawning densities, 325,448,889 fish would require a total area of preferred habitat in the range of 1.3-10.8 km^2.

By comparing these estimated values with the measured values of 'heat' it is possible to assess the scale of available habitat in the context of preferred habitat as detailed above (see Table 2-1). The area surrounding the Greenlink cable route has 941.57 km^2 'high' 'heat' seabed. Therefore, assuming initially that 'high' 'heat' equates to preferred habitat it is evident that the available (preferred) habitat exceeds the highest value of 10.8 km^2. This calculation can be considered precautionary as it does not consider available 'marginal' habitat associated with 'medium' and 'low' 'heat', which increases the available potential habitat further.

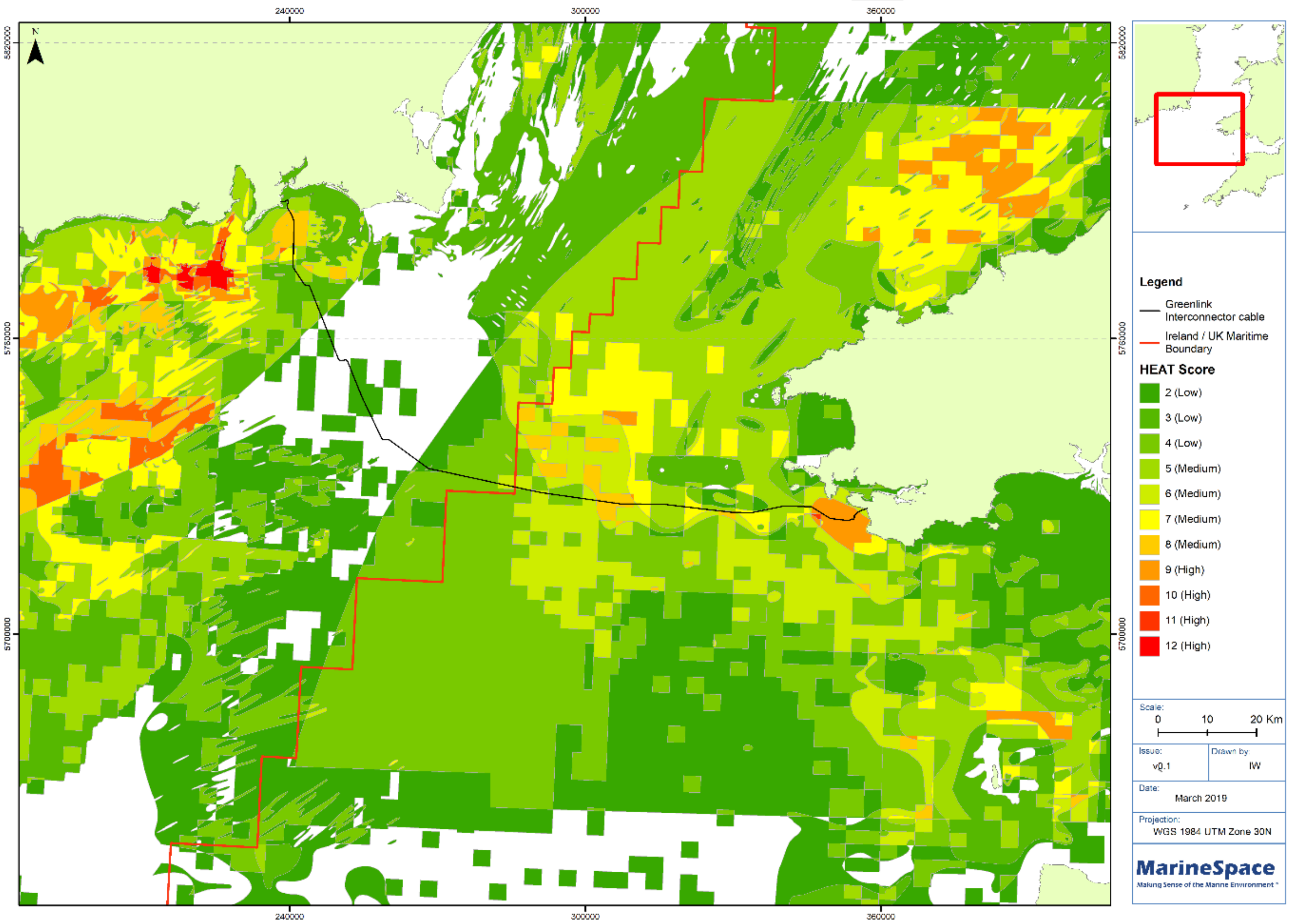
In the context of the population-scale 'heat' map (Figure 2-4) the percentage interaction between the Greenlink cable route and population-scale available preferred habitat in 'high' 'heat' locations = 0.02% (7.75 km^2 ÷ 35,396.07 km^2 x 100). See Section 2.5 for further detail.

[3] http:// www.clupea.net/stocks/NEAtlStocks/NorthSeaHer/NSAS_weca.htm

[4] http://www.gma.org/herring/biology/life_cycle/default.asp

[5] http://www.gov.scot/Publications/2015/05/4861/8

Figure 2-4 Distribution of data and 'heat' score associated with the Greenlink cable route and Atlantic herring potential spawning habitat



2.2 Sandeel Population-scale Mapping Results

MarineSpace *et al*. (2013b) identifies that sandeel habitat has quite specific characteristics which are still not well understood. The revised baseline has used data at a macro-scale. The necessary resolution to identify specific discrete and individual areas of seabed with the potential to act as sandeel habitat does not exist within the data. This is mainly because sandeel habitat is typically associated with localised features. Actual habitat, or habitat that could be used by sandeel in the future, will likely comprise discrete spatial extents, although these may be spread across wide areas of suitable seabed sediment habitat at a regional-scale.

The sandeel habitat mapping exercise relates to habitat used all year round, for all life stages of sandeel species.

It is thought that sandeel display an important level of site fidelity (sandeel are largely sedentary after settlement and form a complex of local (sub-) populations) making them potentially vulnerable at a sub-population level to direct habitat loss (removal) (MarineSpace *et al*. 2013b).

For the area of assessment, no ICES sandeel sub-population data interact with the Irish Sea region. The seabed area coverage considered for the Irish Sea population-scale sandeel habitat assessment is presented in Figure 2-5.

Figure 2-5 Distribution of data and ‘heat’ score associated with the Greenlink cable route and sandeel species potential habitat

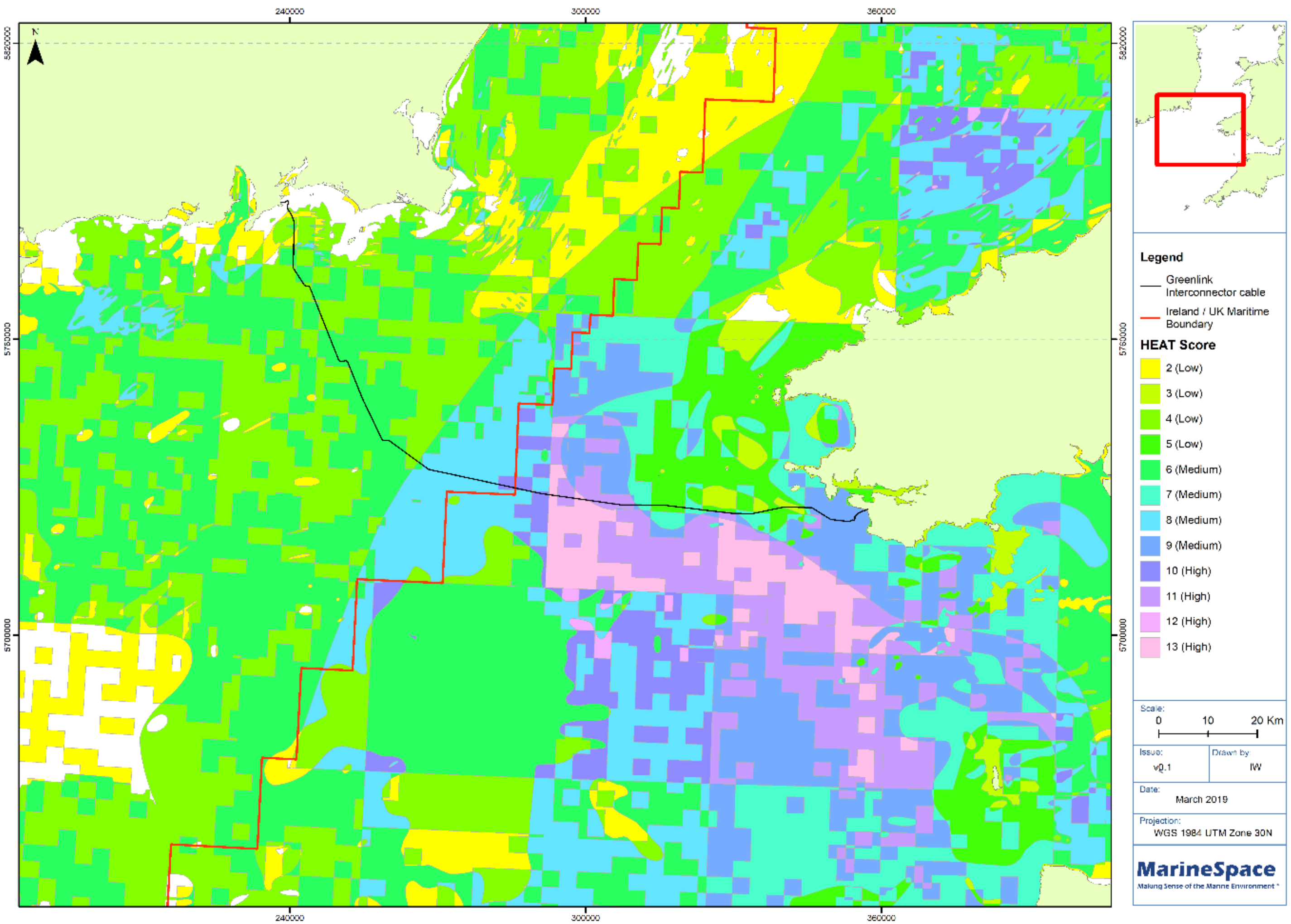


Table 2-3 Sandeel seabed habitat area values in the Greenlink cable route assessment area

'Heat' (confidence) score	Category	Area (km^2)	Total Area of Data (%)
2 - 5	Low	13,190.59	37.27
6 - 9	Medium	15,389.14	43.48
10 - 13	High	3,255.14	9.20
All		35,396.07	89.94

Table 2-3 presents the area of seabed associated with each of the 'heat' categories mapped with the available data. The area of 'high' confidence (10-13) 'heat' is used to set the greatest potential preferred habitat available to the sandeel population. This value equates to 3,255.14 km^2 of 'high' 'heat' (9.2% of the total area of data analysed). These values can be considered precautionary as they do not consider available 'marginal' habitat associated with 'medium' and 'low' 'heat'.

Figure 2-5 presents the 'heat' map in relation to the extent of data acquired and the study area.

In the context of the 'heat' map presented in Figure 2-5, the percentage interaction between Greenlink cable route and population-scale available preferred habitat in 'high' 'heat' locations = 0.04% (14.53 km^2 ÷ 35,396.07 km^2 x 100). See Section 2.6 for further detail.

2.3 Mapping Results

For both the Welsh and Irish region, a 'heat' map has been produced. The map is a magnified view of the population-scale figure. These investigations are presented to set context at the regional-scale, however; determinations of interactions between the Greenlink Interconnector route and preferred habitat are made at the wider population-scale. This is considered the most meaningful measure of interaction because Atlantic herring and sandeel species and available preferred habitat space are not limited by, or to, the Welsh/Irish waters boundary.

These points mean that a population-scale evaluation is the most meaningful in the context of management of marine aggregate dredging; in relation to possible effects on Atlantic herring potential spawning habitat and sandeel habitat.

2.3.1 Atlantic Herring

Overlays of the Greenlink cable route assessed for the Welsh and Irish region on the confidence 'heat' map for Atlantic Herring potential spawning habitat are presented in Figure 2-6 and Figure 2-7 respectively. Regions of 'high' 'heat' (i.e. confidence score 9-12 inclusive) are those areas of seabed where Coull et al. (1998) data layers have shown presence of Atlantic herring spawning populations. Areas of 'high' 'heat' are associated with the inshore region in Welsh and Irish waters. The area that the cable interacts with in both Welsh and Irish waters is mostly ‘low’ and ‘medium’ ‘heat’ and in much of the Irish waters is associated with no ‘heat’ i.e. the majority of the Greenlink cable route are not associated with ‘preferred’ spawning habitat for Atlantic herring.

Figure 2-6 2018 ‘heat’ map for Atlantic herring potential spawning habitat associated with Welsh waters

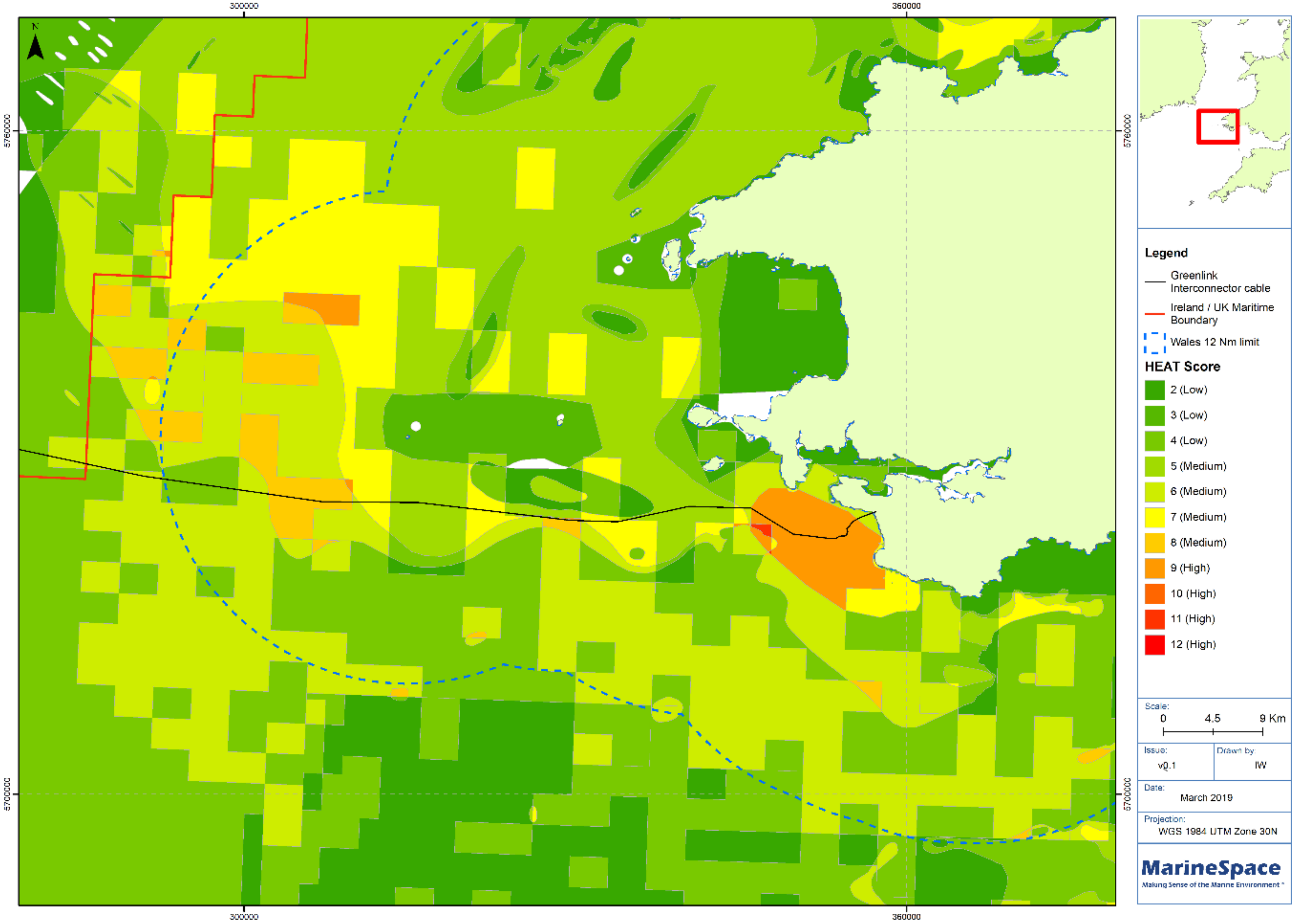
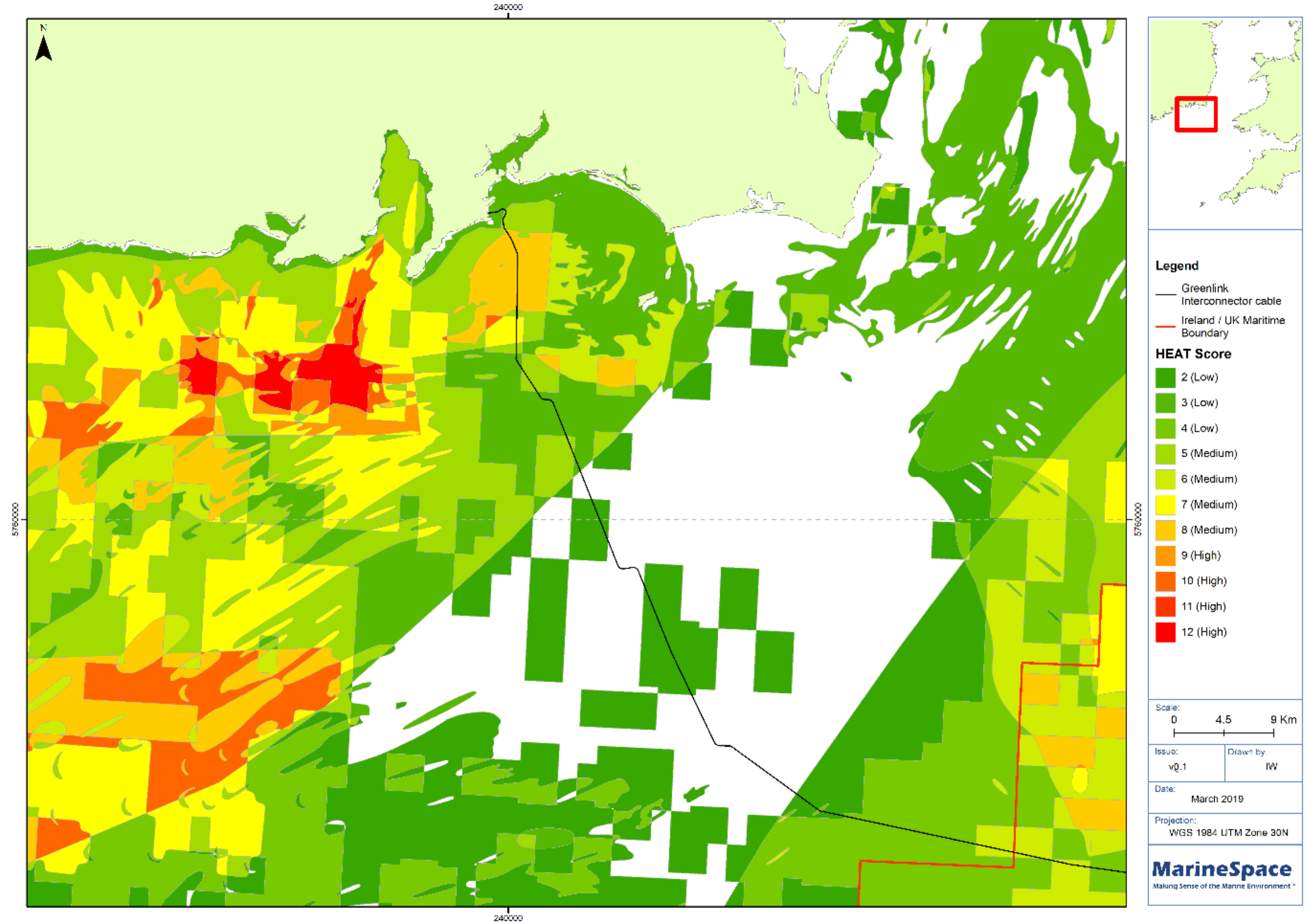


Figure 2-7 2018 'heat' map for Atlantic herring potential spawning habitat associated with Irish waters



2.3.2 Sandeel Species

Figure 2-8 and Figure 2-9 overlays the Greenlink cable route on the confidence ‘heat’ map for sandeel potential habitat in Welsh and Irish waters respectively.

Figure 2-8 illustrates the patchy distribution of ‘heat’ associated with sandeel habitat within Welsh waters with areas of ‘high’ heat in the west and areas of ‘low’ and ‘medium’ ‘heat’ further inshore. Areas of ‘high’ heat are associated with the BGS data layer showing areas of slightly gravelly sand.

Figure 2-9 shows that the Greenlink cable route in Irish waters interacts with only areas of ‘low’ and ‘medium’ ‘heat’.

Figure 2-8 2018 'heat' map for sandeel species potential habitat associated with Welsh waters

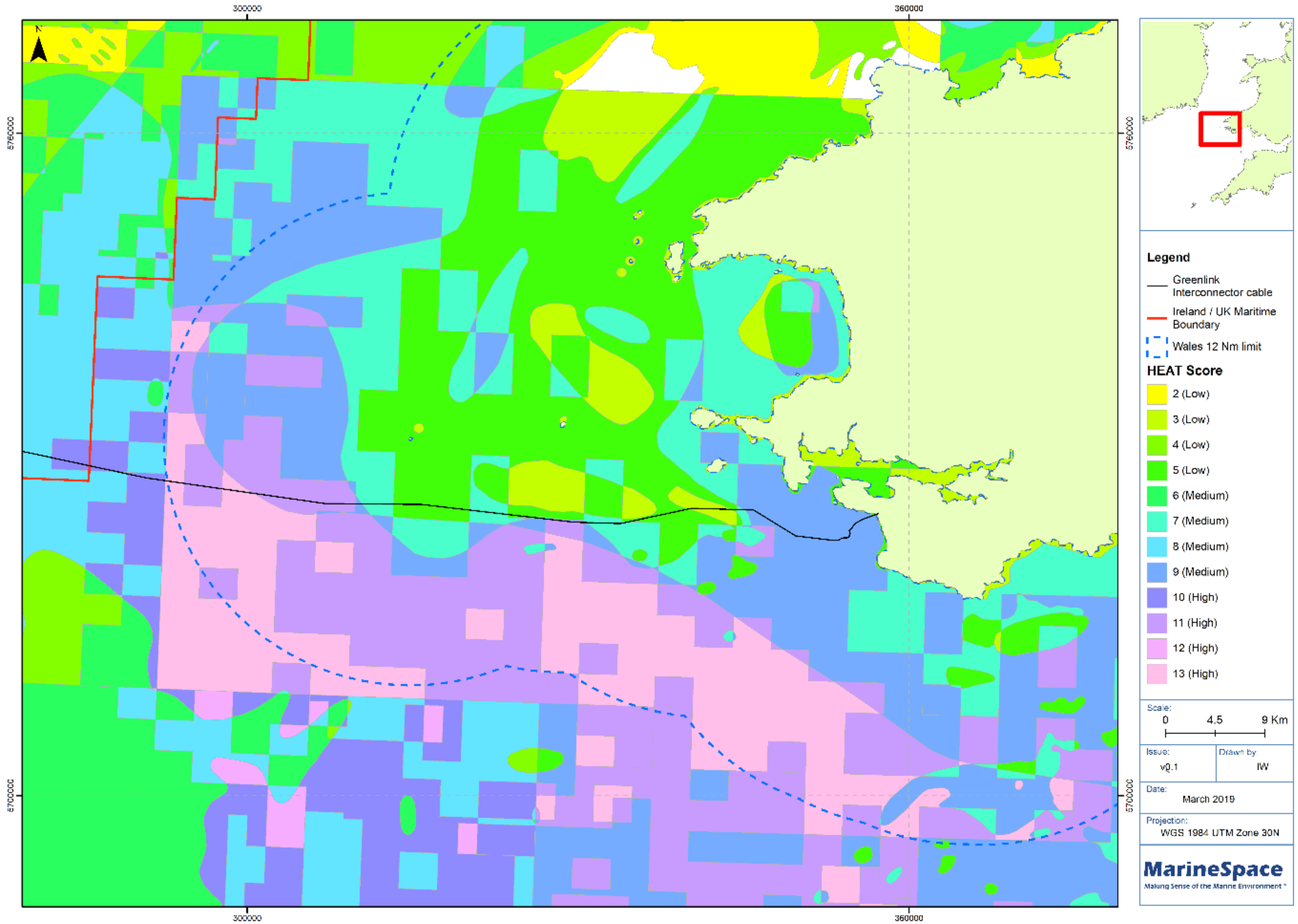
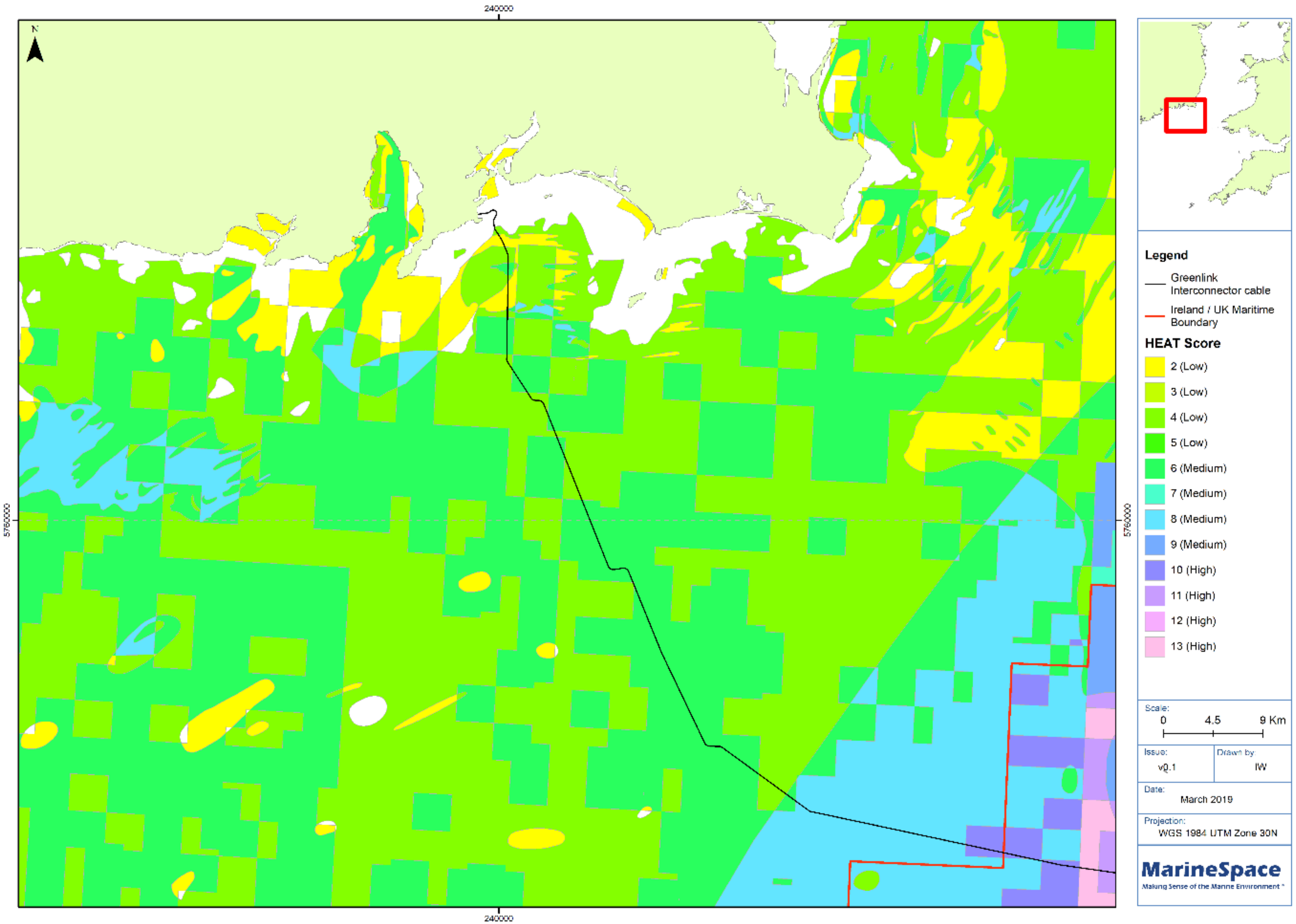


Figure 2-9 2018 ‘heat’ map for sandeel species potential habitat associated with Irish waters



2.4 Atlantic Herring Results – Extent of Greenlink Cable Route Interaction with Potential Spawning Habitat

The area of interaction between the Greenlink cable route corridor and the various mapping 'heat' categories has been calculated for Welsh and Irish waters. The Greenlink cable route overlaps with a total area of 'heat' of 70.9 km^2 across its entire installation corridor[6]. This breaks down as:

- 25.81 km^2 of low 'heat' class;
- 37.34 km^2 of 'medium' 'heat' class; and
- 7.75 km^2 of 'high' 'heat' class.

At the Irish Sea spawning population-scale there is approximately:

- 16,410.73 km^2 of 'low' 'heat' class;
- 9,997.94 km^2 of 'medium' 'heat' class; and
- 941.57 km^2 of 'high' 'heat' class.

Therefore, the following values relate to the potential effect footprint associated with the Greenlink cable route with the Irish Sea spawning population habitat space:

- 0.16% of the total available 'low' 'heat' class;
- 0.37% of the total available 'medium' 'heat' class; and
- 0.82% of the total available 'high' 'heat' class.

2.5 Sandeel Species Results – Extent of Application Area Interaction with Potential Habitat: Regional-scale

The area of interaction between the Greenlink cable route corridor and the various mapping 'heat' categories has been calculated for Welsh and Irish waters. The Greenlink cable route overlaps with a total area of 'heat' of 80.26 km^2 across its entire installation corridor[6]. This breaks down as:

- 20.17 km^2 of low 'heat' class;
- 45.56 km^2 of 'medium' 'heat' class; and
- 14.53 km^2 of 'high' 'heat' class.

At the Irish Sea population-scale there is approximately:

- 13,190.59 km^2 of 'low' 'heat' class;
- 15,389.14 km^2 of 'medium' 'heat' class; and

[6] The installation corridor is approximately 500m wide along the entire route and is equivalent to the area surveyed by the marine cable route survey in 2018.

- 3,255.14 km^2 of ‘high’ ‘heat’ class.

Therefore, the following values relate the potential effect footprint associated with the Greenlink cable route with the Irish Sea spawning population habitat space:

- 0.15% of the total available ‘low’ ‘heat’ class;
- 0.30% of the total available ‘medium’ ‘heat’ class; and
- 0.45% of the total available ‘high’ ‘heat’ class.

2.6 Project-specific Particle Size Analysis Data

PSA data were collected along the Greenlink cable route by MMT (2019). These project-specific data have been compared to the BGS 1:250K seabed surface data to determine whether the two datasets provide an analogous or poor correlation or a separation in description of seabed sediment character (**Error! Reference source not found.**).

A number of sites identified within the MMT dataset show slight discrepancies in the correlation between the two classifications. This is particularly the case within Irish waters associated with the large extent of Sand. Here the MMT data indicate a slightly more coarser sediment classification showing gravelly Sand at many of the sample stations.

Gravelly Sand sits within the ‘marginal’ spawning habitat class for Atlantic herring. This means that the BGS data may slightly under-represent this marginal habitat across the large expanse of Sand in Irish waters. However, the variation is still only within one sediment particle size class and any increases from mapping this ‘marginal’ spawning habitat will still relate to a ‘low’ ‘heat’ class being mapped for Atlantic herring.

Gravelly Sand contributes to ‘preferred’ habitat for sandeel species and thus the representation of the MMT data do not alter the overall assessment or the ‘heat’ mapping for this receptor group.

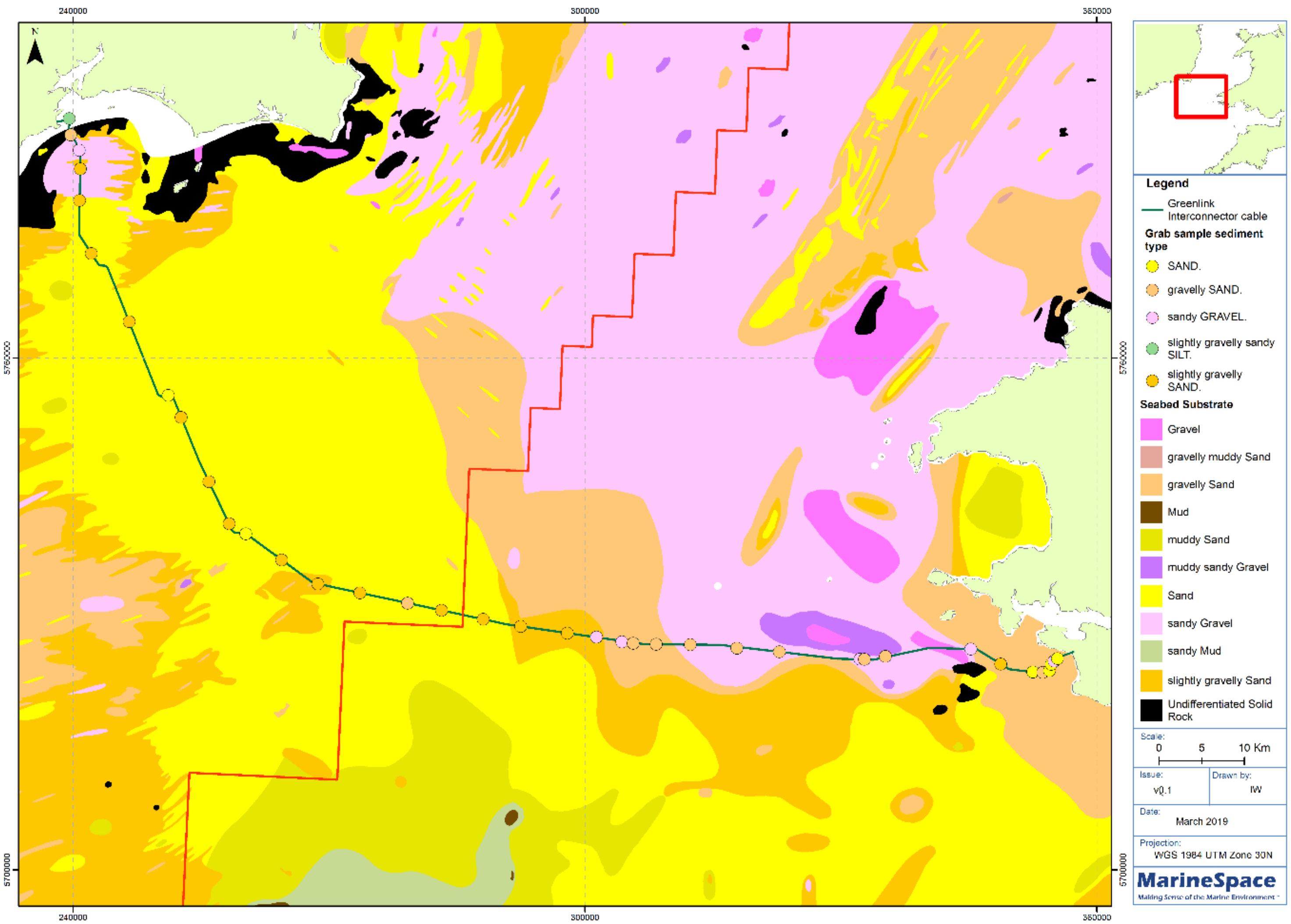
For Welsh waters the MMT data show a strong correlation with the BGS at many locations. However, there are some stations within the central Irish Sea extensive area of sandy Gravel (from the BGS data) that correlate with gravelly Sand (from the MMT data).

Sandy Gravel sits within the ‘preferred’ potential spawning habitat classification for Atlantic herring, whilst gravelly Sand represents ‘marginal’ potential spawning habitat. This means that the BGS data may slightly over-represent the availability of ‘preferred’ habitat within the assessment.

Sandy Gravel represents ‘marginal’ habitat for sandeel species and gravelly Sand ‘preferred’ habitat. Therefore, the MMT data indicate that there may be more habitat suitable for sandeel species within the cable corridor than represented within the BGS data.

However, when considering these observations, the discrepancies between the two datasets are expected given the likelihood of small-scale spatial variability in the principle components of the seabed sediment within the wider Irish sea area. Any small increases relating to 'preferred' sandeel species habitat within Welsh waters will still relate to a 'low' 'heat' class being mapped within the overall assessment.

Figure 2-10 BGS sediment data in the Irish Sea with PSA data for the Greenlink cable route



3. Atlantic Herring and Sandeel Species Conclusions – Extent of Interaction with Potential Spawning Habitat: Area-specific Scale

3.1 Welsh Waters

3.1.1 Atlantic Herring

The Greenlink cable route corridor interacts with 7.75 km^2 of 'high' 'heat' within Welsh waters. This area falls just offshore of Freshwater West and it corresponds with the Coull *et al*. (1998) data layer showing the presence of Atlantic herring spawning areas. However, when comparing the BGS data layer in this area with the project-specific PSA data many of the samples gathered in this area are shown to differ from the BGS data layer. There are a number of PSA data samples that are identified as Sand. This suggests that this area is less suitable for Atlantic herring spawning than is suggested by the 'high' 'heat' level shown in the 'heat' mapping. In addition, the percentage of 'high' 'heat' that the cable route intersects with is 0.02% of that available within Welsh waters.

3.1.2 Sandeel

The Greenlink cable route corridor interacts with 12.78 km^2 of 'high' 'heat' within Welsh waters. The area in which 'high' 'heat' is present falls to the west, close to the UK/Republic of Ireland median line and correlates with the BGS data layers showing the presence of sand and slightly gravelly sand. The installation of the Greenlink cables is unlikely to cause changes to seabed sediments within the area so long as burial depth is achieved. Therefore, no habitat will be lost in this area unless rock dumping is required along the length of the cable route. In addition, the percentage of 'high' 'heat' that the cable route intersects with is 0.39% of that available within Welsh waters.

3.2 Irish Waters

3.2.1 Atlantic herring

The Greenlink Interconnector cable does not interact with 'high' 'heat' within Irish waters. However, an area in the nearshore is defined as 'medium' 'heat' indicating potential or 'marginal' spawning habitat due to the nearshore variable nature of the seabed composition. Spawning bed analysis over the Proposed Development indicates that the cable route does interact with one coastal herring spawning site, referred to as the Dunmore East herring spawning grounds (O'Sullivan *et al*. 2013). Therefore, potential does occur for the cable route to interact with any Atlantic herring spawning habitat within Irish waters. The known locations of all other spawning beds and grounds for Atlantic herring in Irish waters correlate with the south, western and northwestern parts of the inshore around the Republic of Ireland and Northern Ireland coastline, indicating a wide distribution of spawning grounds (Figure 2.3).

3.2.2 Sandeel

The Greenlink cable route interacts with 1.75 km^2 of 'high' 'heat' within Irish waters. The area in which 'high' 'heat' is present falls to the east, close to the Republic of Ireland /UK median line and correlates with the BGS data layers showing the presence of sand and slightly gravelly sand. The installation of the Greenlink cables is unlikely to cause changes to seabed sediments within the area so long as burial depth is achieved. Therefore, no habitat will be lost in this area.

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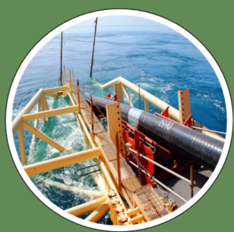
GREENLINK
MARINE ENVIRONMENTAL IMPACT ASSESSMENT REPORT- IRELAND

APPENDIX E

Commercial Fisheries Assessment

P1975_R4500_RevF1
July 2019

Greenlink Interconnector
- connecting the power markets
in Ireland and Great Britain



Greenlink
INTERCONNECTOR

MarineSpace

Making Sense of the Marine Environment ™

Greenlink Interconnector Commercial Fisheries Assessment 2018

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15/02/2018	CG	v1.1	Responses to client comments	
28/02/2018	CG	v1.2	Input from Fisheries Liaison	
14/03/2018	JL	v1.3	Responses to client comments (2)	

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Executive Summary

Greenlink Interconnector Ltd, trading as 'Greenlink,' is proposing to develop an electricity interconnector linking the existing electricity grids in the UK and Ireland. The 'Greenlink' project will consist of two converter stations, one close to the existing substation at Great Island in County Wexford (Ireland) and one close to the existing substation at Pembroke in Pembrokeshire (Wales). The converter stations will be connected by underground cables (onshore) and subsea cables (offshore).

MarineSpace Ltd has been commissioned by Intertek to undertake a desk-based study on commercial and recreational fisheries activity near to the proposed Greenlink cable corridor (Welsh and Irish waters).

This report presents the findings of an assessment of official Marine Management Organisation (MMO) and Scientific, Technical and Economic Committee for Fisheries (STECF) fisheries (landings and activity) data in relation to the Greenlink proposed cable corridor and combines these data with findings of stakeholders engagement meetings held with key representatives of the commercial fishing industry.

The assessment has highlighted that there is a wide spatial distribution of commercial fishing activity in the Irish and Celtic Sea, with demersal and shellfish species being the most important in terms of landings by weight and value. Key demersal target species include; cod, haddock, ling, monkfish, plaice, ray, skate and sole. Key shellfish species include; lobster, *Nephrops*, crabs, scallops, razor clams and whelks. Pelagic fish landings from this area are mainly of herring and mackerel, and of relatively less economic importance compared to demersal and shellfish species.

The Welsh fisheries are particularly characterised by valuable potting grounds for crab, lobster and whelks around the Pembrokeshire coast (inside the 6nm limit), with mollusc fisheries also taking place in some estuaries and bays. Since 1995, a significant whelk fishery has developed in Carmarthen Bay and offshore of the Gower, Fishguard and Milford Haven. Since the late 1980s, the bass rod and line fishery has also proved popular amongst both commercial and recreational fishermen.

The otter/beam trawler fleet concentrates its efforts in the Bristol Channel and Cardigan Bay and lands a mixed catch throughout the year. These trawlers (mostly <10 m) fish mainly inshore, and competition outside 6 miles from the coast can be intense, especially when the sole fishery attracts visiting beam trawlers from the south coast of Devon, Cornwall and Belgium.

There are a large number of medium-sized ports along the south and east coast of Ireland, the largest of which is Dunmore East. The ports along the south coast receive a mix of pelagic, demersal and shellfish species (Marine Institute, 2014). The inshore pot fishery for crab, lobster, *Nephrops* and whelk is an important component of Irish fisheries in this region.

The proposed Greenlink cable corridor lies within International Council for the Exploration of Sea (ICES) Rectangles 32E3, 32E4 and 33E3.

Based on the most recent 5 years of MMO data available at this time, which ranges from 2010-2016, the maximum weight and value of landings by all vessels over the period assessed were from 32E4 which covers the Welsh inshore region. Over this period, for all vessels, over 5.4 million tonnes of fish (all species) were landed with a value of over £10.5 million.

Of this value, £6.6 million was landed by <10 m vessels with the remaining £3.9 million landed by the >10m fleet. 86.7% of the total value of landings from 32E4 were represented by shellfish. These data highlight the importance of the Welsh inshore static gear (potting) fishery in the area of the proposed cable corridor.

With respect to individual species, whelk, edible crab, lobster, haddock and spider crab were the most important in terms of UK fleet landings along the proposed cable corridor.

For the non-UK Fleet, the key ICES Rectangle for the Irish fleet (in terms of landings) was 33E3 (Irish inshore). The key ICES Rectangles for the French fleet were 32E3 (offshore section) and 32E4 (welsh inshore) and for the Belgian fleet the key ICES Rectangle was 32E3 (offshore section).

Key species landed by the Irish (offshore) fleet was the European sprat followed by “other”, herring, great Atlantic scallop and edible crab. Key species landed by French vessels were rays/skates followed by haddock, anglerfish, whiting and “other”. Key species landed by Belgium vessels were anglerfish followed by common sole, megrim, thornback ray and blonde ray.

Although landings by weight and value varied across all ICES Rectangles (32E3, 32E4 & 33E3) between 2012-2016 generally there were no obvious trends in terms of increases or decreases in either of these values. In terms of intra-annual variation, landings for all species/vessels over the period 2012-2016 peaked in July, with a clear seasonal pattern of highest weight/value of landings between May and October each year.

For the top five individual species landed in the ICES Rectangles 32E3, 32E4 & 33E3 the following were the key periods for landings by weight and value:

- Whelk - April to July;
- Crab (C.P Mixed Sexes) – June to November;
- Haddock – June to September;
- Lobster - April to October; and
- Spider Crab - May to July inclusive.

For the non-UK fleet, based on data only presented by Quarter, the period October to December appears to be the most important in terms of landings, especially for species including “other”, herring, sprat and edible crab.

The spatial distribution of fishing activity/value in the entire region has been assessed via review and analysis of Vessel Monitoring System (VMS) data. These data indicate that fishing generally occurs along all parts of the proposed cable corridor, although there appears to be a greater concentration of activity in the Welsh inshore region compared to the Irish inshore region. There is a clearly defined focus of activity by UK and non-UK vessels in the middle “offshore“ section of the proposed cable corridor.

To try and further differentiate areas of particular value within the proposed cable corridor, the value of landings has been calculated based on formal fishery limits, i.e. UK 6nm, UK 12nm etc. This analysis has provided the following average annual values of landings from within the proposed cable corridor over the 2012-2016 study period;

- UK coast to 6nm: £1.3 million per annum;
- 6nm to 12nm: £3.7 million per annum;
- Outside 12nm: £4.8 million per annum;
- Irish coast to 12nm: £1.2 million per annum.

Further data on fishing activity off the Welsh coast has been obtained via review of a range of data sources which have all been collated on the Wales Marine Planning Portal. These data corroborate the official MMO data in that they highlight the distribution of potting activity off the welsh coast and demonstrate otter and beam trawling activity in the inshore region and also further offshore.

Informal consultation has also been undertaken with a number of key representatives of the commercial fishing industry on both the Welsh and Irish coasts. The data analysis and interpretation undertaken to date appears to reflect the key activity and trends in the commercial fishery in this region. The Welsh inshore section of the proposed cable corridor features a high intensity of static gear fishing, particularly in the summer months, even though vessels do move further offshore later in the year. However, weather and sea conditions limit many vessels moving any further offshore which intensifies the importance of the nearshore (0-6nm) section on the Welsh side.

The Irish inshore section of the proposed cable corridor also features high intensity static gear fishing, with a herring fishery becoming important during the late summer/autumn months. Larger vessels, primarily catching white fish species are present further offshore, albeit in lesser numbers than smaller inshore vessels.

Contents

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1. Introduction

1.1 Project Background

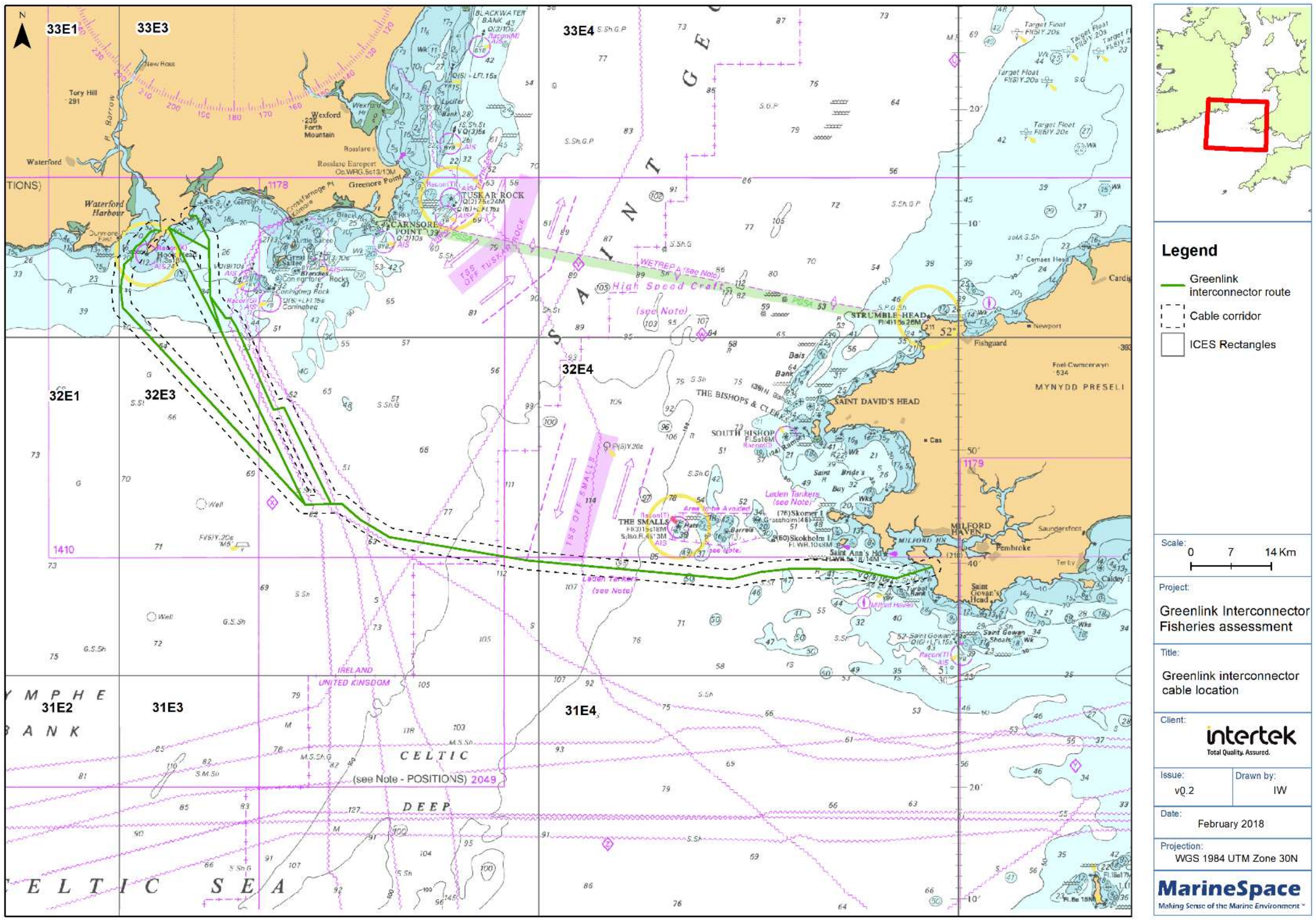
Greenlink Interconnector Limited, trading as 'Greenlink,' is proposing to develop an electricity interconnector linking the existing electricity grids in the UK and Ireland. The 'Greenlink' project will consist of two converter stations, one close to the existing substation at Great Island in County Wexford (Ireland) and one close to the existing substation at Pembroke in Pembrokeshire (Wales) (Figure 1.1). The converter stations will be connected by underground cables (onshore) and subsea cables (offshore).

Greenlink will have key strategic importance providing significant additional interconnection between Ireland, the UK and onwards to mainland Europe. It will provide additional transmission network capacities, reinforcing the existing electricity grids in south-east Ireland and south Wales and contributing to each country's strategic interconnection objectives. The development and construction of Greenlink will deliver increased security of supply, fuel diversity and greater competition and ultimately provide significant benefits to consumers in Ireland, Wales and Great Britain as a whole.

Greenlink was awarded an Interconnector Licence in Great Britain, by Ofgem, on 10th February 2015 and was also awarded Initial Project Assessment (IPA) Status under Ofgem's Cap and Floor Regime, on 30th September 2015.

Greenlink is designated as a European Union (EU) Project of Common Interest (PCI project number 1.9.1) under the provisions of European Union Regulation No. 347/2013 on guidelines for Trans-European Network for Energy (TEN-E Regulations) and has successfully applied for funding under the Connecting Europe Facility (CEF).

Figure 1.1.1: Location of the Greenlink Interconnector cable corridor and International Council for the Exploration of the Sea (ICES) rectangles. Admiralty Charts reproduced under licence. Not to be used for navigation



1.2 Aims and Objectives

The overall aim of this assessment is to identify the extent of commercial and recreational fishing activity in and around the location of the proposed Greenlink interconnector cable. This information will be used to plan future survey work along the cable corridor and to inform any future Environmental Impact Assessment (EIA) work undertaken in relation to this project. To meet this overall aim, the following objectives have been defined:

- To undertake an assessment of commercial fishing activity in relation to the Greenlink proposed cable corridor, covering both UK and Irish waters using the International Council for the Exploration of the Sea (ICES) Statistical Rectangles 33E3, 32E3 and 32E4, with particular attention to the following data:
    - weight and value of landed catch (by vessel size class and species groups);
    - weight and value of landed catch (by species);
    - weight and value of landed catch by regional ports;
    - fishing activity distribution and intensity;
    - presence of indicative fishing grounds for fished species; and
    - any additional information obtained via direct consultation with representatives of local and regional fishing organisations.
- To review and assess the level of recreational fishing (angling) that occurs in and around the proposed Greenlink cable corridor.

2. Commercial Fisheries Activity

2.1 Introduction

Commercial fishing in the Irish and Celtic Sea is widely distributed. demersal and shellfish are the key target species for commercial fisheries in this region. The most important demersal target species include; cod, haddock, ling, monkfish, plaice, ray, skate and sole whilst key shellfish species include; lobster, *Nephrops*, crabs, scallops, razor clams and whelks. Pelagic fish landings from this area are mainly of herring and mackerel, and of relatively less economic importance compared to demersal and shellfish species.

The closest main Welsh fishing port to the proposed Greenlink Interconnector cable corridor is Milford Haven, on the west coast of Wales. In February 2018, there were 416 fishing vessels registered to the Port of Milford Haven, 93% of which were 10 m and under (MMO, 2018). 122 of those vessels form the Pembrokeshire fleet, with only 14 vessels over 10 metres (MMO, 2018). The closest Irish fishing port to the proposed Greenlink Interconnector cable corridor is Dunmore East, on the southeast coast of Ireland.

2.2 Welsh Fisheries

There are valuable potting grounds for crab, lobster and whelks around the Pembrokeshire coast, with mollusc fisheries also taking place in some estuaries and bays. With the exception of larger vessels working out of Milford Haven, most fishing off the southwest coast of Wales occurs close inshore, with very few boats working outside 6 miles. Inshore fishing activities are often inhibited by prevailing westerly winds during the winter (Walmsley & Pawson, 2007).

The shellfish industry in south Wales is now considered to be of the greatest local economic importance in terms of commercial fishing activity. Netting restrictions have been introduced around much of the Welsh coast, although various types are still used to catch bass, rays, cod, flatfish and crustacea. Since the late 1980s, the bass rod and line fishery has also proved popular amongst both commercial and recreational fishermen (Walmsley & Pawson, 2007).

Shellfish

Most fishermen working from the Pembrokeshire coast rely heavily on potting for crabs and lobsters, with activity peaking during the warmer months. Pots and nets are also used for crawfish around the rocky Pembrokeshire coast and for spider crabs both inshore and offshore. Pots are also set for prawns in parts of the north Pembrokeshire coast and there is some limited potting for green crab in Milford Haven (Walmsley & Pawson, 2007).

Since 1995, a significant whelk fishery has developed in Carmarthen Bay and offshore of the Gower, Fishguard and Milford Haven. Larger vessels prosecute the latter fisheries during the winter and set up to 2,000 pots each. Up to 1,000 pots per boat are used on inshore grounds. Effort is dependent upon price, which has generally been around £600/tonne since 1996 to date. Several local and (mainly) Scottish visiting boats dredge for scallops in Cardigan Bay, particularly in winter, landing into Fishguard and Milford Haven (Walmsley & Pawson, 2007).

Trawlers target native oysters in winter in Swansea Bay and Milford Haven. Cuttlefish are caught in pots in spring from Milford to St Brides Bay (Walmsley & Pawson, 2007).

Demersal Fish

Flatfish and rays (principally thornback) are taken in fixed nets and otter and beam trawls from spring through to the end of the year. Boats using gill nets and otter trawls take cod and whiting during the colder months. Large-meshed tangle nets are used for rays and large flatfish such as turbot. In many areas, Welsh Government (previously South Wales Sea Fisheries Committee) byelaws prohibit netting between April and October, and a Minimum Mesh Size (MMS) of 100 mm is in place for all nets, except trawls and purse seines.

The trawler fleet concentrates its efforts in the Bristol Channel and Cardigan Bay and lands a mixed catch throughout the year. These trawlers (mostly <10 m) fish mainly inshore, and competition outside 6 miles from the coast can be intense, especially when the sole fishery attracts visiting beam trawlers from the south coast of Devon, Cornwall and Belgium.

The majority of otter trawling effort is by Devon and Cornish vessels operating twin rig gear. There is also increasing Belgian activity in the 6-12 mile zone (Walmsley & Pawson, 2007).

Pelagic Fish

Bass are caught in fixed and drift nets, by rod and line, on longlines and, more recently, in high lift trawls, increasingly throughout the year. Mullet are sometimes taken as a bycatch in nets. The bass rod and line fishery has expanded since the late-1980s due to these restrictions, the low cost of fishing gear and the high demand for this species. The popularity of bass angling has also increased demand for sandeels as bait and many rod and line fishermen also utilise sandeel nets to collect this species in shallow sandy bays to provide bait for their bass fishing activity. Mackerel are caught in drift nets and by hand-lining and the charter angling sector is highly dependent on mackerel during the summer. Sprats are occasionally taken in mid-water trawls and inshore in gill nets (Walmsley & Pawson, 2007).

2.3 Irish Fisheries

The seas around Ireland are among the most productive and biologically sensitive areas in EU waters. The overall 2016 fishing opportunities for stocks to which the Irish fleet has access to, were 1.1 million tonnes of fish, with an estimated landed value of €1.26 billion. Ireland's total share of these Total Allowable Catches (TAC) in 2016 amounted to 216,261 tonnes with a value of € 201 million (Marine Institute, 2016).

This economic value is based on 2015 average prices and represent a conservative estimate. These values do not include the valuable inshore fisheries (e.g. lobster, whelk) which are not managed using internationally agreed TACs but do come within the remit of the EU Common Fisheries Policy (CFP). These inshore fisheries resource represents a very important resource base for the coastal communities around Ireland (Marine Institute, 2016).

On an average day, more than 1,000 fishing vessels are active in the waters around Ireland, clocking up more than 8 million fishing hours per year. Most of the seabed near Ireland is trawled at least once per year and some regions are trawled more than 10 times per year. Fishing is clearly one of the most significant ocean uses in the waters around Ireland.

There are a large number of medium-sized ports along the south and east coast of Ireland, the largest of which is Dunmore East. The ports along the south coast receive a mix of pelagic, demersal and shellfish species (Marine Institute, 2014).

Based on information presented in Atlas of Commercial Fisheries for Shellfish around Ireland (Tully, 2017), the following key observations can be made with respect to the inshore shellfisheries in and around the Irish part of the proposed cable corridor:

- For the areas West and south of Dunmore East to Saltees (South coast) and South Wexford (South coast), a total of 48 vessels were registered as fishing for crab and lobster in 2015, deploying a total of 13,680 pots;
- This represented 6.2% of all vessels targeting these species in the Irish inshore fleet and 6.3% of total pots deployed in the entire Irish inshore region;
- Shrimp was another key target species for many vessels, including those landing into Dunmore East and Kilmore Quay;
- Razor clams are targeted by some vessels in the inshore region offshore of Wexford using hydraulic water jet dredges or non-hydraulic propeller dredges used to penetrate sediment to 25cm depth. Landings over 1,000 tonnes have been made in recent years; and
- There are key scallop fishing grounds off the south coast of Ireland with approximately 10-20 >15 m vessels and several <15 m vessels working inshore.

Based on information presented in Atlas of Commercial Fisheries around Ireland (Gerritsen & Lordan, 2014), the following key observations can be made with respect to the commercial fisheries in and around the Irish part of the proposed cable corridor:

- Inside the Irish Exclusive Economic Zone (EEZ), around 62% of the fishing hours are accounted for by >15m otter and beam trawlers;
- Longliners account for around 15% and Gill and trammel netters 7%;
- Pelagic trawlers only account for 5% of the total effort inside the EEZ but they are responsible for more landings than any other gear type, both in terms of volume and value;
- Irish vessels are only responsible for 36% of the international effort of vessels >15 m inside the EEZ, with Spanish vessels accounting for 30% of the effort (mainly demersal otter trawlers and longliners) and French and the UK accounting for a further 20% and 11% respectively of total effort;
- International landings inside the Irish EEZ are dominated by pelagic species like horse mackerel, mackerel, boarfish, blue whiting and herring in terms of bulk. In terms of value, mackerel and horse mackerel are important but *Nephrops*, anglerfish and hake stocks are almost equally valuable; and
- Despite the large bulk of boarfish and blue whiting landings, their value is relatively low. Ireland takes around 30% of mackerel and horse mackerel and nearly all of the boarfish and herring inside the Irish EEZ. Ireland also takes more than 75% of *Nephrops* but only around 25% of anglerfish and less than 10% of hake.

2.4 Data Sources & Methodology

To characterise current commercial and recreational fishing in the vicinity of the Greenlink Interconnector cable corridor, a variety of data sources were used:

- Marine Management Organisation (MMO) UK fleet landings by selected ICES Rectangle (2012-2016) – see Figure 1.1.1;
- MMO UK and foreign fleet landings into the UK by port (2011-2015);
- Welsh Government, Marine Planning Portal, NRW – Sea Fish Atlas; (2010);
- European Commission – STECF non-UK landings by ICES Rectangles (2012-2016);
- MMO GIS dataset for UK and Non-UK >15m vessel fishing activity (2007-2010);
- MMO Fishing activity data for UK Vessels >15m, using Vessel Monitoring Systems data (2012-2015); and
- MMO Marine Information System.

2.5 MMO Landings Data (UK Fleet)

The MMO publishes summaries of fishing activity for UK commercial fishing vessels landing into the UK and abroad, as well as foreign-registered commercial fishing vessels landing into the UK, that are deemed to have been fishing within a specified calendar year. These summaries have been aggregated by month of landing, the port of landing, and the length group of the vessel. For each aggregation level, the quantity (tonnes) of live weight fish landed, the actual landed weight (tonnes) and value (sterling) of live weight fish landed are given for specific species, with the remaining species combined into a composite group based on the species group to which they are classified. The groups are demersal fish, pelagic fish and shellfish. Data compiled by the MMO were reviewed for the most recently available 5 years which covers a period of 2012-2016 and were filtered to show only landings into ICES Statistical Rectangles 32E3, 32E4 and 33E3 – see Figure 1.1.1. Data were filtered further to show data by vessel size class, species group and gear types.

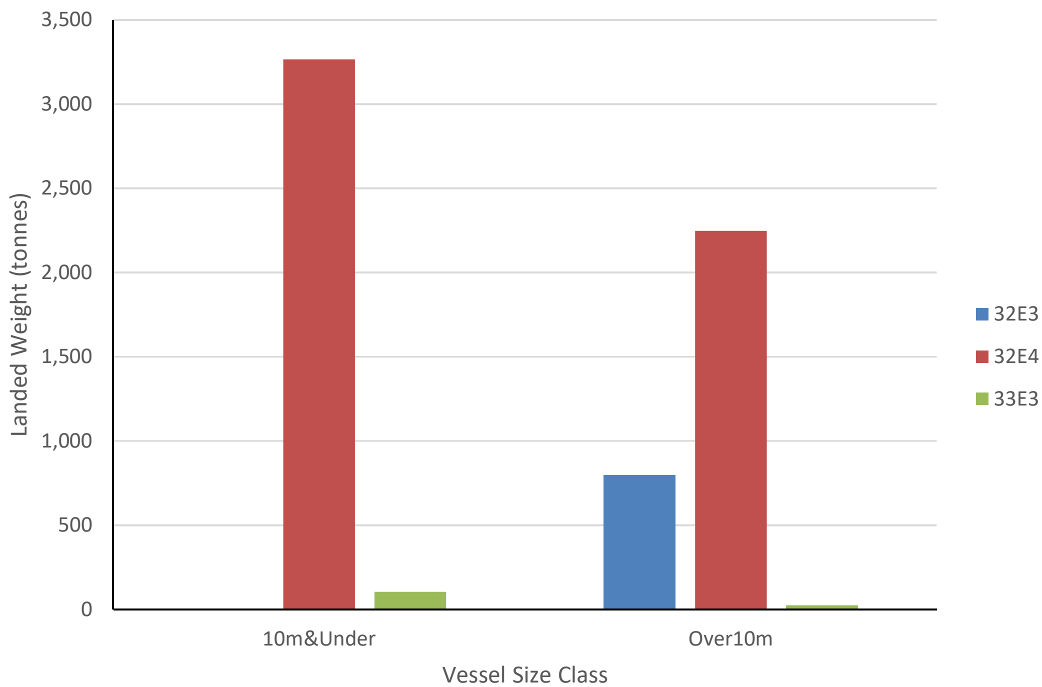
2.5.1 Landed Weight by Vessel Size Class

Table 2.1 and **Error! Reference source not found.** show the total weight of landings from ICES Rectangles 32E3, 32E4 and 33E3 between 2012-2016, divided by vessel size classes. The maximum weight landed throughout this time period was 3,265 tonnes by vessels <10 m within 32E4. The minimum weight was 25.04 tonnes, landed by vessels >10 m and occurred within 33E3. No data exists for vessels <10 m within 32E3, the most offshore of the ICES rectangles included within this assessment, illustrating the fact that fishing activity by <10m vessels was concentrated on more inshore areas.

Table 2.1: Total landings (tonnes) from ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16) based on vessel size classes (Source: MMO, 2017)

ICES Statistical Rectangle	Vessel Size Class	2012	2013	2014	2015	2016	Total (tonnes)
32E3	<10m	Data unavailable	Data unavailable	Data unavailable	Data unavailable	Data unavailable	Data unavailable
	>10m	67.42	233.07	233.65	71.31	190.79	**796.24**
32E4	<10m	516.85	643.30	897.56	610.06	597.22	**3,265.00**
	>10m	507.27	465.57	422.05	386.88	466.88	**2,248.66**
33E3	<10m	7.27	27.19	25.81	19.63	26.28	**106.18**
	>10m	10.07	8.79	2.05	0.21	3.91	**25.04**

Figure 2.5.1: Total landings weight (tonnes) from ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16) based on vessel size classes (Source: MMO, 2017)



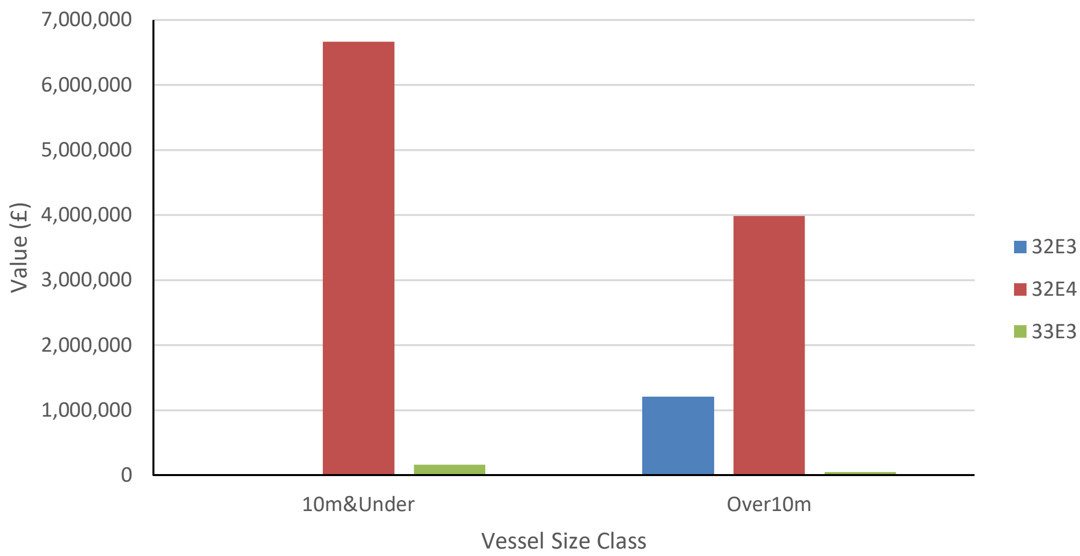
2.5.2 Landings Value by Size Class

Table 2.2 and Figure 2.5.2 show the total value of landings from ICES Rectangles 32E3, 32E4 and 33E3 (2012-2016), divided by vessel size classes. The maximum value landed throughout this time period was £6,663,206 by vessels <10 m within 32E4. The minimum value of £47,695 was landed by vessels > 10 m within 33E3. No data exists for vessels <10 m within 32E3. These trends correspond with landings weight across the three rectangles during the 2012-2016 time period assessed via this study.

Table 2.2: Total value (£) of landings from ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16) based on vessel size classes (Source: MMO, 2017)

ICES Statistical Rectangle	Vessel Size Class	2012	2013	2014	2015	2016	Total Value (£)
32E3	<10m	Data unavailable	Data unavailable	Data unavailable	Data unavailable	Data unavailable	Data unavailable
	>10m	119,447.21	35,6401.96	354,811.99	123,472.27	254,623.68	**1,208,757.11**
32E4	<10m	1,334,036.61	133,6077.38	1,447,053.46	1,200,217.30	1,345,821.83	**6,663,206.58**
	>10m	956,157.35	860,178.52	747,677.17	648,890.14	769,354.68	**3,982,257.86**
33E3	<10m	9,255.00	37,952.16	35,917.90	34,598.25	44,678.00	**162,401.31**
	>10m	106,54.83	17,080.58	8,629.31	555.12	10,775.26	**47,695.10**

Figure 2.5.2: Total landings value (£) from ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16) based on vessel size classes (Source: MMO, 2017)



2.5.3 Landed Weight by Species Group

Table 2.3 presents the total weight of landings from ICES Rectangles 32E3, 33E3 and 32E4 (2012-16) for each species group. The overall maximum weight of 4,931 tonnes of shellfish was landed within 32E4. The minimum weight of 16.08 tonnes of pelagic species and 16.40 tonnes of demersal species related to 32E4 and 33E3 respectively. No data exists for pelagic species landed into 33E3.

Table 2.3: Total landings weight (tonnes) from ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16) based on species group (Source: MMO, 2017)

ICES Statistical Rectangle	Species Group	2012	2013	2014	2015	2016	Total (Tonnes)
32E3	Demersal	56.87	220.84	226.57	61.89	26.19	**592.36**
	Pelagic	Data unavailable	Data unavailable	Data unavailable	Data unavailable	137.12	**137.12**
	Shellfish	10.55	12.23	7.08	9.42	27.48	**66.77**
32E4	Demersal	123.67	196.68	111.71	87.01	46.99	**566.07**
	Pelagic	2.12	1.50	11.72	0.58	0.15	**16.08**
	Shellfish	898.34	910.69	1196.18	909.35	1,016.95	**4,931.51**
33E3	Demersal	9.95	3.29	0.73	0.21	2.21	**16.40**
	Pelagic	Data unavailable	Data unavailable	Data unavailable	Data unavailable	Data unavailable	Data unavailable
	Shellfish	7.39	32.69	27.14	19.63	27.98	**114.82**

2.5.4 Landings Value by Species Group

Table 2.4 presents the total value of landings from ICES Rectangles 32E3, 33E3 and 32E4 (2012-16) for each species group. The overall maximum value of £9,231,667 was landed within 32E4, with 86.7% of the overall value represented by landings of shellfish species. The minimum value, £5,840 related to pelagic species and was also landed from 32E4. No data exists for pelagic species landed into 33E3.

Table 2.4: Total value (£) of landings from ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16) based on species group (Source: MMO, 2017)

ICES Statistical Rectangle	Species Group	2012	2013	2014	2015	2016	Total Value (£)
32E3	Demersal	76,223.06	303,613.48	320,768.53	82,955.24	32,253.35	**815,813.66**
	Pelagic	Data unavailable	Data unavailable	Data unavailable	Data unavailable	75,558.12	**75,558.12**
	Shellfish	43,224.15	527,88.48	34,043.46	40,517.03	146,812.21	**317,385.33**
32E4	Demersal	302,108.41	413,079.05	358,816.88	207,778.90	126,173.37	**1,407,956.61**
	Pelagic	2,741.11	1,555.33	211.47	906.04	426.51	**5,840.46**
	Shellfish	1,985,344.44	1,781,621.52	1,835,702.28	1,6404,22.50	1,988,576.63	**9,231,667.37**
33E3	Demersal	10,110.10	5,280.74	1,839.33	555.12	4,096.94	**21,882.23**
	Pelagic	Data unavailable	Data unavailable	Data unavailable	Data unavailable	Data unavailable	Data unavailable
	Shellfish	9,799.73	49,752.00	42,707.88	34,598.25	51,356.32	**188,214.18**

2.5.5 Landings by Vessel Size Class and Species Group

Figure 2.5.3 and Figure 2.5.4 present a summary of the total landed weight and value (2012-16) for ICES Rectangles 32E3, 33E3 and 32E4, plotted by vessel class sizes and species group. 32E4 is the most dominant region both in terms of weight and value for landings of shellfish by both <10 m and >10 m vessels. Total weight is 4,931.51 tonnes and value £9,231,667. There are landings of pelagic species across all rectangles. Pelagic species are least significant in terms of weight and value with total across all three rectangles of 153.2 tonnes and £81,398.

Figure 2.5.3: Sum of landings weight from ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16), displayed by vessel size classes and species group (Source: MMO, 2017)

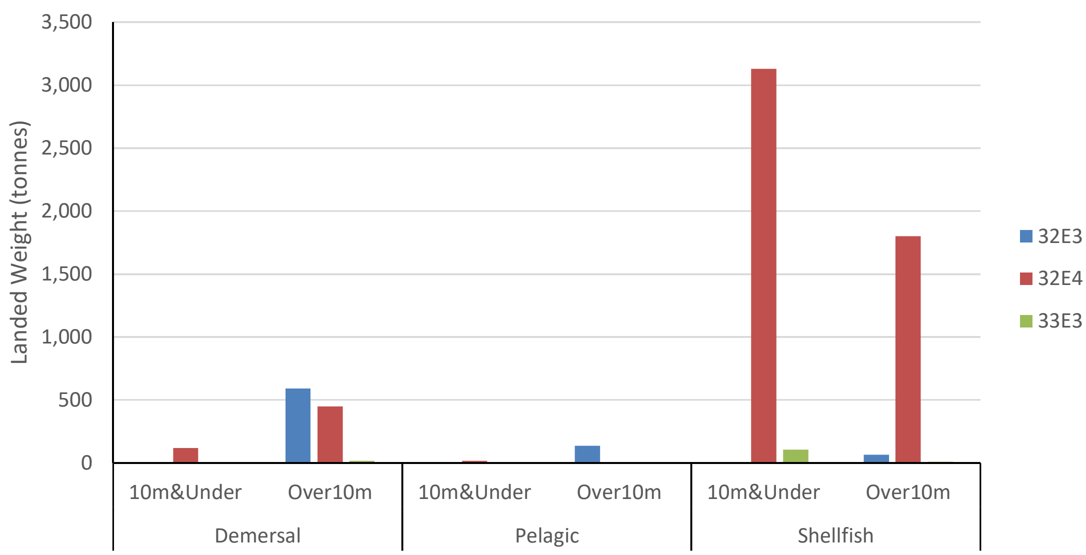
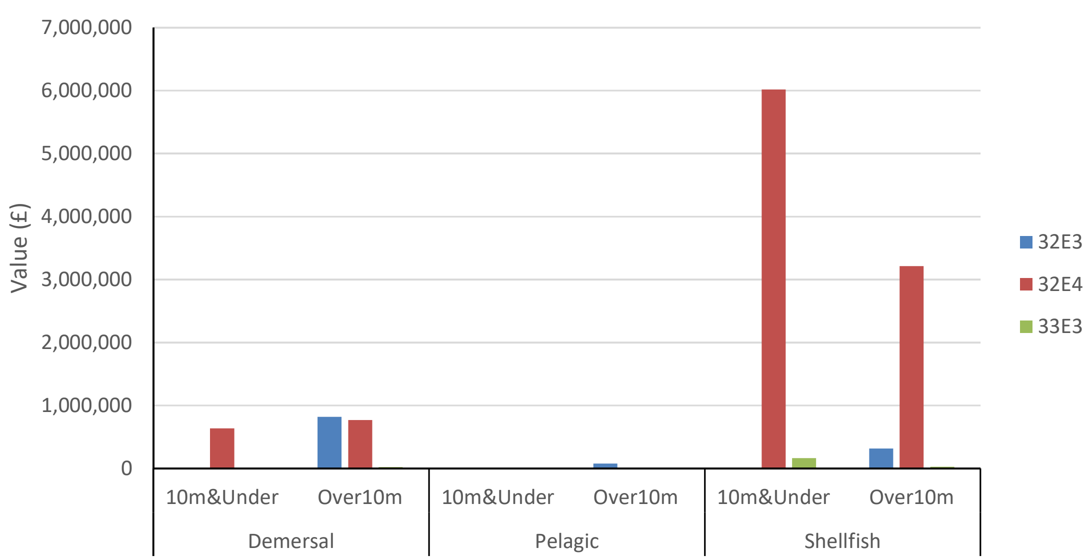


Figure 2.5.4: Sum of landings value from ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16), displayed by vessel size classes and species group (Source: MMO, 2017)



2.5.6 Landings Weight and Value by Species

The MMO landings data for 2012-2016 were filtered to show the weight and value of individual species landed from each ICES Rectangles. A total of 72, 70 and 25 species classes were landed from ICES Rectangles 32E3, 32E4 and 33E3, respectively. However, these data are believed to contain some inaccuracies and inflated figures, due to duplication of species under different common names and grouping at higher taxonomic levels.

Total landed weight and value for each species class were determined for the 5-year period (2012-2016) within the respective ICES Rectangles. Species were then filtered to identify the species with the highest landed weights and corresponding values (Figure 2.5.5, Figure 2.5.6 and Figure 2.5.7), to identify the most commercially important fished species.

Within Rectangle 32E3 (Figure 2.5.5), whelk was the species with the greatest weight of landings (2,389 tonnes) which also resulted in the second largest value of landings (£2,037,042) for the period 2012-2016. The four next most commercially important species landed, in terms of weight, were Crab (C.P. Mixed Sexes), haddock, lobster and spider crab. Lobsters landed from 32E3 were the dominant species in terms of value (£4,182,247) with a corresponding weight of 390.55 tonnes. Other notable species that stand out from the overall trend with relatively low weight, but relatively high value are *Nephrops* (87.15 tonnes and £420,484) and bass (81 tonnes and £576,185).

Within Rectangle 32E4 (Figure 2.5.6), whelk was again the species with the greatest weight of landings (2,379.67 tonnes) which also resulted in the second largest value of landings (£2,029,257) for the period 2012-2016. The four next most commercially important species landed, in terms of weight, were crab (C.P. Mixed Sexes), lobster, spider crab and haddock. As seen within rectangle 32E3, lobsters were again the dominant species in terms of value, £4,133,185. Other notable species that vary from the overall trend with relatively low weight and high value are bass (81.51 tonnes and £575,314) and common prawn (17.53 tonnes and £355,185).

Within Rectangle 33E3 (Figure 2.5.7) the overall weight, value and species diversity is lower than that discussed for 32E3 and 32E4. The dominant species was crab (C.P. Mixed Sexes) which had a total landings weight and value of 79.23 tonnes and £83,683 respectively. The four next most commercially important species landed, in terms of weight, were crab (velvet), whelk, haddock and lobster. As seen in the other rectangles lobster was dominant in terms of value, £47,141 for 4.45 tonnes landed weight. *Nephrops* also exhibited relatively high value (£19,221) for the landed weight (4.41 tonnes).

Figure 2.5.5: Species caught in ICES Rectangle 32E3 (2012-2016) based on highest landings weight (tonnes) and corresponding value (£) (Source: MMO, 2017)

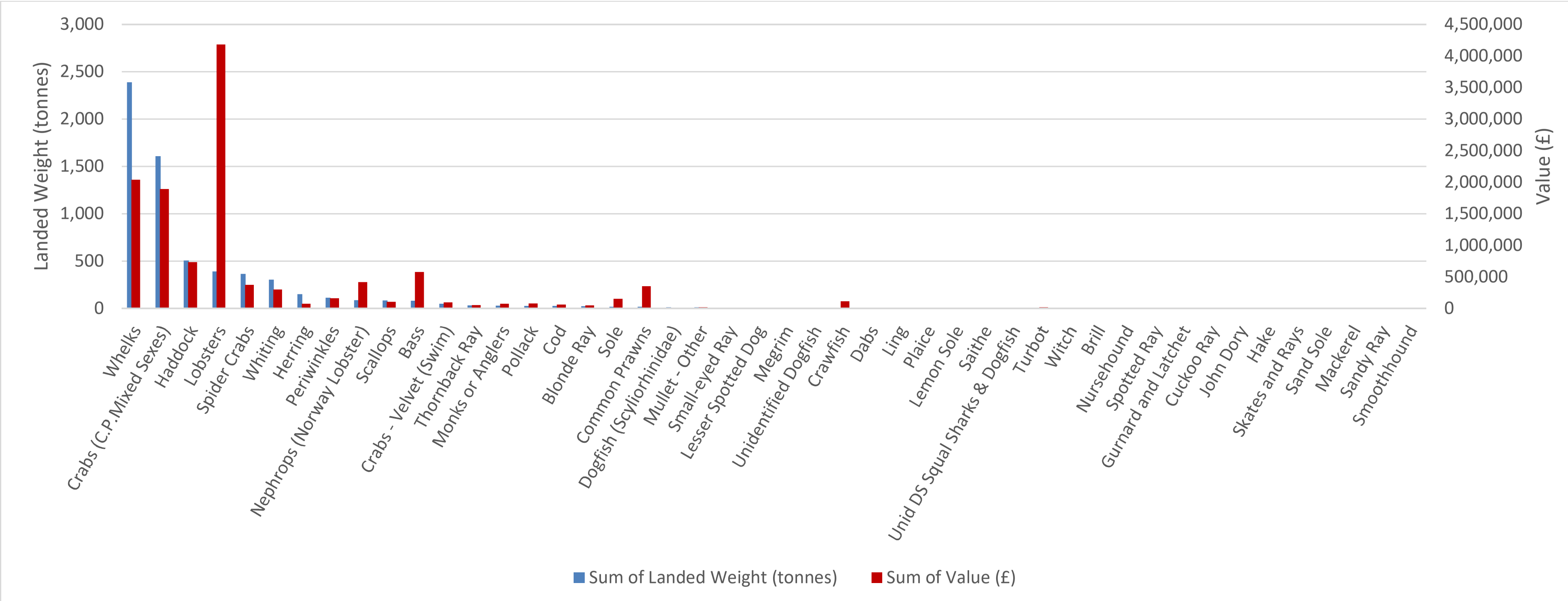


Figure 2.5.6: Species caught in ICES Rectangle 32E4 (2012-2016) based on highest landings weight (tonnes) and corresponding value (£) (Source: MMO, 2017)

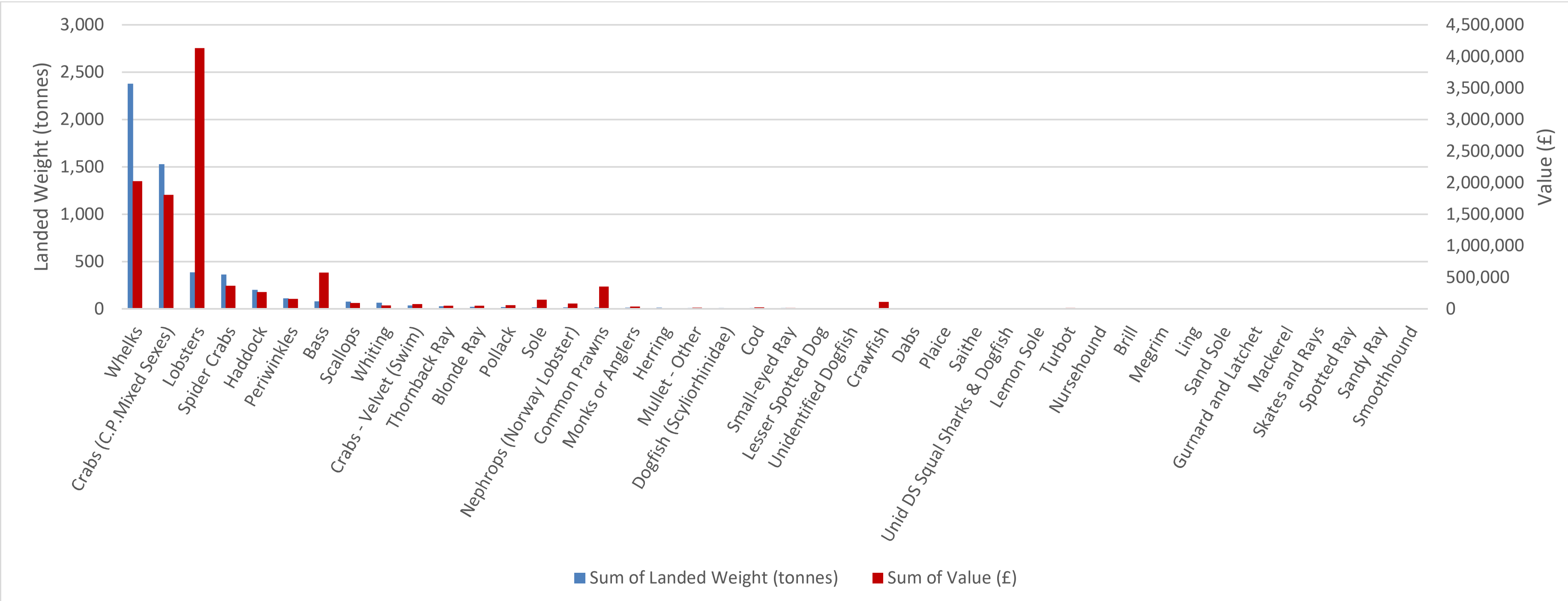
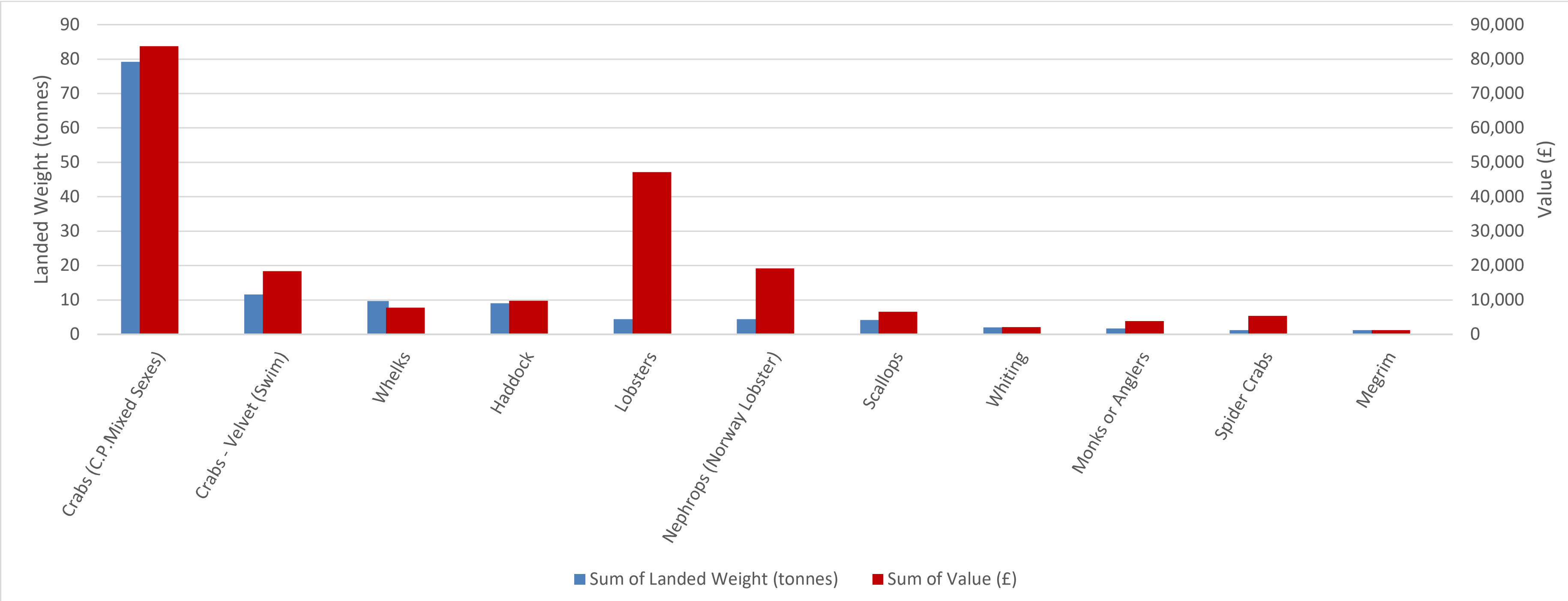


Figure 2.5.7: Species caught in ICES Rectangle 33E3 (2012-2016) based on highest weight (tonnes) and corresponding value (£) (Source: MMO, 2017)



2.5.7 Temporal Variation in Landings Weight and Value

Between 2012-2016, across all ICES Rectangles (32E3, 32E4 & 33E3) the range in the sum of landed weight varied from a minimum of 1,088.1 tonnes in 2015 to a maximum of 1,581.14 tonnes in 2014 (Figure 2.5.8). The range in the sum of landed value varied from a minimum of £2,007,735 in 2015 to a maximum of £2,607,690 in 2013 (Figure 2.5.9).

Figure 2.5.8: Annual Trends in Sum of Landings Weight (2012-2016) for ICES Rectangle 32E3, 32E4 and 33E3 (Source, MMO: 2017)

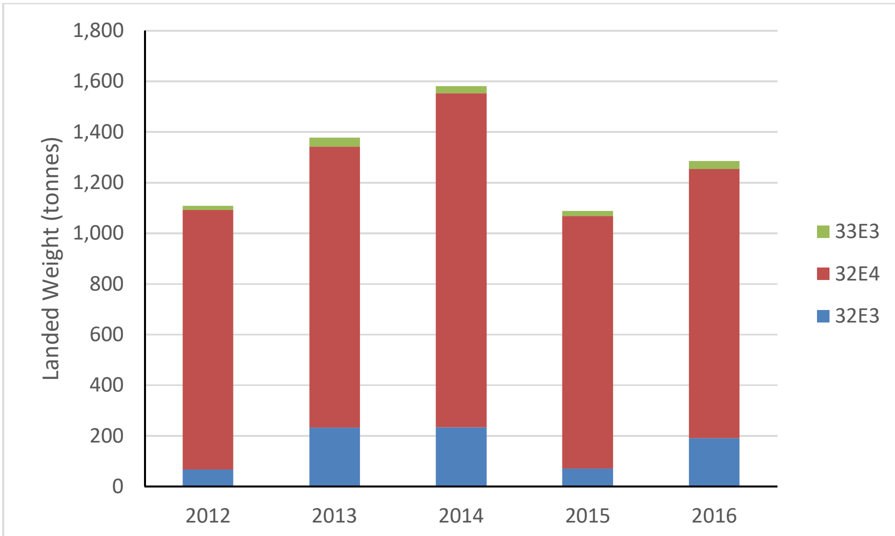
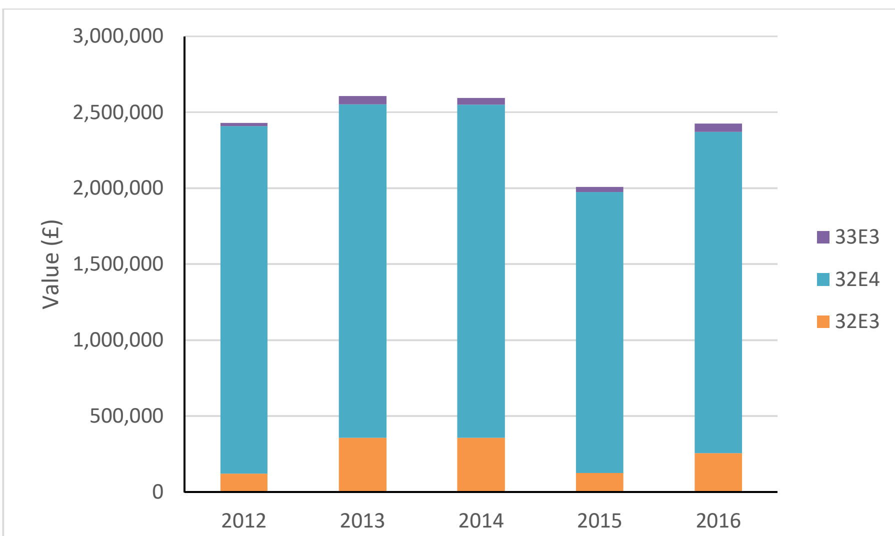


Figure 2.5.9: Annual Trends in Sum of Landings Value (2012-2016) for ICES Rectangle 32E3, 32E4 and 33E3 (Source: MMO, 2017)



Across all ICES Rectangles (32E3, 32E4 & 33E4), the seasonal (intra-annual) range in landed weight (2012-2016) varied from 200.62 tonnes in February to 841.64 tonnes in July (Figure 2.5.10). The landed value follows a similar trend with the minimum value of £484,298 in January and maximum of £1,516,314 in July (Figure 2.5.11). With respect to the individual rectangles, 32E4 (Welsh inshore region) mirrored the overall trend with peak landings in June/July. Both 32E3 (offshore region) and 33E3 (Irish inshore region) actually had greater landings in September/October than June/July.

Figure 2.5.10: Seasonal Trends in Sum of Landings Weight (2012-16) for ICES Rectangles 32E3, 32E4 and 33E3 (Source: MMO, 2017)

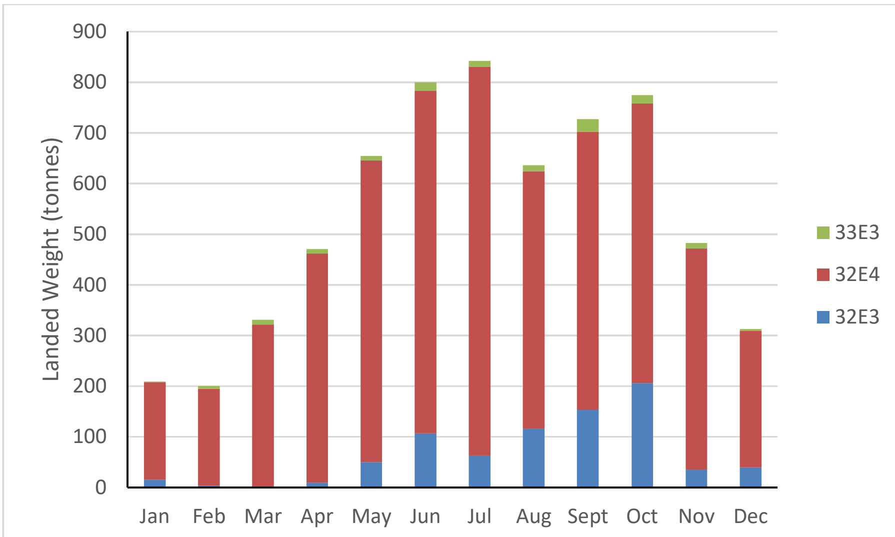
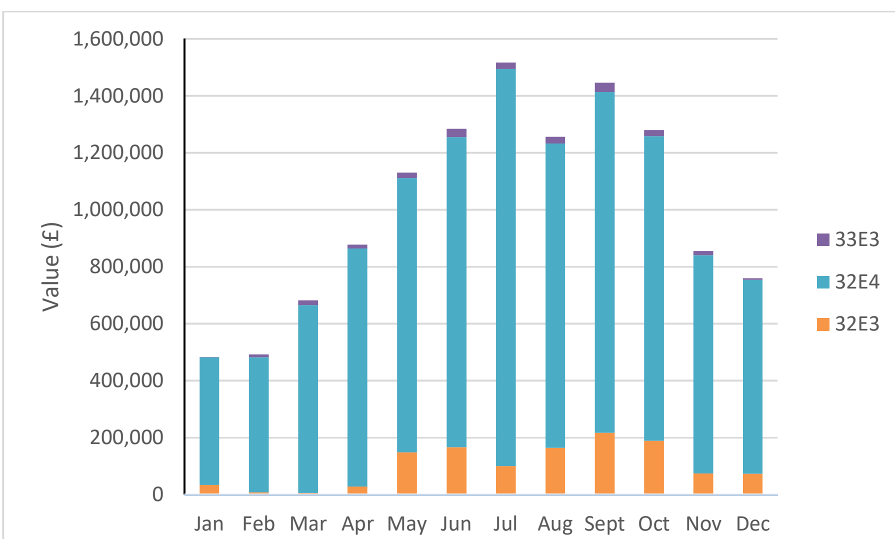


Figure 2.5.11: Seasonal Trends in Sum of Landings Value (2012-16) for ICES Rectangles 32E3, 32E4 and 33E3 (Source: MMO, 2017)



The species data was analysed further to identify notable trends in the temporal variation of the top five most commercially important species. Overall, whelk and crab made up the top 2 species in terms of landed weight across all years and rectangles. Haddock appears to be of particular importance in terms of landed weight during 2013.

The most important months for landings of whelk during 2012-2016 were April to July inclusive, with a landed weight range from 9.84 to 109.37 tonnes (Figure 2.5.13). Landed weight on whelk is noticeably lower during 2012 and the peak occurs later in the year during 2016. The minimum landed weight of whelk occurred during December 2015 at 4.71 tonnes.

Crab (C.P. Mixed Sexes) landings, in terms of weight, were most prominent during June to November inclusive, with a landed weight range of 11.05 to 76.34 tonnes (Figure 2.5.14). The minimum landed weight of crab (C.P. Mixed Sexes) was 2.96 tonnes and occurred during February 2014.

The trend in landings weight of haddock appears particularly seasonal during 2012-2016, with June and September inclusive being the most important months. The landed weight during this peak period ranged from 0.01 to 88.12 tonnes (Figure 2.5.15). There are months of the year where no Haddock is landed, suggesting that seasonality is an important factor with respect to this particular species.

Lobster landings, in terms of weight, were most prominent during April to October inclusive, although this species is landed all year round and appears to have much less of a strong seasonal trend. The range in weight during the key months was 4.18 to 17.31 tonnes (Figure 2.5.16) and the minimum of 0.14 tonnes occurred during January 2014.

Spider crab landings, in terms of weight, were most prominent during May to July inclusive, with a landed weight range of 5.95 to 27.86 tonnes (Figure 2.5.17). The minimum landed weight of spider crab occurred in February 2014 at 0.12 tonnes.

Figure 2.5.12: Annual Trends in Top Five Species by Sum of Landings Weight (2012-2016) for ICES Rectangles 32E3, 32E4 and 33E3 (Source: MMO, 2017)

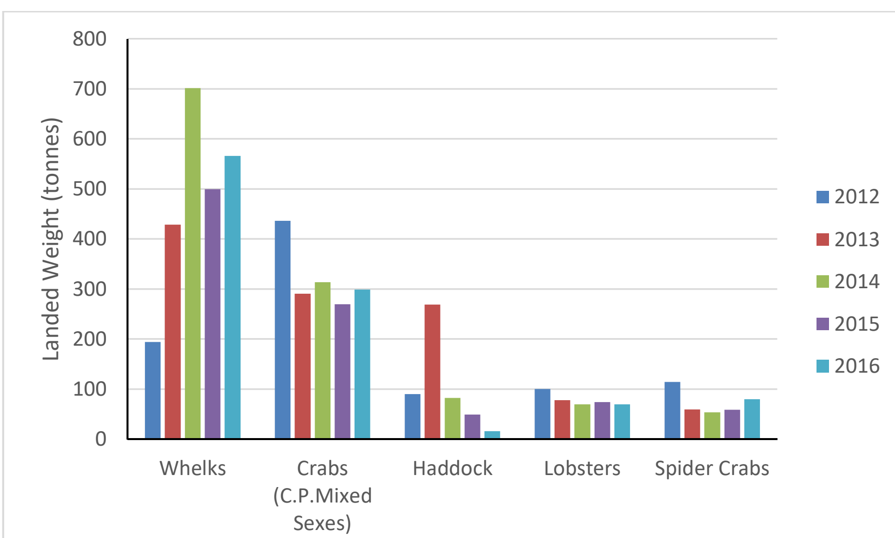


Figure 2.5.13: Seasonality of Landed Weight (tonnes) of Whelk (2012-2016) for ICES Rectangles 32E3, 32E4 and 33E3 (Source: MMO, 2017)

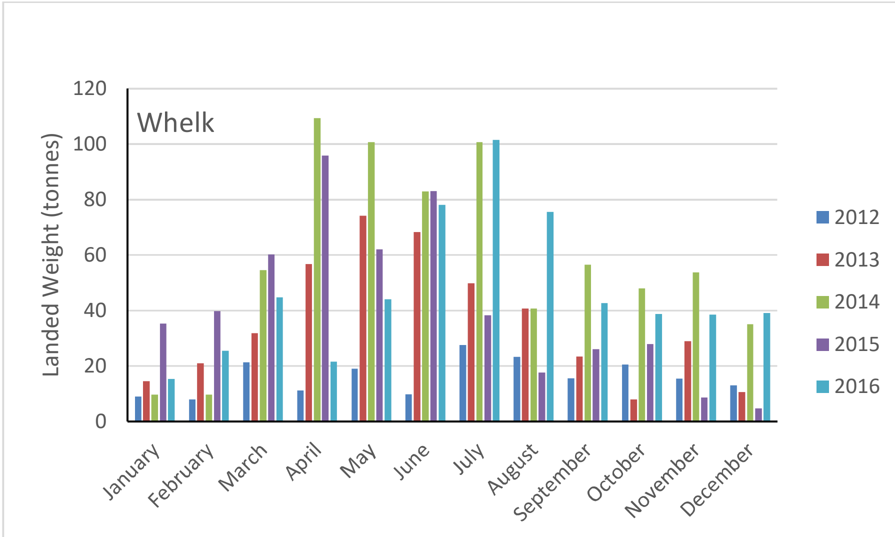


Figure 2.5.14: Seasonality of Landed Weight (tonnes) of Crabs (C.P. Mixed Sexes) (2012-2016) for ICES Rectangles 32E3, 32E4 and 33E3 (Source: MMO, 2017)

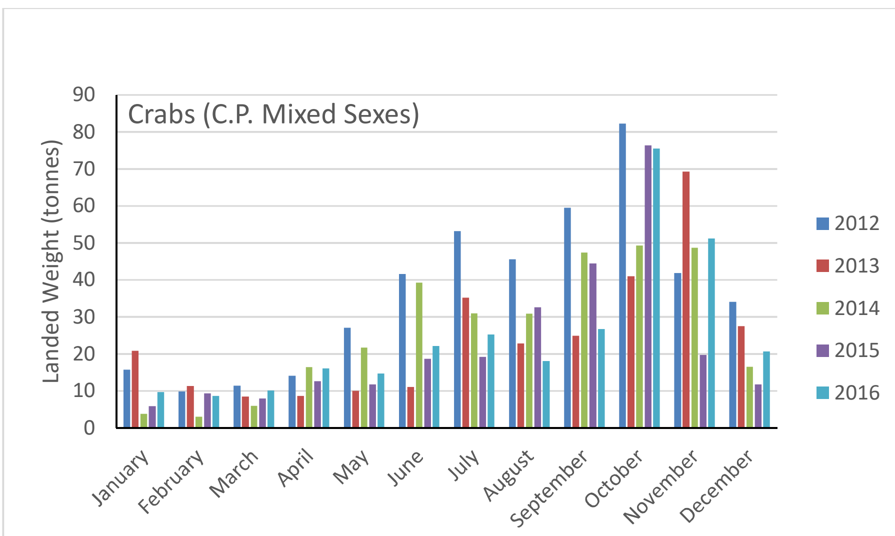


Figure 2.5.15: Seasonality of Landed Weight (tonnes) of Haddock (2012-2016) for ICES Rectangles 32E3, 32E4 and 33E3 (Source: MMO, 2017)

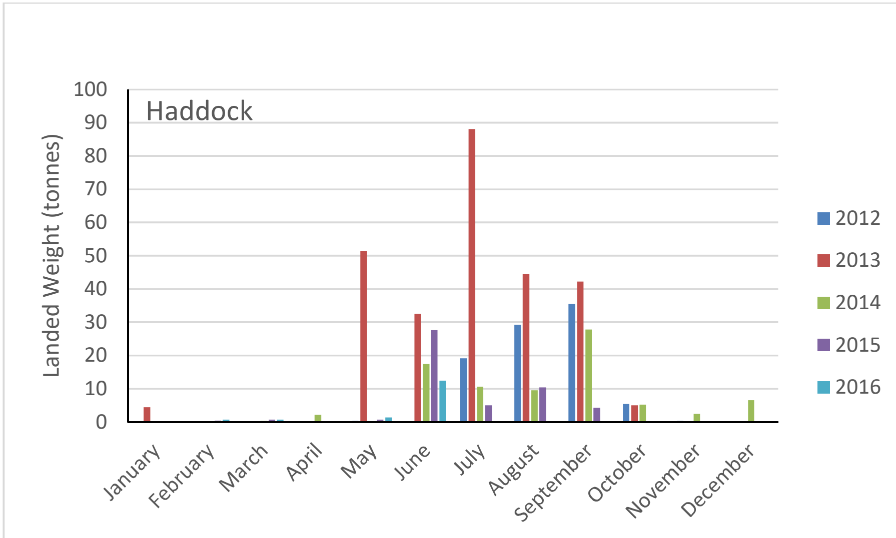


Figure 2.5.16: Seasonality of Landed Weight (tonnes) of Lobster (2012-2016) for ICES Rectangles 32E3, 32E4 and 33E3 (Source: MMO, 2017)

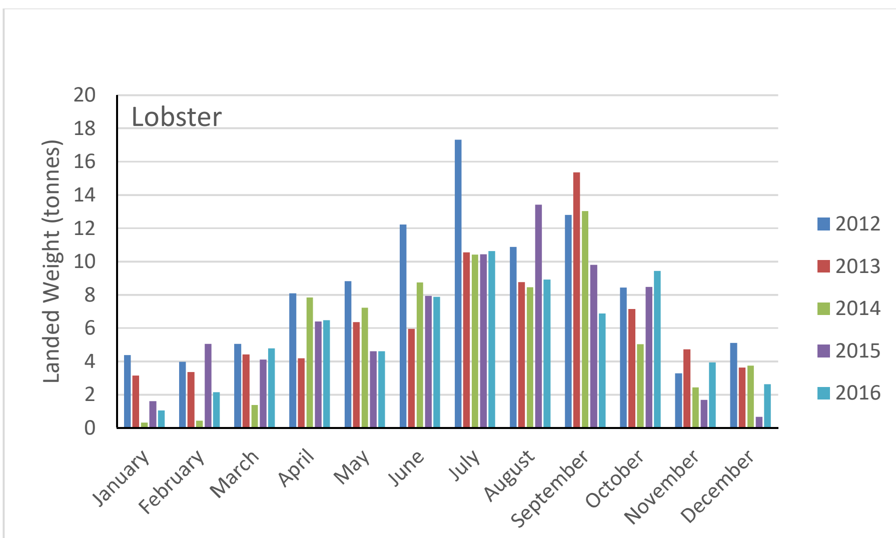
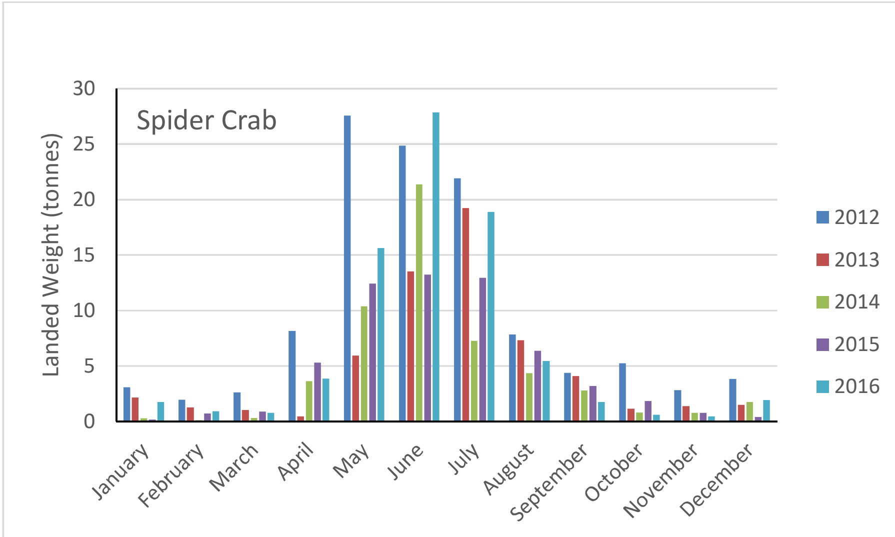


Figure 2.5.17: Seasonality of Landed Weight (tonnes) of Spider Crab (2012-2016) for ICES Rectangles 32E3, 32E4 and 33E3 (Source: MMO, 2017)



2.5.8 Landings Weight and Value by Regional Ports

Landings data compiled by the MMO (MMO, 2017a) were reviewed for the period January 2011 to December 2015 and filtered to just show landings into Welsh and Irish ports closest to the proposed cable corridor. The ports used in this analysis were Milford Haven and Fishguard (Welsh coast) and Dunmore East and Kilmore Quay (Irish coast). Data was sorted by Port and further filtered to analyse details within different vessel size class and species group. This data was further sorted by species to then analyse the most important commercial species, in terms of landed weight and value, into each port. This enabled a more detailed analysis of fishing activity from ports most likely to be affected by the Greenlink interconnector cable.

2.5.8.1 Milford Haven

Vessels >10 m are dominant at the port of Milford Haven in terms of landed weight and the key species groups are demersal and shellfish, with total landed weights between 2011 and 2015 of 16,957.09 and 5,751.87 tonnes respectively (Figure 2.5.18). Landed weight in the <10 m vessel size class were lower but demersal (625.96 tonnes) and shellfish (1,099.82 tonnes) landings were still important. For both vessel size categories, the pelagic species group was the least dominant by weight and value of landings.

A total of 83 species were landed at Milford Haven during 2012-2016 - Figure 2.5.19. The top five species in terms of landed weight were megrim, sole, monks/anglers, scallops and crabs (C.P. Mixed Sexes). The weight range across these five species was 3,117.87 to 1,870.81 tonnes. In terms of value, Sole was the key species with a total value of £17,665,950 from a landed weight of 2,412.22 tonnes. This reflects the role of the beam trawl fishery which operates out of this port.

Figure 2.5.18: Total landings (tonnes) into Milford Haven port (2011-2015) displayed by species group and vessel length (Source: MMO, 2017a)

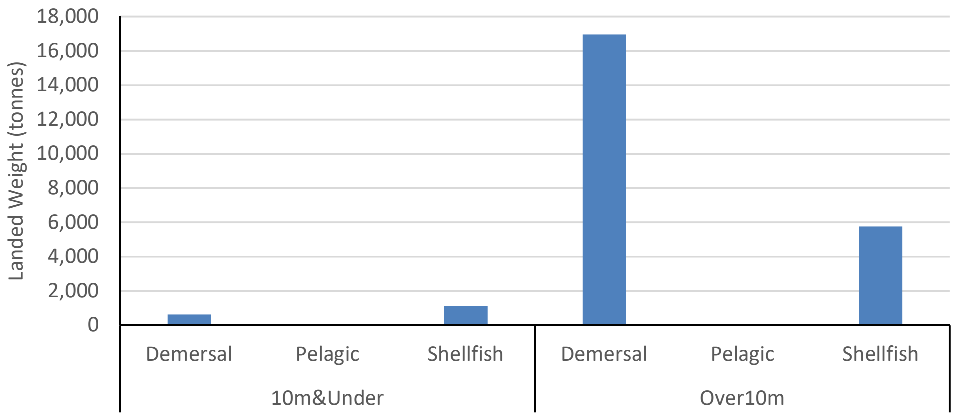
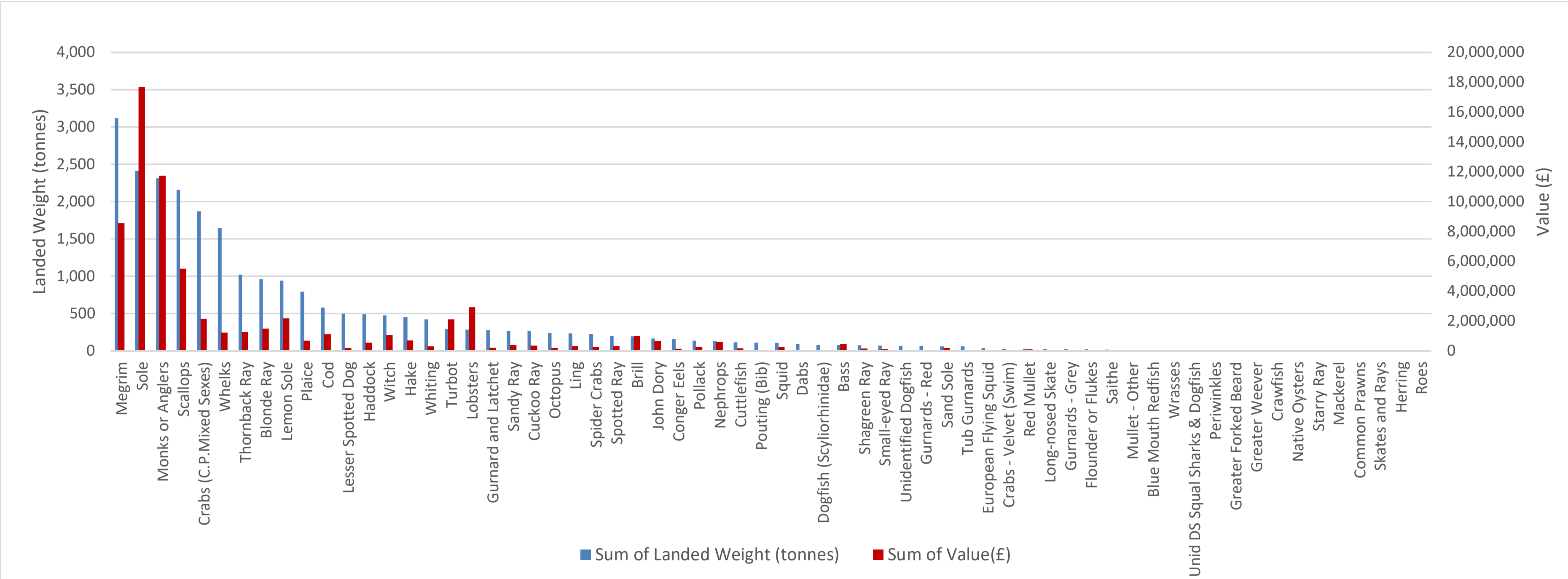


Figure 2.5.19: Total weight (tonnes) and value of landings into Milford Haven port (2011-2015) displayed by species class (Source: MMO, 2017a)[1]



[1] Species with landed weight of <1 tonne are not included within this figure

2.5.8.2 Fishguard

Vessels >10 m are dominant at the port of Fishguard in terms of landed weight and the key species group was shellfish, with total landed weights between 2011 and 2015 of 5,319.35 tonnes (Figure 2.5.20). Whilst lower overall landings weight occurred from the <10 m vessels, shellfish was also the key species group with a weight of 1,516.14 tonnes. Landed weights of demersal and pelagic species was low with a weight of 0.02 and 18.1 tonnes respectively, across all vessel size classes. There were no landings of pelagic species into Fishguard during 2011-2016 by the >10 vessel fleet.

A total of 28 species were landed at Fishguard during 2011-2015 (Figure 2.5.21). The top five species in terms of landed weight were whelk, scallop, crabs (C.P. Mixed Sexes), spider crab and lobster. The weight range across these five species was 3,722.01 to 77.99 tonnes. In terms of value, scallop was the key species with a total value of £5,819,391 from a landed weight of 2,599.30 tonnes.

Figure 2.5.20: Total landings (tonnes) into Fishguard port (2011-2015) displayed by species group and vessel length (MMO, 2017a)

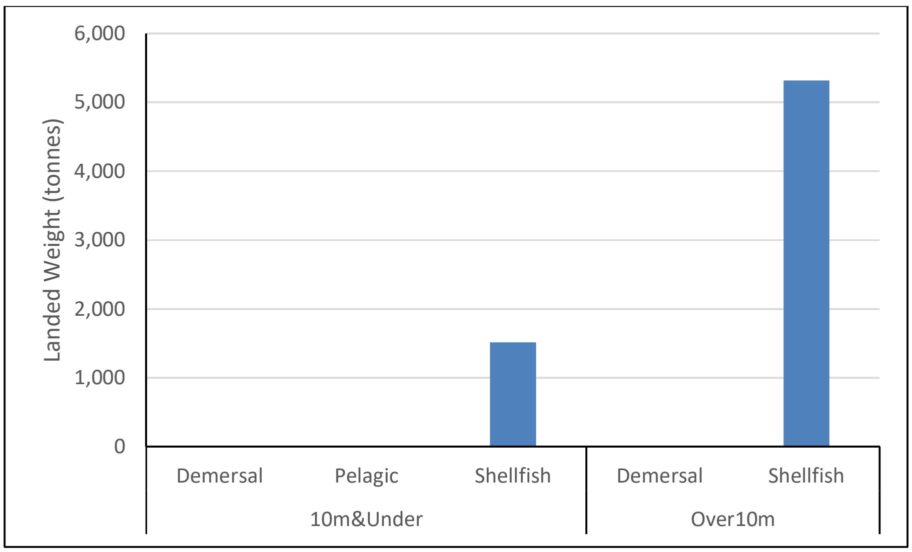
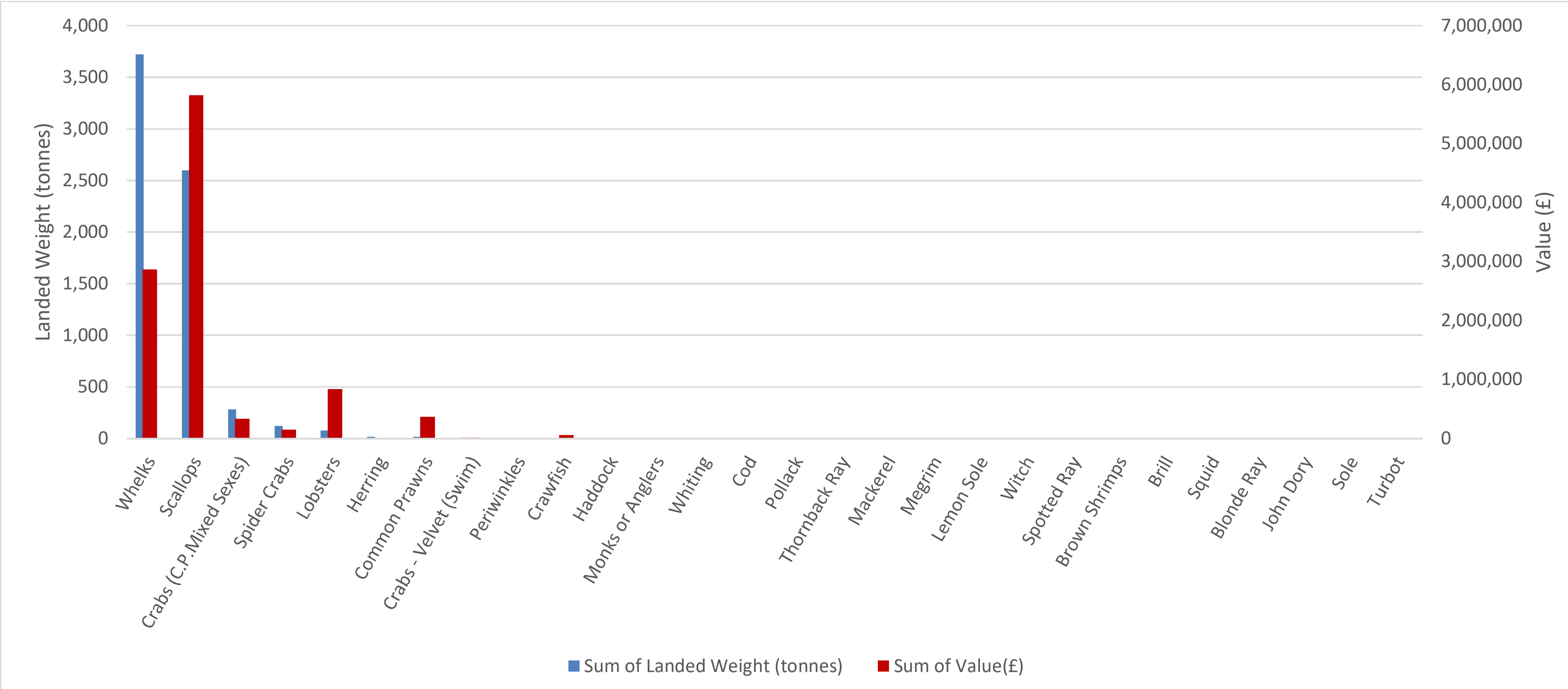


Figure 2.5.21: Total weight (tonnes) and value of landings into Fishguard port (2011-2015) displayed by species class (Source: MMO, 2017a)



2.5.8.3 Dunmore East

Vessels >10 m are dominant at the port of Dunmore East in terms of landed weight and the key species group was demersal, with total landed weights between 2011 and 2015 of 891.98 tonnes (Figure 2.5.22). There are no recorded landings by <10 m vessels into Dunmore East. Landed weights of shellfish species were lower with a weight of 55.83 tonnes.

A total of 33 species were landed at Dunmore East during 2011-2015 (Figure 2.5.23). The top five species in terms of landed weight were haddock, whiting, *Nephrops*, cod and hake. The weight range across these 5 species was 511.25 to 39.50 tonnes. In terms of value, haddock was also the key species with a total landed value of £692,922.

Figure 2.5.22: Total landings (tonnes) into Dunmore East port (2011-2015) displayed by species group and vessel length (MMO, 2017a)

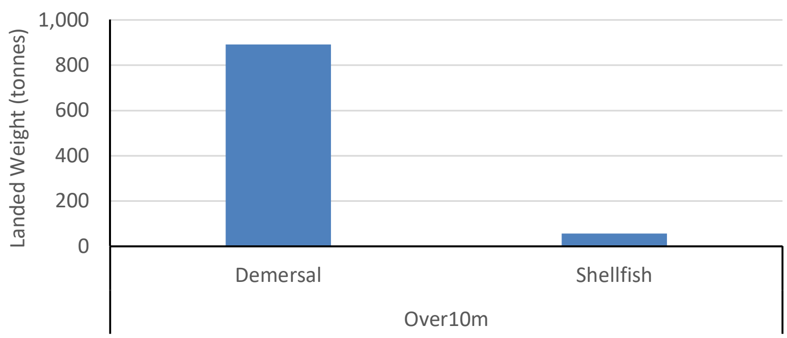
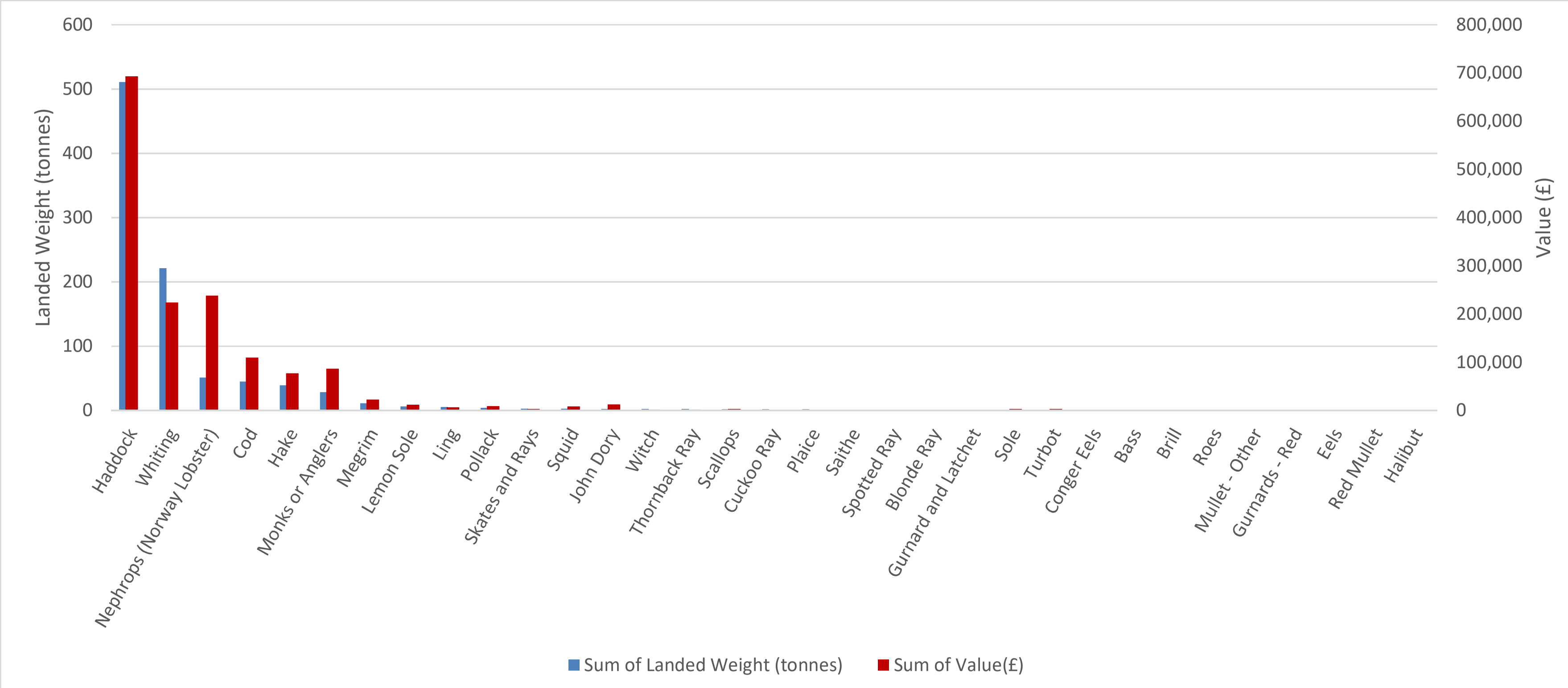


Figure 2.5.23: Total weight (tonnes) and value of landings into Dunmore East port (2011-2015) displayed by species class (Source: MMO, 2017a)

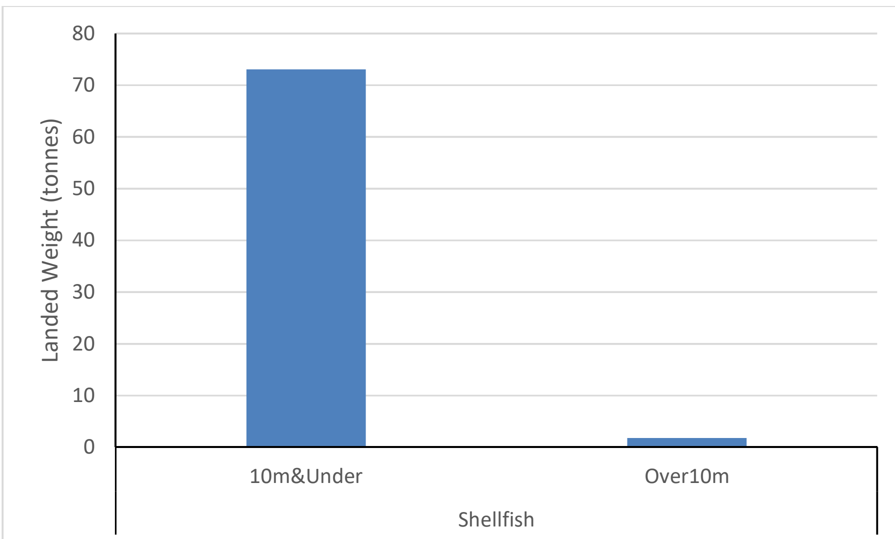


2.5.8.4 Kilmore Quay

There was no recorded landings of demersal or pelagic species into Kilmore Quay by either the <10 m or >10 m vessel size classes. Vessels <10 m are dominant at the port of Kilmore Quay in terms of landed weight and the key species group was shellfish, with total landed weights between 2011 and 2015 of 73.03 tonnes (Figure 2.5.24). This same trend is observed within the >10 m vessel fleet, with a total weight of 1.76 tonnes landed during 2011-15.

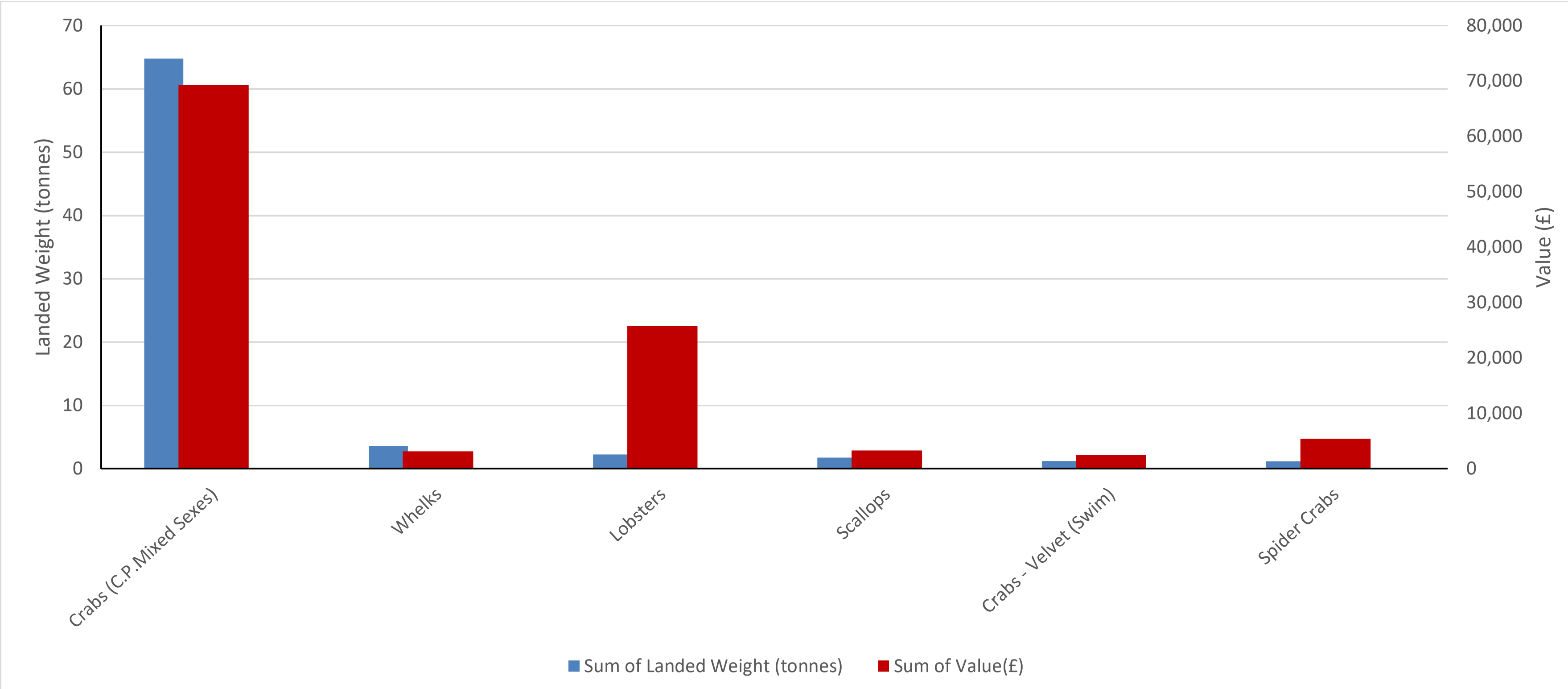
A total of six species were landed at Kilmore Quay during 2011-2015 (Figure 2.5.25). The top five species in terms of landed weight were crab (C.P. Mixed Sexes), whelk, lobster, scallop and crab (velvet). The weight range across these five species was 64.08 to 1.23 tonnes. In terms of value, crab (C.P. Mixed Sexes) was also the key species with a total landed value of £69,232. The overall value of lobster landed (£25,758) was high relative to the weight (2.28 tonnes).

Figure 2.5.24: Total landings (tonnes) into Kilmore Quay port (2012-2015) displayed by species group and vessel length (MMO, 2017a)[2]



[2]Landings data for Kilmore Quay only available from October 2012 to December 2015.

Figure 2.5.25: Total weight (tonnes) and value of landings into Kilmore Quay port (2012-2015)[2] displayed by species class (Source: MMO, 2017a)



2.6 STECF Landings Data (Non-UK Vessels)

Data on other EU fishing activity in and around the proposed Greenlink project have been obtained from the website of the EU Scientific, Technical and Economic Committee for Fisheries (STECF) (https://stecf.jrc.ec.europa.eu/about-stecf). The STECF data set includes most, but not all species and fishing gears that are relevant to Ireland. Additionally effort data for Irish vessels<10m are not available and landings data for these vessels are not available at the rectangle level.

These non-UK data are not in a format that allows direct directly comparison to the data provided by the MMO but they do provide a good overview of fishing activity and trends in this region.

2.6.1 Temporal Variation in Landed Weight by ICES Rectangle

The range in the sum of landed weight for vessels in the Irish fleet (2012-2016), across all ICES Rectangles (32E3, 32E4 & 33E3) varied from a minimum of 53.56 tonnes (2012) to a maximum of 3,947.27 tonnes (2014) – see Figure 2.6.1. The key ICES Rectangle for the Irish fleet in terms of landings was 33E3.

The range in the sum of landed weight by vessels from the French fleet (2012-2016), across all ICES Rectangles (32E3, 32E4 & 33E3) ranged from a minimum of 1.22 tonnes (2016) to a maximum of 1,465.99 tonnes (2012) – see Figure 2.6.2. The key ICES Rectangles for the French fleet were 32E3 and 32E4.

The range in the sum of landed weight by vessels from the Belgian fleet (2012-2016), across all ICES Rectangles (32E3, 32E4 & 33E3) ranged from a minimum of 1.10 tonnes (2015) to a maximum of 837.05 tonnes (2012) – see Figure 2.6.3. The key ICES Rectangle for the Belgian fleet was 32E3.

Figure 2.6.1: Sum of landings weight from Irish vessels within ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16), displayed by year (Source: STECF, 2018)

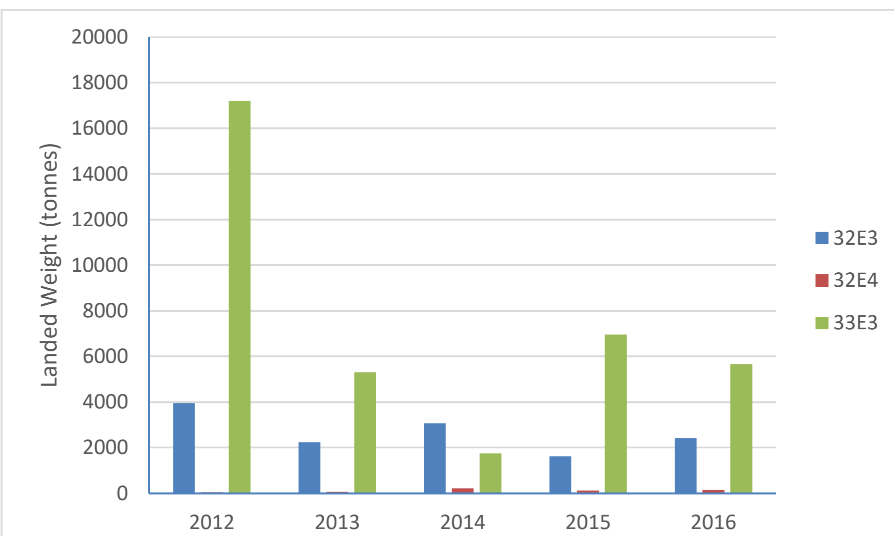


Figure 2.6.2: Sum of landings weight from French vessels within ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16), displayed by year (Source: STECF, 2018)

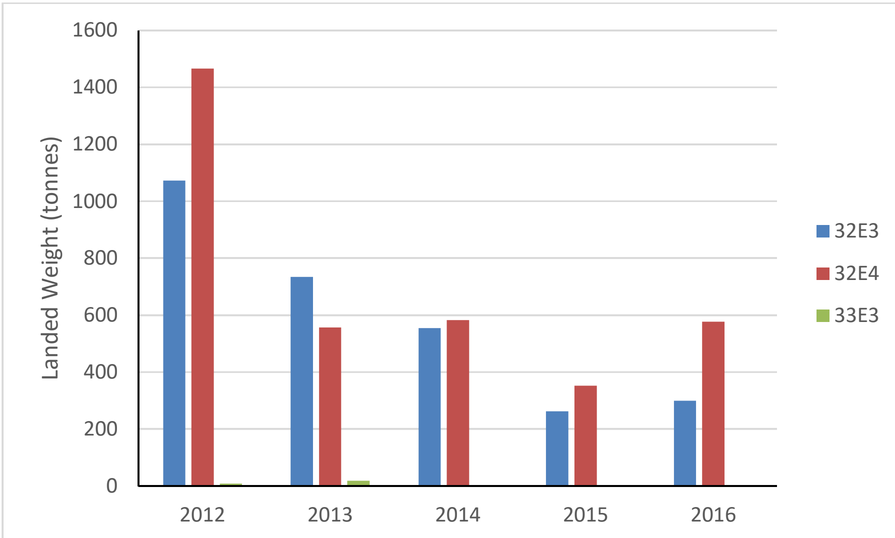
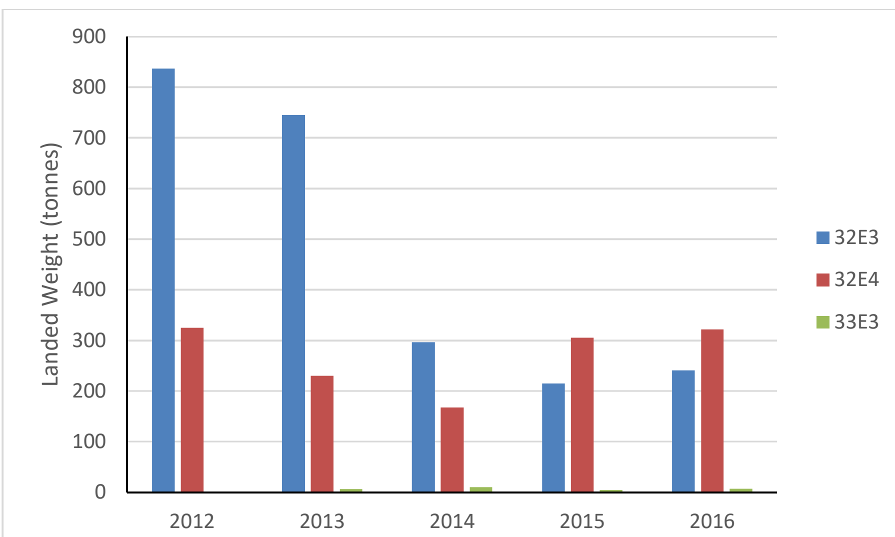


Figure 2.6.3: Sum of landings weight from Belgian vessels within ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16), displayed by year (Source: STECF, 2018)



2.6.2 Landings Weight by Species

A total of 56 species were landed by Irish vessels during 2012-2016 (Figure 2.6.4), with 72% of all landings made from ICES Rectangle 33E3. The key species landed across all Rectangles was European sprat with a total weight of 12,328.61 tonnes. The four next most commercially important species in terms of landed weight were “other”[3], herring, great atlantic scallop and edible crab. There were significant landings of herring and scallop from both 32E3 and 33E3.

A total of 29 species were landed by French vessels during 2012-2016 (Figure 2.6.5). The key ICES Rectangles for the French fleet was 32E3 and 32E4, with landings from 33E3 only making up 0.05% of the total landed weight. The key species landed across all Rectangles was rays/skates with a total weight of 1,989.31 tonnes. The four next most commercially important species in terms of landed weight were haddock, anglerfish, whiting and other[3]. There were significant landings of herring and scallop from both 32E3 and 33E3.

A total of 43 species were landed by Belgian vessels during 2012-2016 (Figure 2.6.6). The key ICES Rectangles for the Belgian fleet was 32E3 (63% of the total landed weight). The key species landed across all Rectangles was anglerfish with a total weight of 713.74 tonnes. The four next most commercially important species in terms of landed weight were common sole, megrim, thornback ray and blonde ray.

[3] This species category is only prominent during 2012 and may possibly be a result of raw data inaccuracies and, therefore, these data should be treated with caution.

Figure 2.6.4: Sum of landings weight from Irish vessels within ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16), displayed by species (Source: STECF, 2018)

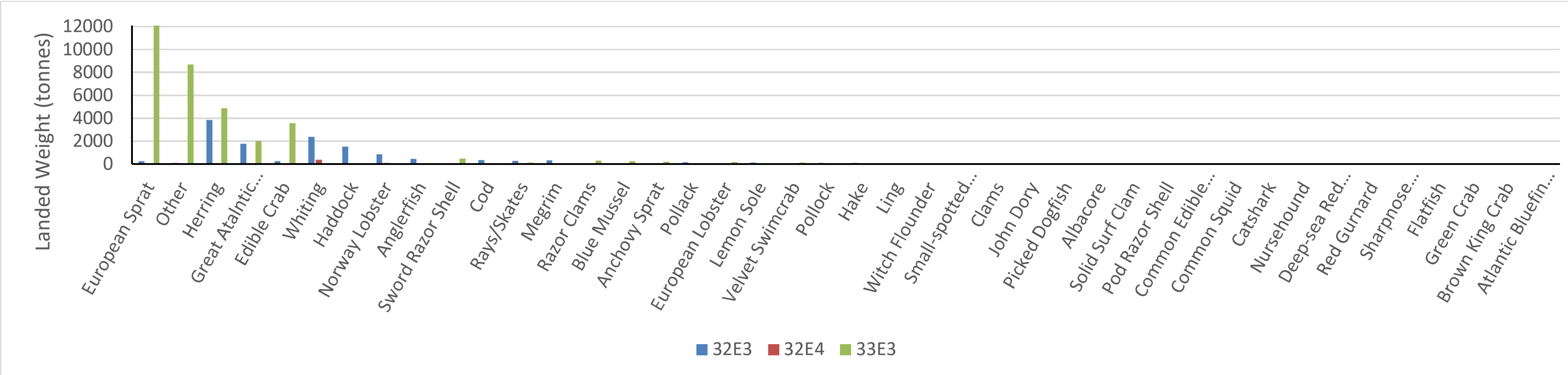


Figure 2.6.5: Sum of landings weight from French vessels within ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16), displayed by species (Source: STECF, 2018)

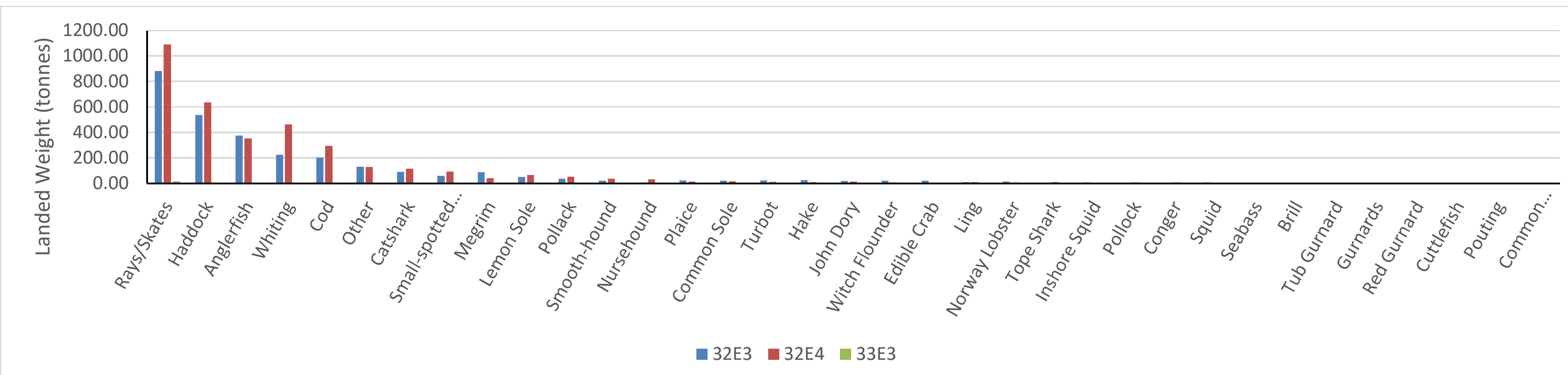
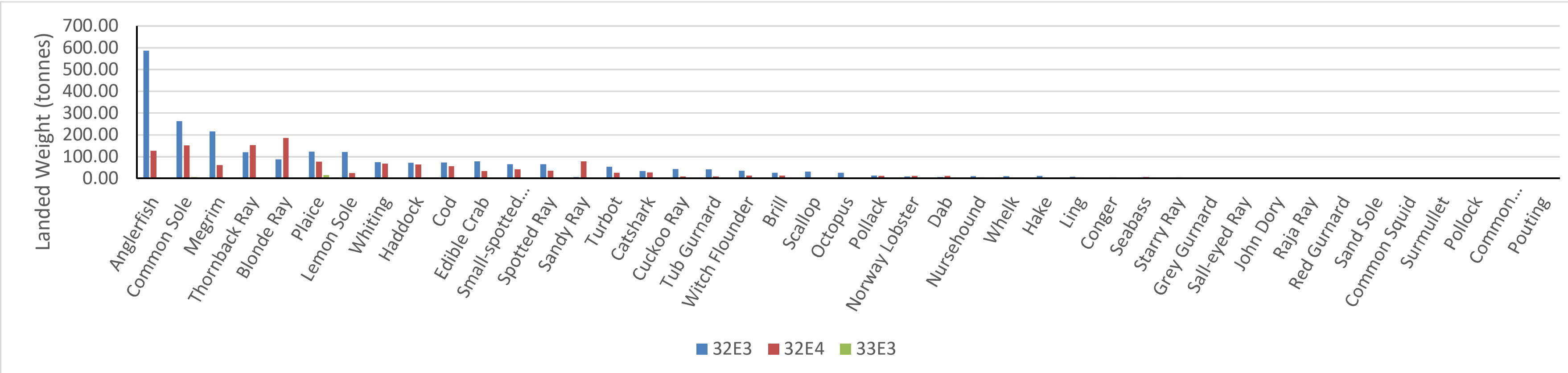


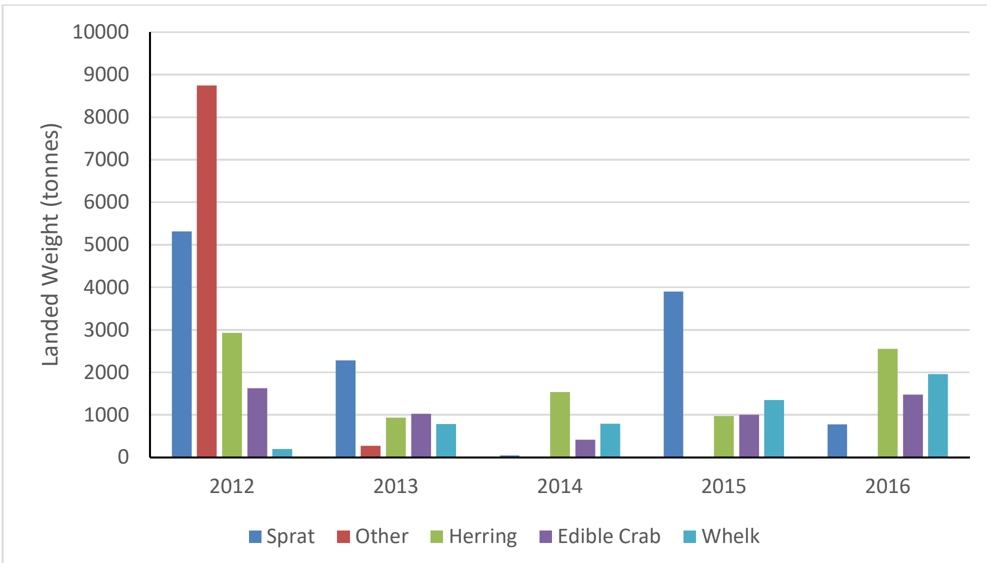
Figure 2.6.6: Sum of landings weight from Belgian vessels within ICES Statistical Rectangle 32E3, 32E4, 33E3 (2012-16), displayed by species (Source: STECF, 2018)



2.6.3 Temporal Variation by Species

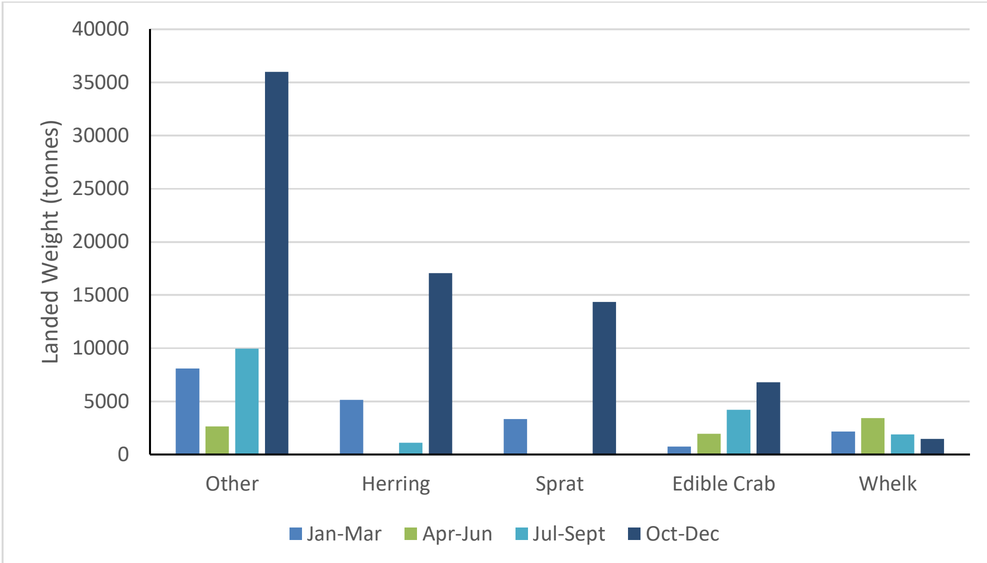
The STECF species data was analysed further allowing a closer look at the temporal variation of the top five most commercially important species. Overall, “other”[3] made up the top species group in terms of total landed weight across all years and rectangles, however, this trend may be skewed due to such a high number in this category during 2012. “Other” does not feature so prominently in 2013-2016. Sprat is more consistently the key species across the years with a landed weight range from 50 to 5,314.8 tonnes. Edible crab and whelk are the species which exhibit the least annual variation with total landed weight ranges of 414.16 to 1,629.53 tonnes and 198.09 to 1,953.65 tonnes respectively.

Figure 2.6.7: Annual Trends in Top 5 Species by Sum of Landings Weight from Non-UK[4] vessels (2012-2017) for ICES Rectangles 32E3, 32E4 and 33E3 (Source: STECF, 2018)



[4] Non-UK data from Irish, French and Belgian vessels.

Figure 2.6.8: Seasonal Trends in Top 5 Species by Sum of Landings Weight from Non-UK[4] vessels (2012-2017) for ICES Rectangles 32E3, 32E4 and 33E3 (STECF, 2018)



2.7 Vessel Monitoring Systems and Landings Data Combined

Since 2000, all fishing vessels ≥ 24 m in length have been required, by European Law, to indicate their position once every 2 hours via the Vessel Monitoring System (VMS), which is a system whereby fishing vessel positional data are collected via a satellite logging the GPS position of the vessel. The requirement for VMS has subsequently been amended several times to include increasingly smaller vessels (2004: fishing vessels ≥ 18 m, 2005: fishing vessels ≥ 15 m). Since 2012, all vessels ≥ 12 m in length have been required to operate VMS. Commercial fishing activity by vessels <12m in length is not captured by VMS data at present.

For this assessment, data (2012-2015) have been analysed to be as consistent as possible with other data used throughout this report. Data have been categorised into aggregated gear groups and positional data have been extracted from GPS-derived VMS data. From 2011 onwards, effort was provided in kilowatt hours (kWh), which has been calculated by multiplying the time associated with each VMS report (in hours), by the engine power of the vessel concerned at the time of the activity. Also included in the GIS data layers are the quantity (tonnes) of live weight fish landed with gear type, and value (sterling) of live weight fish landed with gear type. The GIS data layers of relevance to the current report were those from 2012-2015.

2.7.1 Fishing Effort – UK Vessels

Figure 2.7.1 shows annual (2012-2015) fishing effort by UK vessels (both <15 m and >15 m) using all gear types, on a regional scale plotted by ICES Rectangles. The location of the proposed Greenlink Interconnector cable corridor is included for reference.

Figure 2.7.2 to Figure 2.7.4 show annual (2012-2015) plot of total hours fished in and around the proposed Greenlink Interconnector cable corridor using all gear, static gear and mobile gear, by UK vessels >15 m within ICES Rectangles 32E3, 32E4 and 33E3 using VMS data.

Figure 2.7.1: Greenlink Interconnector Cable Corridor in relation to annual fishing effort (kilowatt/days) (mobile & static gear) by all UK vessels by ICES Rectangles 32E3, 32E4 & 33E3 (2012-2015)(Source: MMO, 2017e)

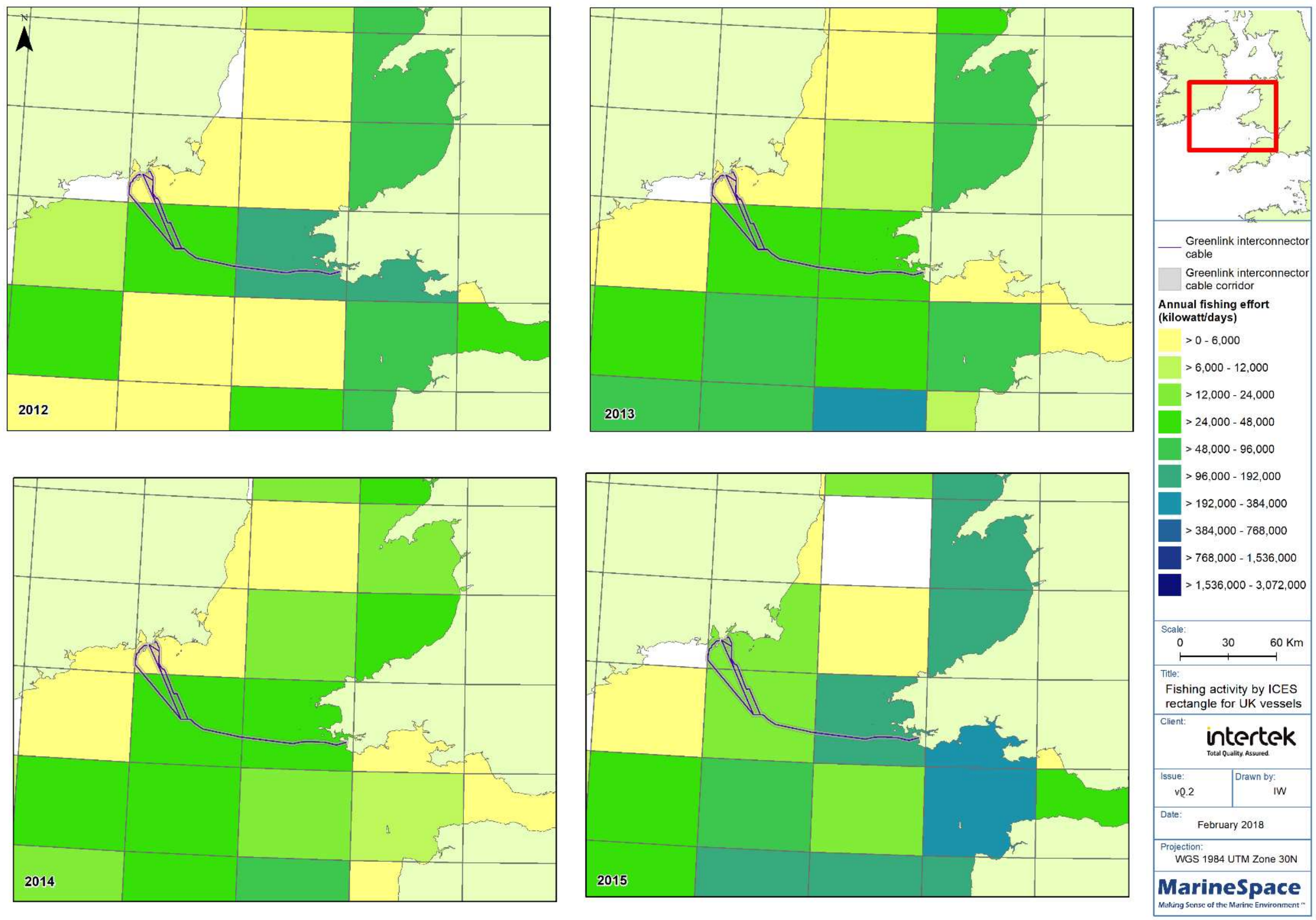


Figure 2.7.2: Greenlink Interconnector Cable Corridor in relation to the total hours fished (mobile & static gear) by UK vessels (>15 m) within ICES Rectangles 32E3, 32E4 & 33E3 (2012-2015) (Source: MMO, 2017d)

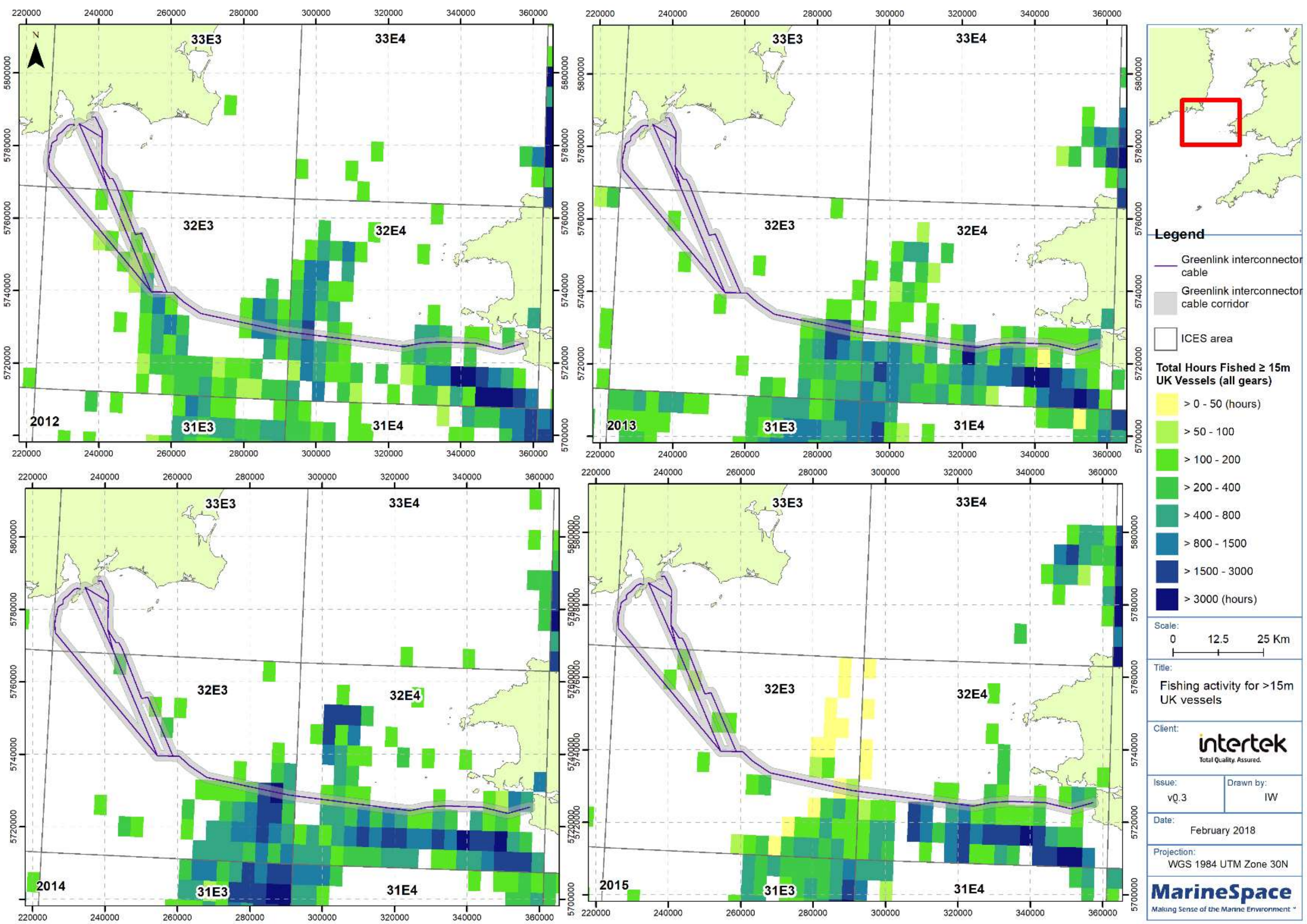


Figure 2.7.3: Greenlink Interconnector Cable Corridor in relation to the total hours fished (static gear) by UK vessels (>15m) within ICES Rectangles 32E3, 32E4 & 33E3 (2012-2015) (Source: MMO, 2017d)

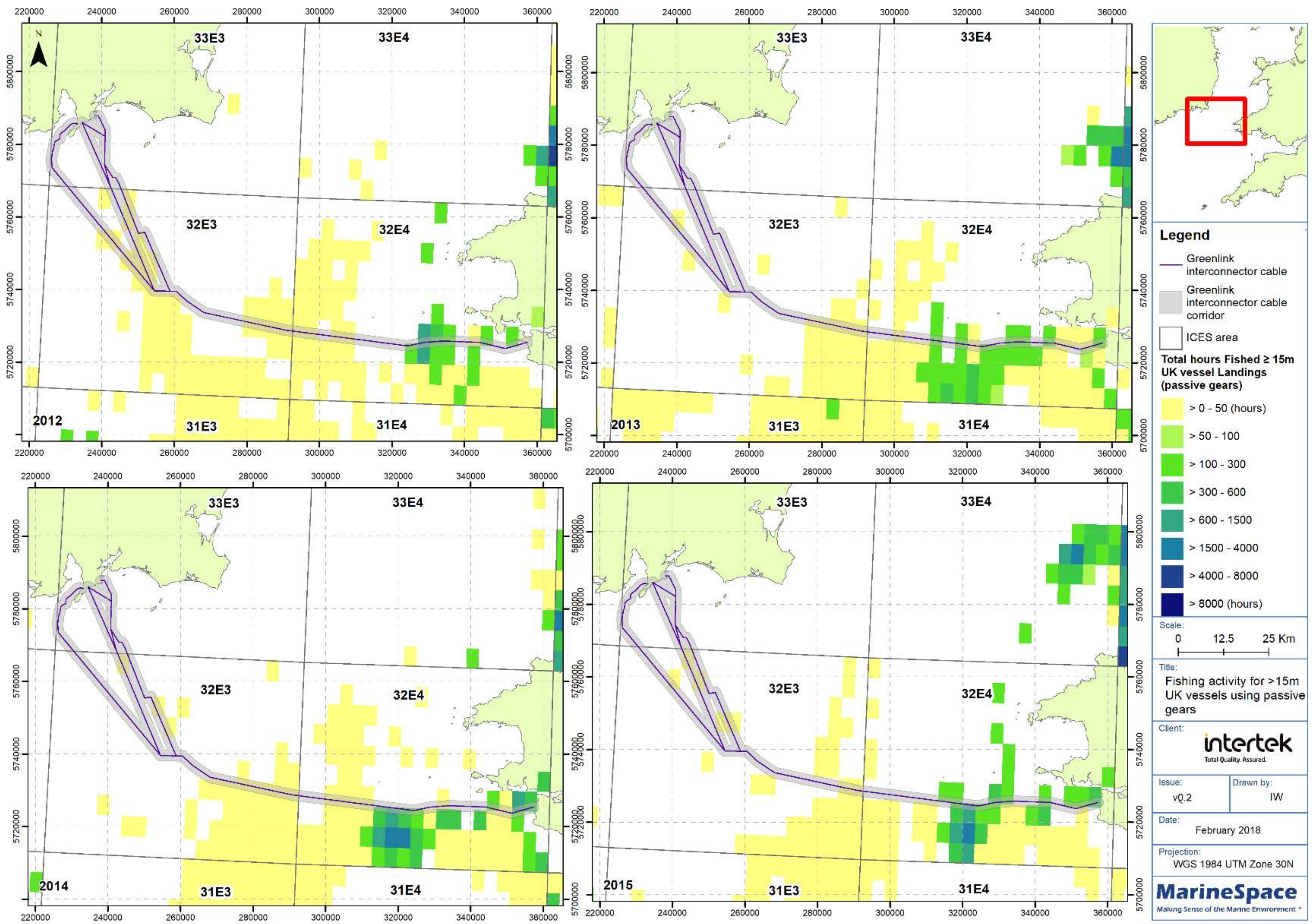
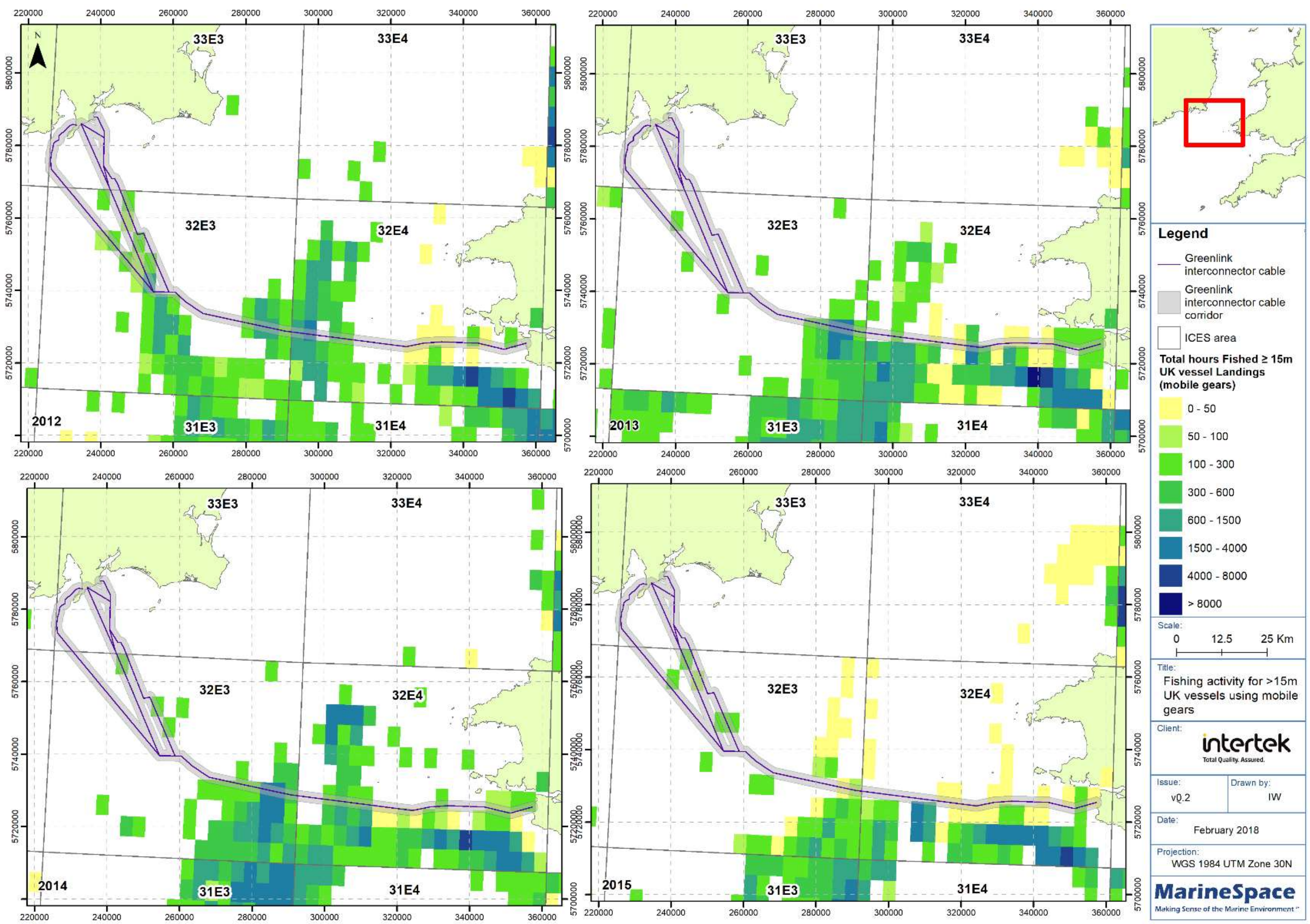


Figure 2.7.4: Greenlink Interconnector Cable Corridor in relation to the total hours fished (mobile gear) by UK vessels (>15 m) within ICES Rectangles 32E3, 32E4 & 33E3 32E4 (2012-2015) (Source: MMO, 2017d)



2.7.2 Fishing Value – UK Vessels

Figure 2.7.5 shows annual (2012-2015) fishing value landed by UK vessels (<15 m and >15 m) using all gear types, on a regional scale plotted by ICES Rectangles. The location of the proposed Greenlink Interconnector cable corridor is included for reference.

Figure 2.7.6 shows annual (2012-2015) total value landed from in and around the proposed Greenlink Interconnector cable corridor using all gear, by UK vessels (>15 m) within ICES Rectangles 32E3, 32E4 and 33E3 using VMS data.

Figure 2.7.7 shows annual (2012-2015) total value landed along the proposed Greenlink Interconnector cable corridor, using all gear, by UK vessels >15 m. The VMS data values have been clipped to the cable corridor and split up into the following sea areas: UK 6 nm (nautical mile) fishing zone, 12 nm boundary, Irish Territorial Seas and Offshore region. Please see Table 2.5 for associated landing values within each region.

Table 2.5: Average Landings Value from VMS Data split into Sea Regions along the proposed Greenlink Interconnector Cable Corridor (Source: MMO, 2017d)

	Sea Region			
Year	UK 6nm	UK 12nm	Irish Territorial Waters	Offshore
2012	£573.03	£3,264.01	£431.85	£1,659.96
2013	£1,968.59	£8,902.66	£1,011.78	£1,1075.80
2014	£1,651.09	£833.40	£3,162.62	£5,886.82
2015	£1,018.98	£1,832.64	£368.66	£819.91
Total Value	**£5,211.69**	**£14,832.71**	**£4,974.91**	**£19,442.49**
Average	**£1,302.92**	**£3,708.18**	**£1,243.73**	**£4,860.63**

Figure 2.7.5: Greenlink Interconnector Cable Corridor in relation to the annual value of landings (mobile & static gear) by all UK vessels by ICES Rectangles 32E3, 32E4 & 33E3 (2012-2015)(Source: MMO, 2017e)

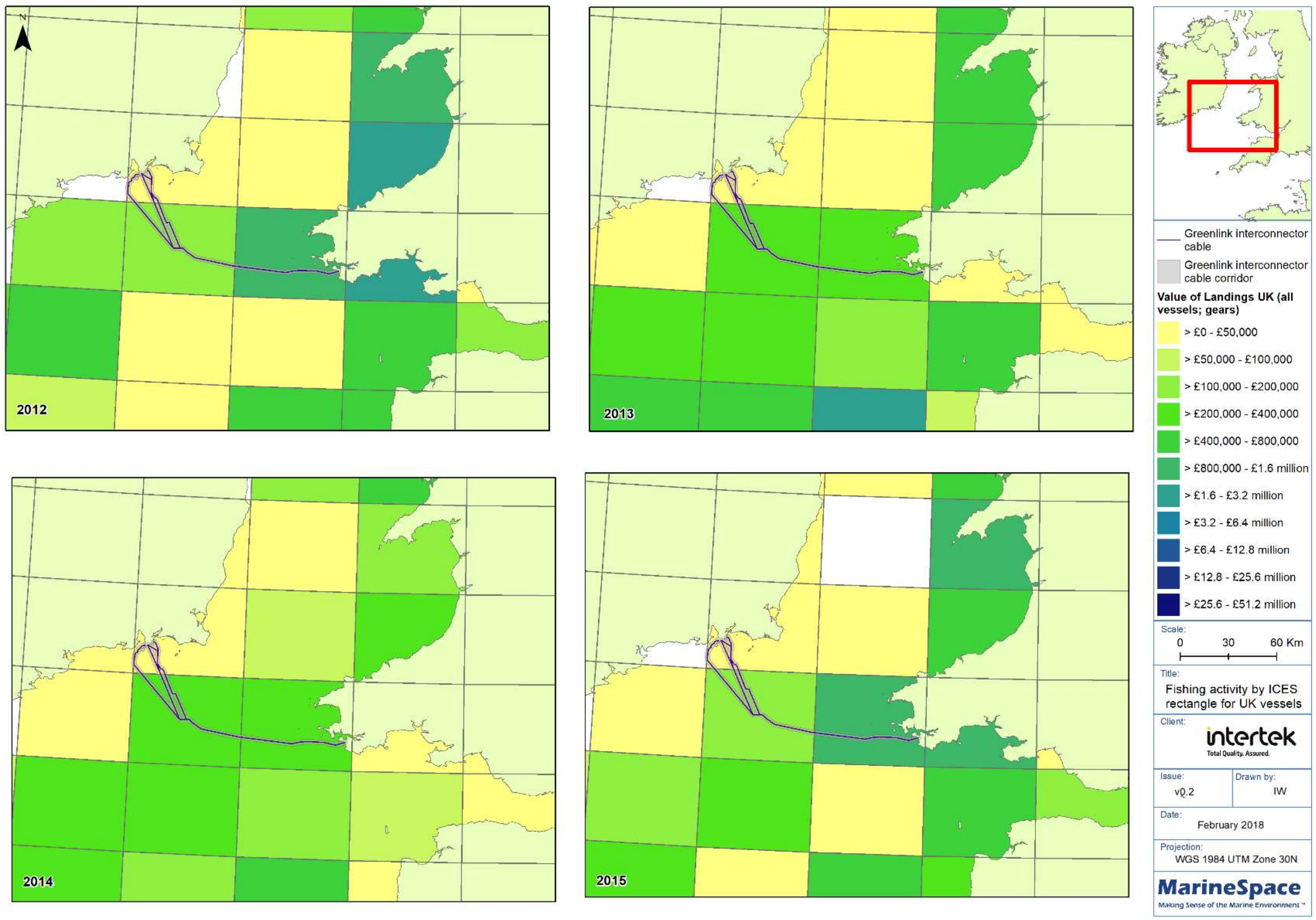


Figure 2.7.6: Greenlink Interconnector Cable Corridor in relation to the total value of landings (mobile & static gear) by UK vessels (>15 m) (between 2012-2015) (Source: MMO, 2017d)

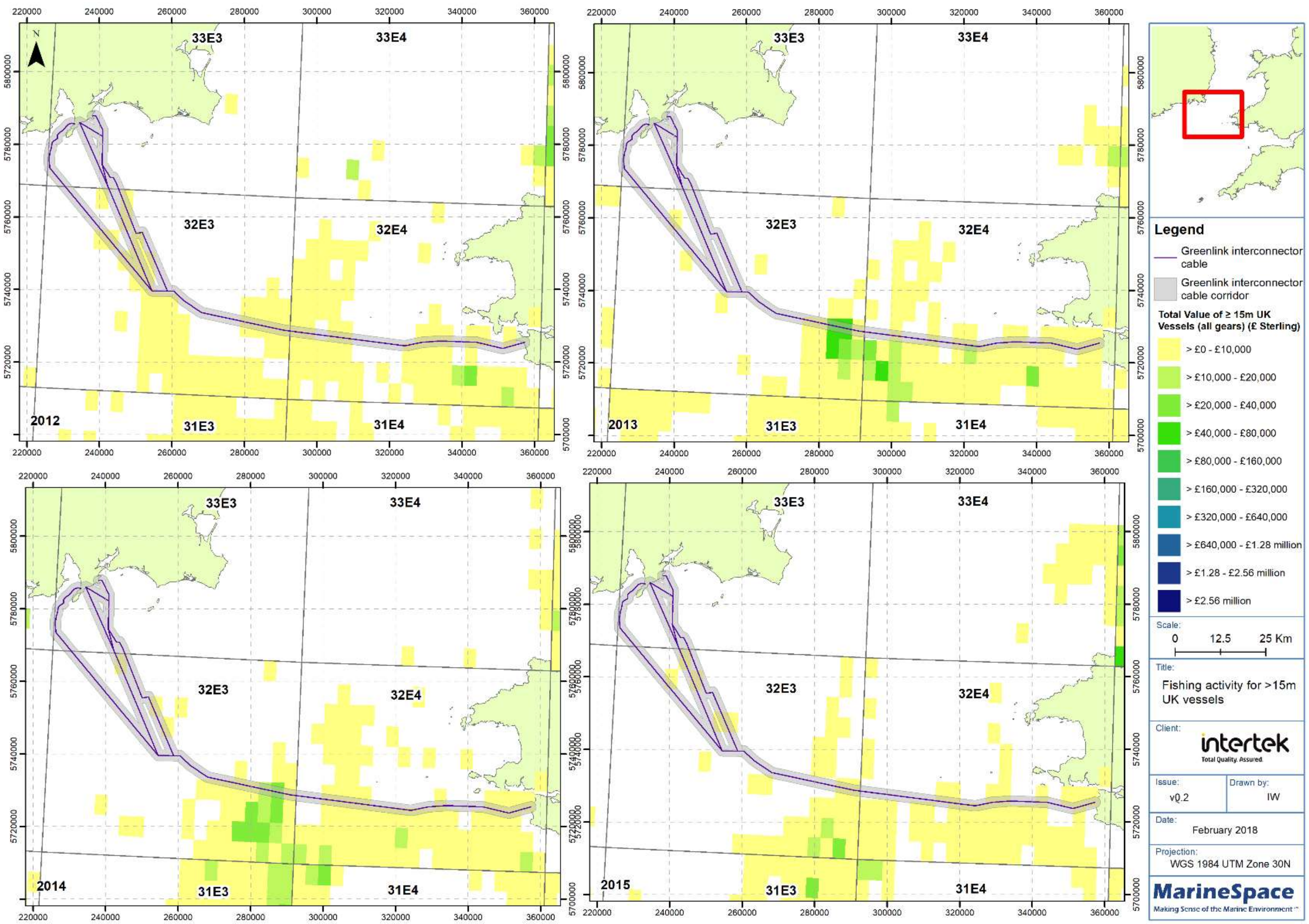
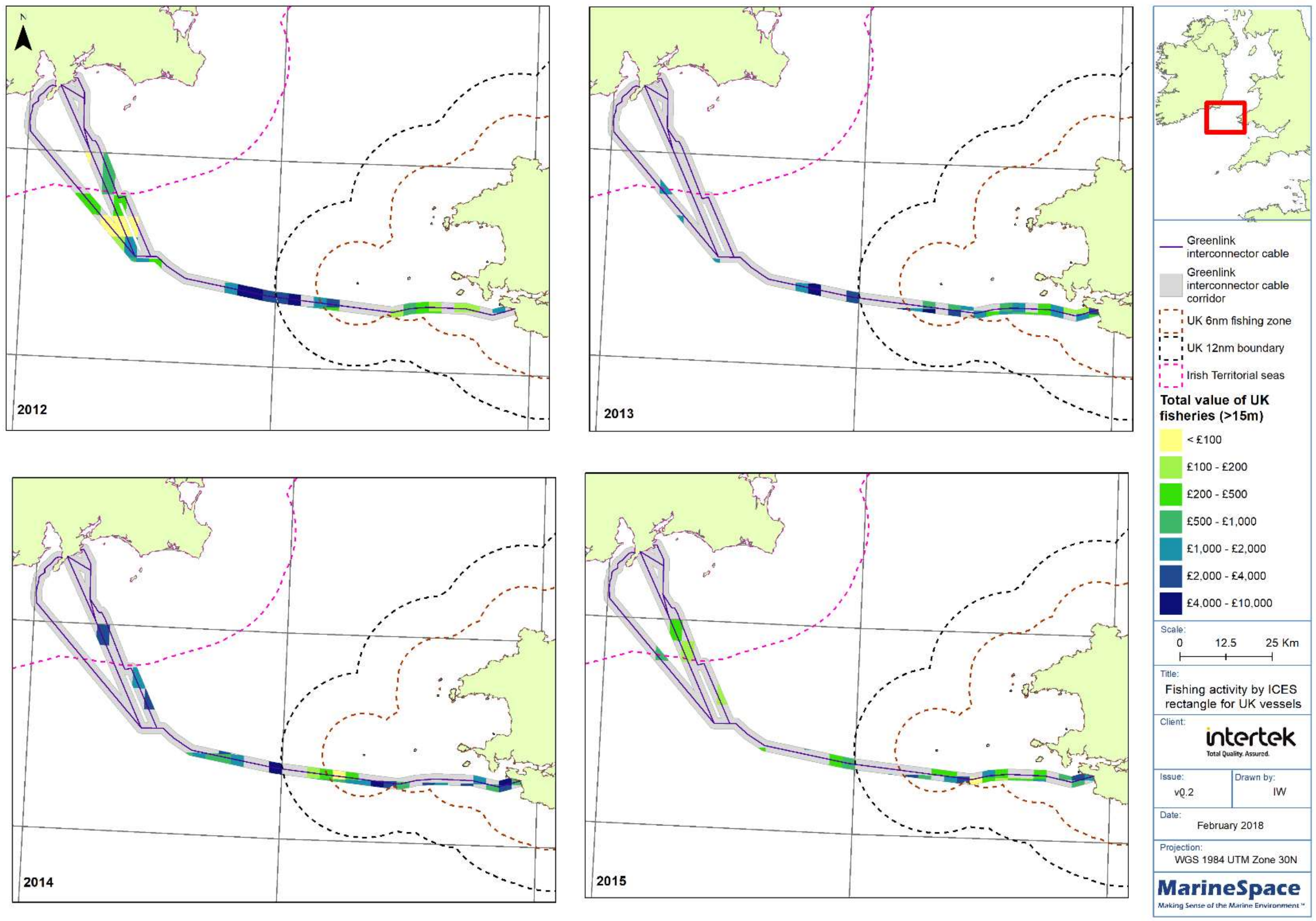


Figure 2.7.7: Greenlink Interconnector Cable Corridor in relation to the total value of landings (mobile & static gear) divided into sea areas by nautical Miles, by UK vessels (>15 m) (between 2012-2015) (Source: MMO, 2017d)



2.7.3 Fishing Effort – Non-UK Vessels

The non-UK data figures below have also been created using VMS data. However, within this non-UK data set there is no landed value figures and the time period is different to that used above for the UK fleet and ranges from 2007-2010.

Figure 2.7.8 to Figure 2.7.11 show total hours fished between 2007-2010 in and around the proposed Greenlink Interconnector cable corridor by non-UK vessels over 15 m, Irish, French, Belgian, Spanish & Dutch, using all gear types within ICES Rectangles 32E3, 32E4 and 33E3 using VMS data.

Figure 2.7.8: Greenlink Interconnector Cable Corridor in relation to the total hours fished (mobile & static gear) by Irish vessels (>15 m) within ICES Rectangles 33E3, 32E3 & 32E4 (2007-2010) (Source: MMO, 2014)

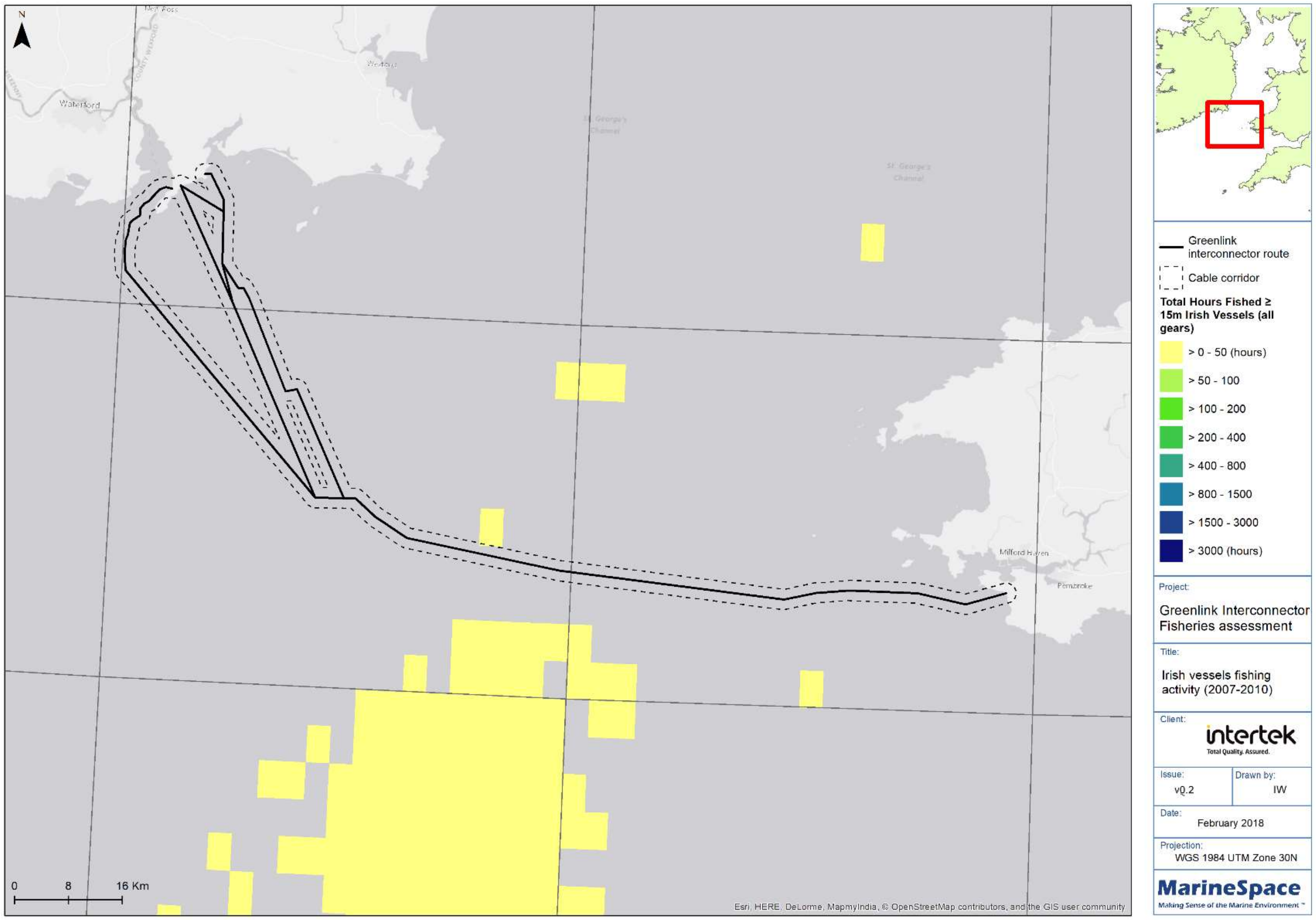


Figure 2.7.9: Greenlink Interconnector Cable Corridor in relation to the total hours fished (mobile & static gear) by French vessels (>15 m) within ICES Rectangles 33E3, 32E3 & 32E4 (2007-2010) (Source: MMO, 2014)

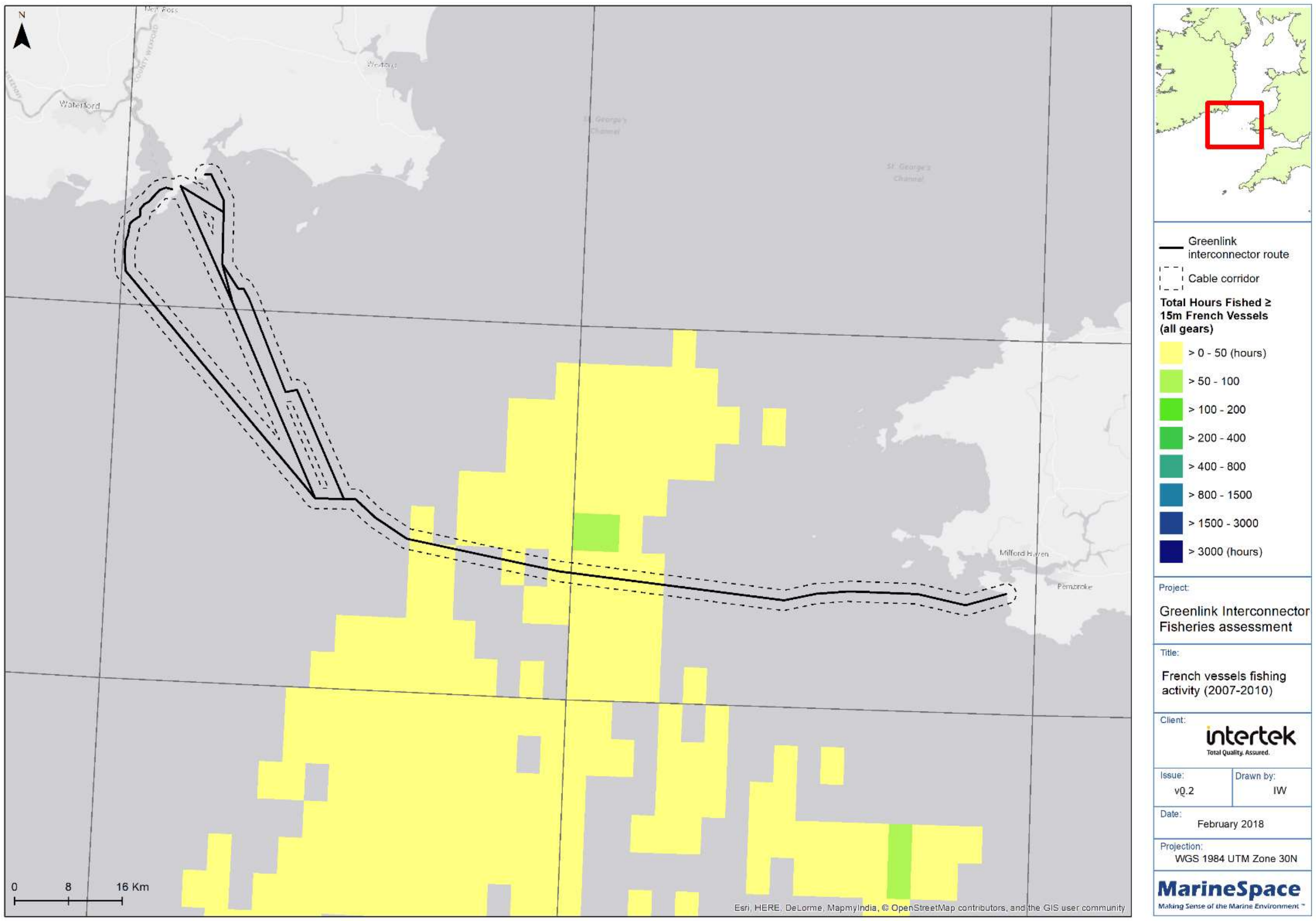


Figure 2.7.10: Greenlink Interconnector Cable Corridor in relation to the total hours fished (mobile & static gear) by Belgian vessels (> 15 m) within ICES Rectangles 33E3, 32E3 & 32E4 (2007-2010) (Source: MMO, 2014)

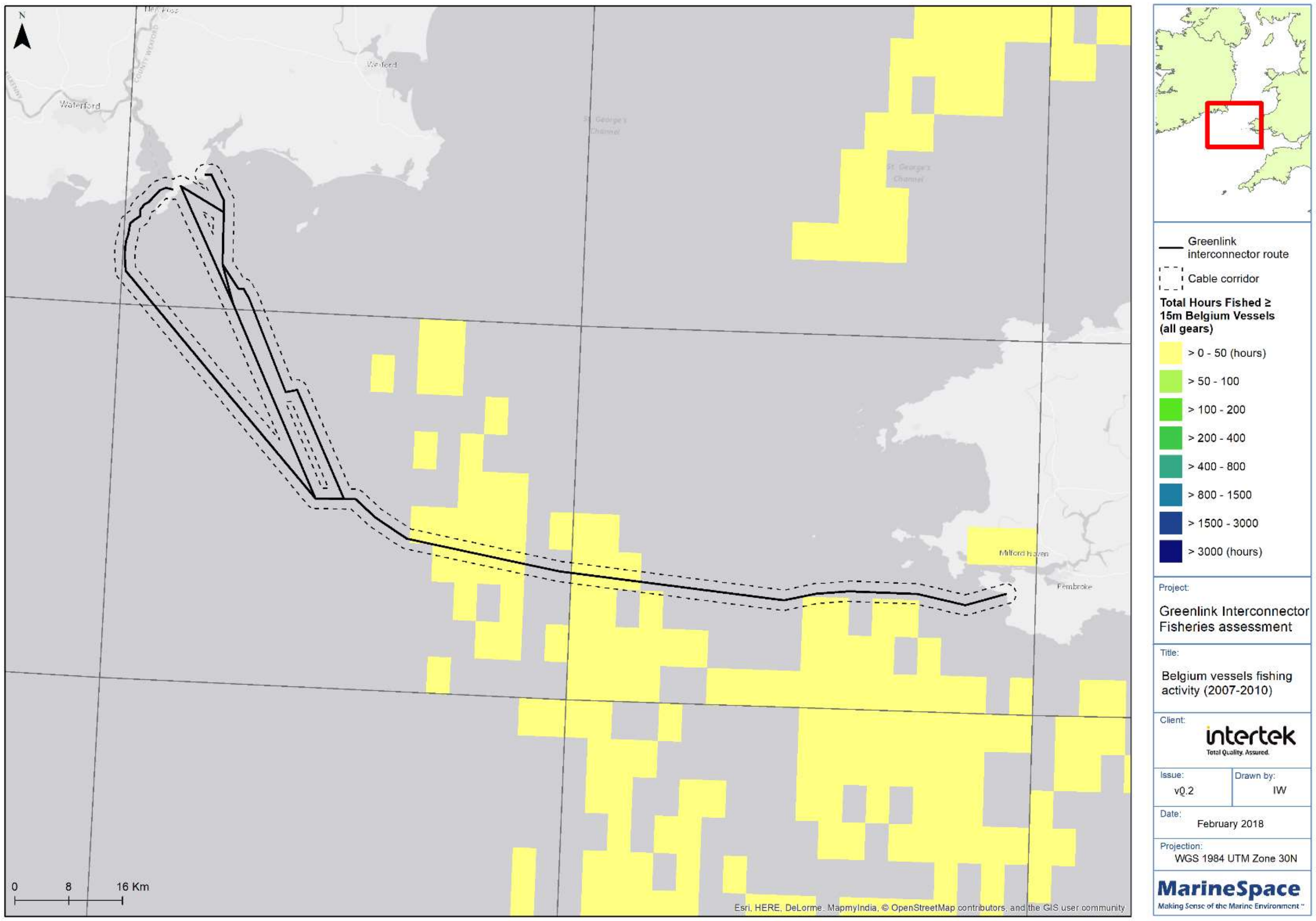
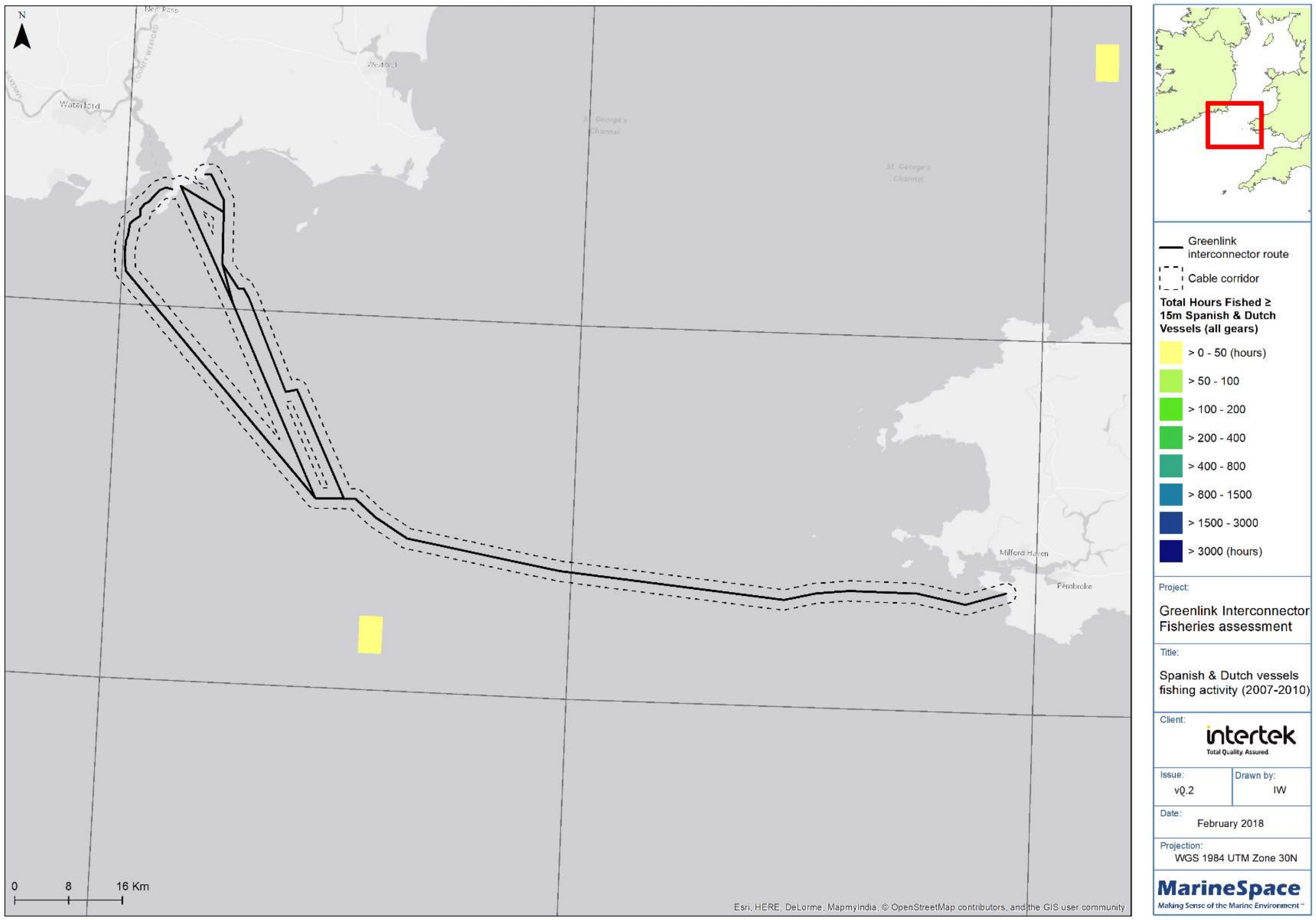


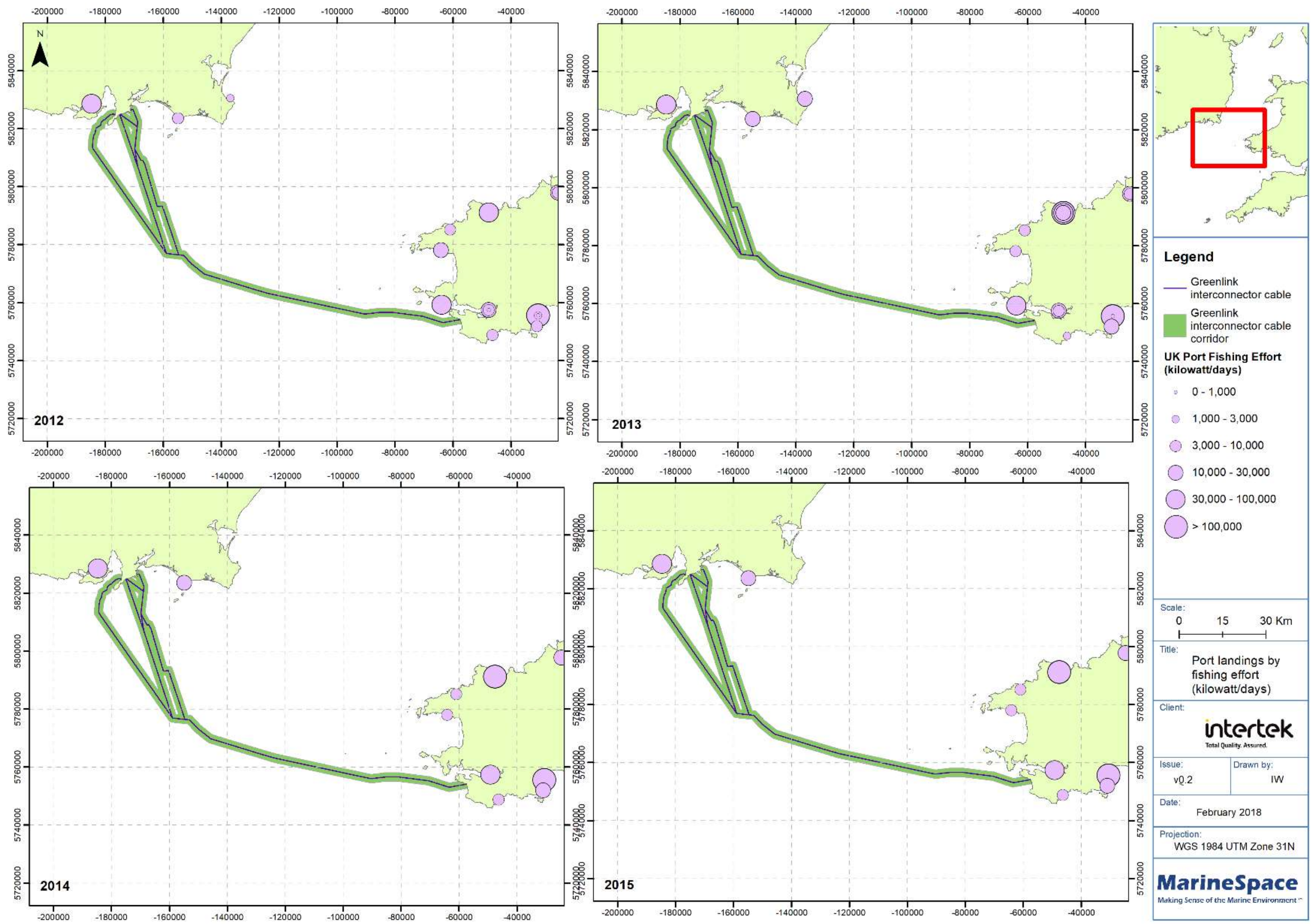
Figure 2.7.11: Greenlink Interconnector Cable Corridor in relation to the total hours fished (mobile & static gear) by Spanish & Dutch vessels (>15 m) within ICES Rectangles 33E3, 32E3 & 32E4 (2007-2010) (Source: MMO, 2014)



2.7.4 Fishing Effort – By Regional Ports

Figure 2.7.12 shows fishing effort (kWh / day) in relation to regional ports in Wales and Ireland and mapped to show proximity to the proposed Greenlink Interconnector cable corridor.

Figure 2.7.12: Greenlink Interconnector Cable Corridor in relation to the fishing effort by regional ports based on data from 2012-2015 (Source: MMO, 2017e)



2.8 Sea Fishing Atlas for Wales

The Sea Fishing Atlas for Wales was compiled by the then Countryside Council for Wales (CCW) (now Natural Resources Wales) in 2010 from information collected between 2000 and 2005 from various sources including fishermen, fishery officers and fishery regulators and other marine users. The maps of fishing activity have been prepared primarily on the basis of anecdotal comments received by the former CCW from a variety of sources. The maps are purely indicative in nature and give a general indication of where fishing activity is thought to have occurred at the given time. Please bear in mind that there is a low level of confidence in the data.

Figure 2.8.1 and Figure 2.8.2 show indicative fishing areas within Welsh waters using both static and mobile gear. These figures have been produced using data from the Wales Marine Planning Portal following a study undertaken by CCW in 2010.

Figure 2.8.1: Indicative fishing areas (static gear) in the vicinity of the Greenlink Interconnector cable corridor, within UK waters (CCW, 2010) (Source: NRW, 2010)

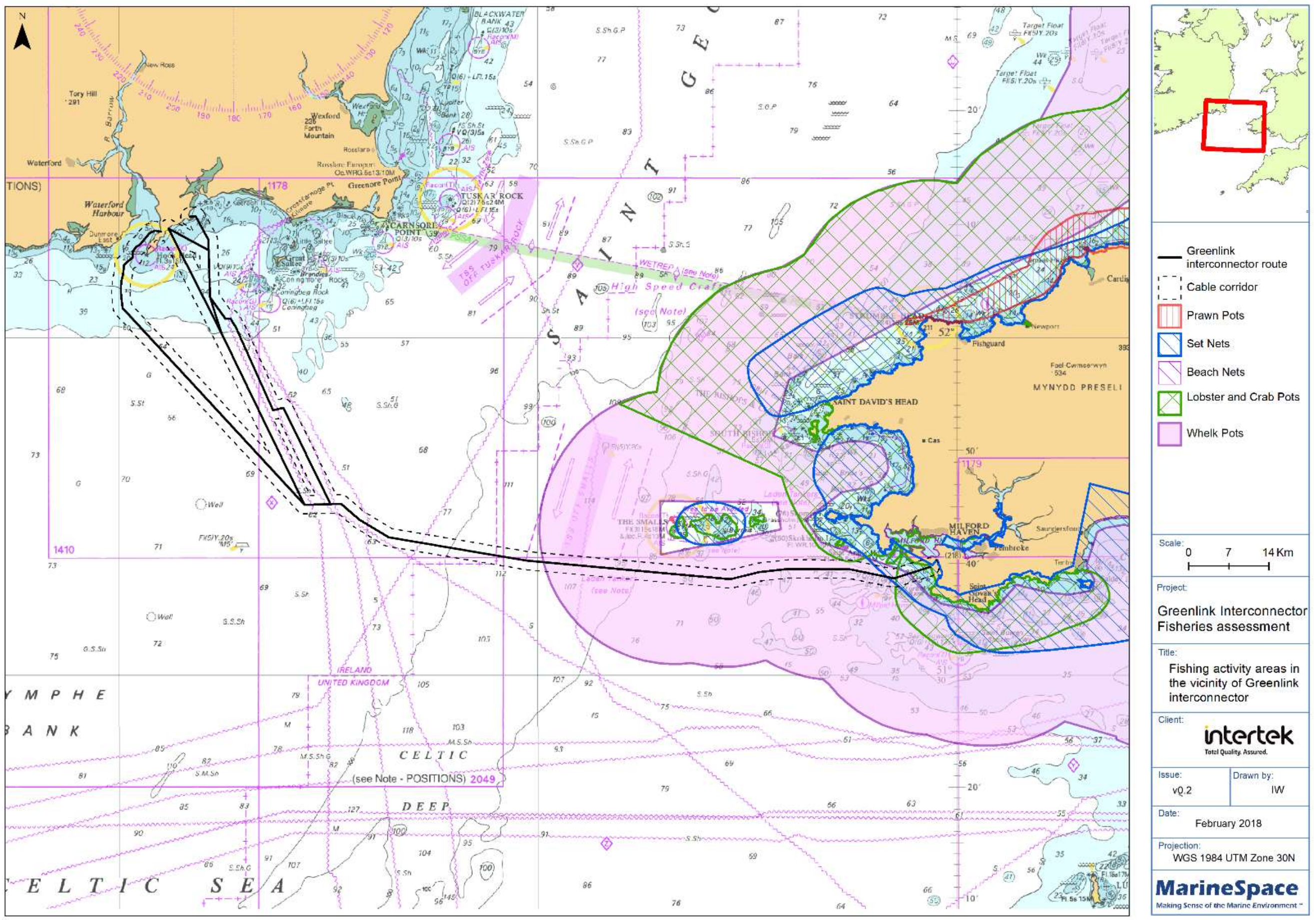
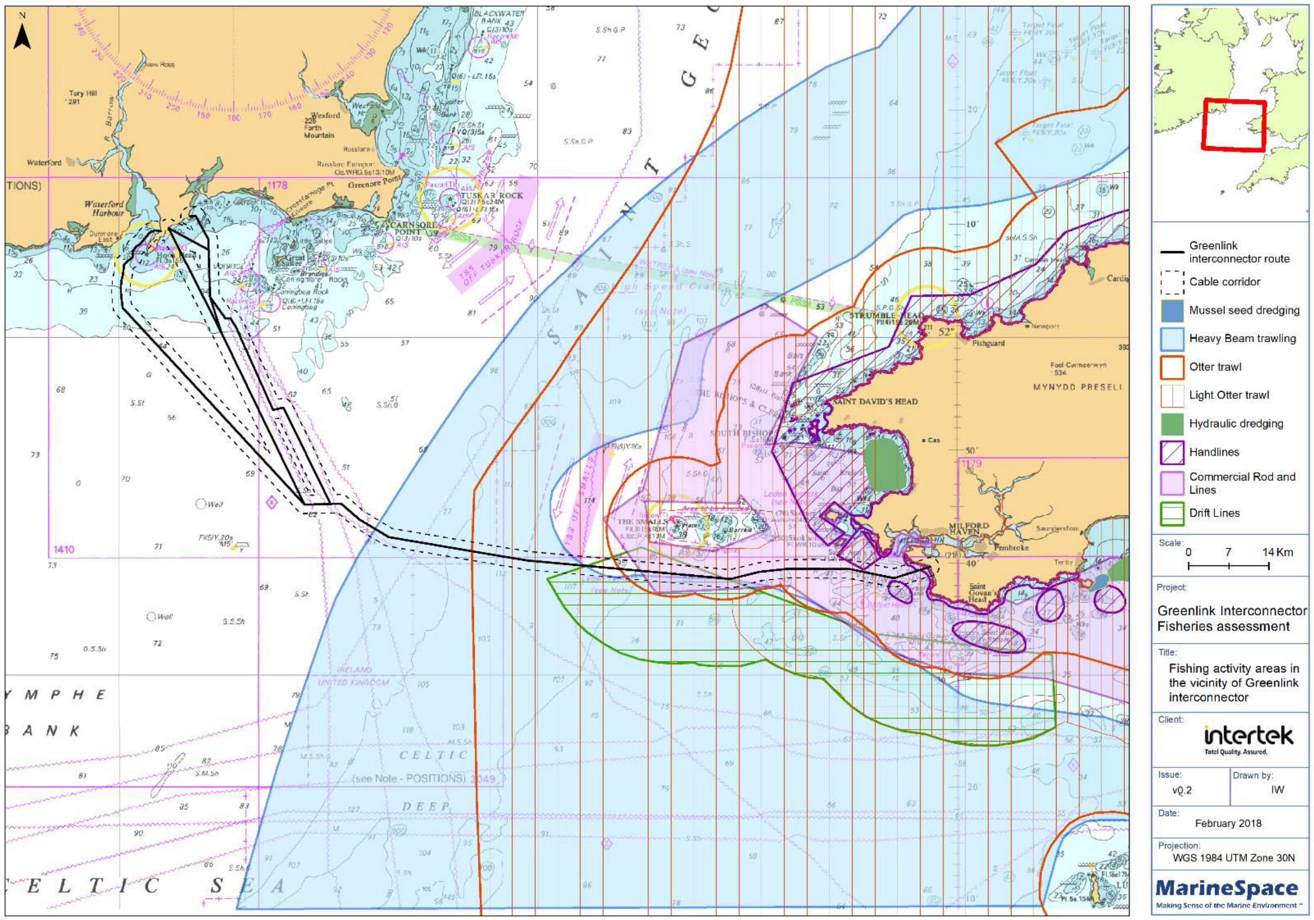


Figure 2.8.2: Indicative fishing areas (mobile gear) in the vicinity of the Greenlink Interconnector cable corridor, within UK waters (CCW, 2010) (Source: NRW, 2010)



3. Recreational Fishing Activity

3.1 Welsh Recreational Fisheries

Sea angling, comprising boat and shore fishing, is a very popular recreational activity in the UK and Ireland. In particular, Wales is able to offer, amongst a wide range of species, excellent shore fishing for bass, cod and whiting, and boat fishing for black bream and tope.

Little statistical information has been hitherto available for the scale and economic worth of sea angling, and despite its obvious popularity, it is often over-looked when tourism and coastal development matters are debated. With the assistance of local sea angling specialists and fishing clubs we have been able to estimate that the sport in Wales involves the participation of approximately 12,000 locally resident anglers, and upwards of 28,000 visiting anglers. Estimates of angler spend suggest that this sport makes a gross contribution to the coastal economy of Wales of over £28 million (Nautilus, 2000).

3.2 Irish Recreational Fisheries

Irish anglers have a high tendency to fish for multiple species and, as such, it is difficult to categorise them by species sought. However, the most recent survey work carried out by IFI (Millward Brown, 2015) indicated that when anglers were asked to choose only one angling type above all others, sea angling was one of the most popular, being chosen by approximately 24% of the Irish anglers surveyed (giving an estimated total of 656,642 Irish sea anglers); a further 4% considered themselves to be bass anglers (109,443). Results of the 2013 Tourist Developmental International (TDI) report indicated that domestic Irish anglers across all angling types spend an estimated €1,974 annually on their fishing, with sea anglers spending an average of €1,331 and bass anglers spending €2,685 (IFI, 2015).

4. Feedback from Commercial Fishing Representatives

Table 4.1 lists the fishing organisations who have been contacted as part of this desk-based study into fishing activity in the region of the Greenlink interconnector project. Contact with these organisations has been primarily focussed on the following objectives:

- Providing and update/introduction to the proposed project, including clarifying the status of the project, i.e. next stage being offshore survey work in summer 2018;
- Discussing the key findings of the review of MMO/EU data to identify any particular anomalies or inaccuracies; and
- Obtaining information on nearshore fishing activity (by <10 m vessels) whose activity may not be fully recorded in official MMO/EU data-sets.

Based on discussions to date, key issues identified are summarised below:

Fishing Activity

- The key observations and trends identified via review of MMO and EU landings/activity data appear sound and in line with consultees understanding of activity in the region;
- The Welsh inshore section of the proposed cable corridor features a high intensity of static gear fishing, particularly in the summer months, even though vessels do move further offshore later in the year;
- Sea and weather conditions (SW prevailing wind and larges swells) limits the ability of smaller inshore vessels to work further offshore, which intensifies the importance of the nearshore (0-6nm) section on the Welsh side;
- The Irish inshore section is also subject to high intensity static fishing activity, along with an active herring fishery towards the later parts of the year; and
- Further offshore (near to where the proposed cable corridor splits) from the Irish coast is fished less intensely, although this area is still important for larger vessels, primarily catching white fish species.

Key Issues Raised by Stakeholders

- Planned survey works in 2018 will impact on fishing activity in Welsh and Irish inshore regions and will require early engagement with the fishing industry to plan gear movements etc;
- The West Wales Shellfishermen's Association (WWSFA) will not deal with the Welsh Fishermen's Association (WFA) in any such future discussions and requests that they be contacted separately for any future consultation;
- Regarding gear removal, the issue regarding potential compensation was raised by both the WWSFA and South West Wales Fishing Communities (SWWFC) for the Welsh inshore fisheries;
- With regards to gear removal ahead of the summer 2018 survey and future cable installation works, the South East Regional Inshore Fisheries Forum (SERIFF) suggest that previous engagement methods be implemented whereby the cable corridor is split into smaller grids and these numbered regions are presented to the fishing community. These areas are then

used by way of actively notifying the fishing vessels which area the survey vessel will be moving into, when and how long it is expected to remain in each region;

- Installation of the cable may damage seabed habitats that are important to local fishing, in particular any sub-tidal reef features;
- Concern regarding the methods of cable installation and that if not buried will cause potential loss of fishing grounds and displacement of the fishing fleet;
- Will the project be subject to a full EIA/HRA process in order to assess impacts around the Pembrokeshire Marine SAC?; and
- Will guard vessels be used during installation?

Table 4.1: Summary of consultation held with commercial fishing organisations

Contact Name	Organisation	Address	Contact No. Email	Liaison to date
Dale Rodmell	National Federation of Fisherman's Organisations (NFFO)	30 Monkgate, York YO31 7PF	01904 635430 dale.rodmell@nffo.org.uk	Notified of project by email and provided with figures for input on 13/02/18
Welsh Fisheries				
Jim Evans	Welsh Fishermen's Association (WFA)	Maes-Y-Dre, New Road Newcastle Emlyn,SA389BA	07376044936 office@wfa-cpc.co.uk	Phonecalls/Emails between Jonny Lewis and Jim Evans throughout Jan 2018. Face to face meeting on 24/01/2018 (See meeting minutes in Appendix 1 for further details)
Marion Warlow	South and West Wales Fishing Communities (SWWFC)	1 Victory House, Milford Marina, Milford Haven Pembrokeshire, SA73 3AA	01646 699127 07769 117 827 marion@swwfc.org.uk	Planned meeting (15/02/2018) postponed. Call with Marion 22/02/2018 (See meeting minutes in Appendix 1 for further details)
Margaret Rees	Welsh Marine Fisheries Advisory Group (WMFAG)	Llys-y-ddraig Penllergaer Business Park, Penllergaer, Swansea SA4 9NX	0300 025 2454 marineandfisheries@gov.wales	Notified of project by email and provided with figures for input on 13/02/18
Stephen De-Waine	West Wales Shell Fisherman's Association (WWSFA)	73 Church Road Llanstadwell, Neyland Pembrokeshire, SA73 1EA	07528 281 246 wwsfa@hotmail.co.uk	Spoke to Stephen on 13/02/18 – followed up with email and figures (cc'd in Sue Burton)to show cable corridor. Face to Face meeting on 15/02/2018 (See meeting minutes in Appendix 1 for further details)
Sue Burton	SAC Officer	Gorsewood Drive, Milford Haven, Pembrokeshire, SA73 3EP	sue.burton@mhpa.co.uk	Notified of project by email to Stephen De-Waine (above) on 13/02/2018. Further email sent 21/02/2018 following meeting with Stephen including figures for input.
Irish Fisheries				
Hugo Boyle	Irish South and East Fish Producers Organisation (IS&EFPO)	Ground Floor, Viewmount House, Viewmount Park, Viewmount Park, WATERFORD X91 NCK4	+353 86 022 2090 +353 51 853 627 ISEFPO@Eircom.net	Phone conversation 31/01/2018 between Hugo Boyle and Claire Griffiths (MarineSpace) – discussed project details. Telecon planned for 20/02/2018, Hugo did not attend.

Contact Name	Organisation	Address	Contact No. Email	Liaison to date
Trudy McIntyre	South East Regional Inshore Fisheries Forum (RIFF)	Dunmore East	+353 87 122 5636 trudymac08@hotmail.com	Phone conversation 31/01/2018 between Trudy McIntyre and Claire Griffiths (MarineSpace) – discussed project details. Trudy had a meeting on 15/02 to discuss the project. Telecon on 21/02/2018 to gain input from the inshore fishing community off the southeast coast. (See meeting minutes in Appendix 1 for further details)
Patrick Murphy	Irish South and West Fish Producers Organisation (IS&WFPO)	The Pier, Castletownbere, Co. Cork, Ireland	+353 862 360001 patrick@IrishSouthAndWest.ie	Email between Patrick and Claire Griffiths (MarineSpace) on 30/01/2018 requesting further on the project. Tried to call and left messages but no response from Patrick. Emailed figures and project details again on 20/02/2018 following telecon with Trudy.
John Hickey	Irish Sea Fisheries Board (BIM)	BIM Office, Stella Maris Community Centre, Kilmore Quay, Co. Wexford	+353 53 29632 john.hickey@bim.ie	Email contact between John Hickey and Claire Griffiths (MarineSpace) on 23/01/2018 – passed on Hugo Boyle and Trudy McIntyre's contacts.
Devon & Cornwall Fisheries				
John Balls	North Devon Fisheries Association	Bidna Wharf, Appledore, North Devon, EX39 1UZ	01237 424185 jaballs@sky.com	Notified of project by email and provided with figures for input on 13/02/18
Sarah Clarke **Libby Ross**	Severn and Devon IFCA	Brixham Laboratory, Freshwater Quarry, Brixham, Devon, TQ5 8BA	01803 854648 office@devonandsevernifca.gov.uk	Anna Farley (Intertek) spoke with Libby Ross in 2016 regarding the project. Notified of project by email and provided with figures for input on 13/02/18
Paul Trebilcock	Cornish Fish Producers Association (CFPO)	46 Fore Street, Newlyn Cornwall, TR18 5JR	01736 351050 admin@cfpo.org.uk	Notified of project by email and provided with figures for input on 13/02/18
Jim Portus	South West Fish Producers Organisation (SWFPO)	5 Pynewood House, 1A Exeter Road, Ivybridge, Devon PL21 0FN	01752 690950 swfpo@btinternet.com	Telecon with Jonny Lewis on 11/01/2018 – discussion on data review being undertaken and assurance that it will capture activity of vessels that operate under SWFPO.
Andrew Pillar	Interfish		andrew@interfish.co.uk	Contacted via email from Jim Portus

5. Summary

An assessment of commercial and recreational fishing activity in the region of the proposed Greenlink Interconnector has been undertaken via a review of official landings and fishing activity data collated from the MMO and EU-data sources. Consultation has also been undertaken with selected representatives of commercial fishing organisations on both the Welsh and Irish coasts.

From the data presented in this report the following key conclusions can be reached with respect to fishing activity in this area:

5.1 Overview of Fisheries Activity

- There is a wide spatial distribution of commercial fishing in the Irish and Celtic Sea, with demersal and shellfish species being the most important in terms of landings by weight and value;
- The most important demersal target species include; cod, haddock, ling, monkfish, plaice, ray, skate and sole;
- Key shellfish species include; lobster, *Nephrops*, crabs, scallops, razor clams and whelks;
- Pelagic fish landings from this area are mainly of herring and mackerel, and of relatively less economic importance compared to demersal and shellfish species;
- The main Welsh fishing port to the proposed cable corridor is Milford Haven, on the west coast of Wales. The closest Irish fishing port to the proposed cable corridor is Dunmore East, on the southeast coast of Ireland.

5.1.1 Welsh Fisheries

- The Welsh fisheries are particularly characterised by valuable potting grounds for crab, lobster and whelks around the Pembrokeshire coast, with mollusc fisheries also taking place in some estuaries and bays. Since 1995, a significant whelk fishery has developed in Carmarthen Bay and offshore of the Gower, Fishguard and Milford Haven;
- With the exception of larger vessels working out of Milford Haven, most fishing off the southwest coast of Wales occurs close inshore, with very few boats working outside 6 miles;
- Several local and (mainly) Scottish visiting boats dredge for scallops in Cardigan Bay, particularly in winter, landing into Fishguard and Milford Haven;
- Although netting restrictions have been introduced around much of the Welsh coast, various types are still used to catch bass, rays, cod, flatfish and crustacea (in particular spider crabs);
- Since the late 1980s, the bass rod and line fishery has also proved popular amongst both commercial and recreational fishermen (Walmsley & Pawson, 2007);
- With respect to demersal fish, key species include flatfish and rays (principally thornback) which are taken in fixed nets and otter and beam trawls from spring through to the end of the year. Boats using gill nets and otter trawls also take cod and whiting during the colder months;
- The trawler fleet concentrates its efforts in the Bristol Channel and Cardigan Bay and lands a mixed catch throughout the year. These trawlers (mostly <10 m) fish mainly inshore, and competition outside 6 miles from the coast can be intense, especially when the sole fishery attracts visiting beam trawlers from the south coast of Devon, Cornwall and Belgium;

- The majority of otter trawling effort is by Devon and Cornish vessels operating twin rig gear. There is also increasing Belgian activity in the 6–12 mile zone (Walmsley & Pawson, 2007).

5.1.2 Irish Fisheries

- There are a large number of medium-sized ports along the south and east coast of Ireland, the largest of which is Dunmore East. The ports along the south coast receive a mix of pelagic, demersal and shellfish species (Marine Institute, 2014);
- The inshore pot fishery for crab, lobster, *Nephrops* and whelk is an important component of Irish fisheries in this region;
- For the areas West and south of Dunmore East to Saltees (South coast) and South Wexford (South coast), a total of 48 vessels were registered as fishing for crab and lobster in 2015, deploying a total of 13,680 pots (This represented 6.2% of all vessels targeting these species in the Irish inshore fleet and 6.3% of total pots deployed in the entire Irish inshore region);
- Shrimp was another key target species for many vessels, including those landing into Dunmore East and Kilmore Quay;
- There are key scallop fishing grounds off the south coast of Ireland with approximately 10-20 >15 m vessels and several <15 m vessels working inshore;
- Inside the Irish EEZ, around 62% of the fishing hours are accounted for by >15m otter and beam trawlers;
- Longliners account for around 15% and Gill and trammel netters 7%;
- Pelagic trawlers only account for 5% of the total effort inside the EEZ but they are responsible for more landings than any other gear type, both in terms of volume and value;
- Irish vessels are only responsible for 36% of the international effort of vessels >15 m inside the EEZ, with Spanish vessels accounting for 30% of the effort (mainly demersal otter trawlers and longliners) and French and the UK accounting for a further 20% and 11% respectively of total effort; and
- International landings inside the Irish EEZ are dominated by pelagic species like horse mackerel, mackerel, boarfish, blue whiting and herring in terms of bulk. In terms of value, mackerel and horse mackerel are important but *Nephrops*, anglerfish and hake stocks are almost equally valuable.

5.2 Overview of Landings Data

5.2.1 Landings by Weight and Value

UK Fleet

- Based on MMO data, the maximum weight and value of landings by all vessels over the period assessed (2012-2016) were from ICES Rectangle 32E4 which covers the Welsh inshore region;
- Over this period, for all vessels, over 5.4 million tonnes of fish (all species) were landed with a value of over £10.5 million. Of this value, £6.6 million was landed by <10 m vessels with the remaining £3.9 million landed by the >10m fleet. 86.7% of the total value of landings from 32E4 were represented by shellfish. These data highlight the importance of the Welsh inshore static gear (potting) fishery in the area of the proposed cable;

- With respect to individual species, within 32E3 (middle "offshore" cable section) and 32E4 (Welsh inshore section), whelk was the species with the greatest weight of landings and the second largest value of landings, followed by Crab (C.P. Mixed Sexes), Haddock, Lobster (highest value species) and Spider Crab;
- Within Rectangle 33E3 (Irish inshore region) the dominant species in terms of weight of landings was Crab (C.P. Mixed Sexes) followed by Crab (Velvet), Whelk, Haddock and Lobster (greatest value of landings);

Non-UK Fleet

- Based on STECP (EU) data, the range in the sum of landed weight for non-UK vessels in the Irish fleet (2012-2016), across all ICES Rectangles (32E3, 32E4 & 33E3) varied from a minimum of 53.56 tonnes (2012) to a maximum of 3,947.27 tonnes (2014). The key ICES Rectangle for the Irish fleet in terms of landings was 33E3 (Irish inshore);
- The range in the sum of landed weight by non-UK vessels from the French fleet (2012-2016), across all ICES Rectangles (32E3, 32E4 & 33E3) ranged from a minimum of 1.22 tonnes (2016) to a maximum of 1,465.99 tonnes (2012). The key ICES Rectangles for the French fleet were 32E3 (offshore section) and 32E4 (welsh inshore); and
- The range in the sum of landed weight by non-UK vessels from the Belgian fleet (2012-2016), across all ICES Rectangles (32E3, 32E4 & 33E3) ranged from a minimum of 1.10 tonnes (2015) to a maximum of 837.05 tonnes (2012). The key ICES Rectangle for the Belgian fleet was 32E3 (offshore section);
- Key species landed by the Irish (offshore) fleet was the European Sprat followed by "Other", Herring, Great Atlantic Scallop and Edible Crab;
- Key species landed by French vessels were Rays/Skates followed by Haddock, Anglerfish, Whiting and Other;
- Key species landed by Belgium vessels were Anglerfish followed by Common Sole, Megrim, Thornback Ray and Blonde Ray.

5.2.2 Temporal Trends (2012-2016)

- Whilst landings by weight and value varied across all ICES Rectangles (32E3, 32E4 & 33E3) between 2012-2016, generally there were no obvious trends in terms of increases or decreases in either of these values;
- In terms of intra-annual variation, landings for all species/vessels in the three ICES rectangles combined over the period 2012-2016 peaked in June/July, with a clear seasonal pattern of highest weight/value of landings between May and October each year;
- When assessed in more detail, peak landings in 33E3 (Irish inshore) and 32E3 (offshore section) were actually slightly later in the year around September/October;
- For the top five individual species landed in the study area, the following were the key periods for landings by weight and value:
    - Whelk - April to July;
    - Crab (C.P Mixed Sexes) – June to November;
    - Haddock – June to September;
    - Lobster - April to October; and
    - Spider Crab - May to July inclusive.

- For the non-UK fleet, based on data only presented by Quarter, the period October to December appears to be the most important in terms of landings, especially for species including “other”, herring, sprat and edible crab.

5.3 Overview of Spatial Distribution of Fishing Activity/Value

- The spatial distribution of fishing activity/value in the entire region has been displayed via review and analysis of VMS data;
- Fishing generally occurs along all parts of the proposed cable route, although there appears to be a greater concentration of activity in the Welsh inshore region compared to the Irish inshore region. There is a clearly defined focus of activity by UK and non-UK vessels in the middle “offshore“ section of the proposed cable corridor;
- To try and further differentiate areas of particular value along the proposed cable route, the value of landings has been calculated based on fishery limits, i.e. UK 6nm, UK 12nm etc. This analysis has provided the following average annual values of landings over the 2012-2016 study period;
    - UK coast to 6nm: £1.3 million per annum;
    - 6nm to 12nm: £3.7 million per annum;
    - Outside 12nm: £4.8 million per annum;
    - Irish coast to 12nm: £1.2 million per annum.
- Further data on fishing activity off the Welsh coast has been obtained via review of a range of data sources which have all been collated on the Wales Marine Planning Portal[5]. These data corroborate the official MMO data in that they highlight the distribution of potting activity off the welsh coast and also demonstrate otter and beam trawling activity in the inshore region and also further offshore.

5.4 Feedback from Targeted Consultation

- Contact has been made with the following commercial fishing organisations;

    Welsh Organisations
    - Welsh Fishermen’s Association;
    - South and West Wales Fishing Communities;
    - Welsh Marine Fisheries Advisory Group;
    - West Wales Shellfishermen’s Association;
    - Pembrokeshire Marine SAC Officer;

    Irish Organisations
    - Irish South and East Fish Producers Organisation;
    - South East Regional Inshore Fisheries Forum;
    - Irish South and West Fish Producers Organisation;

[5] http://lle.gov.wales/apps/marineportal/#lat=52.5145&lon=-3.9111&z=8

  - Irish Sea Fisheries Board (BIM);

  Devon & Cornish Fisheries
  - North Devon Fisheries Association;
  - Severn and Devon IFCA;
  - Cornish Fish Producers Organisation;
  - South West Fish Producers Organisation;
  - Interfish;
- The data analysis and interpretation undertaken to date appears to reflect the key activity and trends in the commercial fishery in this region;
- There is a targeted fishery for *Nephrops* by French vessels in the mid-section of the proposed cable corridor;
- The Welsh inshore section of the proposed cable corridor features a high intensity of static gear fishing, particularly in the summer months, even though vessels do move further offshore later in the year. However, weather and sea conditions limit many vessels moving any further offshore which intensifies the importance of the nearshore (0-6nm) section on the Welsh side;
- The Irish inshore section of the proposed cable corridor in and around Hook Head features high intensity static gear fishing undertaken by smaller inshore vessels. The Herring fishery is important inshore in late summer/autumn;
- Further offshore on the Irish side there is fishing activity undertaken by larger vessels, albeit to a lesser intensity than the static fishing closer inshore. This is primarily with mobile gear for white fish species;
- Planned survey works in 2018 will impact on fishing activity in Welsh and Irish inshore regions and will require early engagement with the fishing industry to plan gear movements etc; and
- Installation of the cable may damage seabed habitats that are important to local fishing, in particular any sub-tidal reef features.

6. References

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APPENDIX 1 – Meeting Minutes

Meeting Date & Time: 24/01/2018 - 10:00

Meeting Called by: Jonny Lewis (MarineSpace Ltd)

Meeting Attendees: Jonny Lewis, Claire Griffiths (MarineSpace Ltd) and Jim Evans (Welsh Fishermen's Association)

Objective: To discuss the proposed Greenlink project and planned survey works due to commence summer 2018

Agenda Topics:

- Introduce MarineSpace, Intertek and Greenlink Companies
- Introduce Greenlink Project and provide update on the status
- Overview of role of the WFA and which areas/sectors it represents
- Discuss the desk-based fisheries assessment being undertaken
- Discussion on key findings of data review and confirmation that key findings make sense.
- Discuss planned survey operations for summer 2018
- Discuss key contacts and fisheries and provision of additional contact names

Action Items:

- MarineSpace to issue a more detailed email with relevant charts to Jim Evans to take along to a board meeting at the end of February 2018 for further input
- MarineSpace to contact other Welsh fisheries groups for input
- MarineSpace to arrange a further meeting with Marion Warlow of South and West Wales Fishing Communities (SWWFC)

Meeting Date & Time: 15/02/2018 - 13:00

Meeting Called by: Claire Griffiths (MarineSpace Ltd)

Meeting Attendees: Jonny Lewis, Claire Griffiths (MarineSpace Ltd) and Steve De-Waine (West Wales Shell Fisherman's Association WWSFA)

Objective: To discuss the proposed Greenlink project and planned survey works due to commence summer 2018

Agenda Topics Covered:

- Introduce MarineSpace, Intertek and Greenlink Companies
- Introduce Greenlink Project and update on status
- Introduce the desk-based fisheries assessment being undertaken by MarineSpace
- Overview of role of the WWSFA and which areas/sectors it represents including fact it sits completely discrete from the WFA
- Discuss planned survey operations for summer 2018
- Detailed discussion on nature and seasonality of fishing in the inshore section of the cable corridor (static gear, very busy in summer months)
- Discussion on potential impacts of the actual cable (installation and operation). Topics included damage to reef features, SAC (HRA) issues, need for cable protection.
- Need to engage properly; expectation that 2018 survey will require gear clearance and disruption payments. Dialogue must be via WWSFA and not WFA only or disruption will be promoted.

Action Items:

- MarineSpace to issue a more detailed email with relevant charts to Stephen to disseminate to all members of the WWSFA to give the opportunity for individuals to make comment.

Meeting Date & Time: 20/02/2018 - 15:15

Meeting Called by: Claire Griffiths (MarineSpace Ltd)

Meeting Attendees: Claire Griffiths (MarineSpace Ltd), Trudy McIntyre (South East Regional Inshore Fisheries Forum SERIFF), Hugo Boyle - *did not attend* (Irish South and East Fish Producers Organisation IS&EFPO).

Objective: To discuss the proposed Greenlink project and planned survey works due to go commence summer 2018

Agenda Topics:

- Introduce MarineSpace, Intertek and Greenlink Companies
- Introduce Greenlink Project and update on status
- Introduce the desk-based fisheries assessment being undertaken by MarineSpace
- Discuss planned survey operations for summer 2018
- Detailed discussion on nature and seasonality of fishing in the inshore section of the cable corridor (static gear in and around Hook Head, but presence of Herring fishery predominantly in late summer/autumn, larger vessels, but to lesser magnitude than inshore vessels, present further offshore
- Discussion on potential impacts of the actual cable (installation and operation). Topics included damage to rocky ground which is important to static inshore fisheries. Concern that if cable is not buried there will be loss of fishing grounds and displacement
- Need to engage properly; expectation that 2018 survey will require gear clearance and that inshore fisheries will need ample warning as they are restricted by weather for moving gear. Dialogue must be via SERIFF and IS&EFPO in order that smaller vessels are kept fully informed and not just by NtM
- Suggest that a similar protocol is adopted here as used on previous surveys in the region whereby the cable corridor was split into grids and these smaller areas were used to notify the local fishing community on exactly where the survey would be in advance
- Expressed that any form of seismic survey would not be accommodated by the local fishing community following previous disturbance caused to crabs and white fish
- Discussed any additional contacts – Trudy offered to liaise with Patrick Murphy at a meeting she was attending that evening

Action Items:

- MarineSpace to issue a more detailed email along with figures to Patrick Murphy of Irish South and West Fish Producers Organisation (IS&WFPO)

Meeting Date & Time: 22/02/2018 - 15:15

Meeting Called by: Claire Griffiths (MarineSpace Ltd)

Meeting Attendees: Claire Griffiths (MarineSpace Ltd), Marion Warlow (South and West Wales Fishing Communities SWWFC)

Objective: To discuss the proposed Greenlink project and planned survey works due to go commence summer 2018

Agenda Topics:

- Introductions of MarineSpace, Intertek, Greenlink Companies and update of Greenlink Project already undertaken during previous call to Marion
- Confirmation of MarineSpace's role in the project and the purpose of desk-based fisheries assessment
- Brief discussion of planned survey operations for summer 2018
- Expressed concern over extent of cable corridor zone shown on the figures, but assured that this area is for indicative purposes and that the cable itself will sit within this larger area with the exact location to be confirmed following this summer's survey
- Confirmation that Marion represents around 20 fishing vessels (under 10m) within Pembrokeshire and estimated that of around 8 of the larger vessels they would estimate in excess of around 5,000 pots to be present in the proposed cable corridor region off the coast of Pembrokeshire
- Concerns that this area is heavily fished (static gear) and that it may be problematic to get fishermen to move pots with a brief discussion on the potential need for compensation

Action Items:

- Marion to try and get a figure to MarineSpace with any key fishing ground areas marked on for reference

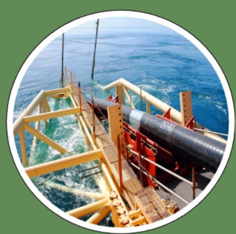
GREENLINK
MARINE ENVIRONMENTAL IMPACT ASSESSMENT REPORT- IRELAND

APPENDIX F

Marine Archaeology Technical Report

P1975_R4500_RevF1
July 2019

Greenlink Interconnector
- connecting the power markets
in Ireland and Great Britain

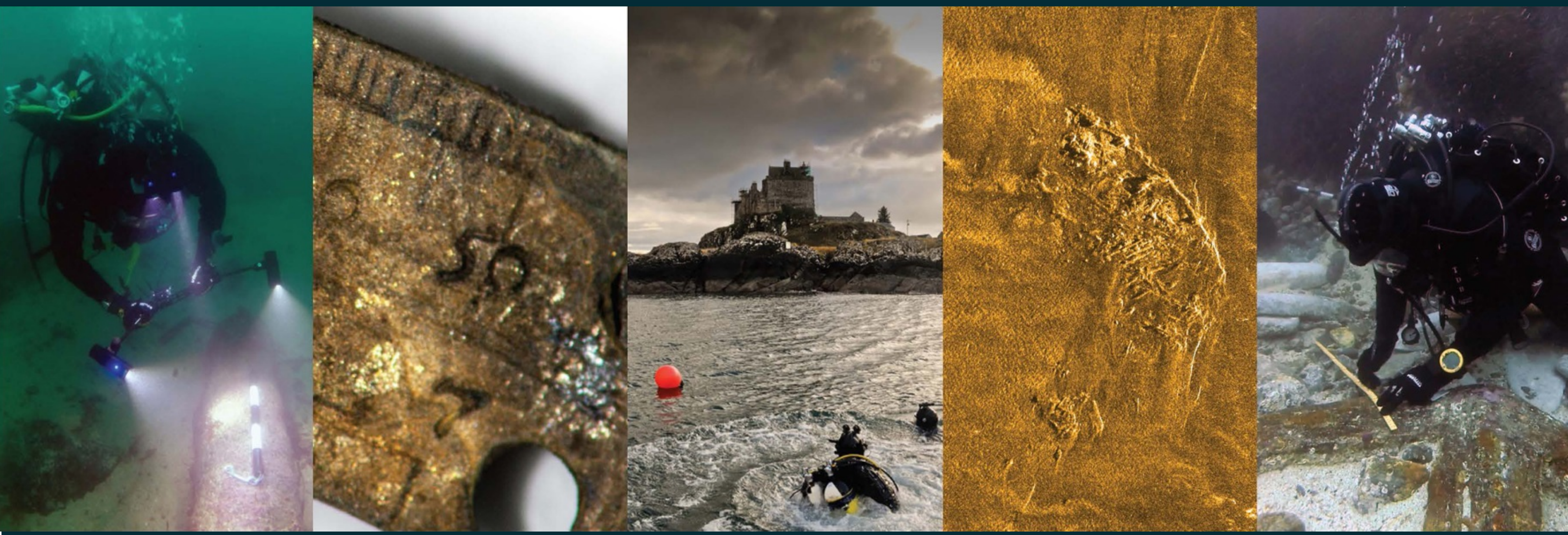


Greenlink
INTERCONNECTOR

Cotswold Archaeology *marine*

Greenlink Interconnector Project

Marine archaeology and cultural heritage technical report



for

Intertek

CA Project: 770349

CA Report: 770349_02

May 2019

Andover Cirencester Exeter Milton Keynes Suffolk

Greenlink Interconnector Project

Marine archaeology and cultural heritage technical report

CA project: 770349

CA report: 770349_02

prepared by date	Michael Walsh, Senior Marine Consultant Zoe Arkley, Heritage Consultant Rebecca Ferreira, Marine Archaeologist with contributions by Dr Michael Grant, Coastal and Offshore Archaeological Research Services, University of Southampton May 2019
checked by date	Michael Walsh, Senior Marine Consultant May 2019
approved by signed date	Michael Walsh, Senior Marine Consultant *Not usually signed unless requested by client* May 2019
issue	1.0

Cirencester	**Milton Keynes**	**Andover**	**Exeter**	**Suffolk**
Building 11 Kemble Enterprise Park Kemble, Cirencester Gloucestershire GL7 6BQ t. 01285 771022 f. 01285 771033	Unit 8 – The IO Centre Fingle Drive Stonebridge Milton Keynes MK 13 0AT t. 01908 564660	Stanley House Walworth Road Andover, Hampshire SP10 5LH t. 01264 347630	Unit 1 - Clyst Units Cofton Road Marsh Barton, Exeter EX2 8QW t. 01392 573970	Unit 5, Plot 11 Maitland Road Lion Barn Industrial Estate Needham Market, Suffolk IP6 8NZ t. 07449 900120
e. enquiries@cotswoldarchaeology.co.uk				

SUMMARY

Project name: Greenlink Interconnector project

Cotswold Archaeology (CA) was commissioned by Intertek in 2019 to produce a Technical Report for the Greenlink Interconnector project: a proposed submarine cable between Ireland and Wales. This report is a summary of the previous assessments relating to the current Proposed Development comprising an updated archaeological desk-based assessment (DBA), an assessment of foreshore geophysical and walkover, and offshore geophysical survey data along the Proposed Development corridor. These assessments include identification of archaeological potential in proximity to the Proposed Development.

Although three routes (A, B and E) were proposed initially, route B is now no longer under consideration. The current proposed route is approximately 157km long and will run from Freshwater West in Wales to the Fethard-river Suir area, County (Co.) Wexford in Ireland. There is no deviation to the route in Irish waters, but routes A and E diverges in UK waters, before converging at Freshwater West.

The archaeological DBA was originally prepared by CA in April 2018 but has been updated to include two new sites (**CA24 & 25**) that now fall within then Cable Study Corridor (CSC). The assessment highlights known marine and coastal cultural heritage assets potentially affected by this project, up to mean high water springs (MHWS) unless otherwise stated.

The landfall surveys were conducted in September 2018 over the foreshore and inter-tidal zones at Baginbun beach, Fethard-on-Sea, Co. Wexford, Ireland and at Freshwater West, Pembroke, Wales. These surveys comprised walk-over, hand-held metal detector and terrestrial geophysical (electrical conductivity) surveys. No features of archaeological potential were identified at either landfall location.

In October 2018, MMT undertook a marine geophysical survey of the final Greenlink Proposed Development. The survey collected multibeam echosounder (MBES), side scan sonar (SSS), magnetometer and sub-bottom profiler (SBP) data. The archaeological assessment of the survey data identified 148 anomalies with archaeological potential along the proposed route. None of these anomalies were identified as coherent wreck sites. Archaeological Exclusion Zones (AEZs) have

been proposed for each of the identified anomalies in close proximity to the Proposed Development.

CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

1. INTRODUCTION

Outline

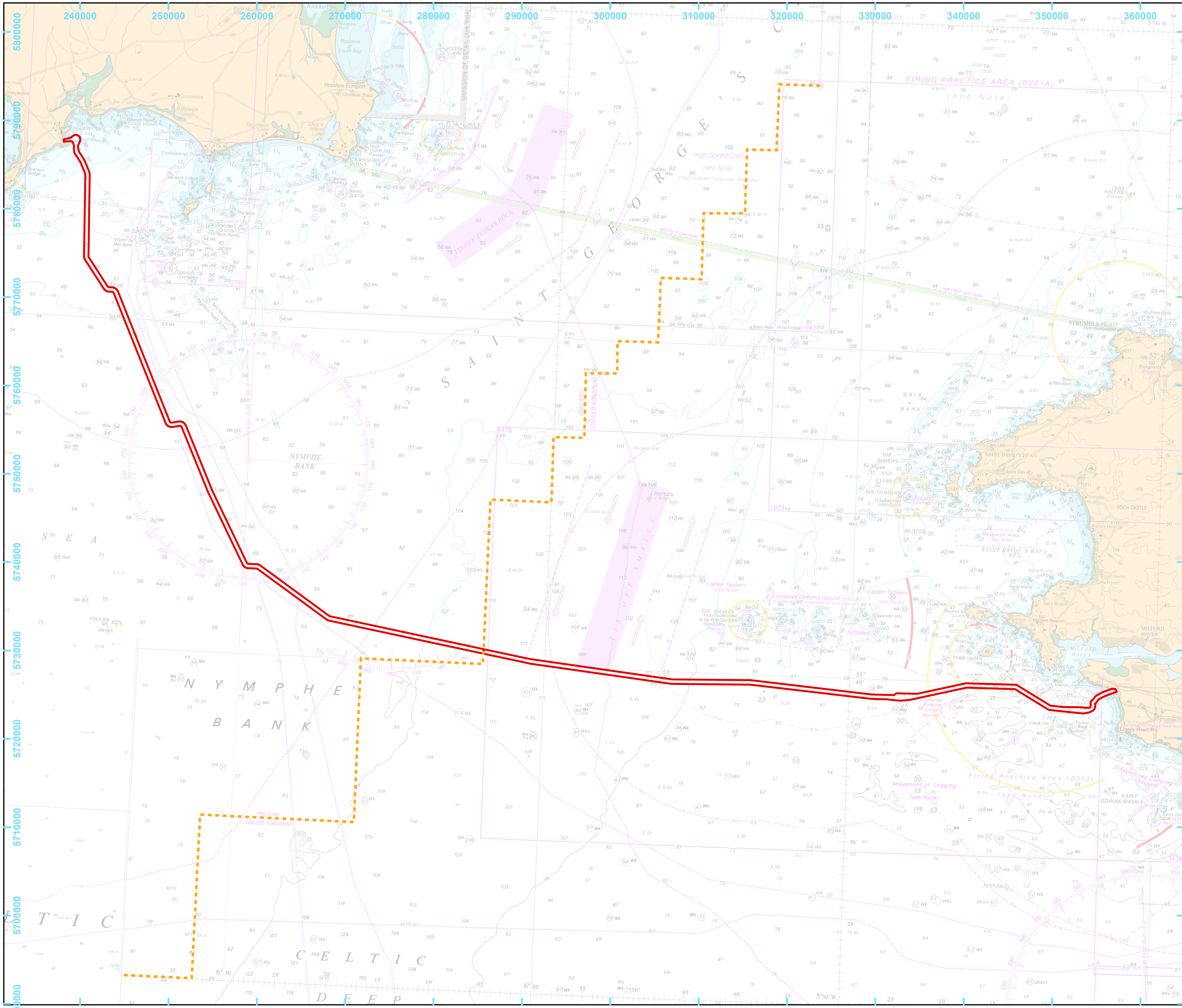
1.1. Cotswold Archaeology (CA) was commissioned by Intertek in 2019 to prepare a Technical Report for the Greenlink Interconnector project (henceforth ‘the project’). The purpose of this report is to collate all previous reports for the project into one overarching archaeological assessment including the results of the desk-based assessment (DBA) and the marine and foreshore survey assessments. Any information relating to routes that are no longer under consideration has been removed.

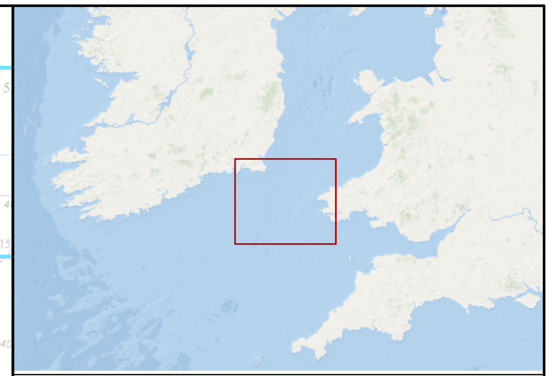
Proposed Development

1.2. The Proposed Development comprises a 500MW electrical underground and submarine interconnector, connecting the UK National Grid system at Pembroke substation in Pembrokeshire, Wales to the Irish Eirgrid Network at Great Island substation at Co. Wexford, Ireland (Fig. 1). The Proposed Development route corridor runs for approximately 157km across the southern Irish or Celtic Sea between Baginbun Beach in the Fethard-river Suir area in Co. Wexford on the south-east coast of Ireland and Freshwater West, Milford Haven, Pembrokeshire on the south-west coast of Wales. Although a number of routes options (A, B and E) were originally proposed, this report focuses on the current Proposed Development, which no longer includes route B. There is no deviation to the route in Irish waters, but routes A and E diverge in UK waters, before converging at Freshwater West. (Fig. 2 and Fig. 3).

Project background

1.3. In April 2018, CA was appointed by Intertek to prepare an archaeological DBA for the project. This included an assessment of marine and coastal cultural assets up to mean high water springs (MHWS) that could potentially be affected by this project. The purpose of the DBA was to identify any sites and features of cultural heritage significance within and in proximity to the project that may be affected by the Proposed Development. The results of the DBA outlined the archaeological potential of the marine environment and included information on sites and areas of archaeological significance identified within and in proximity to the project.





Legend

- Proposed Development
- Median line

0 15km

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
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False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Cotswold Archaeology marine

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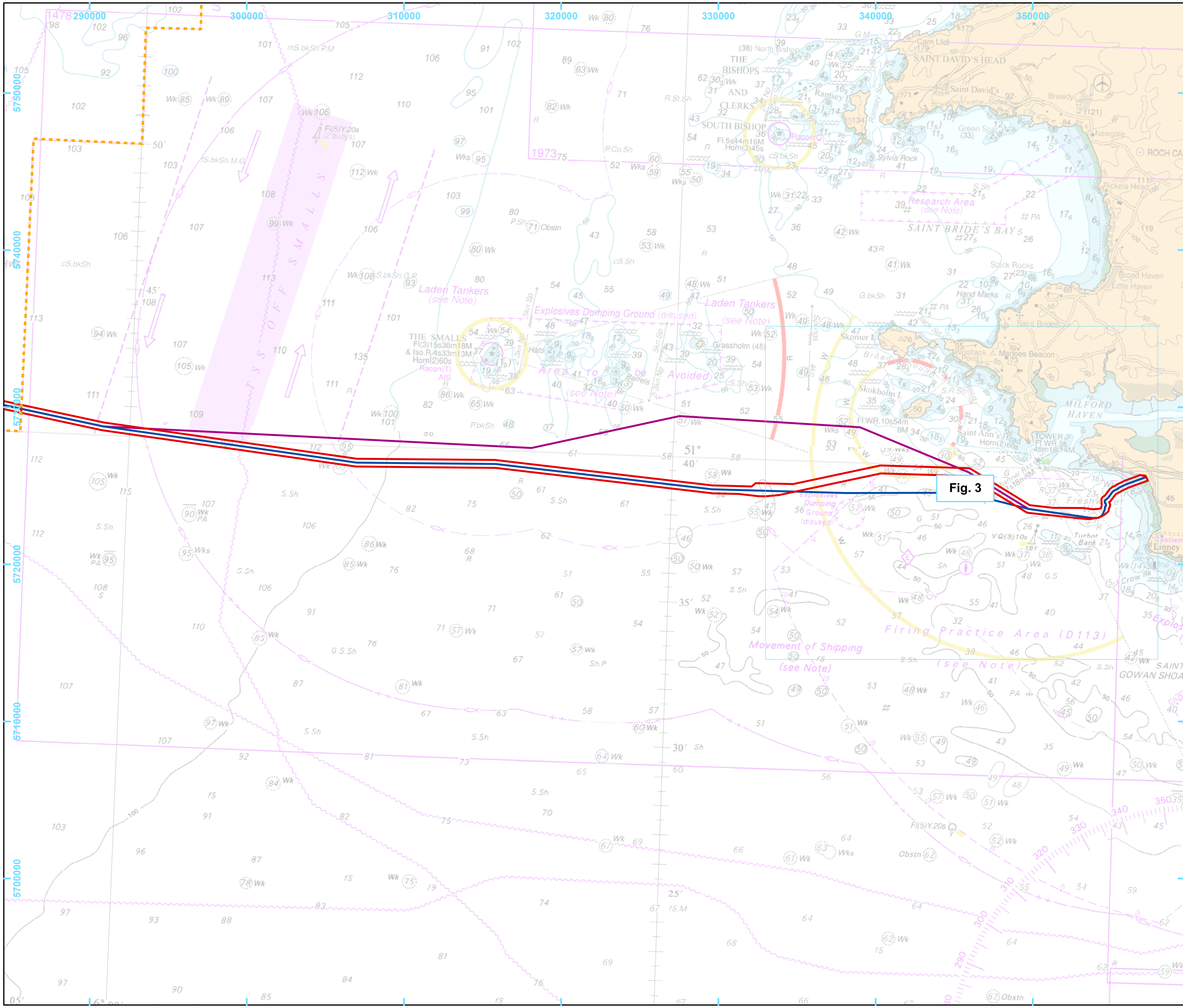
PROJECT TITLE
Greenlink Interconnector

FIGURE TITLE
Greenlink Proposed Development route corridor

DRAWN BY	RLF	PROJECT NO	770349	FIGURE NO.
CHECKED BY	ZA	DATE	09/05/2019	1
APPROVED BY	MTW	SCALE@A3	1:400,000	



Legend

- Proposed Development
- Median line
- Route A
- Route E

0 7.5km

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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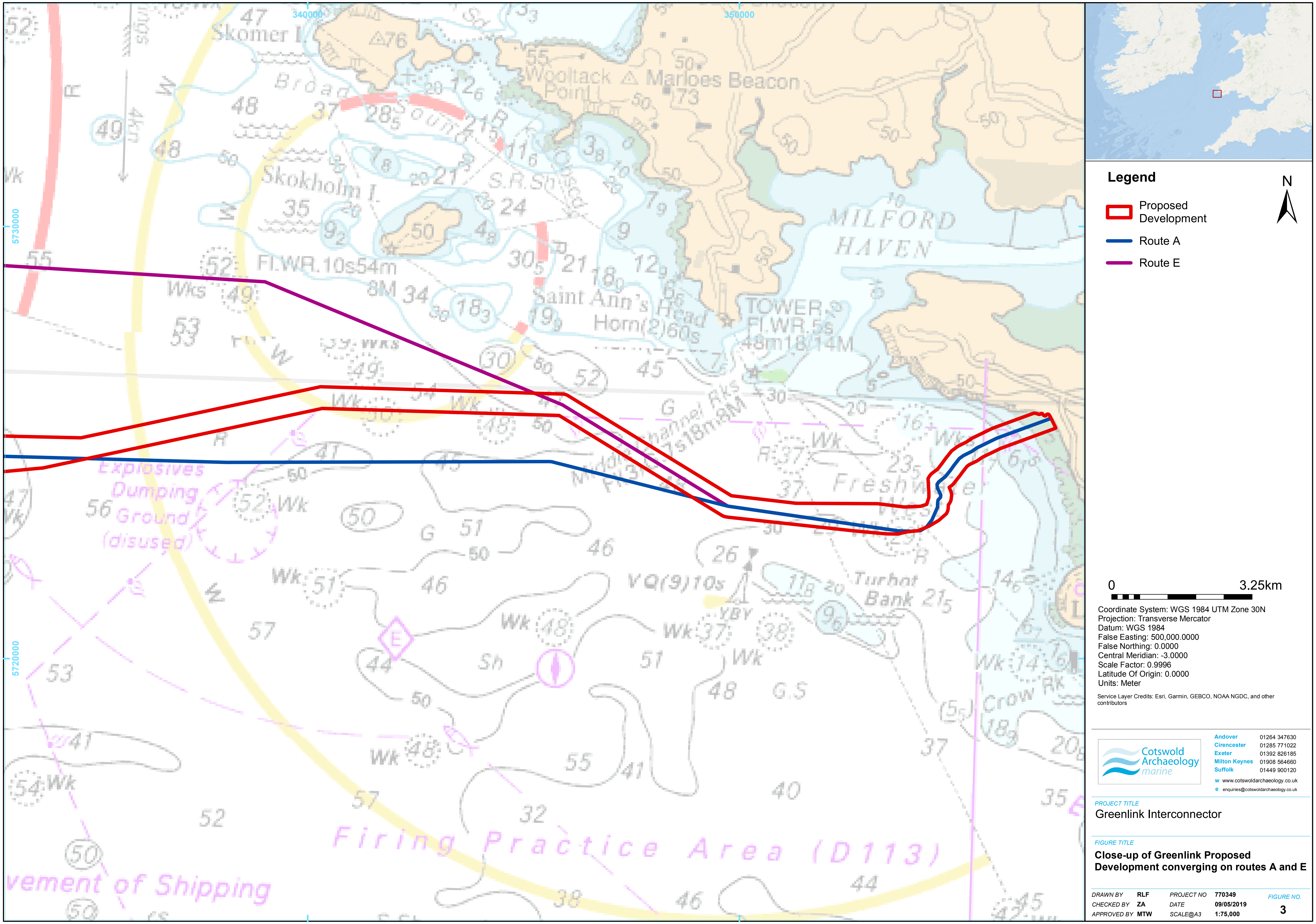
PROJECT TITLE
Greenlink Interconnector

FIGURE TITLE
Overview of Greenlink Proposed Development route corridor English Waters

DRAWN BY	RLF	PROJECT NO	770349	FIGURE NO.
CHECKED BY	ZA	DATE	09/05/2019	2
APPROVED BY	MTW	SCALE@A3	1:225,000	



Legend

- Proposed Development
- Route A
- Route E

N

0 3.25km

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
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False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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PROJECT TITLE
Greenlink Interconnector

FIGURE TITLE
Close-up of Greenlink Proposed Development converging on routes A and E

DRAWN BY	RLF	PROJECT NO	770349	FIGURE NO.
CHECKED BY	ZA	DATE	09/05/2019	3
APPROVED BY	MTW	SCALE@A3	1:75,000	

1.4. In August 2018, the foreshore surveys, comprising metal detector, walkover, and geophysical surveys were conducted at the two landfall locations by CA in collaboration with Earthsound Archaeological Geophysics (EAG).

1.5. In October 2018 MMT began offshore geophysical surveys of the proposed submarine routes to inform the engineering plans for the cable installation including, but not limited to, understanding the geomorphology of the seabed, its composition and sediment thickness, presence of geophysical anomalies (including those with archaeological potential) and to inform the geotechnical campaign. A preliminary archaeological assessment of marine geophysical survey data collected by MMT was undertaken for each of the proposed vibrocore locations prior to the commencement of the Geotechnical investigations. The survey data was transferred to CA and COARS (University of Southampton) at the end of October 2018 for a rapid archaeological assessment of each of the 55 proposed coring locations. Following this initial assessment, a more extensive assessment was undertaken along the entire survey route.

Aims and objectives

1.6. The aim of this technical report is to present our current understanding of the marine archaeology and cultural heritage in the vicinity of the Proposed Development.

1.7. The objectives of this report are:

- To synthesise all the project-specific archaeological assessments that have been completed to date; and
- To include only information relevant to the current Proposed Development. All other information relating to routes that are no longer under consideration has been removed.

2. LEGISLATIVE FRAMEWORK AND GUIDANCE

2.1. As the project is located in Irish and UK territorial and offshore waters, this assessment takes account of the following national and international legislative procedures and guidelines:

Republic of Ireland

- National Monuments Acts (1930-2004);

- Heritage Act (Ireland, 1995); and
- Framework and Principles for the Protection of the Archaeological Heritage, Department of the Arts, Heritage, the Gaeltacht and the Islands (1999).

UK

- Draft Welsh national Marine Plan
- National Heritage Act 1983 (amended 2002);
- Protection of Wrecks Act 1973;
- Protection of Military Remains Act 1986;
- Marine and Coastal Access Act 2009;
- Merchant Shipping Act 1995;
- Burial Act 1857;
- Ancient Monuments and Archaeological Areas Act 1979;
- UK Marine Policy Statement (HM Government 2011);
- Historic Environment (Wales) Bill (Draft bill May 2015);
- Planning Policy Wales (PPW) Chapter 6: The Historic Environment (Draft, May 2015);
- Planning Policy Wales Edition 7 (July 2014);
- Technical Advice Note (TAN) 24: The Historic Environment; and
- Historic Environment Strategy for Wales – Welsh Government 2013.

General

- European Convention on the Protection of the Archaeological Heritage (Valetta) 1992;

2.2. This assessment has been compiled in line with industry best practice and the relevant offshore renewables and marine historic environment guidance. These include:

Republic of Ireland

- Institute of Archaeologists of Ireland code of conduct for archaeological assessments (2006).

UK

- Chartered Institute for Archaeologists (CIfA) guidelines: Standard & guidance for archaeological desk-based assessment (2014);
- Cadw guidance on Caring for Coastal Heritage (1999);
- Cadw Conservation Principles (2011);
- Joint Nautical Archaeology Policy Committee (JNAPC) code of practice for seabed development (2008);
- Collaborative Offshore Wind Research into the Environment (COWRIE) Historic environment guidance for the offshore renewable energy sector (2007);
- COWRIE Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy (2008);
- COWRIE Guidance for offshore geotechnical investigations and historic environment analysis: guidance for the renewable energy sector (2011);
- The Crown Estate (2014). Offshore renewables protocol for archaeological discoveries;
- The Crown Estate (2010). Round 3 offshore renewables projects model clauses for archaeological written schemes of investigation; and
- EIA Directive 85/337/EEC as amended by 97/11/EC and 2003/35/EC.

3. METHODS AND DATA SOURCES

3.1. The following section sets out the methods used for the assessment of the Proposed Development route corridor, including the sources used for collation of data and the relevant legislative framework and guidance.

Desk-based assessment methodology

3.2. The DBA included a documentary and cartographic search, utilising a variety of sources in order to locate all known cultural heritage assets within the Proposed Development, and to identify the archaeological potential of the area (Cotswold Archaeology 2018a).

3.3. Sources consulted for this assessment include, where relevant:

Republic of Ireland

- Information held by the Underwater Archaeology Unit (UAU) of the National Monuments Service, Department of Culture, Heritage and the Gaeltacht (DCHG);
- Information held by Heritage Ireland on protected wrecks;
- Wrecks database of Ireland (WIID);
- Information held on the Record of Monuments and Places (RMP) website, maintained by the National Monuments Service;
- Information held by Integrated Mapping for the Sustainable Development of Ireland's Marine Resources (INFOMAR);
- National Museum of Ireland archives; and
- National Library of Ireland (for historic charts and maps only).

UK

- Information held on the National Monuments Record (NMR) of Wales by the Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW);

- Archaeological records in the Historic Environment Record (HER) held by the Dyfed Archaeological Trust;
- Aerial photographs held by the Welsh Assembly Government and/or the RCAHMW;
- Pembrokeshire Seascape Character Assessment;
- Pembrokeshire archives, for a review of cartographic information;
- The OceanWise Wrecks and Obstructions database;
- United Kingdom Hydrographic Office (UKHO) review of cartography, historic charts and sailing directions;
- Ministry of Defence (military remains only);
- UK Receiver of Wreck (RoW);
- Records held with the Archaeology Data Service (ADS);
- Marine Environment Data Information Network (MEDIN); and
- British Geological Survey regional guide and previous work in the area.

General

- Readily accessible published sources and grey literature (e.g. results from previous studies);
- Relevant external marine historic environment specialists;
- Relevant dive groups and local interest groups;
- Relevant external marine historic environment specialists (e.g. palaeo-environmental); and
- Relevant Strategic Environmental Assessment (SEA) reports (e.g. UK Continental Shelf SEA archaeological baseline) and Coastal Survey Assessment reports.

3.4. The DBA included all known and potential maritime cultural heritage assets, identified during this assessment and each was assigned a unique CA number for ease of identification.

Consultation with statutory bodies

3.5. For this assessment, the following statutory bodies and stakeholders were consulted, including:

- Underwater Archaeology Unit (UAU) of the National Monuments Service, Department of Culture, Heritage and the Gaeltacht (DCHG);
- Heritage Ireland;
- Cadw;
- RCAHMW;
- Ministry of Defence (military remains only); and
- Receiver of Wreck (UK Maritime Coastguard Agency).

Limitations of data

3.6. One of the greatest limitations when researching known and potential offshore cultural heritage is the difficulty of locating recorded maritime losses. For many losses the location of the sinking of the vessel can be in the form of a general area description, as in ‘SW and W from southern Ireland’ or ‘not confirmed as present at this location, but may possibly be in the vicinity’, which is not useful practically for accurate assessment, except to show that the potential exists to encounter lost cultural remains (Cotswold Archaeology 2018a).

3.7. Many wrecks have been identified through sonar survey, but this too presents difficulties as many of these wrecks have been located using GPS, which until relatively recently was only accurate to 100m (Baird 2009; see also Satchell 2012); or by DECCA which can give locations accurate to only one kilometre. Accuracy has been much improved in inshore Irish waters by the recent INFOMAR surveys. In addition, recorded maritime losses are heavily biased towards the 19th and 20th centuries when more comprehensive records of losses began to be compiled by the UK Hydrographic Office.

3.8. To reduce error in sonar measurements due to tidal range varying across bays and coastlines during the recent INFOMAR surveys, onshore and offshore tidal gauges were installed to ensure accurate tidal height data.

3.9. The details for specific offshore cultural heritage assets within the study area were acquired from the three main sources cited above. All these databases are each derived, in turn, from a variety of sources including various published lists of marine losses and marine surveys. Consequently, there are considerable overlaps and discrepancies between the datasets.

3.10. Wrecks discussed in this report are generally referred to as either ‘live’, ‘dead’ or ‘lifted’. ‘Live’ wrecks are those for which there is a known location which has been verified by recent surveys. ‘Dead’ refers to sites that have been recorded in a certain location, but which have not been detected by repeated or the most recent surveys. ‘Lifted’ wrecks or wreckage are those which have been removed from their recorded location. The status of wrecks has been determined based on the information available at the time of writing.

3.11. Where a live wreck has been identified this information is provided in Table 3 and Appendix 2; a wreck in a known location that has not been identified is referred to as unidentified. Where the status of a wreck is given as ‘unknown’, this means that it is not recorded whether the wreck is live, dead or lifted.

3.12. The DBA assets relate to the current Proposed Development in Irish and UK territorial and offshore waters, and cover all UAU, INFOMAR, Dyfed HER, NMRW, and UKHO entries (as held by OceanWise) within the study areas including dead entries. Dead entries are included, if applicable, because, although wrecks may not have been detected in recent surveys, the recorded locations may still contain remains of cultural heritage interest. Given locational discrepancies (Satchell 2012) the possibility that wrecks lie outside previous search areas cannot be discounted.

3.13. All the data held by OceanWise, the UAU and INFOMAR, Dyfed HER and the NMRW – the primary historic data repositories for the DBA – was considered, and for completeness, listed and cross-referenced. Information from the relevant areas of the Pembrokeshire Seascape Character Assessment website was assessed and, where deemed appropriate, has been incorporated in this assessment (Cotswold Archaeology 2018a).

Foreshore survey methodology

3.14. The landfall surveys, conducted on the foreshore and in the inter-tidal zone, comprised walkover, hand-held metal detector, and geophysical (electro-magnetic conductivity) surveys. The surveys were conducted by CA staff in collaboration with EAG who undertook the geophysical surveys. The aim of the surveys was to assess and map the extent of any archaeological remains within the Proposed Development.

3.15. The surveys were conducted between 27-30 August 2018 during Spring tides to achieve full overlap with the offshore marine surveys. All surveys were positioned using the geodetic datum WGS 1984, with projection in the Universal Transverse Mercator Zone 30 North (UTM 30N) (Cotswold Archaeology 2018b).

Metal detector and walkover surveys

3.16. Hand-held metal detector and walkover surveys were conducted following 5m wide traverses to match those used for the geophysical survey (Table 1).

3.17. A Minelab X-Terra 705 metal detector was used to conduct the surveys. The metal detector was set to detect all metal, but the sensitivity was adjusted to compensate for the high salt content of the beach sand. All identified features and detected finds spots were recorded photographically with a brief description, if deemed necessary. Locations were recorded using a hand-held Garmin GPS and plotted into an AutoCAD base plan. As this survey was non-intrusive, no findspots were excavated. The numeric values displayed on the detector were also recorded as they can potentially assist in the identification of the type of metal detected, with higher values more likely to be indicative of non-ferrous metals (Minelab 2017:11).

Geophysics

3.18. The geophysical survey areas were 200 x 50m at Baginbun beach and 300 x 305m at Freshwater West (Cotswold Archaeology 2018b).

Table 1 Electromagnetic induction survey

EMI Measurement	Apparent Electrical Conductivity (EC_a)
Instrument	GF Instruments CMD-Mini Explorer (Bonsall *et al*. 2013)
Data Acquisition Resolution	5m x 0.2s
Coil Configuration	Horizontal Coplanar Coil configuration (HPC) or ‘full-depth’
Platform	SparrowHawk-1000 cart system, sensor positioned 10cm above the ground

Data Acquisition Method	Continuous mode, Gridded
Measuring Range	EC_a: 1000mS/m, resolution 0.1mS/m
Data Logger	CMD Control Unit
Calibration	According to manufacturer's guidelines (GF Instruments 2010)
Data Processing	CMD Data Transfer: dowloaded as Apparent Electrical Conductivity (EC_a) (Quadrature); drift correction using a moving filter, Despike, Low Pass Gaussian Filter, Interpolation
Graphical Display / Dynamic Range	Colourscale 0 mS/m to 6 mS/m (Baginbun beach) Colourscale 0 mS/m to 20 mS/m (Freshwater West)

3.19. The geophysical survey and report were completed in accordance with relevant professional guidance (see Bonsall et al. 2014; David et al. 2008; Gaffney et al. 2002; Schmidt et al. 2015).

3.20. The electromagnetic surveys were undertaken at a sample resolution of 5m x 0.25m. The methodology for the work undertaken in Ireland was approved by the Archaeological Licensing Section of the National Monuments Service. Detection Device Consent (No. 18R0136) was issued by the Minister for Culture, Heritage and the Gaeltacht in accordance with Section 2 (2) of the National Monuments (Amendment) Act 1987.

Offshore survey methodology

Bathymetric and geophysical survey specification and data acquisition

3.21. Bathymetric and geophysical survey was undertaken by MMT using the survey vessel MV Franklin and MV Seabeam in October to November 2018. The survey corridor was c. 500m wide, with seven survey lines spaced c. 60m apart, resulting in >100% MBES and SSS coverage of the survey corridor (Cotswold Archaeology 2019).

3.22. Bathymetric data were acquired using a dual head R2Sonic 2024 (200-400 kHz) MBES, with positioning provided using an Applanix POS ¬¬MV 320 with CNav 3050 and C2 (SF2).

3.23. SSS survey was undertaken using an Edgetech 2200 Series dual frequency (600 and 300 kHz), set to 50m range to provide a total swath of 100m. The magnetometer survey was undertaken using a Geometrics G882 Magnetometer. The SBP seismic data were acquired using an EdgeTech DW106 (1-10kHz) Chirp. Geophysical survey positioning was provided by USBL aided by an iXblue ROVINS INS, with a manual layback of 9.5m for the magnetometer, and a Geosparker

Sparker, positioned using a manual layback distance of 19.5m for the SBP (Cotswold Archaeology 2019).

Geodetic and projection parameters and vertical datum

3.24. Surveys positions were recorded in the geodetic datum WGS84, with projection UTM 30N. The vertical reference level is Lowest Astronomical Tide (LAT), with MBES elevation corrected to mLAT using the VORF vertical reference.

Assessment methodology

3.25. Geophysical assessment was undertaken utilising the programs Coda Octopus Survey Engine 4.3 and ArcGIS 10.5 following professional guidelines (Plets et al. 2013). The positions of surface and sub-surface anomalies, identified in the SSS and SBP data, were exported into ArcGIS 10.5 as shapefiles alongside processed magnetometer data provided by MMT. MBES supplied at a gridded resolution of 0.5m was also imported into ArcGIS. The geophysical data were assessed for anomalies with archaeological potential, with selection based on the presence of multiple lines of evidence (confirming datasets) (Cotswold Archaeology, 2019).

4. RESULTS

Desk-based assessment

Baseline environment

4.1. The following section outlines the nature of the existing environment and the recorded maritime cultural heritage.

4.2. The aim of this section is to provide a brief assessment of the palaeo-environmental potential of sediments that may be impacted by the Proposed Development. This assessment will review available data in respect of seabed and sub-seabed deposits likely to be of palaeo-environmental and archaeological interest.

4.3. The specific objectives of this palaeo-environmental assessment are:

- to review available data in respect of seabed and sub-seabed deposits likely to be of palaeo-environmental and archaeological interest;
- to identify any deposits of palaeo-environmental and archaeological potential.

4.4. For the palaeo-environmental assessment the route has been divided into three sections:

- Offshore route;
- Irish landfall; and
- Welsh landfall.

Offshore route

4.5. The two landfall sites are shown on Figure 4 plotted over existing INFOMAR and UKHO swath bathymetry covering the proposed route, with background bathymetry derived from the EMODnet regional Digital Terrain Models (DTM), which is at a resolution of 0.125 minute * 0.125 minute. The bathymetry clearly shows the presence of the main deep associated with St George's Channel between Wales and Ireland, which reaches a maximum depth of -140m chart datum (CD).

4.6. At the time the DBA was written (Cotswold Archaeology 2018a) no modern swath bathymetry data coverage existed so confidence in the palaeo-environmental (e.g. presence of palaeo-channel visible on the seabed) and archaeological record (e.g. wreck sites) was reduced. As detailed above, bathymetric data was subsequently collected and assessed.

4.7. The modelled positions of the Irish Sea Ice Sheet (ISIS) during the Late Devensian period (see Chiverell et al. 2013; Clark et al. 2012) are shown in Figure 5. Southern Ireland would have been covered by the ISIS during its maximum extent, but south Pembrokeshire is thought to have avoided being covered by it. At 24.3 - 23.0 kilo-annum (ka or 1,000 years) the ISIS reached its maximum limits in the Celtic Sea, having extended to a position west of the Isles of Scilly. After this maximum extension, the ISIS began to regress with rapid marginal retreat to the northern Irish Sea basin. This retreat was rapid and driven by climatic warming, sea-level rise, mega-tidal amplitudes and reactivation of meridional circulation in the North Atlantic (Cotswold Archaeology 2018a).

4.8. The modelling presented by Chiverell et al. (2013) suggests that the ISIS would have retreated to the north of the Celtic Sea area by 23.7 to 23.0 ka. The expansion and retreat of the ISIS along St George's Channel and into the Celtic Sea resulted in the deposition of thick Pleistocene deposits (e.g. Blundell et al. 1968; Garrad 1977).

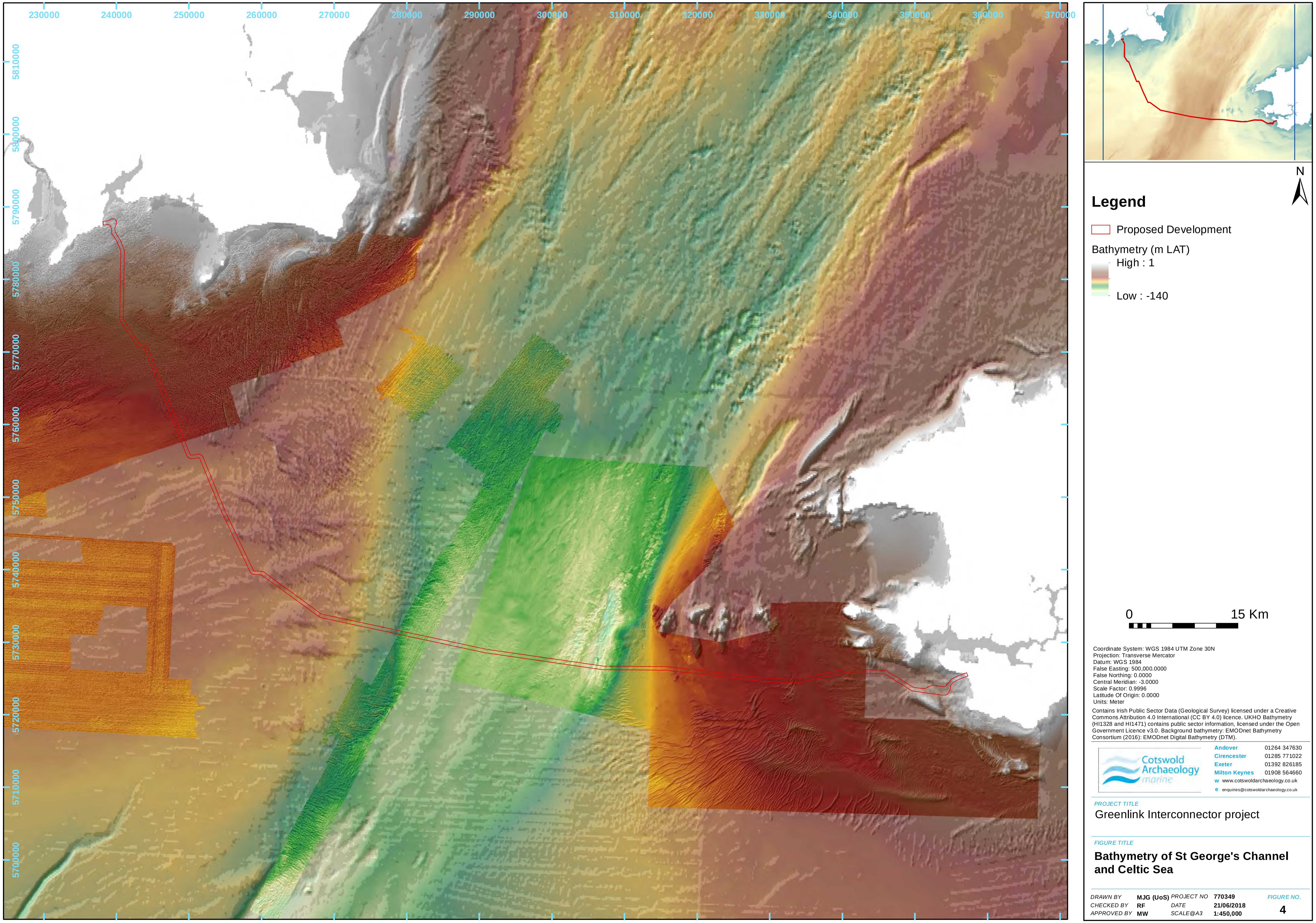
4.9. Scourse & Furze (2001) present the results of a series of boreholes from the centre of St George's Channel, showing that, in the upper 5-10m of those intersecting with the proposed cable route (labelled on Figure 5), a series of glacio-fluvial and glacio-lacustrine deposits are overlain by late-glacial / Holocene marine gravel and marine sand. Figure 5 shows the distribution of available borehole and grab sample data consulted, which intersect with the proposed route. The boreholes containing Pleistocene Tills are present in the deeper central section of St George's Channel.

4.10. To the east, the underlying mudstone bedrock is present closer to the seabed surface, although south of Milford Haven there is a persistent weathered bedrock record in the shallow cores. Surface gravels and shelly sands overlying the till / bedrock were most common closer to the shore, whereas muddy sands were more prevalent in the deeper offshore areas. Evans (1990) suggests that much of the seabed of the Celtic Sea consists of a thin lag deposit reworked from pre-existing deposits. No borehole data were available to assess the likely sediments present below the seabed from the Irish side of St George's Channel.

4.11. The retreat of the ISIS coupled with sea level rise led to the submersion of coastal areas. The rate of change of this relative sea-level (RSL) has been constrained by studies using sea level index points (SLIPs). The most recent review of SLIPs for the British Isles has been presented by Shennan *et al*. (2018) which indicates only one SLIP for south Wales (Pembrokeshire), derived from the submerged forest at Freshwater West.

4.12. On the Irish coast, fifteen SLIPs were used to define the RSL curve for south Wexford, with the closest point derived from Woodvillage, Fethard-on-sea, located c. 2.5km north of the Baginbun Bay landfall (Dresser 1980). These Irish SLIPS date to between 7.3 to 2.3 ka and range in elevation from -6.8 to 0.61m relative to mean sea level (MSL).

4.13. To supplement these radiocarbon-dated SLIPs, glacial isostatic adjustment (GIA) models are used to predict broad patterns of RSL change over longer periods of time. For both areas the GIA models predict sea levels at the start of the Holocene (11.7 ka) around –30m MSL, rapidly rising to c. -4m (South Wexford) and -8m MSL



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Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Contains Irish Public Sector Data (Geological Survey) licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence. UKHO Bathymetry (HI1328 and HI1471) contains public sector information, licensed under the Open Government Licence v3.0. Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM).

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PROJECT TITLE

Greenlink Interconnector project

FIGURE TITLE

Bathymetry of St George's Channel and Celtic Sea

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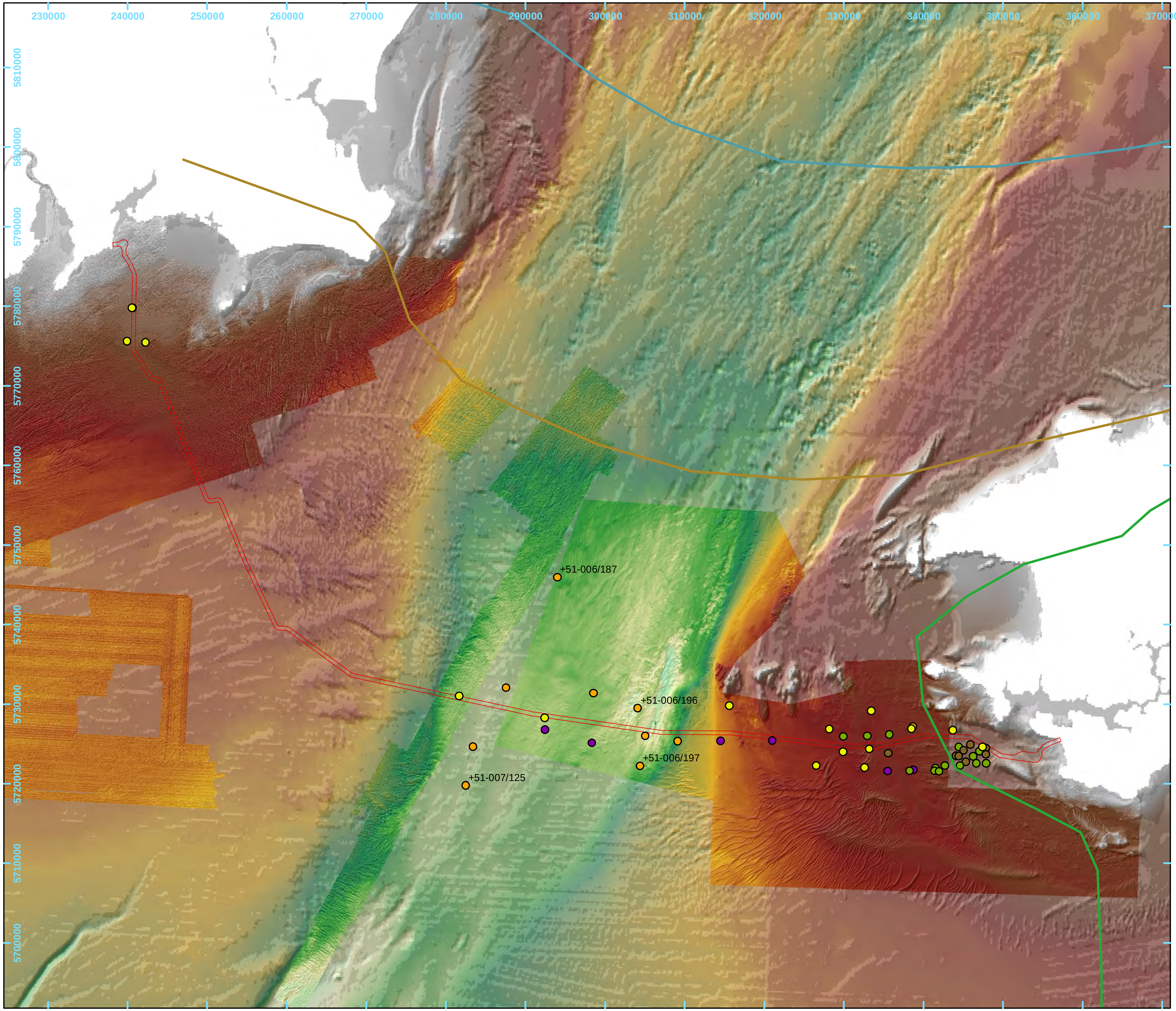

N

Legend

Proposed Development

Modelled Glacial Limits

- 23.2 To 22.4 Ka
- 23.7 To 22.9 Ka
- 24.3 To 23.0 Ka

Seabed Sediments

- Over Bedrock
- Over Till
- Over Weathered Bedrock
- Grab: Shelly Sand / Gravel
- Grab: Muddy Sand Over Gravel

Bathymetry (m LAT)

High : 1

Low : -140

0 15 Km

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
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FIGURE TITLE

Late Devensian Ice Sheet Limits and geotechnical samples along Proposed Development

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CHECKED BY	RF	DATE	21/06/2018		
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(Pembroke) by c. 7.5ka, and then a reduced rate of sea level rise up until modern day.

4.14. In St George's Channel, RSL has been modelled recently coupled with tidal amplitude data for sectors of the ISIS since the last glacial maximum (22 ka) (Scourse *et* al. 2018). At the approximate position of the 23.7 to 22.4 ka glacial limit shown in Figure 5, Scourse *et al*. (2018, Fig. 4) suggest that RSL was c. -60m between 20 to 14 ka, rising to c. -40m at the end of the last glaciation and then following the curves predicted for south Wexford and Pembroke for the Holocene.

4.15. The modelled RSL suggests that, after the retreat of the ISIS, a land bridge no longer existed between Wales and Ireland in St George's Channel, and it is therefore improbable that palaeo-environmental material associated with submerged palaeo-landscapes exists in the main channel area (see Westley & Edwards 2017).

4.16. The presence of Late Devensian Till across much of the Irish coastal shelf would also mean that it is unlikely pre-Devensian sediments would be encountered in the uppermost few metres of seabed sediments, although Pleistocene fauna material has been dredged from Waterford (displayed at the National Museum in Dublin). It has been suggested that survival potential, especially in areas exposed to high-energy conditions typified by lag gravel deposits or scoured bedrock, are expected to be low with the exception of infilled depressions, including palaeo-channels (see below), which may have collected and protected material (Westley & Edwards 2017: 270).

Baginbun Bay

4.17. There are no records of deposits with palaeo-environmental importance having been encountered at the proposed Irish landfall site in Baginbun Bay. The presence of tree roots in grey wedges of glacial deposits, however, has been reported between the high and low water marks on the beach at Woodvillage (Dresser 1980; Figure 6). These roots might indicate the last vestiges of an eroded submerged forest, with a radiocarbon date on the roots producing a date of 2890-2210 calibrated (cal.) BC (D-119; 4030±120 before present (BP) (Dresser 1980). It is therefore possible that remnants of submerged forest deposits and their associated palaeo-soils could be present in the Baginbun Bay area (Cotswold Archaeology 2018a).

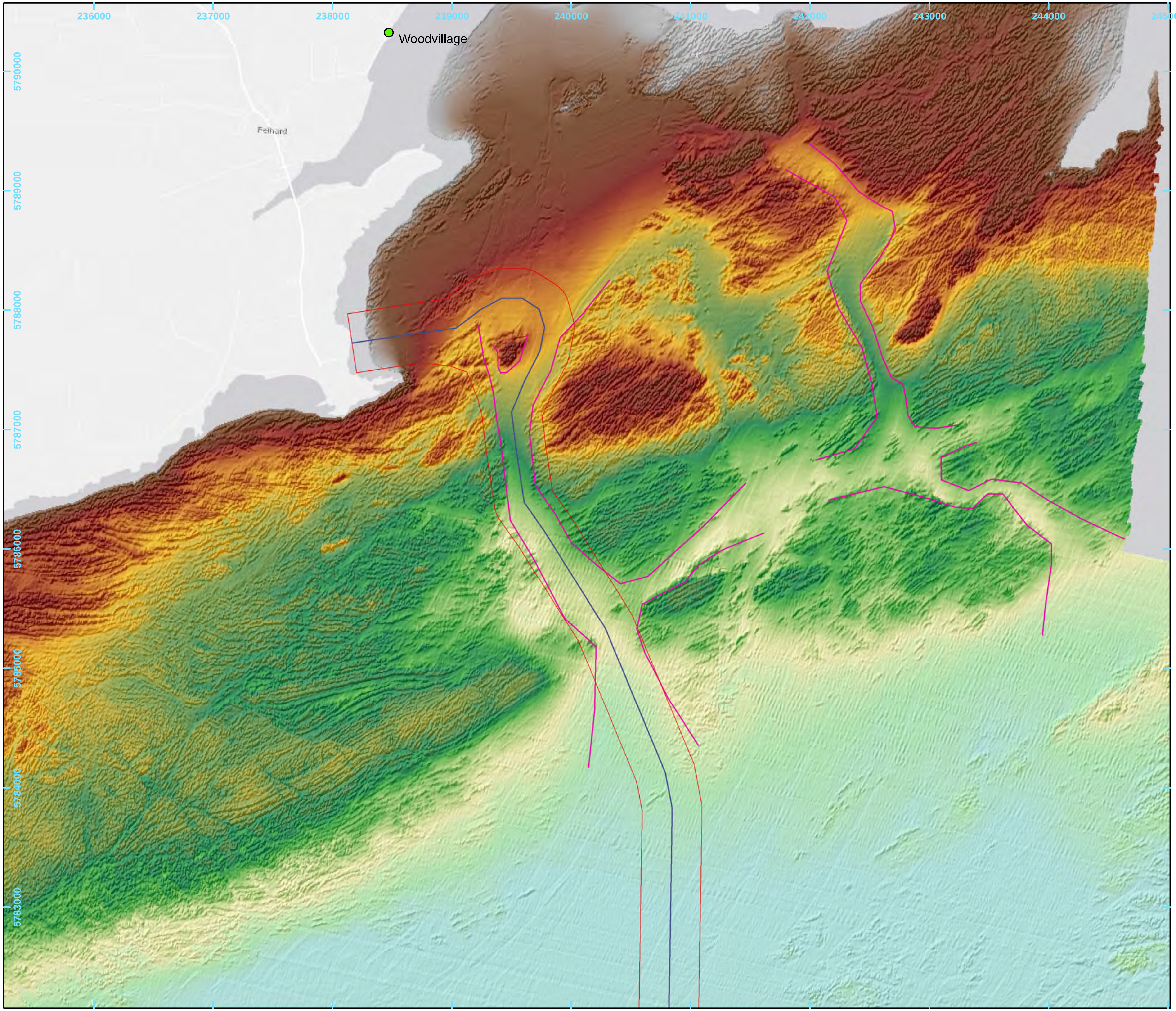
4.18. The available INFOMAR bathymetry shows the proposed cable route aligned with a north-south orientated channel at c. 1.2km offshore. This channel dissects the exposed bedrock and can be traced for c. 3.5km before opening up into a wider expanse of seabed, below c. -23m lowest astronomical tide (LAT), where the underlying bedrock geology is less discernible. The formation process and sediment fill of this channel is unknown but is likely to be dominated by glacially-derived material and could exhibit some similarities to the palaeo-channel identified at the mouth of Waterford Harbour (Gallagher *et al*. 2004). This extends 22km south to c. -56m Ordnance Datum (OD) where it terminates in an area of possible glacio-genic sediments. Using a variety of geophysical survey methods, Gallagher *et al*. (2004) suggested that this channel formed in an ice-marginal environment, with the various bedforms attributed to sedimentation at the margins of ice progressively retreating from the nearshore shelf of the Celtic Sea during the last glacial maximum. The presence of later Holocene deposits in, or on the margins of, this channel has not, however, been fully established (Cotswold Archaeology 2018a).

Freshwater West

4.19. The proposed Welsh landfall is situated at the northern end of Freshwater West beach. As no bathymetric data was available at the time the DBA was written it was not possible to assess the seabed in this area. Subsequent survey identified a palaeo-channel associated with the Castlemartin Corse stream crossing this area. This area is believed to be beyond the ISIS limit, so it could preserve older Pleistocene material (Cotswold Archaeology 2018a).

4.20. The palaeo-environmental potential of this area was first established by Leach (1913) who identified a series of flint scatters in the area, especially associated with a ‘soil drift’ in the Little Furznip area at the south of the beach. In March 1912 Leach surveyed the outermost submerged forest that had become exposed to the north of Little Furznip near the mouth of Castlemartin Brook.

4.21. In August of that year a patch remained visible and below the peat Leach found flint flakes. The stratigraphic recording of the sequence is summarised in Table 2. The flakes were found below the undisturbed peat in the large patch of (outermost) peat bed shown in Figure 7. Leach also reported that pieces of hard brittle charcoal were found beneath the peat and on the surface of the clay, forming in one place a thin layer, apparently the remains of a fire, with the flints interpreted as a ‘clipping floor’.



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Scale Factor: 0.9996
Latitude Of Origin: 0.0000
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FIGURE TITLE
Baginbun Bay: proposed Irish Landfall

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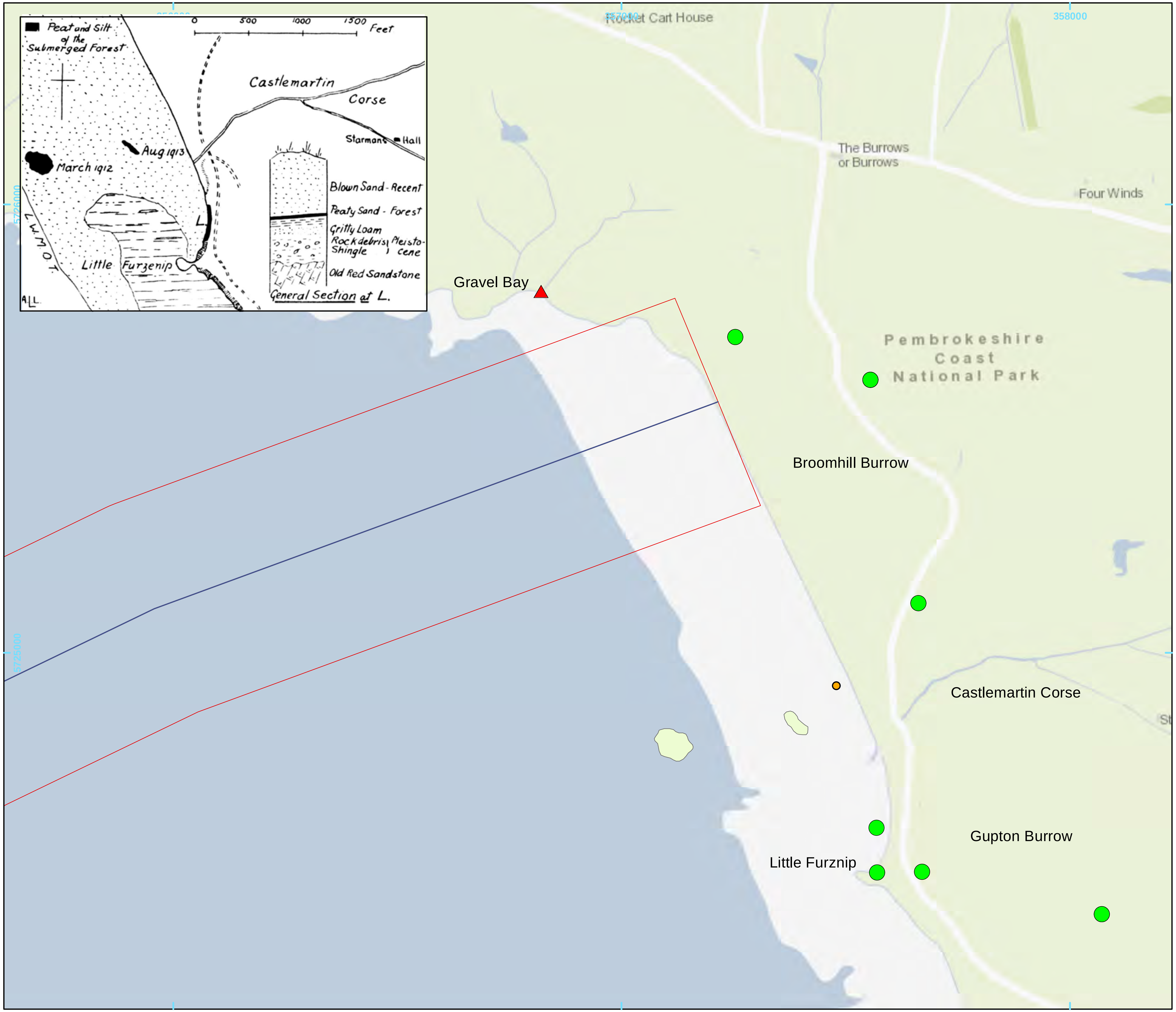
CHECKED BY	RF	DATE	30/08/2018	6	
APPROVED BY	MW	SCALE@A3	1:30,000		



N

Legend

- Greenlink Route Centreline (Indicative)
- Proposed Development
- Submerged Forest (Leach 1913)
- Submerged Forest (RCAHMW)
- PaMELA Database

0 300m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
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PROJECT TITLE
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FIGURE TITLE
Freshwater West: proposed Welsh landfall. Insert from Leech 1913

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APPROVED BY	MW	SCALE@A3	1:8,000	

4.22. The outermost submerged forest was reinvestigated by Wainwright (1961; 1963) when it was exposed in the summer of 1960. He encountered one small tranchet axe and a few flint flakes from the surface of the blue clay, where they were sealed by the peat.

Sampling of the peat at the low water mark by H. Godwin (in Wainwright 1961; 1963 Appendix II) was undertaken for pollen and plant macrofossils analysis, which identified that the assemblage was dominated by Quercus (oak) and *Alnus glutinosa* (alder) pollen, the latter also present within the macrofossil record along with a series of other aquatic / wetland plant species. The macrofossils notably showed a transition from a fen wood at the base of the sequence to one with 'more muddy conditions' at the top. A radiocarbon date was also obtained from the lower wood peat which produced a date of 5210-4550 cal. BC (Q-530; 5960±120 BP; Godwin & Switsur 1964).

Table 2 Description of the sediments at the outermost Freshwater West submerged forest

Leach 1913	Godwin in Wainwright (1961; 1963)
Peat '8 inches'	Dark laminated coarse detritus mud with abundant twigs and some leaf fragments; some sand and silt and occasional pebbles of stone and clay.
	Dark brown wood peat with abundant wood fragments, compressed, and in situ.
Blue slime '4 to 6 inches', a tenacious blue clay	Peat clay contact at top; stiff grey blue clay with pebbles, some large rootlets penetrating from above
	Stiff silty clay with scattered, small pebbles; largely blue grey but red brown at base
Stoney clay about '1ft', stiff gritty clay, full of pebbles and angular fragments of igneous rocks and local sandstones.	

4.23. Geo-rectification of the map produced by Leach (1913: Figure 2), coupled with the site descriptions provided by Wainwright (1959; 1961; 1963), centres the outermost submerged forest which contained the occupation surface on SR 8805 9969 (WGS84 UTM 30N 357120 5724790), c. 350m west of the position recorded in the RCAHMW (NPRN 524740), straddling the present chart datum. The inner submerged forest exposure is likely to be centred on SR 8832 9973 (WGS84 UTM 30N 357390 5724840). This would place the two submerged forest exposures just beyond (south) the 500m route buffer (shown in Fig. 7). The submerged forest still exists on the beach, as it was observed after storms in 2014 (Fig. 8 and Fig. 9).

Figure 8 Exposed peats on the foreshore at Freshwater West (courtesy of Intertek)

Figure 9 Remains of the submerged forest preserved in the exposed peats on the foreshore (courtesy of Intertek)

4.24. The significance of the submerged forest deposits was realised by Leach (1913) because he was able to show that the sediments were laterally continuous, with the 'stoney rubble' overlain by an organic horizon also present in exposed hillside sections several feet above the beach (see insert in Fig. 7). Leach further refined his interpretation of the sediments of the area and suggested that the flints appeared to be contained only in the fine-grained clayey soil-drift, not in the coarse underlying rubble (Cotswold Archaeology 2018a).

4.25. Leach was able to confirm this by finding further flints associated with this surface, although the main excavation of these deposits and occupation surface was undertaken by Wainwright (1959; 1961) who investigated an old quarry in the Little

Furznip area. It is not clear where the excavation took place as Wainwright stated that it was undertaken a few hundred yards south of the submerged forest (though the description of the position varies between accounts and historic mapping suggests quarries were probably east of the beach). Cornwall (in Wainwright 1961, 1963 Appendix I) investigated the sediments associated with the artefact-rich horizon and was able to demonstrate that the red loam of the 'soil drift' represented a buried land surface (Cotswold Archaeology 2018a).

4.26. Beyond the finds around Little Furznip, Leach also encountered small sharp flakes and chips from the sandy downwash on the side of Gravel Bay, located at the northern end of Freshwater West and within the CSC boundary. Wainwright (1963; Plate X) maps these and a series of other scatters along this cliff line to the north of the beach. Leach also reports flint flakes and implements, indistinguishable from those found at the 'chipping floor' sites, obtained near shell-heaps and shell-strewn spaces, although the location of these sites is unclear.

4.27. The PaLMEA database (Wessex Archaeology and Jacobi 2014) includes a large number of locations with Mesolithic material. Most of these records, however, are spatially inaccurate and relate to the submerged forest or the excavation by Wainwright in the Little Furznip / Gupton Burrows area. The PaLMEA database does, however, cite a collection at the Ashmolean Museum that is recorded as derived from Broomhill Burrows, the dunes north of the Castlemartin Corse stream that enters the bay east of the submerged forest. It is therefore possible that the 'soil drift' deposit may be found to extend into the Celtic Sea area, from under the beach, which could yield a buried land surface with both archaeological and palaeo-environmental importance (Cotswold Archaeology 2018a).

Sites of cultural heritage interest within the CSC

4.28. The various datasets used in the compilation of the DBA (Cotswold Archaeology 2018a) were amalgamated to remove duplicate entries. Table 3 shows the wrecks/obstructions which were identified within the 500m wide CSC as a result of the DBA. It includes two additional records (**CA24 & CA25**) identified as a result of new data searches, that were collected to cover a slight deviation to the proposed cable route, not assessed at the DBA stage (see Fig. 10).

4.29. **CA8** and **CA9** refer to a large number of wrecks recorded in the same position with limited attributed information. A full list of the wrecks covered under **CA8** and **CA9** is provided in Appendix 1. The locational information for these wrecks is considered to be arbitrary (Cotswold Archaeology 2018a).

4.30. The initial results of the 2018 DBA listed wrecks within the CSC for all three routes, A, B and E (Cotswold Archaeology 2018a). The entries that are no longer relevant to the current Proposed Development have been removed but are included in Appendix 2 for reference.

4.31. There are 12 recorded wrecks, obstructions and sites within the CSC, across Irish and Welsh jurisdictions, including:

- seven known (live) wrecks or wreckage (**CA1, 2, 5, 14, 16, 24 & 25**) including two separate findspots associated with (**CA16**);
- two dead wrecks (**CA13 & 17**), that recent surveys have not located;
- two areas of multiple known and potential wreck sites (**CA8 & 9**) off Milford Haven, and at Freshwater West; and
- one findspot on the Irish foreshore (**CA15**).

4.32. All of the known wrecks within the CSC date from the 19th and 20th centuries. The SS Candidate (**CA1**) is one of the earliest to have sunk within the CSC. This was a merchant steamship vessel of 5,858 gross tonnage. The vessel was captured by German submarine U-20 while on passage from Liverpool to Jamaica and was sunk by torpedo on passage from Liverpool to Jamaica on 6 May 1915 without loss of life (WIID no W03284). The survivors were picked up by HMS Lord Allendale and were landed at Milford Haven. It was built in 1906 by Connell, C & Co. The wreck lies at a depth of 55-67m (Cotswold Archaeology 2018a).

4.33. The wreck of the *Willemoes* (**CA2**) of Thuro was uncovered and recorded in Freshwater Bay in storms of December 2013/January 2014 and again in January 2016 (Fig. 10). The wreck comprises the inverted remains of a wooden vessel comprising a length of keel, outer planking fastened with iron pins, together with main and filling frames. This was identified as the *Willemoes* by a local resident, who was able to confirm that the vessel originally ran aground near Gravel Bay on Christmas Day 1924, and has been uncovered on the beach on numerous occasions (Coflein NPRN 420445) (Cotswold Archaeology 2018a).

4.34. The wreck of the *Thorold* (**CA5**) was a casualty of the Second World War (WW2). The *Thorold* sunk in 1940 after it was bombed by German aircraft in the Irish Sea. It lies in 65-73m water depth (Wrecksite.eu) (Cotswold Archaeology 2018a).

4.35. There are two areas centred on Freshwater Bay and Milford Haven (**CA8 & CA9**) that have been identified by the RCAHMW as areas which have the potential to contain wrecks of vessels and downed aircraft. The location of these areas is centred on numerous potential wreck sites (see Appendix 1) (Cotswold Archaeology 2018a).

4.36. Two unnamed wrecks (**CA13 & 14**) are recorded in close proximity at a depth of 109m, but there are few other details. An exposed section of **CA14** has been seen on two separate occasions in the late 20th century, measuring 11m in length and 6.7m in height (Cotswold Archaeology 2018a).

4.37. Records of a number of features on the Irish foreshore are held by the National Museum of Ireland (NMI). These are located above MHWS close to the edge of the CSC. These include the site of a promontory fort (RMP monument no. WX050-01501-), a linear earthwork (RMP monument no. WX050-01502-), and a hut site (RMP monument no. WX050-015005), near which a piece of corroded iron was found on the beach, close to the cliff face (**CA15**). This find was too corroded to be dated or identified, although it is possible that it could be associated with a nearby medieval battlefield encampment. This artefact was removed by the finder and inspected by the curator at the NMI (Cotswold Archaeology 2018a).

4.38. The wreck site of what is believed to be the *Saint Jaques* (**CA16**) was recorded during a marine geophysical survey by Wessex Archaeology in 2010 within 30m of proposed cable route E. This steel-hulled steamship was built in Dunkirk in 1909, with a gross tonnage of 2,459. It sank when it was torpedoed by German submarine UC51 in September 1917 while transporting coal from Barry, South Wales to Tunisia. The wreck now lies on a sandy seabed at 29m depth. The partially buried wreck measured 70.2m x 23.5m. Divers recorded the bow to the east of the main wreck, and buried propellers have been reported nearby (Coflein NPRN 273164). These separate components may be part of two sites of multiple findspots are thought to be debris from the *St Jaques* (Cotswold Archaeology 2018a).

4.39. The *Margaret* (**CA17**) was a 14-ton fishing smack from Milford Haven which sank in high winds in August 1893. The presence of any remains at the recorded location is unconfirmed (Coflein NPRN 273052) (Cotswold Archaeology 2018a).

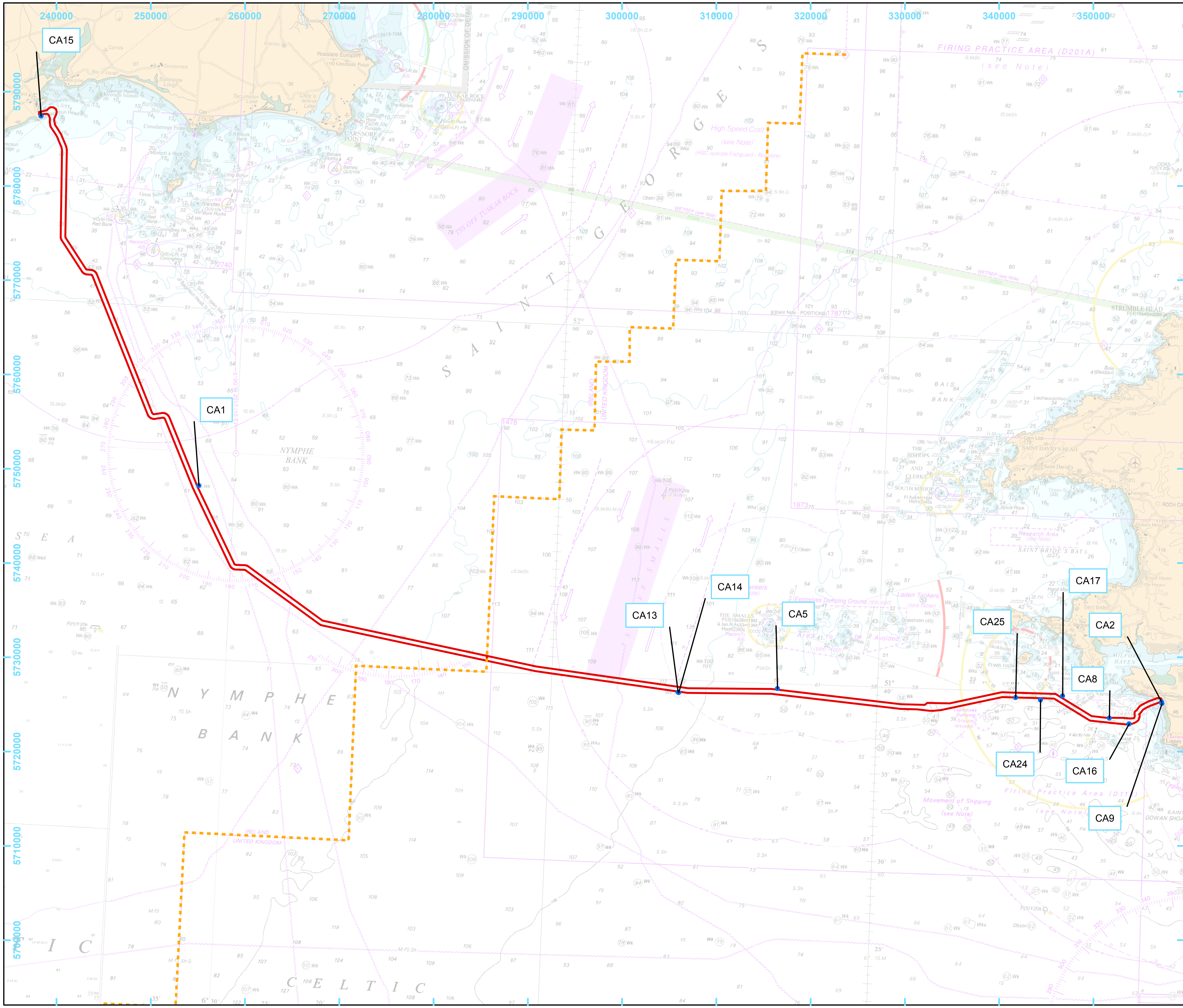
4.40. The *Concha* (**CA24**) was a steel-hulled cargo vessel built by Eriksbergs M/V A/B in 1919. It was approximately 53.4m long and 12.32m wide (175ft 2in long and 38ft 9in wide). On 10 September 1958, the *Concha* was on passage from Dublin to Swansea when there was an explosion and fire in the ship's engine room. The wreck is now thought to be at a depth of approximately 48m and was last recorded in 1976 (Coflein NPRN 273235).

4.41. The wreck at the position of **CA25** is believed to be that of the *Gisella*, which was a steel-hulled steamship built by W Gray & Co Ltd in 1904. It sank on November 1917 approximately 3.21km south-south-west of Skokholm Island, after picking up cargo in Cardiff. It had been badly damaged by a German mine, and then torpedoed by a UC77, resulting in the loss of life.

Table 3 Wrecks and obstructions within the CSC of the Proposed Development

CA no.	Jurisdiction	Name	Type	Date	Status	Longitude	Latitude	Source & ref. no.
CA1	Ireland	*Candidate*	Wreck	Modern (1915)	Live	-6.554167	51.83083	OceanWise 1001695985 WIID W03284
CA2	Wales	Wreck, possibly *Willemoes* of Thuro	Wreck	Modern (1924)	Live	-5.06413	51.6601	RCAHMW 273193 / 420445
CA5	Wales	*Thorold*	Wreck	Modern (1940)	Live	-5.653234	51.66098	OceanWise 1001707586
CA8	Wales	Off Milford Haven	Site (possible area of multiple wrecks/aircraft)	Multi period	Unknown	-5.143374	51.64337	RCAHMW 506396 See Appendix 1
CA9	Wales	Freshwater West	Site (possible area of multiple wrecks/aircraft)	Multi period	Unknown	-5.06336	51.65878	RCAHMW 525694 See Appendix 1
CA13	Wales	Unnamed wreck	Wreck	Unknown	Dead	-5.80545	51.65403	OceanWise 1001695736
CA15	Ireland	Find near promontory fort	Findspot	Unknown	Lifted	-6.82644	52.1750	NMI WX050-015001
CA14	Wales	Unnamed wreck	Wreck	Post Medieval	Live	-5.804496	51.65363	RCAHMW 518432

CA no.	Jurisdiction	Name	Type	Date	Status	Longitude	Latitude	Source & ref. no.
CA16	Wales	*Saint Jaques*	Wreck and two associated findspots	Modern (1917)	Live	-5.11285	51.63829	OceanWise 1001695624 RCAHMW 273164 / 518626 / 518627
CA17	Wales	*Margaret*	Wreck	Modern (1893)	Dead	-5.21604	51.66312	RCAHMW 273052
CA24	Wales	Concha	Wreck	Modern (1958)	Live	-5.249812	51.658547	OceanWise 1001695677 RCAHMW 273235
CA25	Wales	Gisella	Wreck	Modern (1917)	Live	-5.288007	51.660163	OceanWise 1001695671 RCAHMW 237169



Legend

- Wrecks and obstructions
- Proposed Development
- Median line

N

0 15km

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

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PROJECT TITLE
Greenlink Interconnector

FIGURE TITLE
Overview of wrecks and obstructions within the Proposed Development

DRAWN BY	RLF	PROJECT NO	770349	FIGURE NO.
CHECKED BY	ZA	DATE	09/05/2019	10
APPROVED BY	MTW	SCALE@A3	1:375,000	

Foreshore survey results

Walkover and metal-detecting survey results

Baginbun beach

4.42. The DBA recorded very little of archaeological interest on the foreshore at Baginbun beach. This was confirmed by the walkover and metal-detecting surveys (Cotswold Archaeology 2018b) which found nothing of archaeological potential. The few ferrous and non-ferrous objects that were detected displayed no patterning or archaeological potential and therefore seemed more indicative of casual losses.

Freshwater West

4.43. The walkover and metal-detecting surveys at Freshwater West revealed nothing of archaeological interest. All the sites recorded on the foreshore in the DBA in 2018 were visited including the wreck of the *Willemoes* (**CA2**), a heavy anti-aircraft battery (**CA3**) and a weapons pit (**CA4**). Neither **CA2** nor **CA4** were visible on the surface of the beach. The wreck of the *Willemoes* (**CA2**) was photographed on the beach after a storm in December 2013 / January 2014 standing roughly 0.6m proud of the sand, had left no trace whatsoever on the beach (see Fig. 11). This suggests that sand levels on the beach at the time of the surveys were considerably higher than they have been in the recent past. The increased depth of sand may explain the sparsity of ferrous and non-ferrous objects that were detected on the beach as the depth of detection is relatively shallow. The objects that were detected again displayed little patterning or archaeological potential and therefore seemed more indicative of casual losses (Cotswold Archaeology 2018b).

Geophysical survey results

Baginbun beach

4.44. The survey was restricted both by the relatively short distance by which the water regressed at low water, and by the presence of bedrock outcrops. This near-surface geology impacted the geophysical survey results in the form of a linear band of high conductivity, which can be seen running along the length of the data. Within this, there are several breaks (or lower conductivity zones) associated with the restriction, by the bedrock, of water drainage from the sand. Conductivity level drops associated with gaps in the surface bedrock indicate that the gaps continue under the sand (Cotswold Archaeology 2018b).

4.45. Two larger areas of higher conductivity were detected on the northern and southern edges of the survey area. These are likely to be associated with deeper sand deposits over dips in the geological bedrock. No bedrock outcrops were visible on the northern sector of the survey area; the geophysical survey data, however, indicates that the sand is impacted by restricted drainage suggesting that the bedrock is relatively close to the surface in this location as well (Cotswold Archaeology 2018b).

Figure 11 Comparison of Freshwater West at time of foreshore survey in August 2018 versus when the *Willemoes* (CA2) was visible in February 2014 http://www.pemcoastphotos.com/_photo_12563415.html)

4.46. No potential ferrous anomalies were detected in the survey data (see Fig. 12-14).

Freshwater West

4.47. The geophysical survey revealed a band of bedrock, adjacent to the cliff edge, on the north-east sector of the beach. The bedrock appears to be covered by moderately shallow sand. A cable line was detected running inland from the sea and is believed to be a relict listening cable from the Ministry of Defence. A second similar anomaly to the south extends from the waterline but either terminates or becomes more deeply buried towards the shoreline. The route of the proposed Greenlink interconnector lies predominantly between these features although the more northerly cable may be impacted (see Fig. 15-17). There is a relatively uniform interface between the bedrock and the thicker sand deposits. (Cotswold Archaeology 2018b).

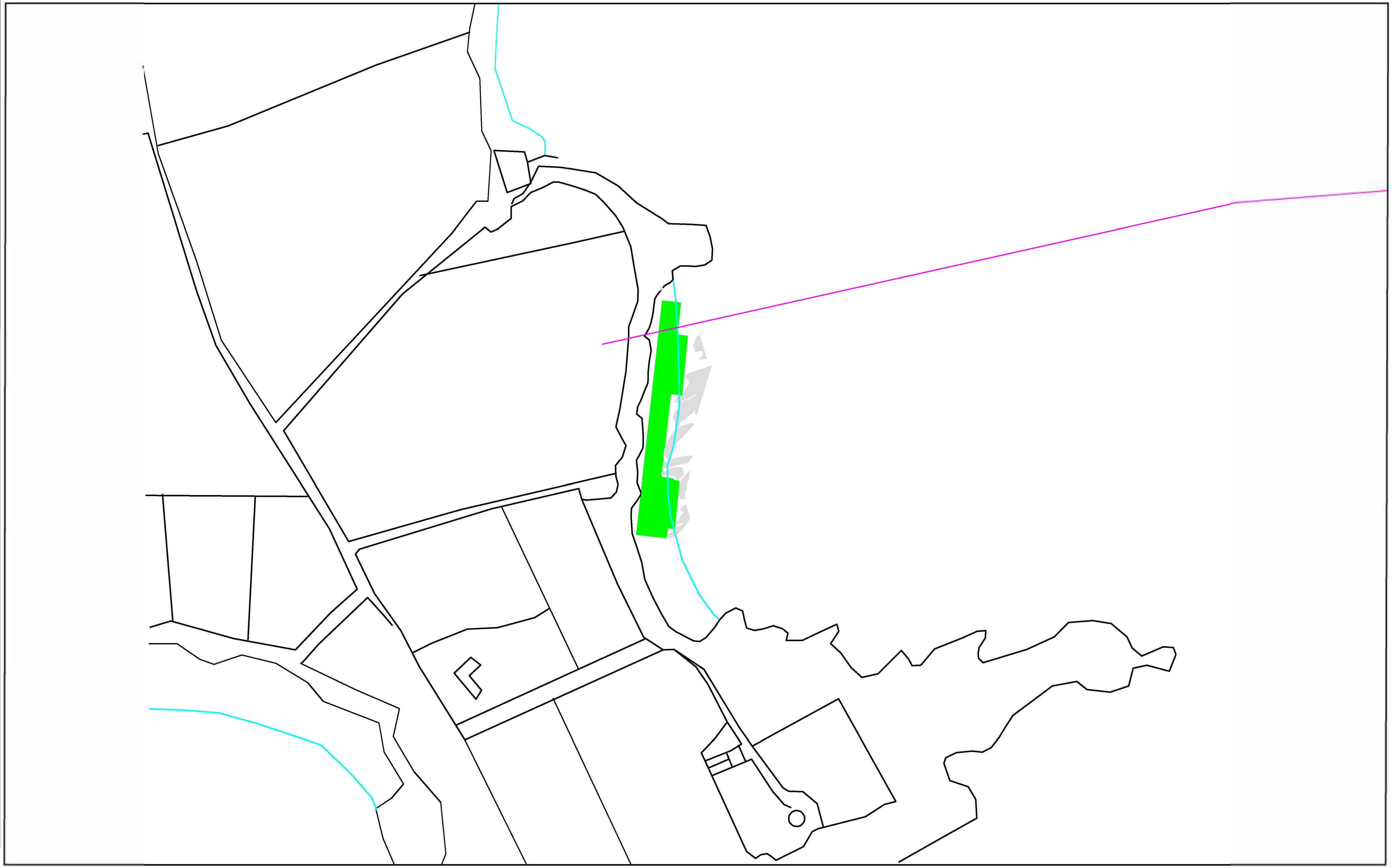
4.48. A band of high conductivity, surrounded by moderate conductivity, has been identified in the foreshore area, implying a break in the bedrock. This break may relate to a former channel, which can be seen running through the centre of the survey area.

4.49. Apart from the cable and other similar feature, two isolated, possible ferrous anomalies were detected during the survey. Both are located on the eastern edge of the possible channel and may represent deeply buried metallic objects as they also appear in the in-phase data. There is insufficient evidence to suggest the nature of these anomalies (Cotswold Archaeology 2018b).

Offshore survey results

4.50. Analysis of the marine geophysical datasets (Cotswold Archaeology 2019) identified 148 anomalies with archaeological potential (see Figures 18-21 and Table 4; each anomaly with medium archaeological potential is illustrated in Appendix 3). Other geophysical anomalies identified within the survey data, notably the SSS, consisted of small (<2m) boulders, sometimes with associated scour, within areas where bedrock was not exposed on the surface. These anomalies did not have an associated magnetic signal so are interpreted as being natural in origin and not listed as having archaeological potential.

4.51. Of the 148 anomalies identified, none were identified as wreck sites. None of the anomalies was identified as having high archaeological potential. 62 were deemed to have medium potential, typically consisting of magnetic anomalies exceeding 25 nanotesla (nT) and sometimes associated bathymetric or SSS anomalies. These might suggest metallic objects upon, or just under the seabed. No corresponding anomalies were identified in the neighbouring SBP surveys, though survey lines rarely directly coincided with the position of these anomalies visible in the surface datasets. The remaining 86 anomalies were identified as having low archaeological potential (Cotswold Archaeology 2019).



Legend

- Basemap
- Waterline
- Rock Outcrop
- Proposed Greenlink Interconnector Route
- Geophysical Survey Area

Site Location: Greenlink Interconnector Foreshore Survey

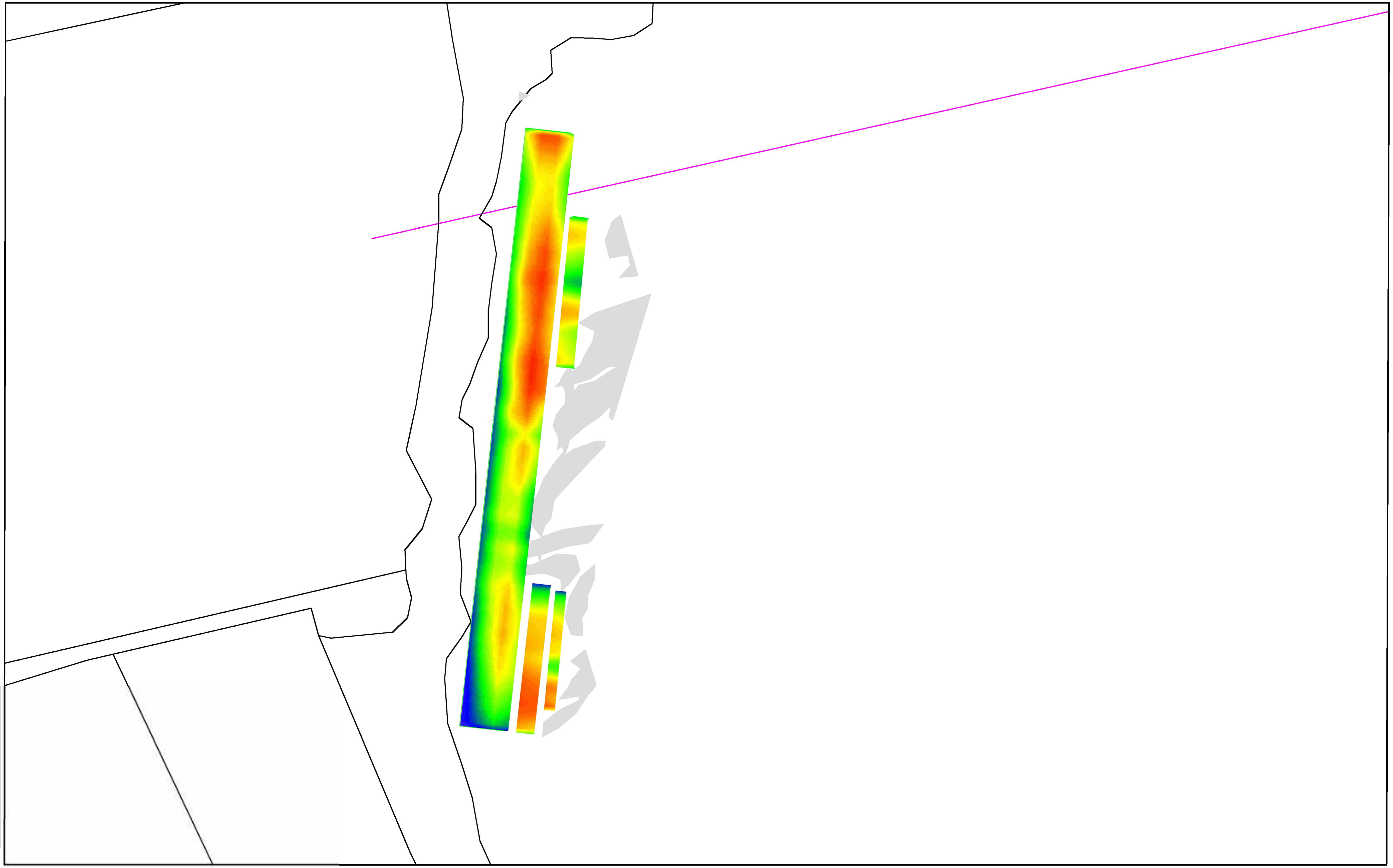
Client: Cotswold Archaeology

Drawing Courtesy of: OSI	Date: 20/09/18	Drawing No.: 18-047/02

0m 100m 200m

Figure No. 12: Detailed location map - Baginbun beach

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Rock Outcrop
- Proposed Greenlink Interconnector Route

mS/m

0 6

Site Location: Greenlink Interconnector Foreshore Survey

Client: Cotswold Archaeology

Drawing Courtesy of: OSI	Date: 21/09/18	Drawing No.: 18-047/04

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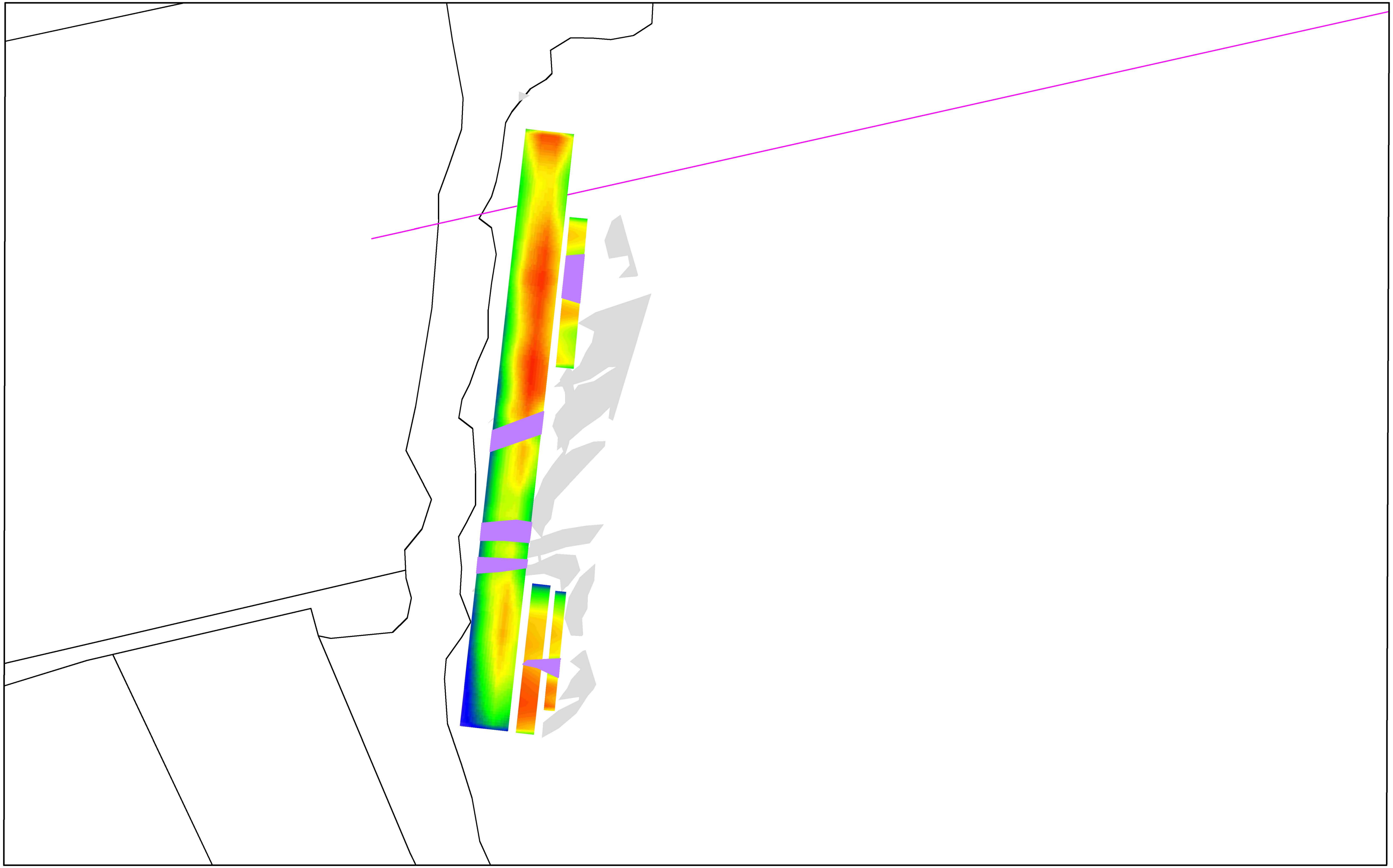
0m 100m 200m

Figure No. 13: Bagingun beach conductivity data

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Rock Outcrop
- Proposed Greenlink Interconnector Route
- Break in the Near Surface Bedrock

mS/m

0 6

Site Location: Greenlink Interconnector Foreshore Survey		
Client: Cotswold Archaeology		
Drawing Courtesy of: OSI	Date: 21/09/18	Drawing No.: 18-047/05

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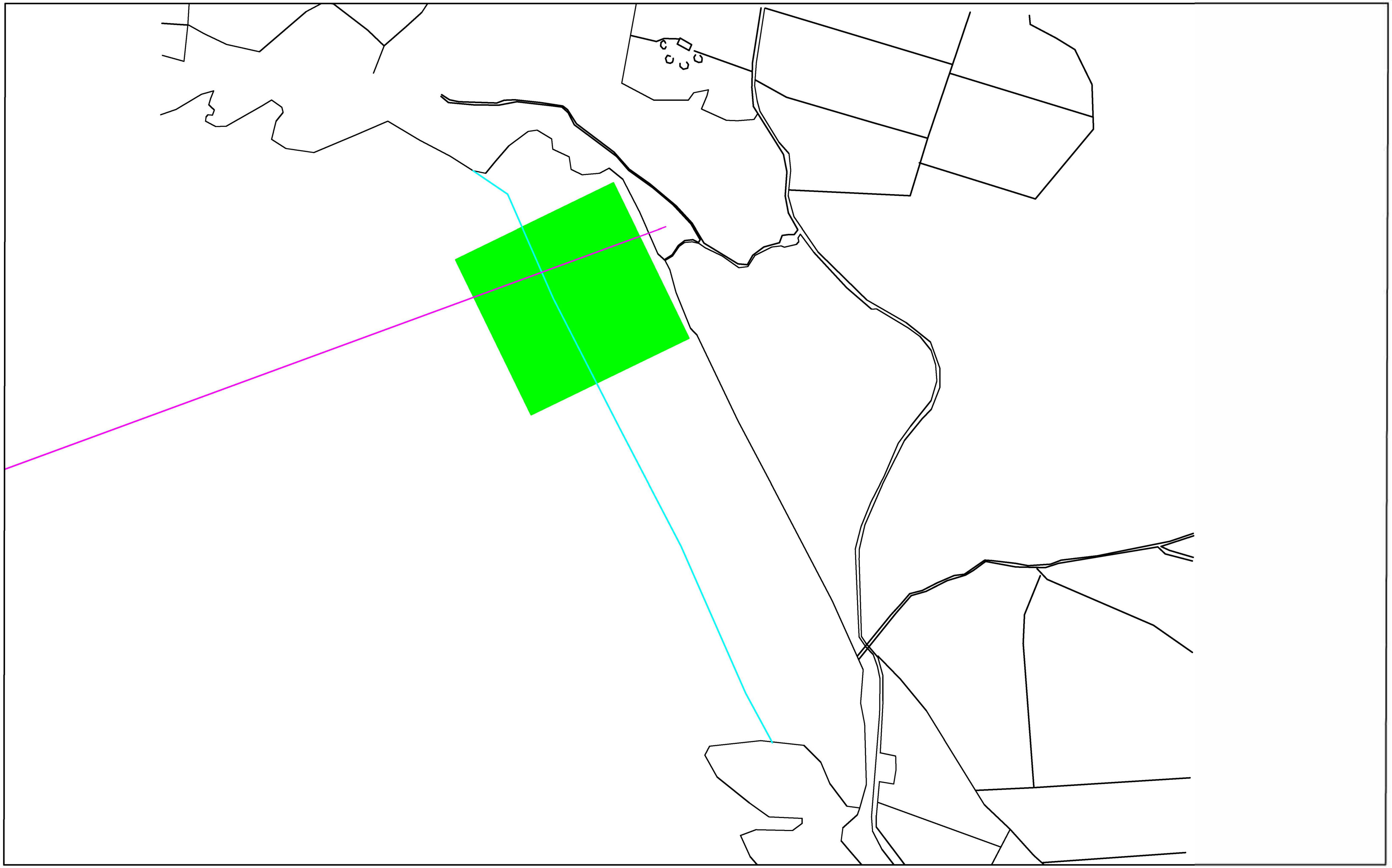
0m 100m 200m

Figure No. 14: Conductivity interpretation - Baginbun Beach

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Waterline
- Proposed Greenlink Interconnector Route
- Geophysical Survey Area

N

0m 200m 400m

Site Location: Greenlink Interconnector Foreshore Survey

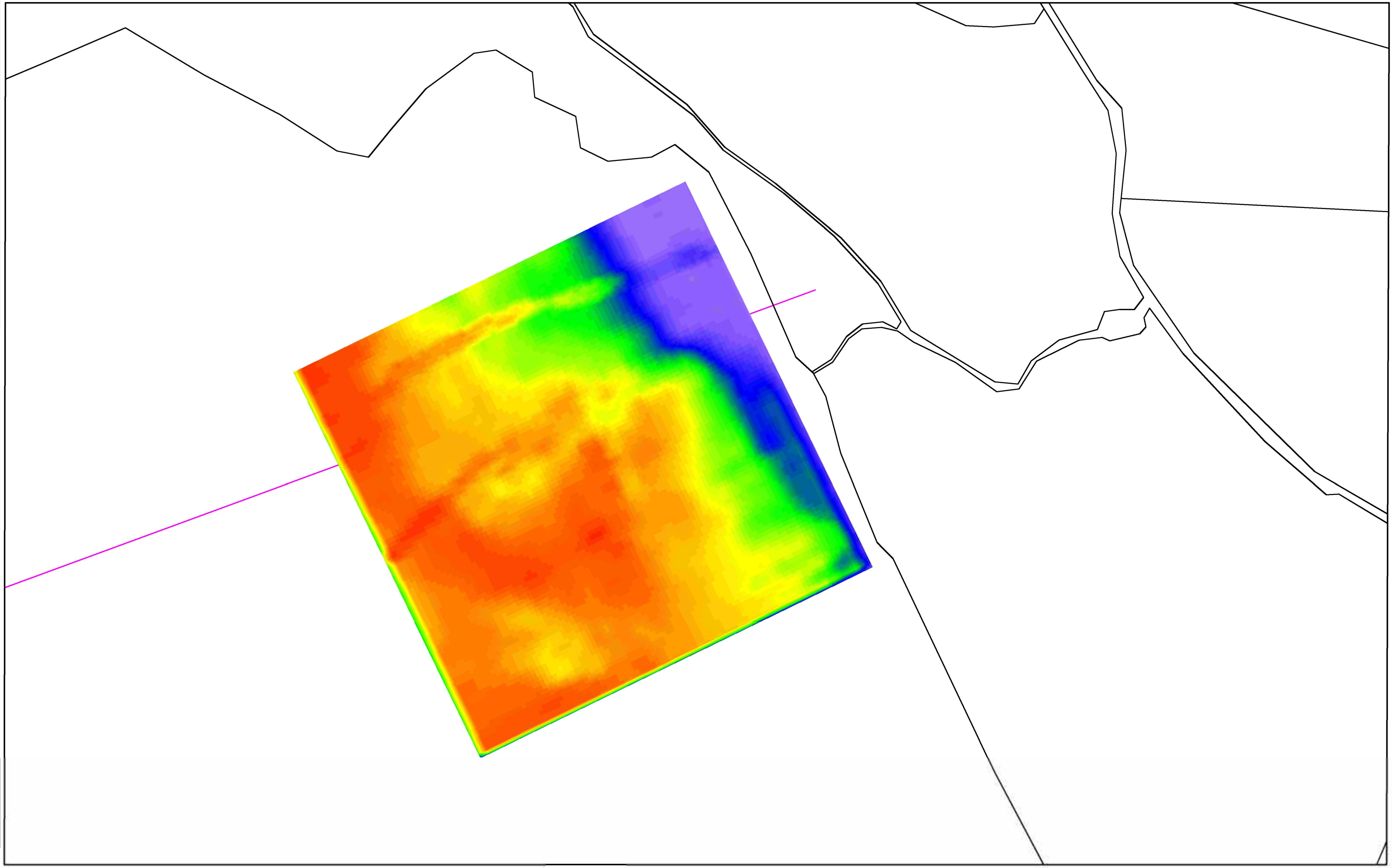
Client: Cotswold Archaeology

Drawing Courtesy of: Cotswold Archaeology | Date: 20/09/18 | Drawing No.: 18-047/03

Ordnance Survey Ireland Licence No. AR 0047318

Figure No. 15: Detailed location Map - Freshwater Beach

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Proposed Greenlink Interconnector Route

mS/m

0 20

N

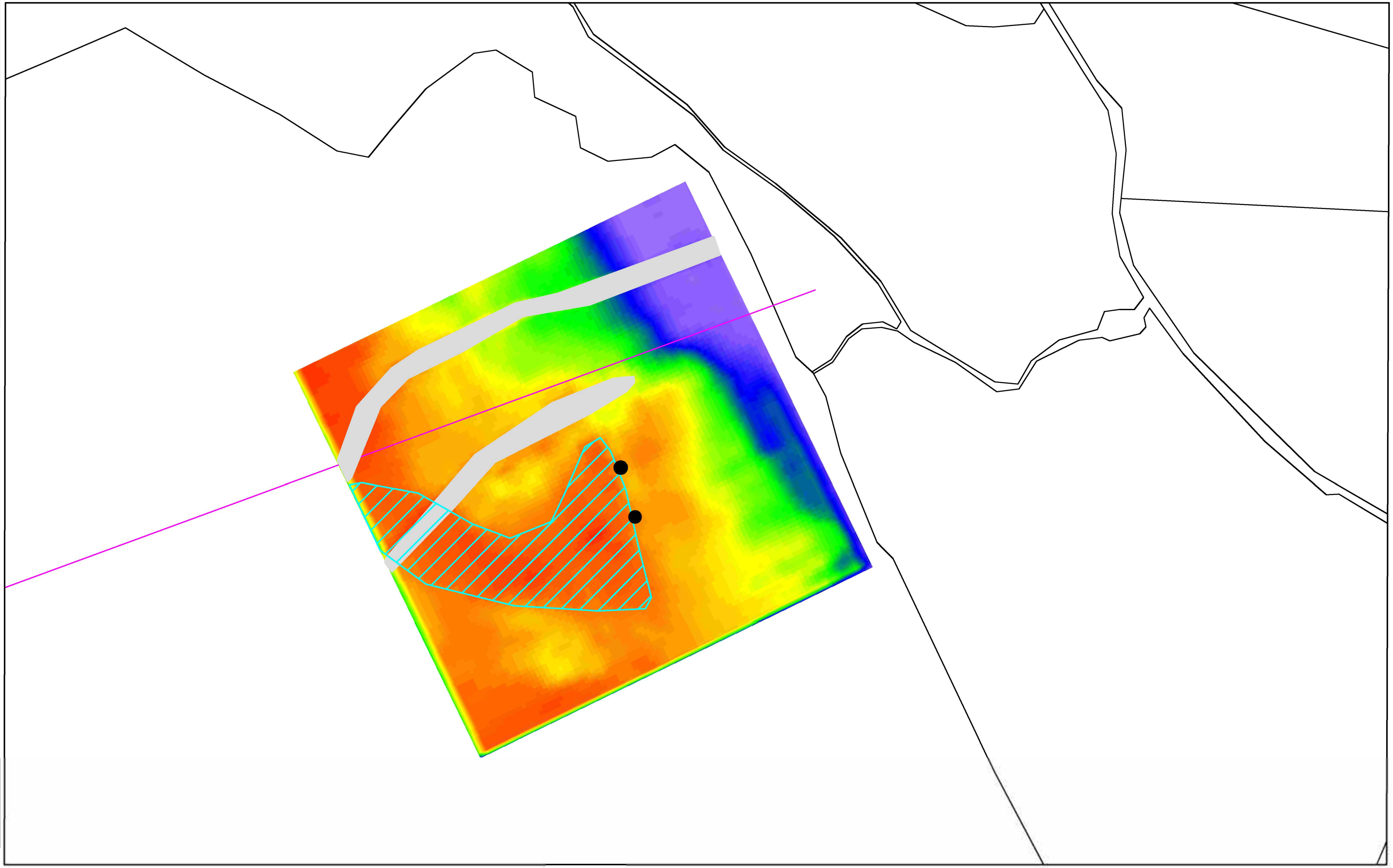
Client: Cotswold Archaeology

Drawing Courtesy of: Cotswold Archaeology	Date: 21/09/18	Drawing No.: 18-047/06

0m 200m 400m

Figure No. 16: Conductivity data - Freshwater West beach

EARTHSOUND archaeological geophysics



Legend

- Basemap
- Proposed Greenlink Interconnector Route
- Cable or Pipeline
- Proposed Greenlink Interconnector Route
- Possible Ferrous Response

mS/m

0 20

N

Site Location: Greenlink Interconnector Foreshore Survey

Client: Cotswold Archaeology

Drawing Courtesy of: Cotswold Archaeology	Date: 21/09/18	Drawing No.: 18-047/07

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0m 200m 400m

Figure No. 17: Conductivity interpretation - Freshwater Beach

EARTHSOUND archaeological geophysics

Table 4 Description of geophysical anomalies identified with archaeological potential

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2001	238322	5787591	Mag Anomaly M_SB_B1_0005 (207nT)	Medium	10
CA_2002	238365	5787591	Mag Anomaly M_SB_B1_0006 (62nT)	Medium	10
CA_2003	238386	5787591	Mag Anomaly M_SB_B1_0008 (55nT) and SSS S_SB_B1_5340 (1.5 x 1.2 x 0.6m)	Medium	10
CA_2004	238410	5787594	Mag Anomaly M_SB_B1_0009 (173nT)	Medium	10
CA_2005	238475	5787663	Mag Anomaly M_SB_B1_0010 (30nT)	Medium	5
CA_2006	238825	5788057	Mag Anomaly M_SB_B1_0013 (15nT)	Medium	5
CA_2007	238858	5787799	Mag Anomaly M_SB_B1_0014 (24nT) and SSS S_SB_B1_0082	Medium	10
CA_2008	239240	5788036	Mag Anomaly M_SB_B1_0015 (30nT) and associated SSS anomaly (1.5 x 1m)	Medium	15
CA_2009	239466	5788057	Mag Anomaly M_SB_B1_0017 (686nT) and SSS S_SB_B1_0141	Medium	20
CA_2010	240879	5784038	Mag Anomaly M_FR_B2_0025 (27nT)	Medium	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2011	240680	5783481	Mag Anomalies M_FR_B2_0022 (20nT) and M_FR_B2_0023 (12nT) and SSS Anomalies S_FR_B2_5254 (1.2x0.4x0.7m) and S_FR_B2_5255 (0.7x0.7x0.5m)	Medium	25
CA_2012	240644	5783397	Mag Anomaly M_FR_B2_0021 (233nT) and SSS Anomaly S_FR_B2_RA_0019 (4.1x3.9x0.7m)	Medium	20
CA_2013	240621	5781370	SSS Anomalies S_FR_B2_5245 (1.4x1x1m), S_FR_B2_5246 (4.5x1.5x0.6m) and S_FR_B2_5248 (1x0.8x0.7m)	Medium	25
CA_2014	240710	5777664	SSS Anomaly S_FR_B2_5215 (8.7x3.7x0.4m) within bathymetric depression measuring 28x15m	Medium	25
CA_2015	240907	5776850	SSS Anomaly S_FR_B2_5214 (5.5x1m)) within bathymetric depression measuring 10x1m	Medium	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2016	240936	5776818	SSS Anomaly S_FR_B2_5213 (7x2m) within bathymetric depression measuring 14x1m	Medium	10
CA_2017	240513	5776094	Mag Anomaly M_FR_B2_0020 (63nT)	Medium	15
CA_2018	240783	5775285	SSS S_FR_B2_5212 (1.3x0.6m)	Medium	10
CA_2019	242331	5772325	SSS Anomaly S_FR_B2_5210 (1x0.9x0.6m)	Medium	10
CA_2020	245745	5766840	Mag Anomaly M_FR_B2_0027 (39nT)	Medium	10
CA_2021	245507	5766633	SSS Anomaly S_FR_B2_5207 (1.1x0.8x0.3m) within bathymetric depression measuring 19x12m	Low	10
CA_2022	247677	5761990	Mag Anomaly M_FR_B2_0029 (28nT)	Low	10
CA_2023	247987	5760881	SSS Anomaly S_FR_B2_5203 (2.9x1x0.1m)	Medium	20
CA_2024	248002	5760789	SSS Anomaly S_FR_B2_5202 (1.3x1.7x0.5m)	Medium	20
CA_2025	249454	5756980	Mag Anomaly M_FR_B2_0032 (23nT) and slight bathymetric depression 8x6m	Medium	15

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2026	252508	5753304	Mag Anomaly M_FR_B2_0034 (20nT) and SSS Anomalies S_FR_B2_5190 (1.4x1m) and S_FR_B2_5191 (1.4x1.4x0.5m)	Medium	25
CA_2027	252928	5752230	SSS Anomaly S_FR_B2_5186 (1.2x0.8x0.2m)	Low	10
CA_2028	253990	5749814	Mag Anomaly M_FR_B2_0039 (32nT)	Low	10
CA_2029	254600	5748569	SSS Anomaly S_FR_B3_5180 (1.2x0.8x0.5m)	Low	10
CA_2030	254656	5748509	SSS Anomaly S_FR_B3_5179 (2x1.6m)	Low	10
CA_2031	254697	5748369	SSS Anomaly S_FR_B3_5176 (1.5x00.9x0.3m)	Low	10
CA_2032	254888	5748141	Mag Anomaly 87 (line LMag_ROTV_0437_MMT_953_GRL_FR_MAG_R_A_GEO_S205_ALL) and SSS Anomaly S_FR_B3_5173 (3.4m)	Medium	15
CA_2033	254566	5748002	Mag Anomaly M_FR_B3_0040 (65nT)	Medium	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2034	255631	5746412	Mag Anomaly M_FR_B3_0041 (115nT) and SSS Anomaly S_FR_B3_5166 (1.8x1.4x0.3m)	Medium	25
CA_2035	256337	5744279	Mag Anomaly 2 (line LMag_ROTV_0420_MMT_953_GRL_FR_MAG_R_A_GEO_P150_0006-0011) and 45 (line LMag_ROTV_0420_MMT_953_GRL_FR_MAG_R_A_GEO_P150_0001-0006): 7.5nT	Low	10
CA_2036	259278	5739623	Mag Anomaly 42 (1180nT) and 43 (37nT) (line LMag_ROTV_0433_MMT_953_GRL_FR_MAG_R_A_GEO_S75_ALL)	Medium	30
CA_2037	259751	5739325	Mag Anomaly 80 (178nT) (line LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL)	Medium	10
CA_2038	261303	5738535	SSS Anomaly S_FR_B3_5159 (4.7x1.7m)	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2039	265426	5735531	Mag Anomaly 18 (30nT) (Line: LMag_ROTV_0421_MMT_953_GRL_FR_MAG_R_A_GEO_P75_-_ALL)	Low	10
CA_2040	268207	5733432	Mag Anomaly 78 (1272nT) (Line LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Medium	20
CA_2041	268969	5733549	Mag Anomaly 39 (97nT) (Line LMag_ROTV_0433_MMT_953_GRL_FR_MAG_R_A_GEO_S75_ALL)	Medium	15
CA_2042	272473	5732814	SSS Anomaly S_FR_B3_5154 (2.8x1.7x1m) and associated bathymetric depression (6x3m)	Medium	20
CA_2043	272386	5732534	Mag Anomaly 73 (645nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Medium	15

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2044	272455	5732520	Mag Anomaly 72 (2367nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Medium	15
CA_2045	272599	5732486	Mag Anomaly 71 (321nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Medium	15
CA_2046	273182	5732571	Linear alignment of Magnetic Anomalies M_FR_B3_0054-60 (11-43nT) running between 273060 5732386 and 273291 5732756. Probably a cable but not visible in SSS, bathymetric or intersecting SBP.	Medium	15
CA_2047	276108	5732177	SSS Anomaly S_FR_B3_5152 (3x3m)	Medium	20

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2048	278131	5731585	Mag Anomaly 31 (66nT) (line LMag_ROTV_0433_MMT_953_GRL_FR_MAG_R_A_GEO_S75_ALL)	Low	10
CA_2049	278052	5731317	Mag Anomaly 68 (633nT) (line LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10
CA_2050	279995	5730901	Mag Anomaly 67 (102nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL)	Low	10
CA_2051	280227	5730851	Mag Anomaly 66 (863nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2052	281081	5730668	Mag Anomaly 65 (1248nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly be environmental noise	Low	10
CA_2053	281118	5730660	Mag Anomaly 64 (1220nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10
CA_2054	281337	5730614	Mag Anomaly 63(1104nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10
CA_2055	281616	5730553	Mag Anomaly 62 (604nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2056	281892	5730494	Mag Anomaly 60 (155nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10
CA_2057	281950	5730482	Mag Anomaly 59 (543nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10
CA_2058	282594	5730455	SSS Anomaly S_FR_B3_5146 (4.7x1.4m)	Medium	15
CA_2059	282663	5730329	Mag Anomaly 57 (1916nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2060	283236	5730206	Mag Anomaly 56 (353nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10
CA_2061	284188	5730002	Mag Anomaly 54 (1946nT) (line: LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Low	10
CA_2062	285780	5729945	SSS Anomaly S_FR_B4_5138 (24x1.9m)	Medium	20
CA_2063	286018	5729689	SSS Anomaly S_FR_B4_5136 (4x0.6m)	Medium	20
CA_2064	286984	5729403	SSS Anomaly S_FR_B4_5133 (3x0.4m)	Medium	15
CA_2065	288056	5729539	SSS Anomaly S_FR_B4_5124 (1.7x2m)	Medium	15
CA_2066	288768	5729058	SSS Anomaly S_FR_B4_5116 (1.7x2.2m)	Low	10
CA_2067	289465	5729018	SSS Anomaly S_FR_B4_5108 (4.7x0.6x0.1m))	Low	10
CA_2068	289710	5728894	SSS Anomaly S_FR_B4_5102 (2.6x0.6m)	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2069	289912	5728845	SSS Anomaly S_FR_B4_5094 (1.8x1.8m) and S_FR_B4_5096 (2.7x0.8m))	Medium	20
CA_2070	289868	5728739	SSS Anomaly S_FR_B4_5097 (2.6x0.6m)	Low	10
CA_2071	289928	5728901	SSS Anomaly S_FR_B4_5095 (2.3x0.7x0.1m)	Low	10
CA_2072	290041	5729031	Mag Anomaly M_FR_B4_0064 (37nT)	Low	10
CA_2073	290417	5728952	Mag Anomaly M_FR_B4_0065 (28nT)	Low	10
CA_2074	291054	5728625	SSS Anomaly S_FR_B4_5085 (5.9x0.6m)	Medium	15
CA_2075	292487	5728623	Mag Anomaly M_FR_B4_0067 (80nT)	Low	10
CA_2076	302042	5727323	SSS Anomaly S_FR_B4_5028 (1.6x0.5m)	Low	10
CA_2077	302793	5726910	SSS Anomaly S_FR_B4_5003 (7.8x1.4m)	Low	15
CA_2078	303371	5726860	SSS Anomaly S_FR_B4_4978 (11x0.9m)	Low	12
CA_2079	303715	5726808	SSS Anomaly S_FR_B4_4949 (4.6x0.3m)	Low	10
CA_2080	303921	5726825	SSS Anomaly S_FR_B4_4932 (4.2x0.6m) and S_FR_B4_4934 (10x0.8m)	Medium	20
CA_2081	305354	5726848	SSS Anomaly S_FR_B4_4869 (0.8x0.8m)	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2082	306173	5726513	SSS Anomaly S_FR_B4_4837 (1.8x1m) – possible cable	Low	25
CA_2083	307222	5726617	SSS Anomaly S_FR_B4_4771 (8.3x1.8m)	Low	15
CA_2084	307234	5726505	SSS Anomaly S_FR_B4_4765 (1.4x1x0.4m) and S_FR_B4_4766 (4.2x1.2x0.4m)	Medium	10
CA_2085	307297	5726621	Mag Anomaly M_FR_B4_0079 (28nT) and SSS S_FR_B4_4760 (3x1.5x0.6m)	Medium	20
CA_2086	309351	5726550	SSS Anomaly S_FR_B4_4686 (3x0.7x0.6m)	Low	10
CA_2087	311932	5726205	SSS Anomaly S_FR_B4_4578 (2x1x0.4m) and S_FR_B4_4579 (3.7x1x0.5m)	Low	10
CA_2088	313925	5726343	SSS Anomaly S_FR_B4_4436 (12.4x0.7x0.7m)	Low	15
CA_2089	314540	5726162	SSS Anomaly S_FR_B4_4411 (3.4x0.3x0.7m)	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2090	314691	5726459	SSS Anomaly S_FR_B4_4397 (1x0.8x0.5m) and S_FR_B4_4398 (3.6x0.7x0.6m)	Low	10
CA_2091	314864	5726386	SSS Anomaly S_FR_B4_4386 (3.4x0.6x0.4m)	Low	10
CA_2092	315834	5726531	SSS Anomaly S_FR_B4_4334 (5.5x0.8x0.4m)	Low	10
CA_2093	317457	5726088	SSS Anomaly S_FR_B4_4328 (14.3x1.1m)	Low	18
CA_2094	319171	5725939	SSS Anomaly S_FR_B4_4283 (3.8x0.8x0.2m)	Low	10
CA_2095	320269	5725795	SSS Anomaly S_FR_B4_4254 (18.8x3.4x0.6m)	Low	20
CA_2096	322833	5725690	Mag Anomaly M_FR_B4_0084 (90nT)	Low	15
CA_2097	324624	5725607	SSS Anomaly S_FR_B4_4093 (4.5x0.9x0.3m)	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2098	328898	5725020	Mag Anomaly M_FR_B5_0088 (10nT) and SSS Anomalies S_FR_B5_3249 (2.2x1.6x0.3m) and S_FR_B5_3250 (2.3x1.6x0.6m)	Medium	20
CA_2099	328903	5724641	SSS Anomalies S_FR_B5_3227 (2.4x1.2x0.4m), S_FR_B5_3229 (3x1x0.5m) and S_FR_B5_3233 (0.5x0.4x0.3m)	Medium	20
CA_2100	330169	5724757	Mag Anomaly M_FR_B5_0092 (21nT) and SSS Anomaly S_FR_B5_3073 (4.7x2.2x0.8m)	Medium	15
CA_2101	331090	5724881	Mag Anomaly M_FR_B5_0093 (35nT)	Low	10
CA_2102	331221	5724881	Mag Anomaly M_FR_B5_0094 (21nT) and SSS Anomaly S_FR_B5_2789 (0.6x1.2x0.2m)	Medium	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2103	331314	5724874	Mag Anomaly M_FR_B5_0095 (12nT) and SSS Anomalies S_FR_B5_2779 (4.7x1.9x0.4m) and S_FR_B5_2780 (0.6x0.6x0.2m)	Medium	15
CA_2104	331691	5724937	Mag Anomaly M_FR_B5_0097 (15nT) and SSS Anomaly S_FR_B5_2691 (1x1.1m)	Medium	15
CA_2105	331779	5724944	Mag Anomaly M_FR_B5_0098 (10nT) and SSS Anomalies S_FR_B5_2666 (1.8x1.4x0.1m) and S_FR_B5_2667 (2.9x1.6x0.1m)	Medium	20
CA_2106	331963	5724783	Mag Anomaly M_FR_B5_0099 (39nT)	Low	10
CA_2107	334027	5724698	SSS Anomaly S_FR_B5_2470 (4.2x3.7x1.4m) and discrete bathymetric depression (7x2x1.4m)	Low	10
CA_2108	339904	5725799	Mag Anomaly M_FR_B5_0140 (43nT)	Low	10
CA_2109	342555	5726122	Mag Anomaly M_FR_B5_0165 (69nT) with bathymetric depression 5x4m	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2110	343297	5726101	SSS Anomaly S_FR_B5_0672 (3x1.5x0.5m) with bathymetric depression 8x6m	Low	10
CA_2111	344397	5726068	Mag Anomaly M_FR_B5_0173 (26nT)	Low	10
CA_2112	344540	5725990	Mag Anomaly M_FR_B5_0178 (33nT) and SSS S_FR_B5_0554 (5x1.5x0.5m)	Medium	15
CA_2113	344577	5726064	Mag Anomaly M_FR_B5_0180 (54nT)	Low	10
CA_2114	344538	5725832	Mag Anomaly M_FR_B5_0177 (21nT) and SSS S_FR_B5_0553 (2.5x1.3x0.5m)	Medium	20
CA_2115	344958	5726015	Mag Anomaly M_FR_B5_0190 (48nT)	Low	10
CA_2116	346355	5725569	SSS Anomaly S_FR_B5_0443 (4.5x2.6x0.6m)	Medium	15
CA_2117	346746	5725610	Mag Anomaly M_FR_B5_0235 (49nT) and SSS S_FR_B5_0439 (1.1x0.9x0.7m)	Medium	20

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2118	347825	5724428	Mag Anomaly M_FR_B5_0242 (91nT) and SSS S_FR_B5_0232 (1.1x0.9x0.6m)	Medium	15
CA_2119	348269	5724503	Mag Anomaly M_FR_B5_0245 (51nT) with north-south bathymetric high (25x5m)	Medium	20
CA_2120	348826	5723989	Mag Anomaly M_FR_B5_0252 (57nT)	Low	10
CA_2121	348942	5723833	Mag Anomaly M_FR_B5_0253 (57nT)	Low	10
CA_2122	349318	5723865	Mag Anomaly M_FR_B5_0259 (38nT)	Low	10
CA_2123	349422	5723541	Mag Anomaly M_FR_B5_0263 (76nT)	Low	10
CA_2124	350544	5723612	Mag Anomaly M_FR_B5_0279 (102nT)	Low	10
CA_2125	351413	5723283	Mag Anomaly M_FR_B5_0283 (30nT)	Low	10
CA_2126	353806	5723080	Mag Anomaly M_FR_B5_0289 (52nT)	Low	10
CA_2127	354660	5723545	Mag Anomaly M_FR_B5_0293 (48nT)	Low	10
CA_2128	355103	5724821	Mag Anomaly M_FR_B5_0294 (47nT) and M_SB_B5_0297 (59nT)	Low	15
CA_2129	355523	5724792	Mag Anomaly M_SB_B5_0302 (34nT)	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2130	355577	5724886	SSS Anomaly S_SB_B5_0002 (2.4x2.2x0.8m)	Low	10
CA_2131	355428	5725009	Mag Anomaly M_SB_B5_0300 (589nT) and M_SB_B5_0301 (18nT)	Medium	15
CA_2132	355638	5725108	Mag Anomaly M_SB_B5_0304 (51nT)	Low	10
CA_2133	355684	5725180	Mag Anomaly M_SB_B5_0305 (39nT)	Low	10
CA_2134	355895	5725302	SSS Anoamly S_SB_B5_0001 (1.7x0.8x0.5m)	Low	10
CA_2135	356646	5725107	Mag Anomaly M_SB_B6_0337 (33nT) and 0338 (39nT)	Low	20
CA_2136	356607	5725482	Mag Anomaly M_SB_B6_0336 (56nT)	Low	10
CA_2137	356701	5725470	Mag Anomaly M_SB_B6_0341 (21nT) and 0342 (16nT)	Low	15
CA_2138	356713	5725437	Mag Anomaly M_SB_B6_0343 (27nT)	Low	10
CA_2139	356783	5725269	Mag Anomaly M_SB_B6_0347 (18nT) and 0350 (26nT)	Low	20
CA_2140	356930	5725371	Mag Anomaly M_SB_B6_0351 (22nT)	Low	10
CA_2141	247953	5760544	Mag Anomaly M_FR_B2_0030 (35nT)	Low	10

Anomaly ID	Easting WGS84 UTM 30N	Northing WGS84 UTM 30N	Description	Archaeological Potential	Proposed AEZ Radius (m)
CA_2142	248948	5757957	SSS Anomaly S_FR_B2_5195 (2.3x1.3m)	Low	10
CA_2143	271734	5732674	Mag Anomaly 74 (624nT) line LMag_ROTV_0435_MMT_953_GRL_FR_MAG_R_A_GEO_P205_-_ALL). Surveyors note this could possibly environmental noise	Medium	15
CA_2144	292544	5728421	SSS Anomaly S_FR_B4_5071 (3x1m)	Low	10
CA_2145	294845	5728270	SSS Anomaly S_FR_B4_5051 (10x1.4m)	Low	20
CA_2146	297191	5727947	SSS Anomaly S_FR_B4_5047 (3.7x1.7m)	Low	10
CA_2147	293864	5728196	SSS Anomaly S_FR_B4_5063 (4.3x1.8m)	Low	10
CA_2148	292683	5728736	Mag Anomaly M_FR_B4_0069 (21nT) and SSS S_FR_B4_5070 (2.3x1.5m)	Medium	20

Submerged palaeolandscape

4.52. A review of the SBP seismic survey data has identified 20 areas where features with archaeological potential are present along the Proposed Development (Cotswold Archaeology 2019). The distribution of these areas is shown in Figure 22 and described below. Illustrations of a selection of these areas, including corresponding SBP seismic lines, are provided in Appendix 4.

CA 3001

4.53. The sub-bottom survey shows a series of fills, up to 4.6m below the seabed, centred on 260600 5755500. These deposits show multiple phases of fills, with strong seismic reflectors at the base of the modern seabed sediments and channel fills.

CA 3002

4.54. A single wide channel is present in this area, centred on an area of low bathymetry, up to 5m deep and 1.5km wide. The deeper channel area shows at least two fills, with potentially coarser material on its southern margin.

CA 3003

4.55. Single channel, measuring up to 8m deep and 1km wide. The channel shows no internal reflectors.

CA 3004

4.56. Wide area showing many overlapping fills, up to 6.2m deep, suggesting multiple phases of sediment deposition

CA 3005 to 3010

4.57. Area of deep fill, up to 16m, with areas of onlap at the northwest and southeast margins. There are few internal reflectors in the main channel area. These features continue to the position of CA 3010, where they thin out below the modern seabed. At CA 3006 the multiple fills also show evidence of cross bedding, possibly indicating submerged bedforms.

CA 3011 to 3013

4.58. A series of shallow depressions are visible below the seabed within the area of St George’s Channel.

CA 3014 and 3015

4.59. Located on the eastern margins of the St George’s Channel, a series of intercutting features are visible below the seabed, indicating multiple phases of incision and deposition.

CA 3016 to 3019

4.60. Series of almost horizontal reflectors present below the modern seabed, some showing areas of deepening and some cross-bedding (CA 3017). The main seismic reflector thins out at the position of the re-route centred on 334430 5724670.

CA 3020

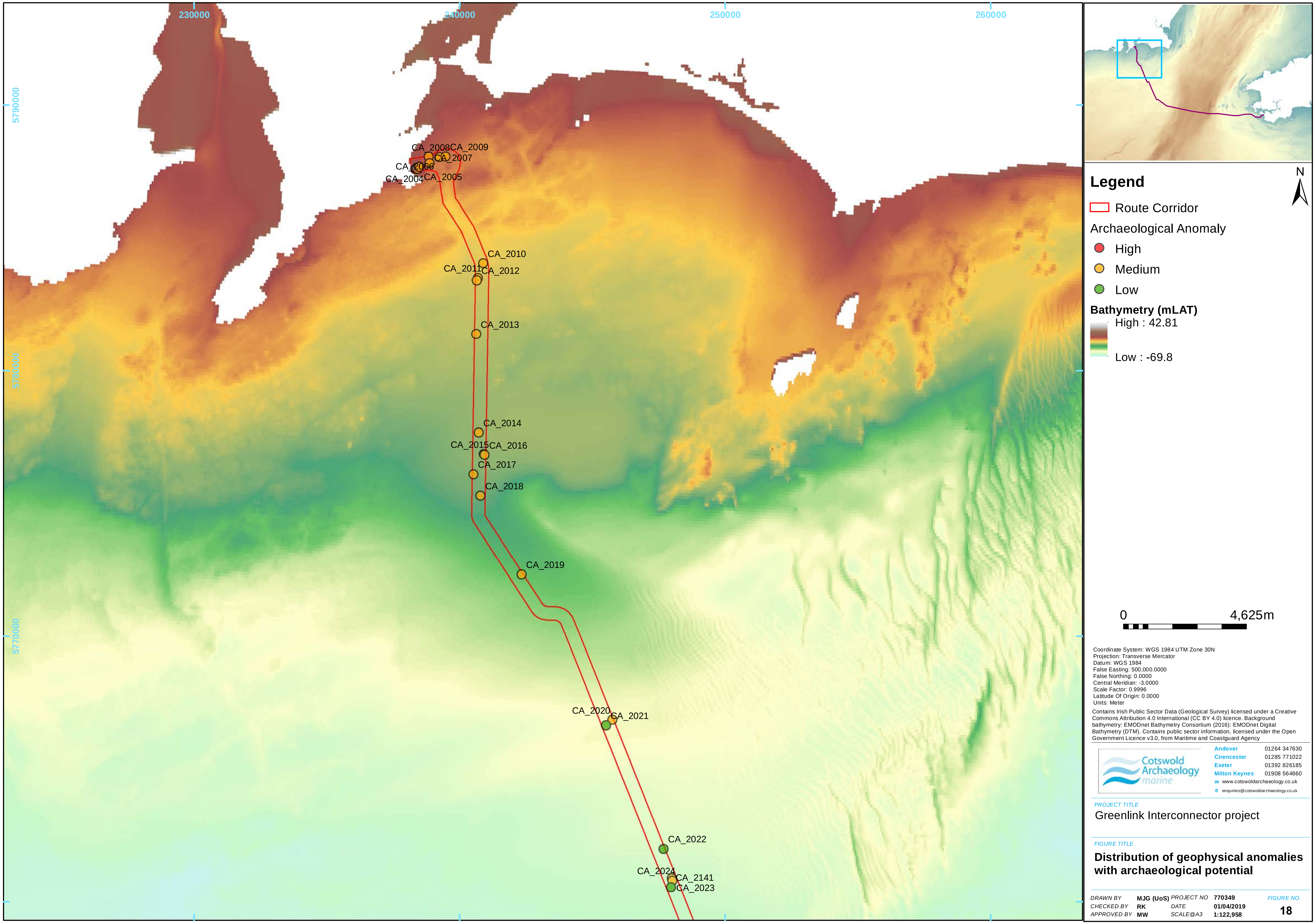
4.61. Series of shallow seismic reflectors below the modern seabed, with no clearly defined reflectors below this. West of this area, there are no strong seismic reflectors between CA 3019 and 3020.

5. CONCLUSIONS

5.1. The DBA recorded very little of archaeological interest on the foreshore of Baginbun Beach. This was confirmed by the walkover and metal-detecting surveys. All sites recorded in the DBA in the vicinity of the foreshore at Freshwater West were visited during the surveys. These included the wreck of the *Willemoes* (**CA2**), a heavy anti-aircraft battery (**CA3**) and a weapons pit (**CA4**). Neither CA2 nor CA4 were visible or apparent on the surface of the beach. The walkover and metal-detecting surveys revealed nothing of archaeological interest. The objects detected at both landfall locations displayed little patterning or archaeological potential and therefore seemed more indicative of casual losses.

5.2. The geophysical surveys of the Proposed Development were assessed for features containing archaeological potential. A series of channel areas and fills were found within the Proposed Development. However, these tended to be in deeper water and no clearly defined channel fills are preserved nearshore within the available datasets, with modern seabed sediments typically overlying bedrock or till deposits. It is probable that much of the channel fills within the offshore channels will comprise of glacio-marine deposits, which would have low archaeological potential.

5.3. Geophysical anomalies along the Proposed Development are of low to medium density, with no wreck sites identified within the available data. For each of the 148 archaeological anomalies identified, Archaeological Exclusion Zones (AEZs) have been defined (see Table 4).



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Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Contains Irish Public Sector Data (Geological Survey) licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence. Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM). Contains public sector information, licensed under the Open Government Licence v3.0, from Maritime and Coastguard Agency

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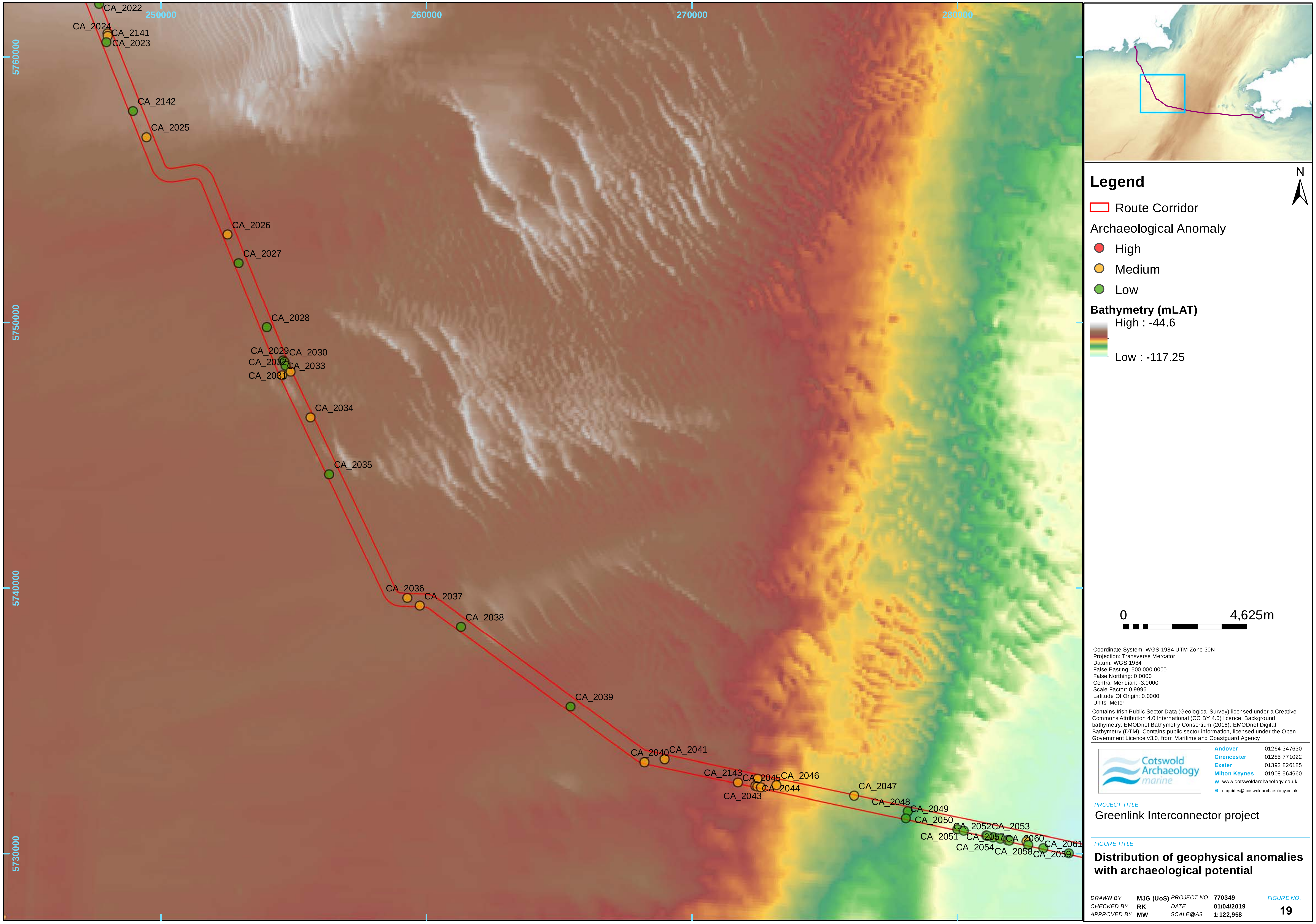
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Distribution of geophysical anomalies with archaeological potential

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	18
APPROVED BY	MW	SCALE@A3	1:122,958	



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Distribution of geophysical anomalies with archaeological potential

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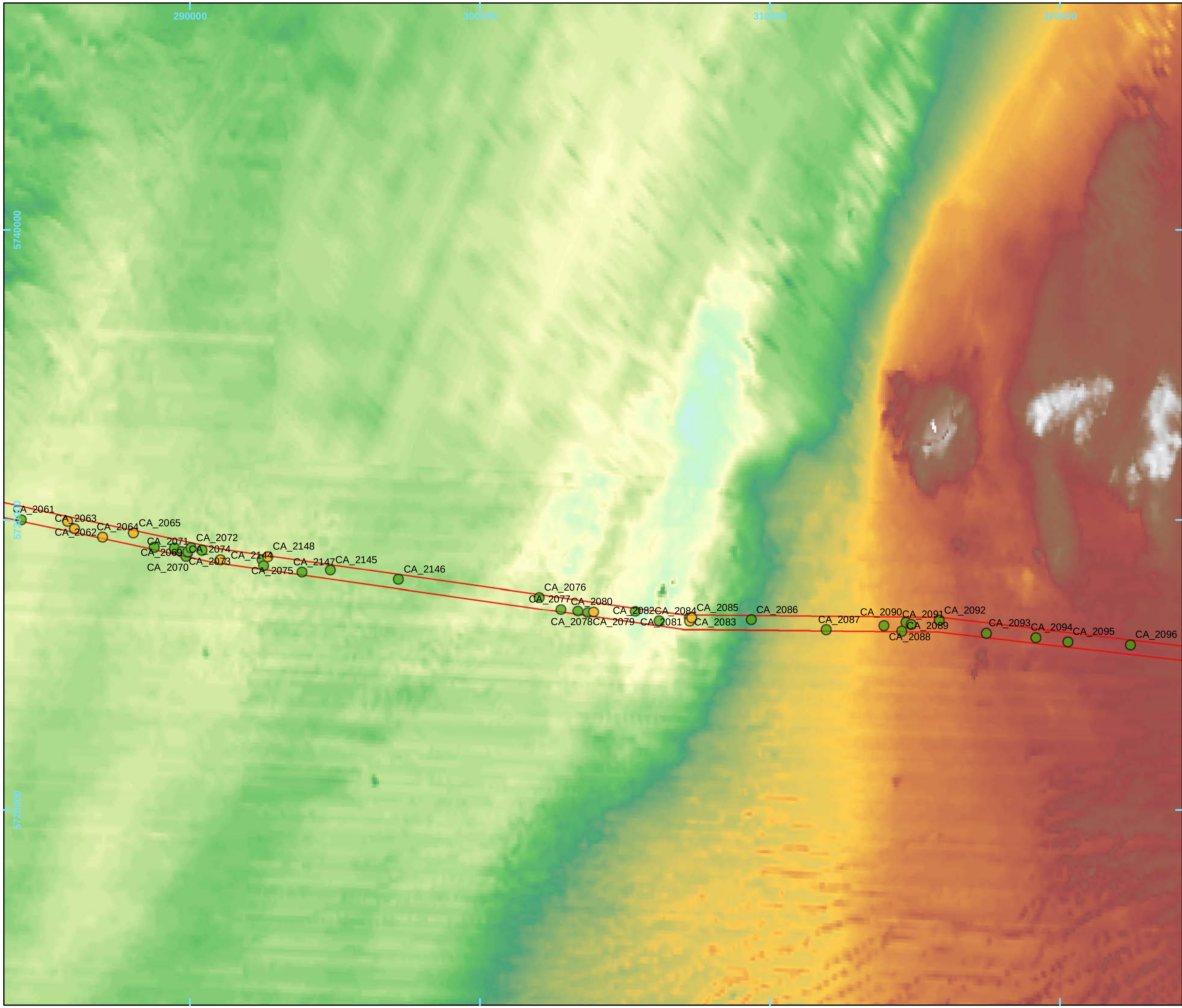
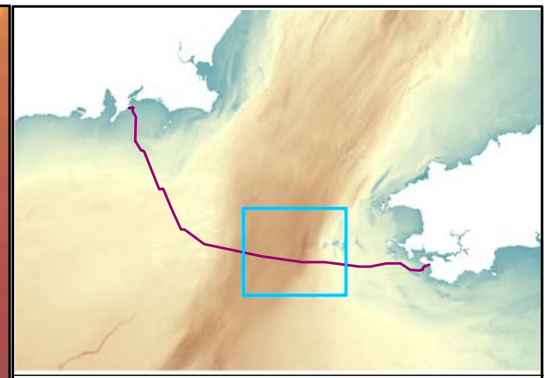
APPROVED BY	MW	SCALE@A3	1:122,958	





Legend

Route Corridor

Archaeological Anomaly

- High
- Medium
- Low

Bathymetry (mLAT)

High : -6.75

Low : -138.45

N

0 4,625m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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Distribution of geophysical anomalies with archaeological potential

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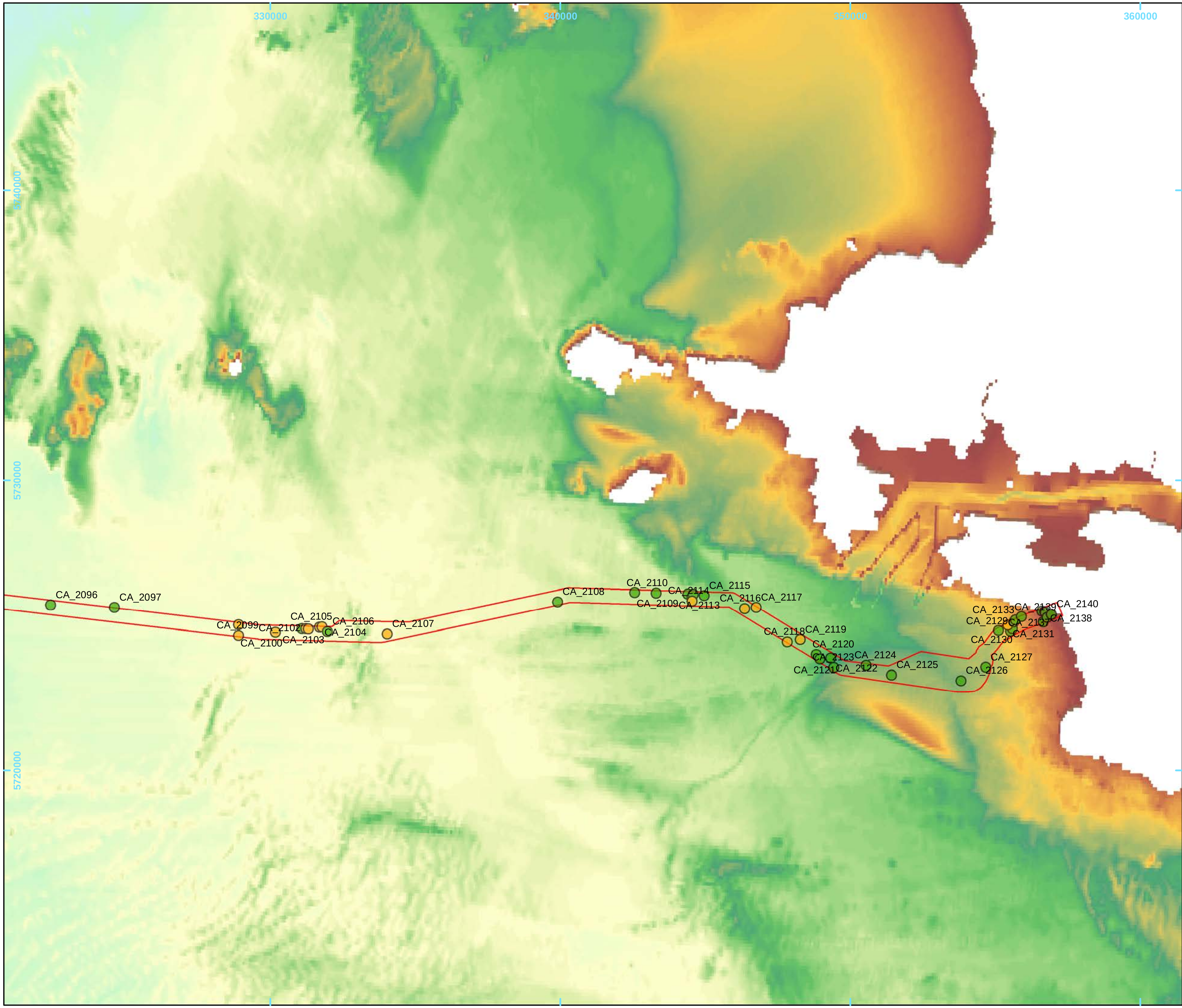
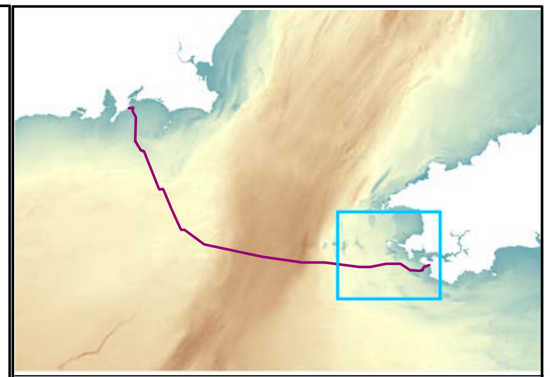
CHECKED BY	RK	DATE	01/04/2019	20
APPROVED BY	MW	SCALE@A3	1:122,958	





Legend

Route Corridor

Archaeological Anomaly

High

Medium

Low

Bathymetry (mLAT)

High : 58.67

Low : -78.4

N

0 4,625m

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Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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FIGURE TITLE

Distribution of geophysical anomalies with archaeological potential

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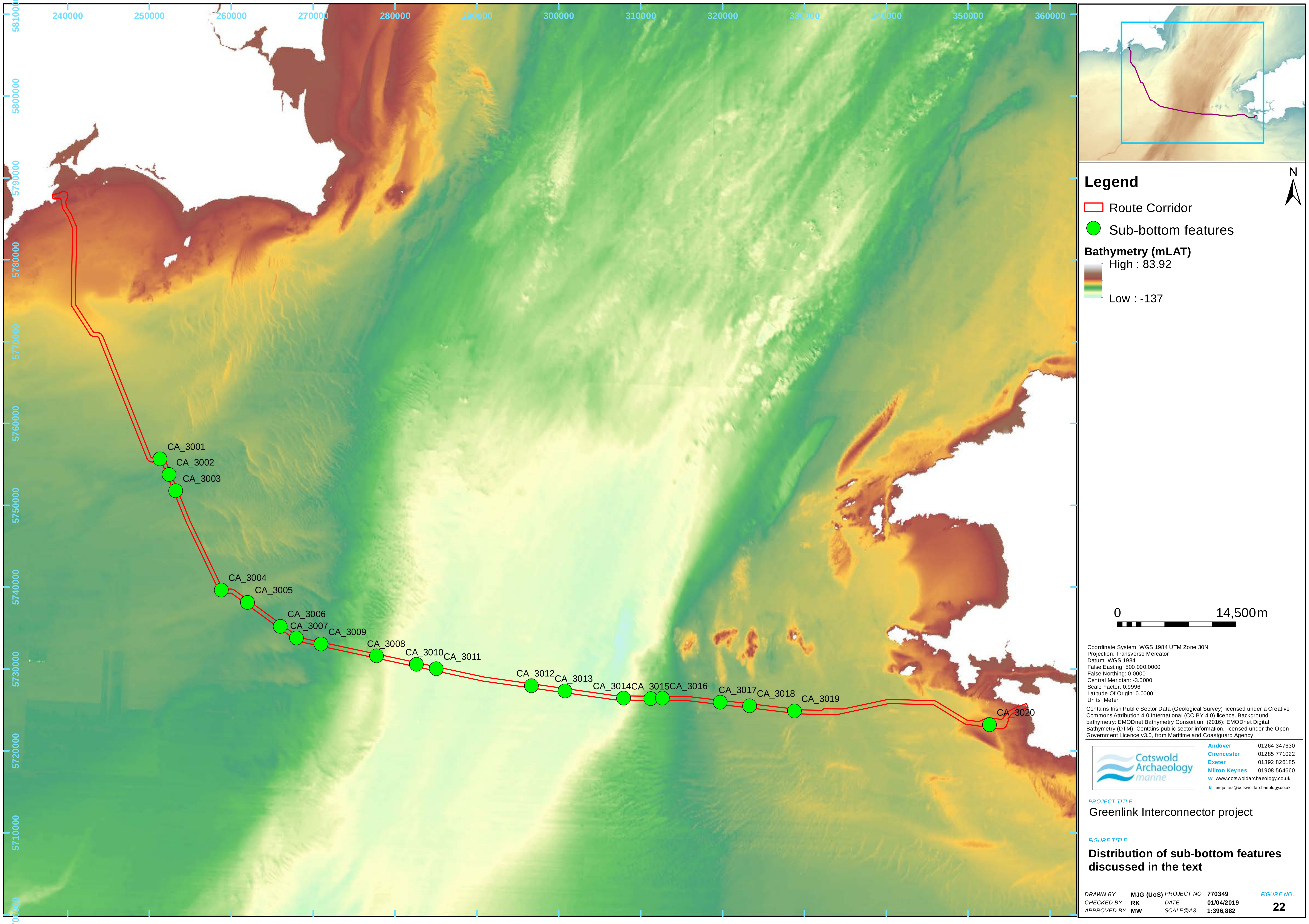
APPROVED BY	MW	SCALE@A3	1:122,958	



N

Legend

- Route Corridor
- Sub-bottom features

Bathymetry (mLAT)

High : 83.92

Low : -137

0 14,500m

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False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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FIGURE TITLE
Distribution of sub-bottom features discussed in the text

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APPROVED BY	MW	SCALE@A3	1:396,882

FIGURE NO.
22

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APPENDIX 1: ADDITIONAL WRECKS AND OBSTRUCTIONS

There are two areas centred on Freshwater Bay and Milford Haven (**CA8 & CA9**) that have been identified by the RCAHMW as areas which have higher potential to contain wrecks of vessels or downed aircraft. The following two tables include wrecks that have all been assigned similar loss co-ordinates in these areas. Recorded incidents at sea are often assigned arbitrary co-ordinates, usually coinciding with the corner of a grid square, when an incident is recorded in a particular location but no physical evidence of the incident (such as wreckage) has been found. This could be the result of poor recording of an incident, perhaps when lives were at risk, or no obvious landmark was visible. Alternatively, the wreckage could have been buried, dispersed or destroyed subsequently through the actions of natural forces in a dynamic environment.

Records associated with 'CA8'

Name	Type	Date	Latitude	Longitude	Source	Ref. No
UNNAMED WRECK	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273256
ENTERPRIZE	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272636
PRINCE WILLIAM	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272419
SWALLOW	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272591
SWAN	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272924
LEEBA	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272633
MARY	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273282
CATHARINE	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272420
HMS EVANGEL	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273185
WILLIAM AND MARY	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273526
CERES	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273521
ELIZABETH AND KITTY	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273371

Name	Type	Date	Latitude	Longitude	Source	Ref. No
FRIENDSHIP	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273523
ANT	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273376
FARMER	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273528
BARLEY CORN	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272822
HMS ACTIVE III	WRECK	MODERN	-5.14337	51.6434	RCAHMW	273167
THOMAS	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272687
ELVINA	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272759
HOLBERG	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273547
VICTORIA	WRECK	MODERN	-5.14337	51.6434	RCAHMW	272613
ILFRACOMBE	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272962
HMS LOCH SHIEL	WRECK	MODERN	-5.14337	51.6434	RCAHMW	273220
ROSE	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272800
BREEZE	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	272661
CHARLES	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	273373
OSPRAY	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	507154
FAVOURITE	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	507182
ELEANOR	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	507132
ENERGY	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	506301
TREDEGAR	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	518303
DETONATOR HOUSING FROM BRASS WRECK, PEMBROKESHIRE COAST	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	240920
EMBLEM	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	516187
SPECULATION	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	518321

Name	Type	Date	Latitude	Longitude	Source	Ref. No
UNNAMED WRECK	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	519166
NEW HOPE	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	518322
ARDENT	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	524912
OSPREY	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	525150
CYFARTHFIA	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	524861
GLEANER	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	524892
ROYAL OAK	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	525142
SISTERS	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	525168
ELLEN HUGHES	WRECK	POST MEDIEVAL	-5.14337	51.6434	RCAHMW	524864

Records associated with ‘CA9’

Name	Type	Date	Latitude	Longitude	Source	Ref. No
MARGARET ANN	WRECK	MODERN	-5.06336	51.6588	RCAHMW	273157
PRINCESS ELIZABETH	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	273340
BROTHERS	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	273396
HOPE	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	273362
DOVE	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	273478
THOMAS M REED	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	272601
BLESSING	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	272829
ASTRONOMER	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	273023
MARY ANN	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	273486
EXPRESS	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	272837
UNNAMED WRECK	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	272855

Name	Type	Date	Latitude	Longitude	Source	Ref. No
CHEROKEE	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	272857
VICKERS WELLINGTON XII MP638	AIR CRASH SITE	MODERN	-5.06336	51.6588	RCAHMW	515652
GRAM PARA	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	518276
BARABARA	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	524746
UNNAMED WRECK	WRECK	POST MEDIEVAL	-5.06336	51.6588	RCAHMW	515147

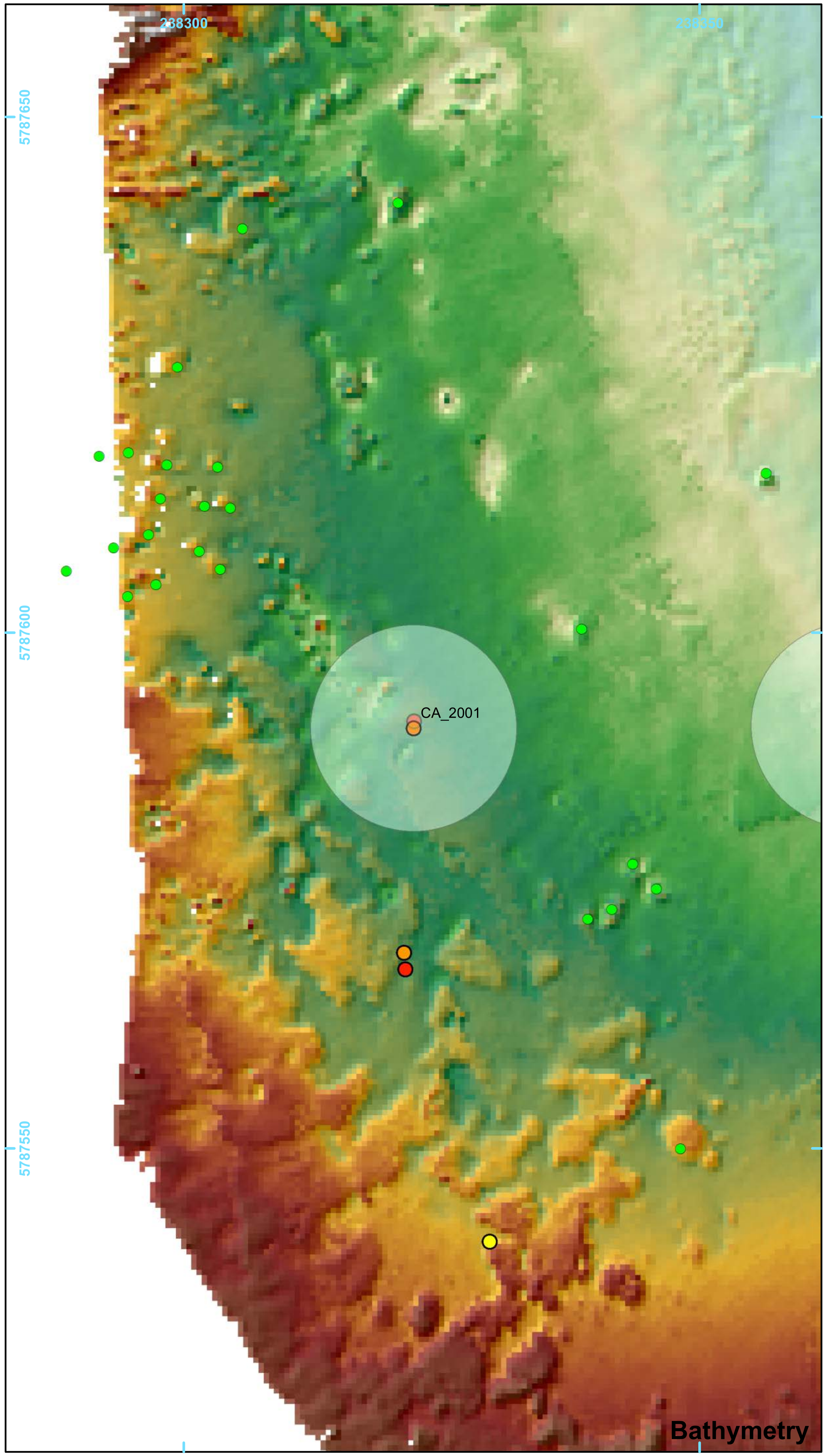
APPENDIX 2: WRECKS AND OBSTRUCTIONS RECORDED IN DBA FROM AREAS NO LONGER UNDER CONSIDERATION

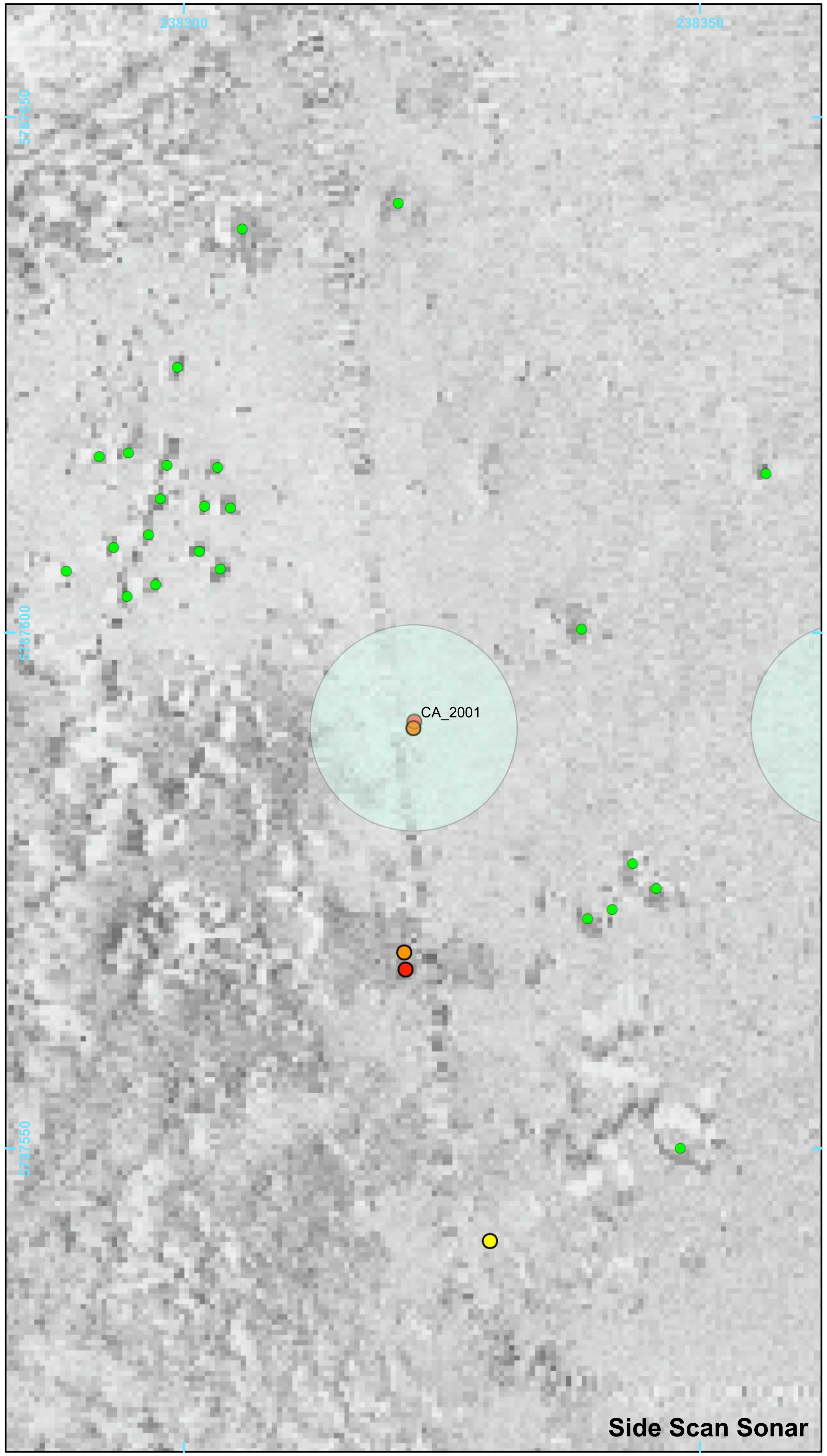
CA no.	Jurisdiction	Name	Type	Date	Status	Longitude	Latitude	Source & ref. no.
CA3	Wales	Heavy anti-aircraft battery (Scheduled Monument)	Structure	Modern	Live	-5.063615	51.66574	RCAHMW 270761 Cadw PE494
CA4	Wales	Weapons pit	Structure	Modern	Dead	-5.066337	51.66438	RCAHMW 270760 Dyfed HER 33440
CA6a CA6b	Wales	*Empire Beacon*	Wreck	Modern (1942)	Live	-5.30495	51.62373	OceanWise 1001695326 RCAHMW 506367
CA7	Wales	Submerged forest, Freshwater West	Site	Mesolithic	Live / Lifted	-5.060436	51.65723	RCAHMW 524740
CA10	Wales	*Ribicia*	Wreck	Modern (1929)	Dead	-5.62233	51.6419	RCAHMW 506493
CA11	Wales	*Young King*	Wreck	Post Medieval	Dead	-5.61243	51.6430	RCAHMW 518310

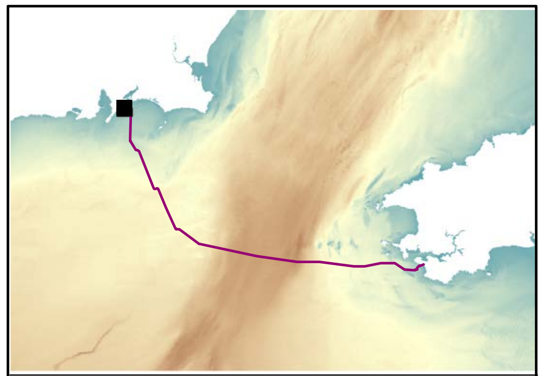
CA no.	Jurisdiction	Name	Type	Date	Status	Longitude	Latitude	Source & ref. no.
CA12	Wales	Seabed anomaly (man-made origin)	Find	Post Medieval	Dead	-5.35055	51.6494	RCAHMW 525235
CA18	Wales	*Hurst*	Wreck	Modern (1917)	Live	-5.34476	51.68934	OceanWise 1001695614 RCAHMW 273165
CA19	Wales	Unnamed wreck	Wreck	Unknown	Live	-5.33725	51.68377	OceanWise 1001826800
CA20	Wales	Porthole find, off Stokholm Island	Findspot	Unknown	Lifted	-5.35004	51.68442	RCAHMW 240749 RoW RCIM6/2/5
CA21	Wales	Unnamed site	Unknown	Unknown	Dead	-5.49143	51.68584	RCAHMW 506342
CA22	Wales	Unnamed wreck	Wreck	Unknown	Dead	-5.49177	51.68745	OceanWise 1001705787
CA23	Wales	Bristol Beaufighter VIF X8134	Aircraft	Modern (1943)	Dead	-5.66752	51.67118	OceanWise 1001705787

APPENDIX 3: GEOPHYSICAL ANOMALIES OF MEDIUM POTENTIAL

APPENDIX 3: GEOPHYSICAL ANOMALIES OF MEDIUM POTENTIAL







Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -0.89
  - Low : -3.35

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Contains Irish Public Sector Data (Geological Survey) licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence. Background bathymetry: EMODnet Bathymetry Consortium (2016): EMODnet Digital Bathymetry (DTM). Contains public sector information, licensed under the Open Government Licence v3.0, from Maritime and Coastguard Agency

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PROJECT TITLE
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FIGURE TITLE
Archaeological Anomaly CA_2001

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
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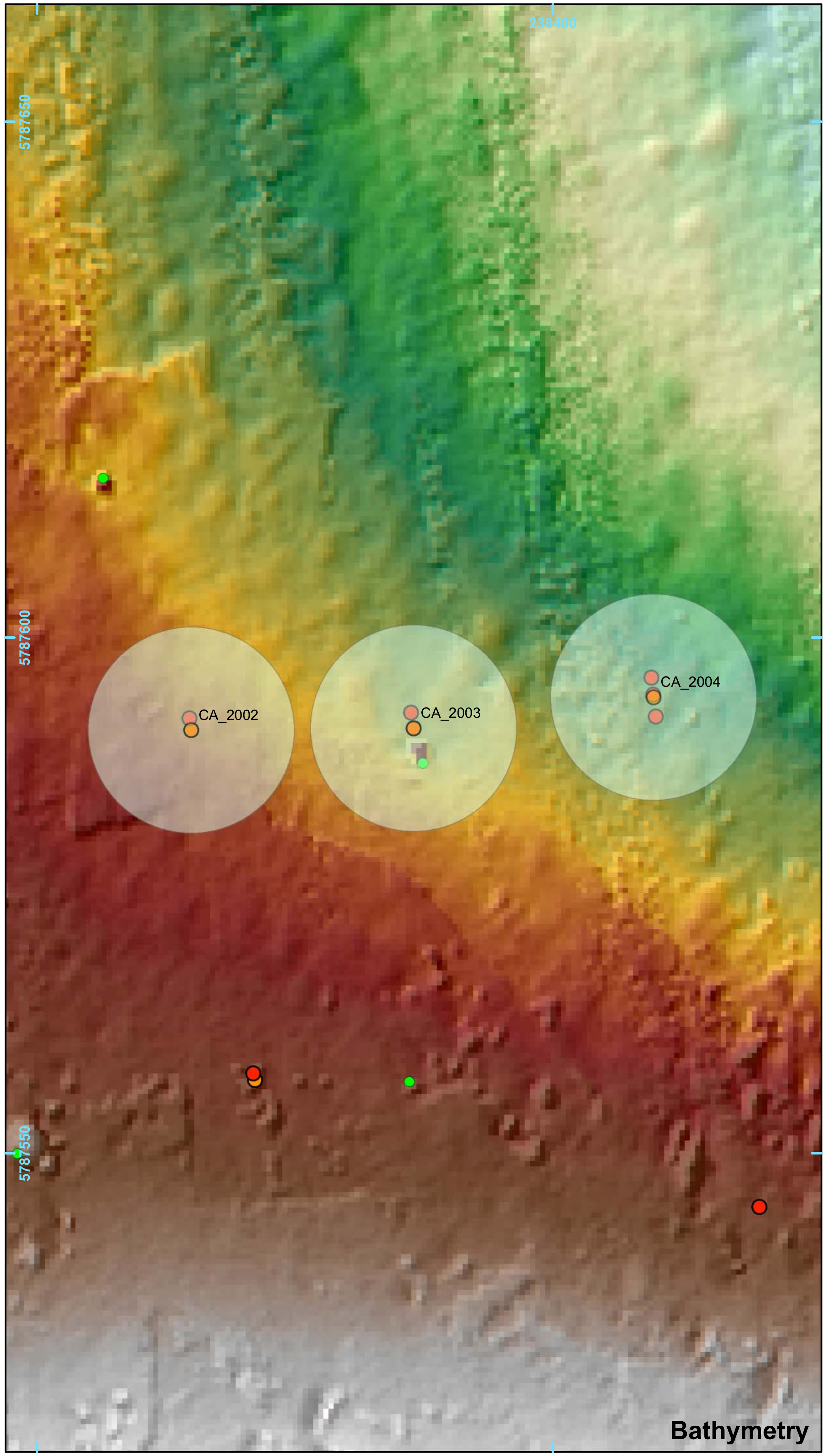

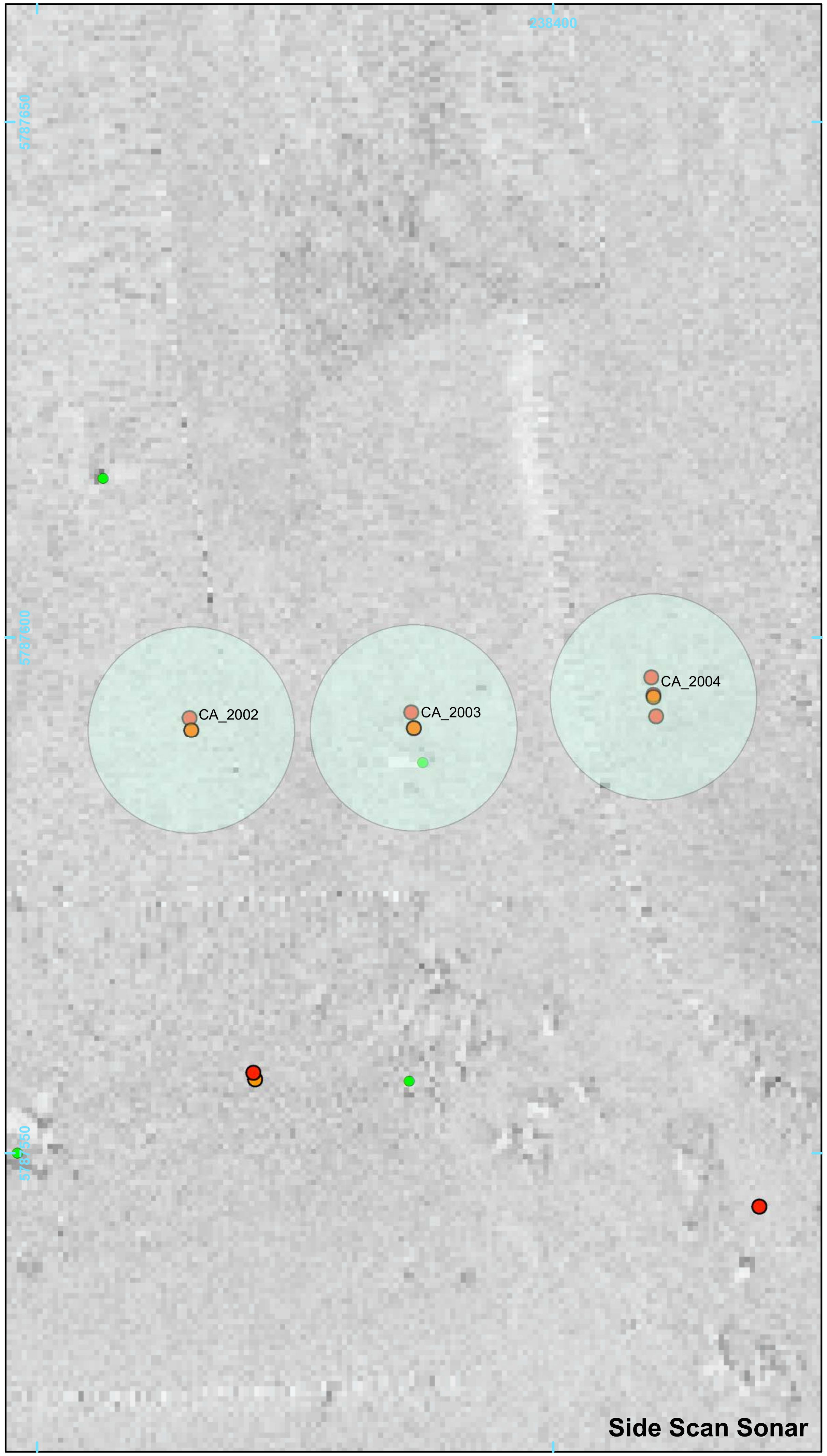

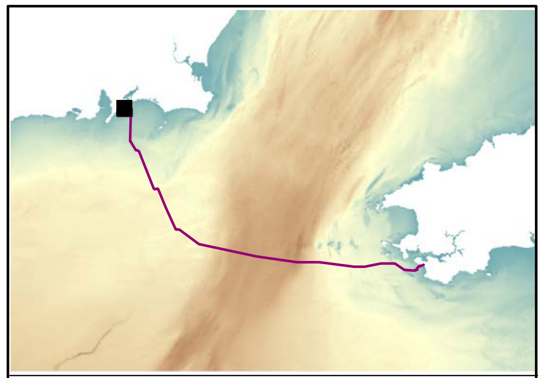

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -1.77
Low : -4.09

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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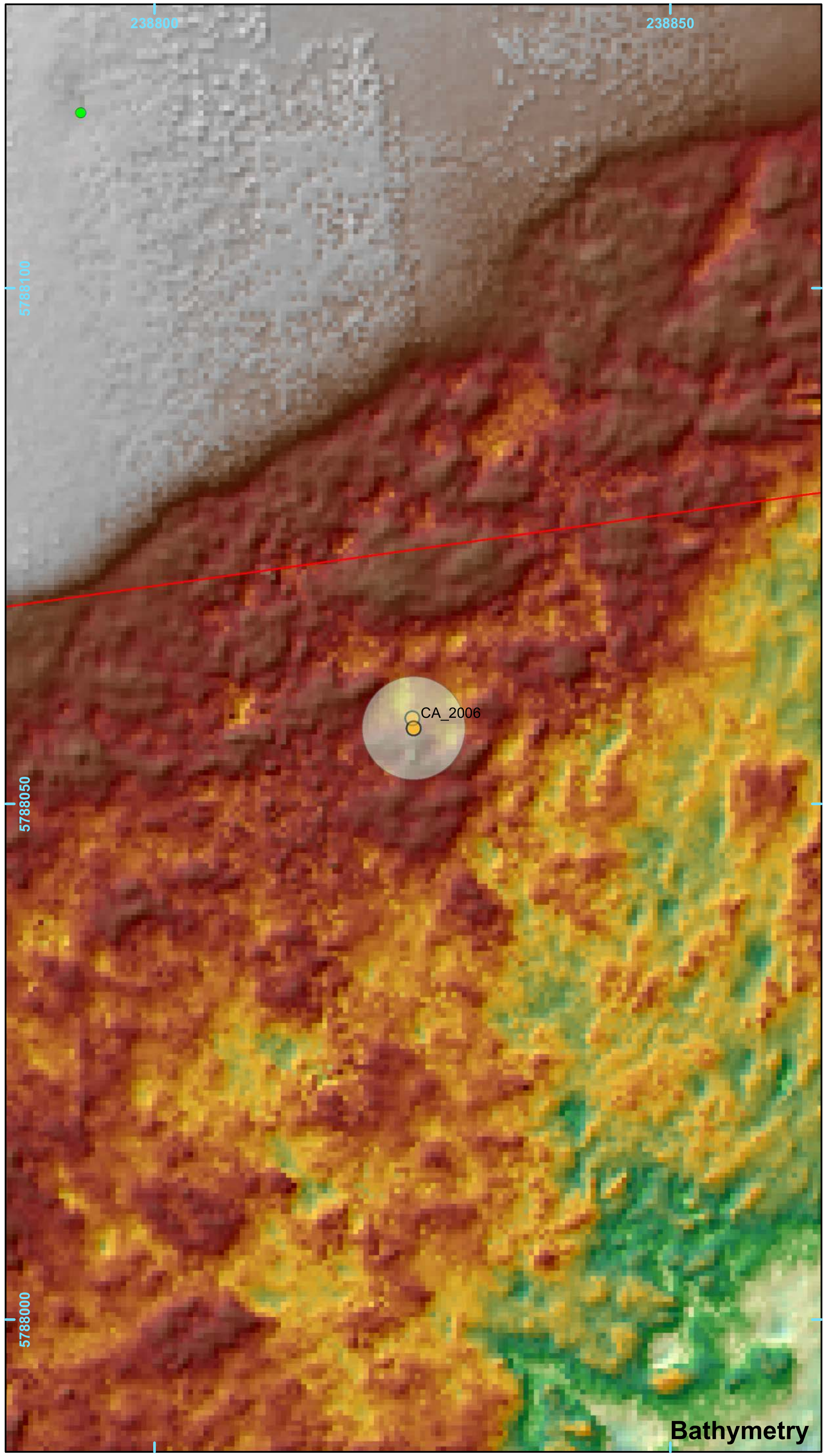
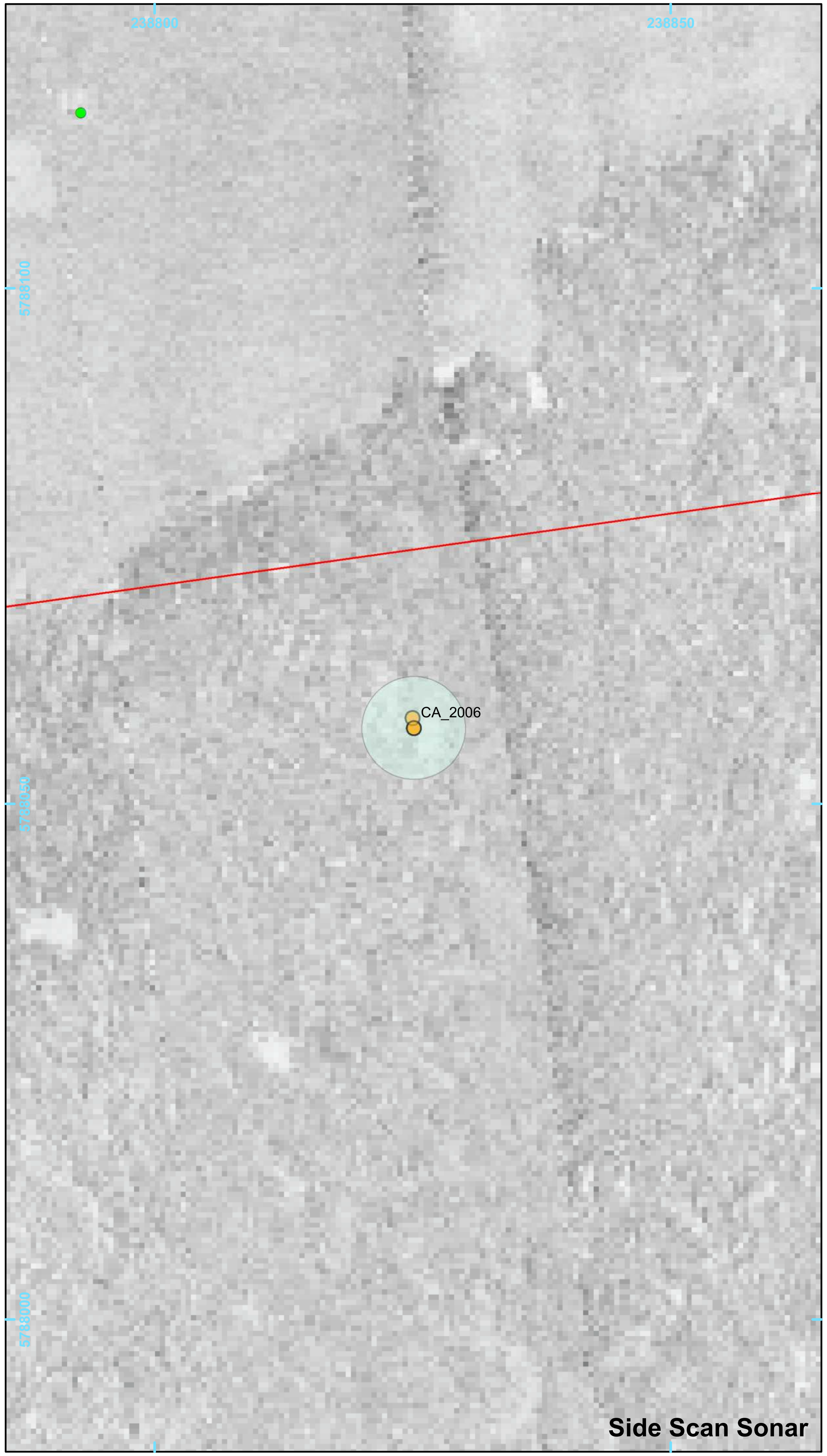
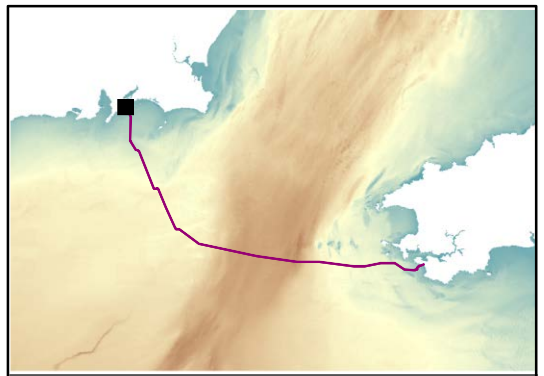
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2003 to CA_2005

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.2
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -9.22
Low : -11.42

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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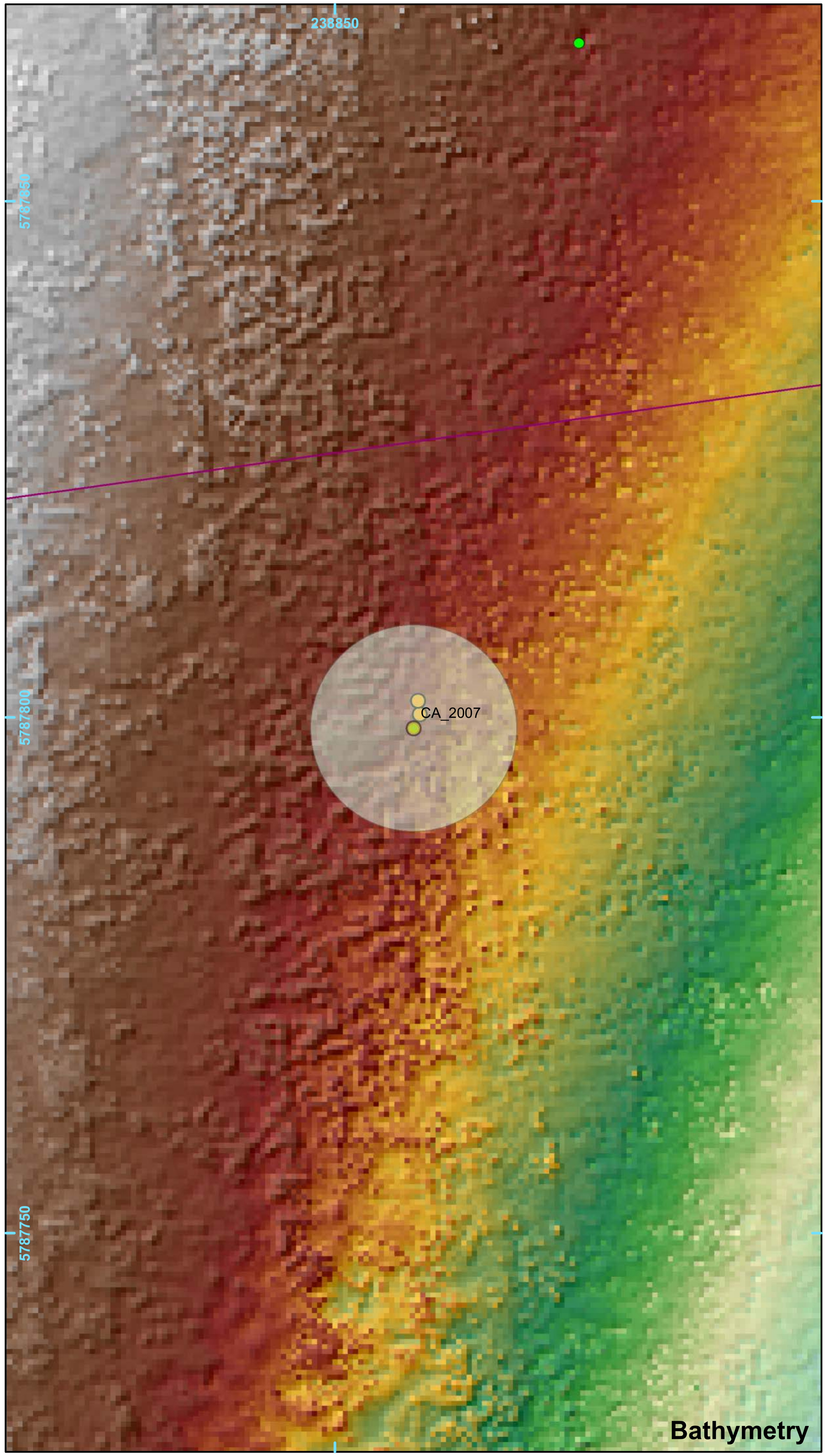
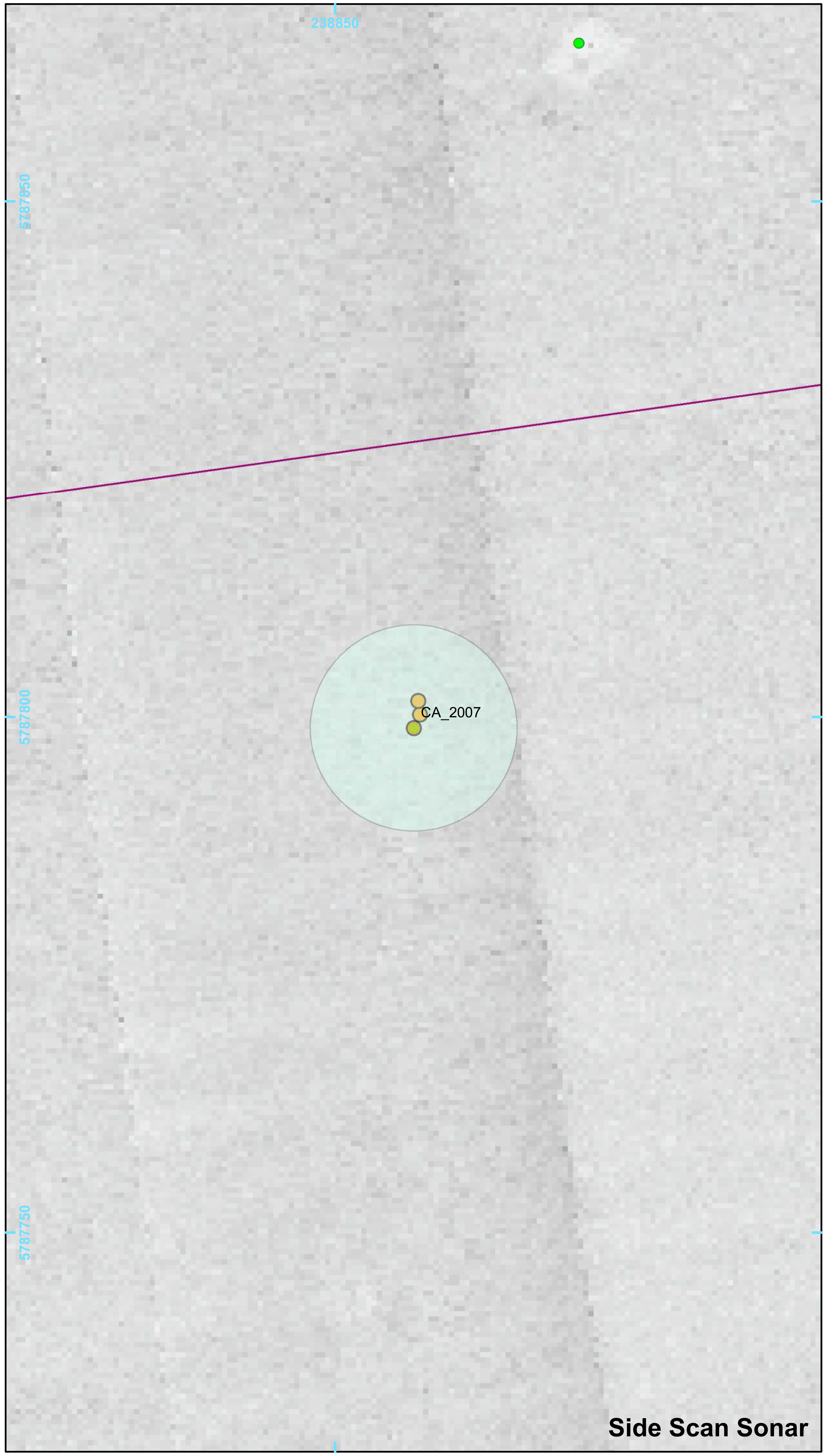
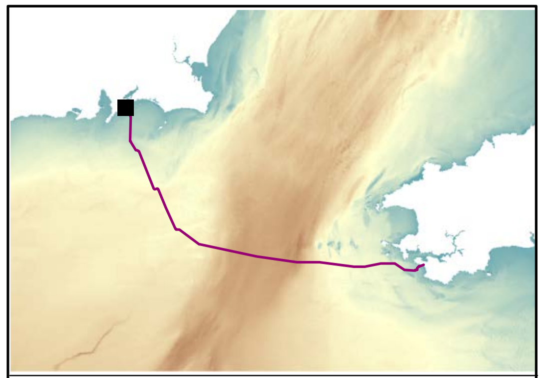
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2006

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.3
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -11.04
  - Low : -12.31

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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FIGURE TITLE
Archaeological Anomaly CA_2007

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.4
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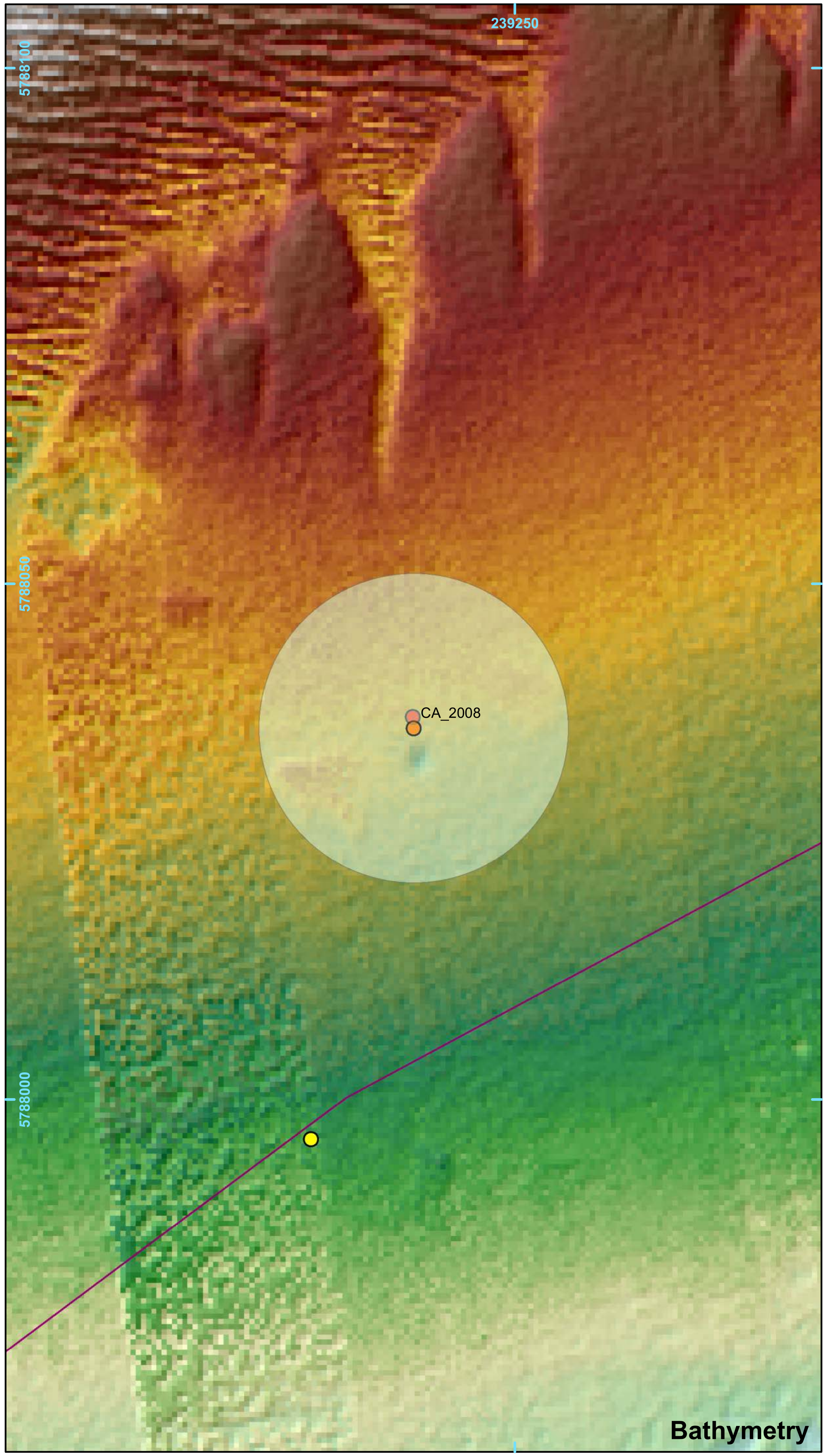

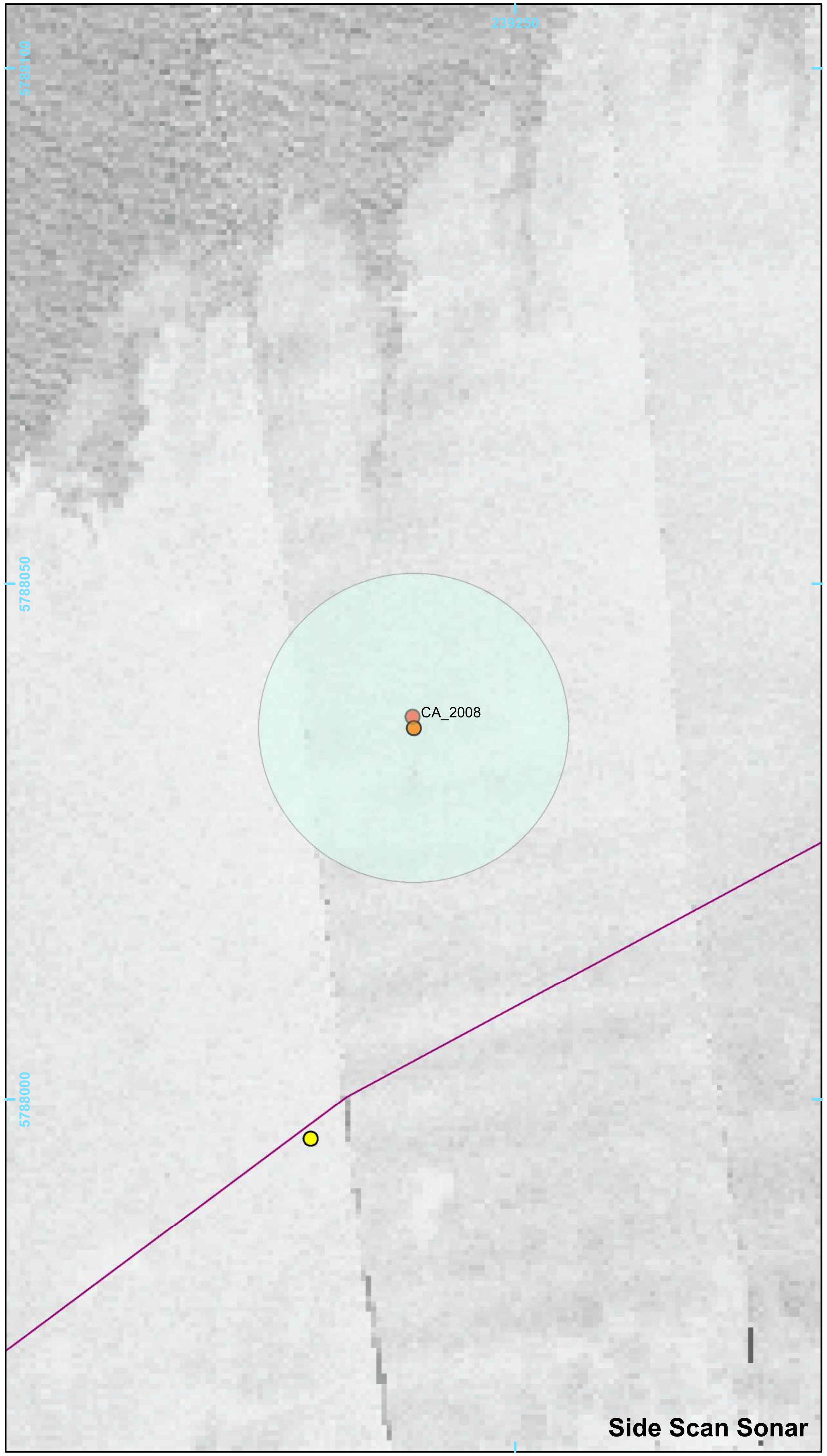

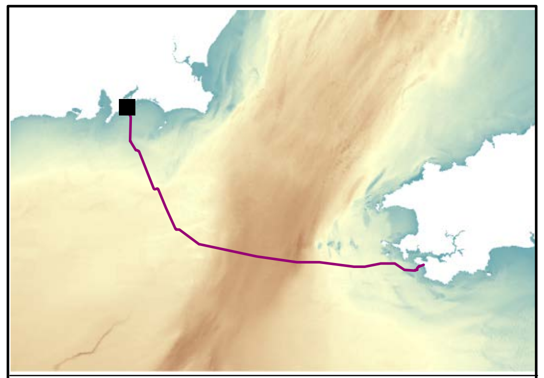

Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -12.52
  - Low : -13.64

N

0 17.5m

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False Easting: 500,000.0000
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Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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FIGURE TITLE
Archaeological Anomaly CA_2008

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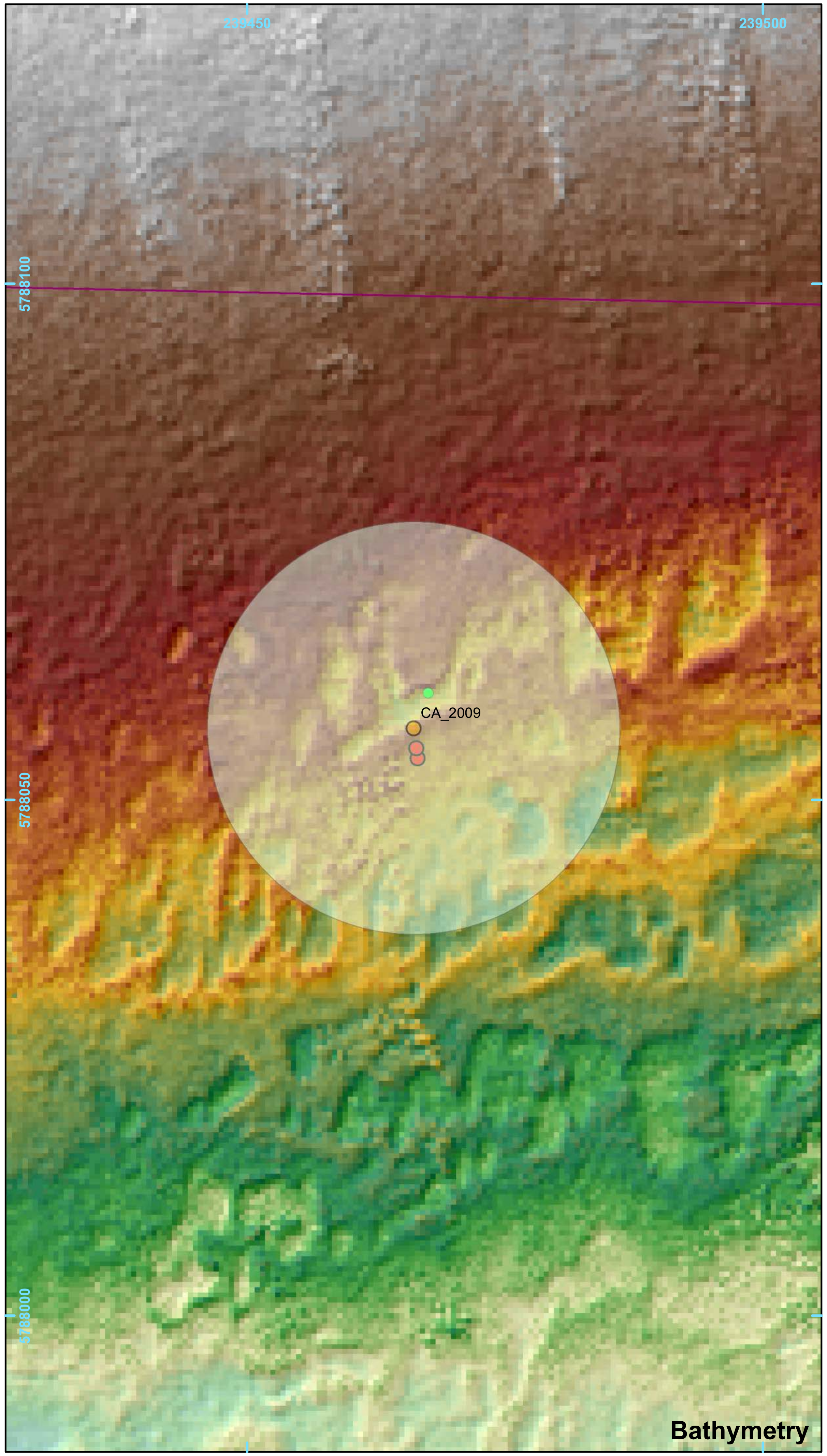

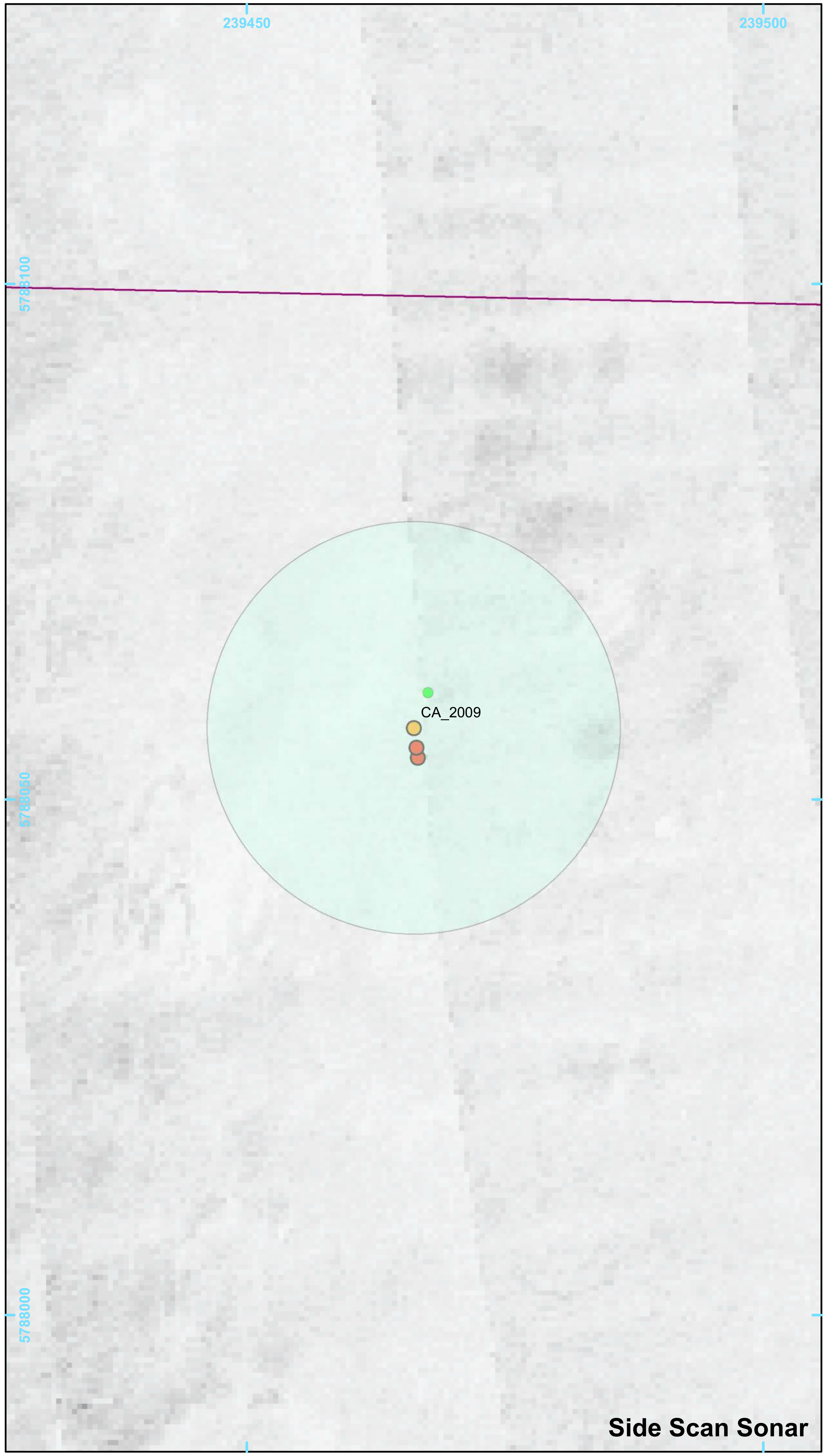

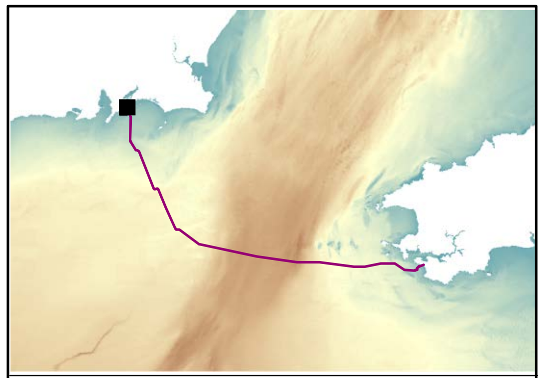

Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -13.16
  - Low : -13.93

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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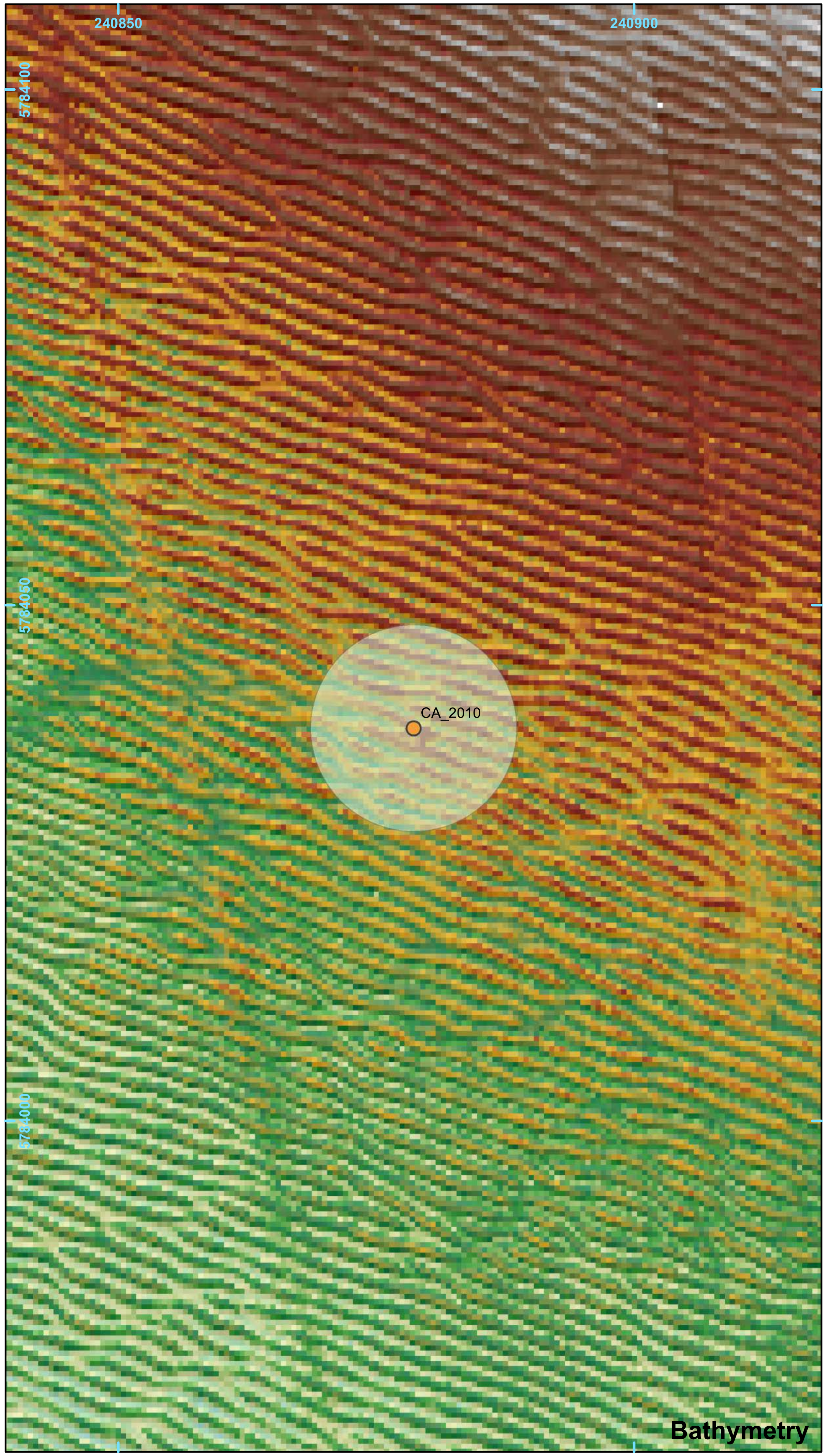
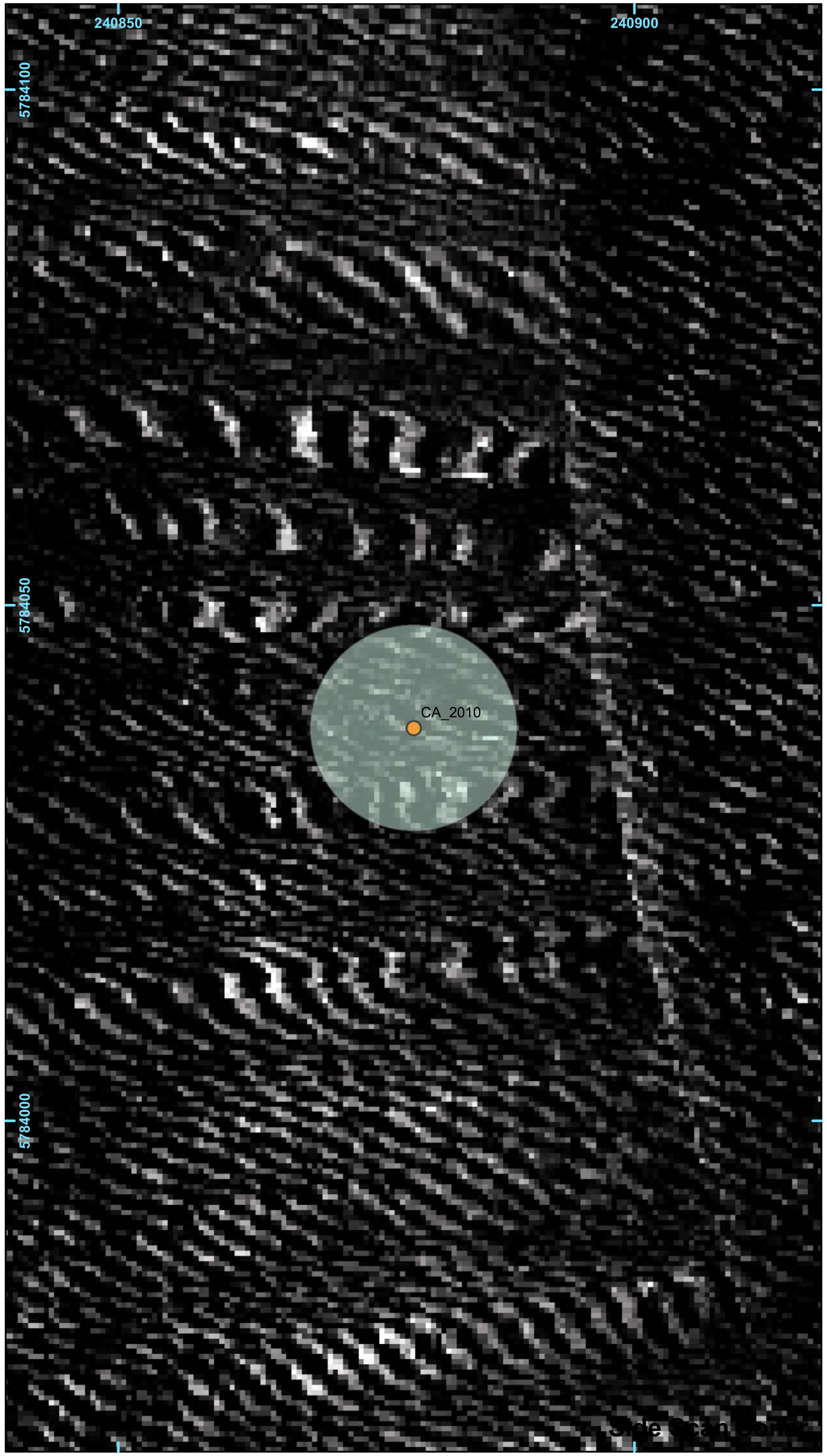
FIGURE TITLE
Archaeological Anomaly CA_2009

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.6
APPROVED BY	MW	SCALE@A3	1:500	





Legend

N

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)

High : -23.565

Low : -24.474

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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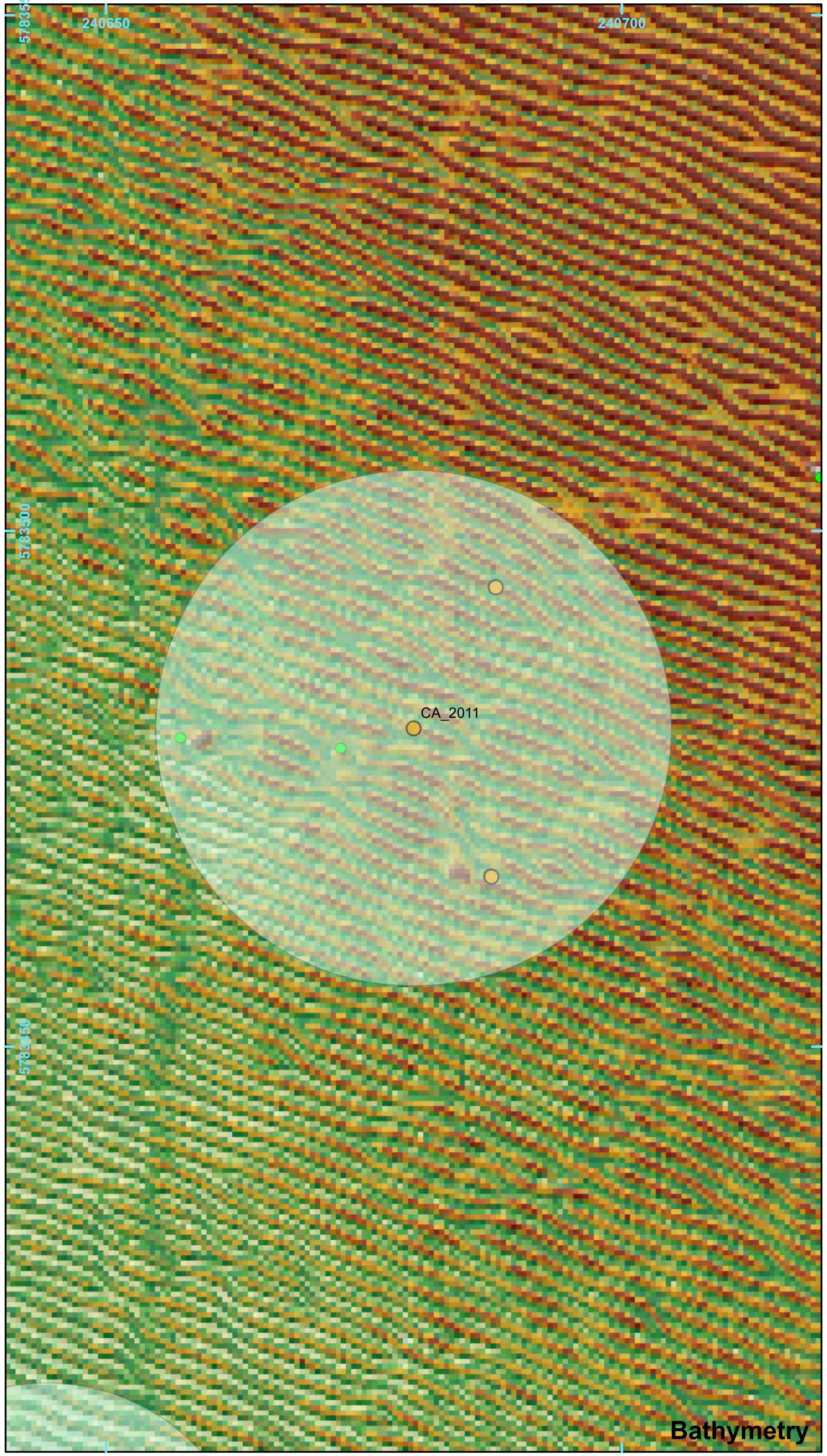
PROJECT TITLE

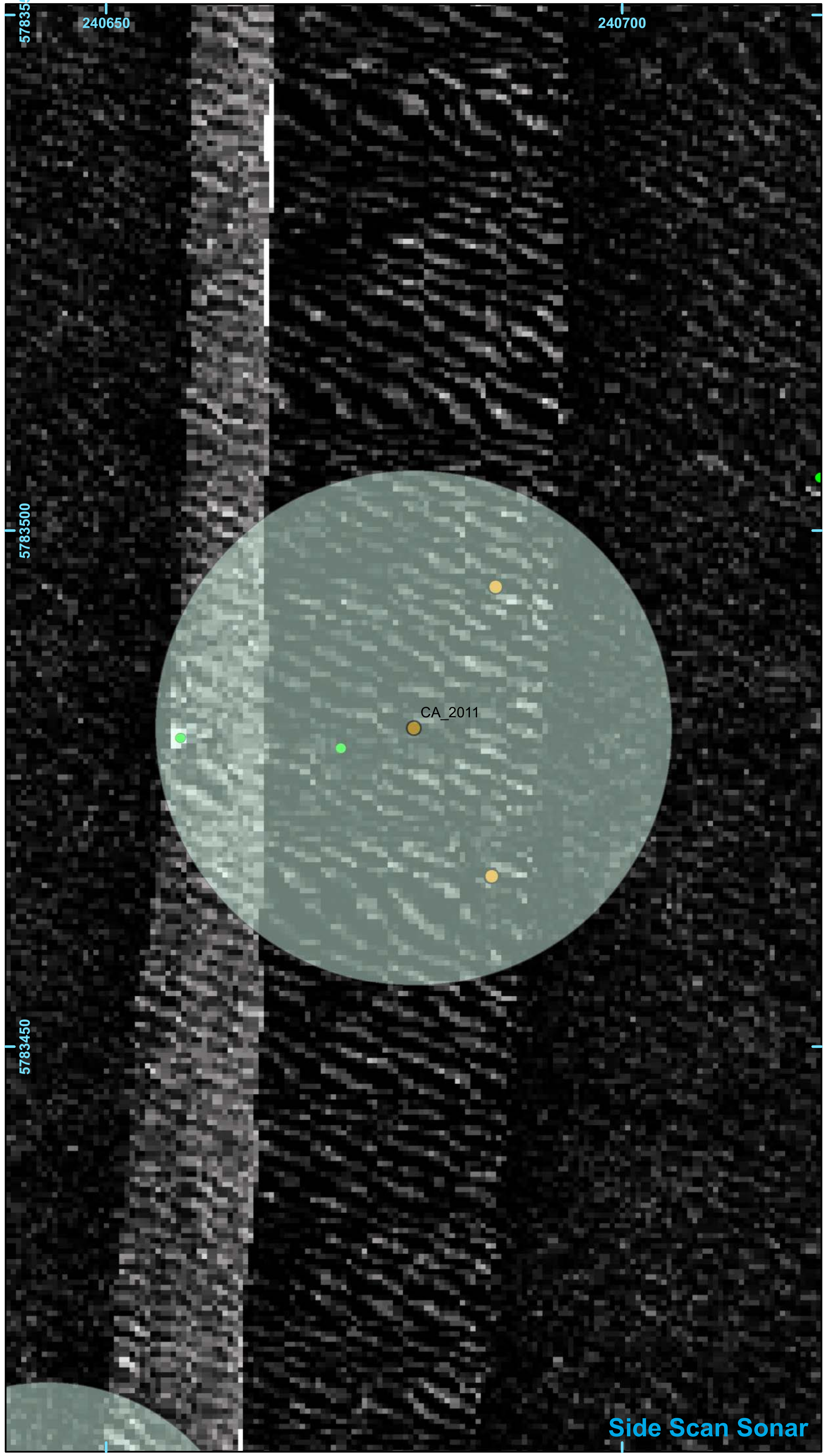
Greenlink Interconnector project

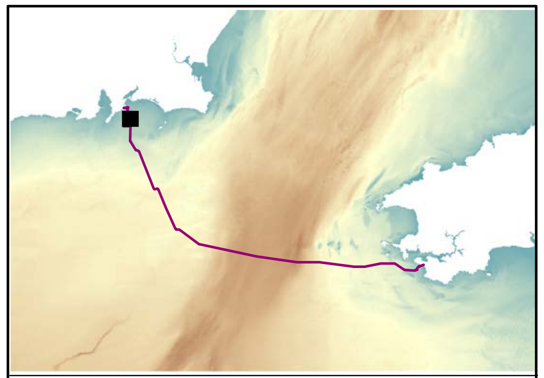
FIGURE TITLE

Archaeological Anomaly CA_2010

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.7
APPROVED BY	MW	SCALE@A3	1:500	







Legend

N

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -24.882
Low : -25.584

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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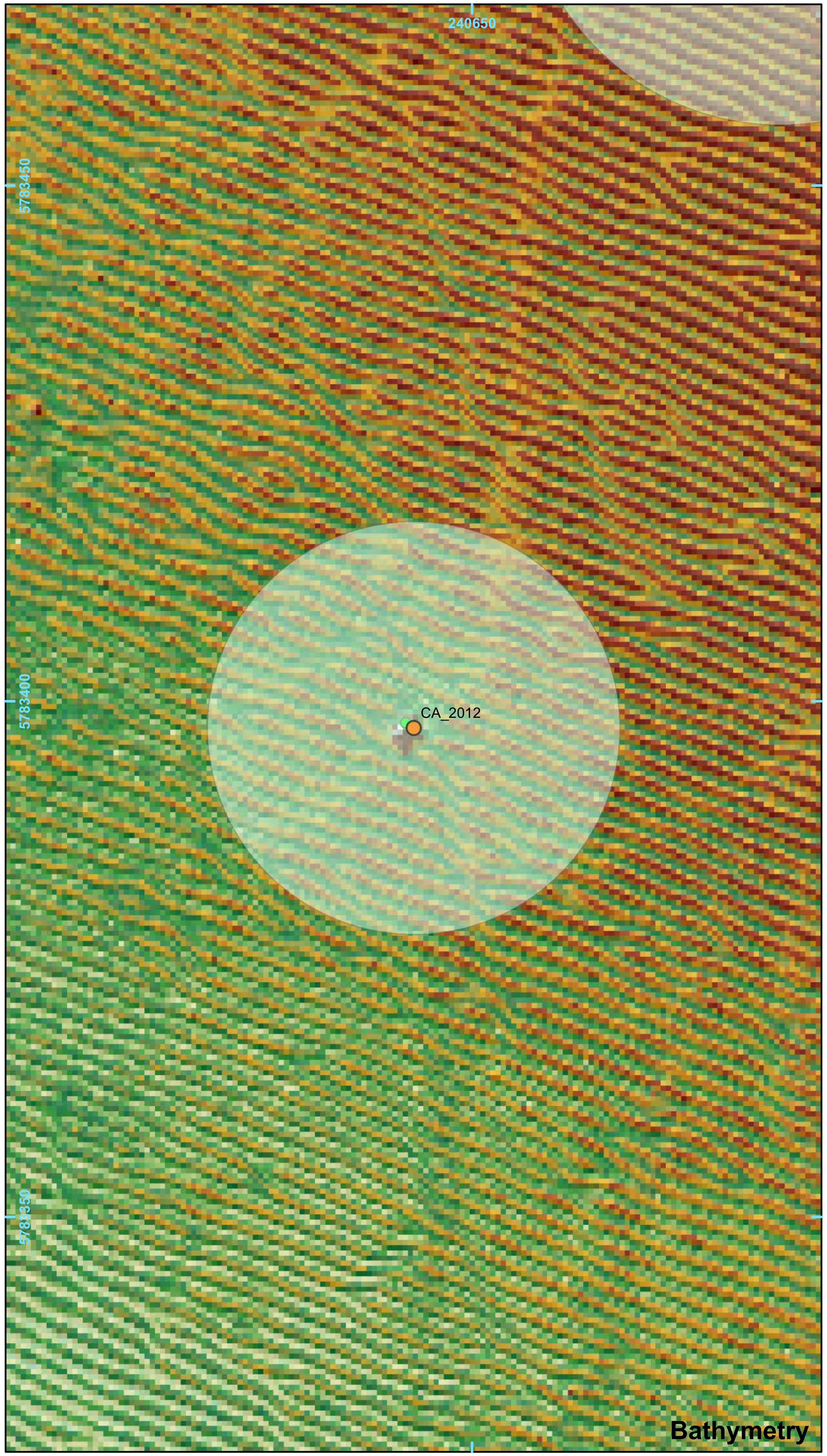
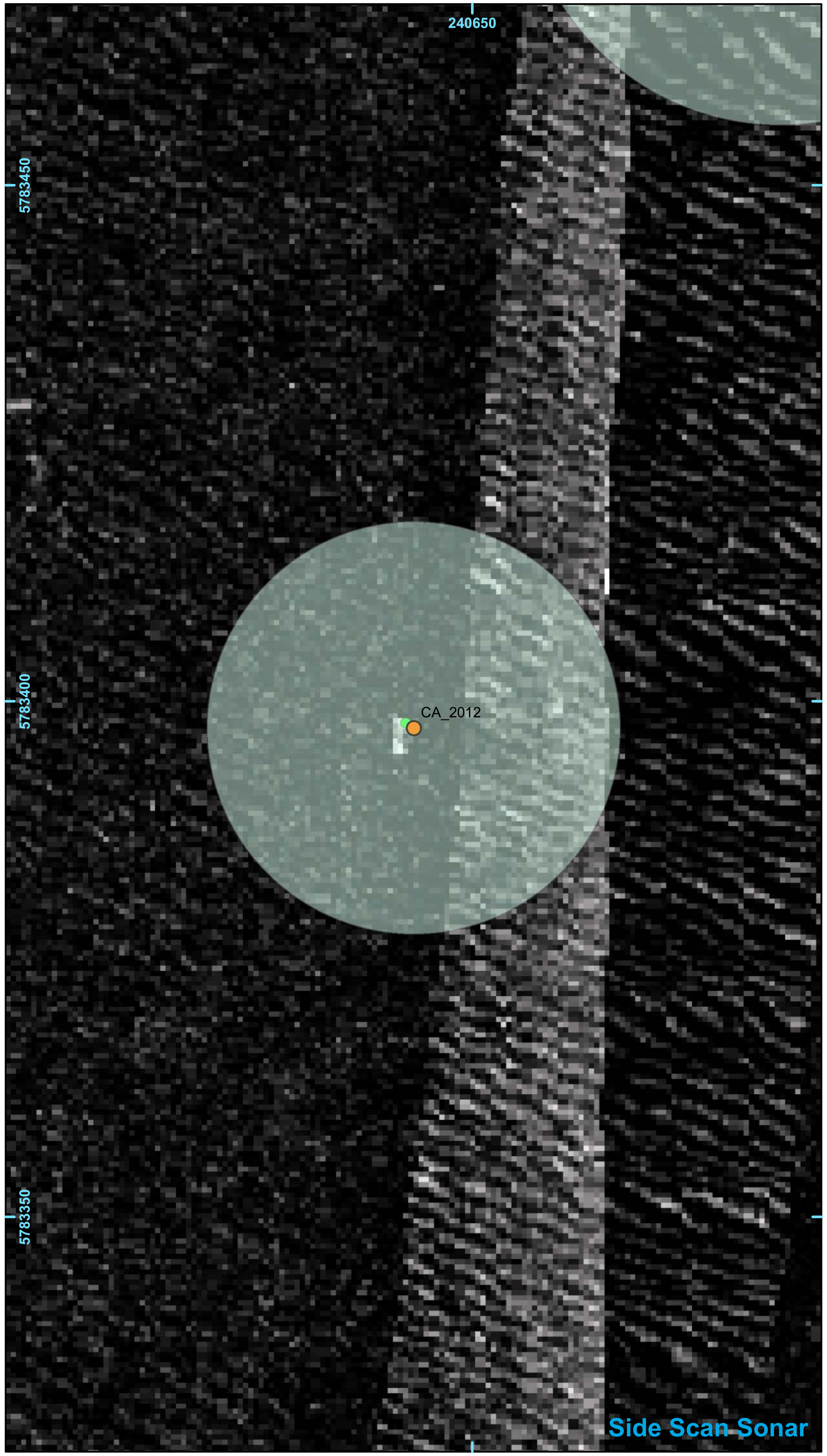
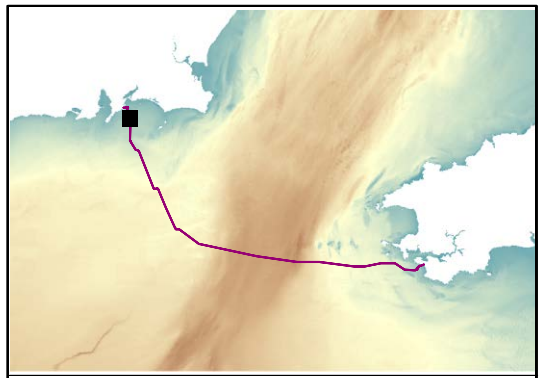
FIGURE TITLE
Archaeological Anomaly CA_2011

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.8
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -24.963
  - Low : -25.742

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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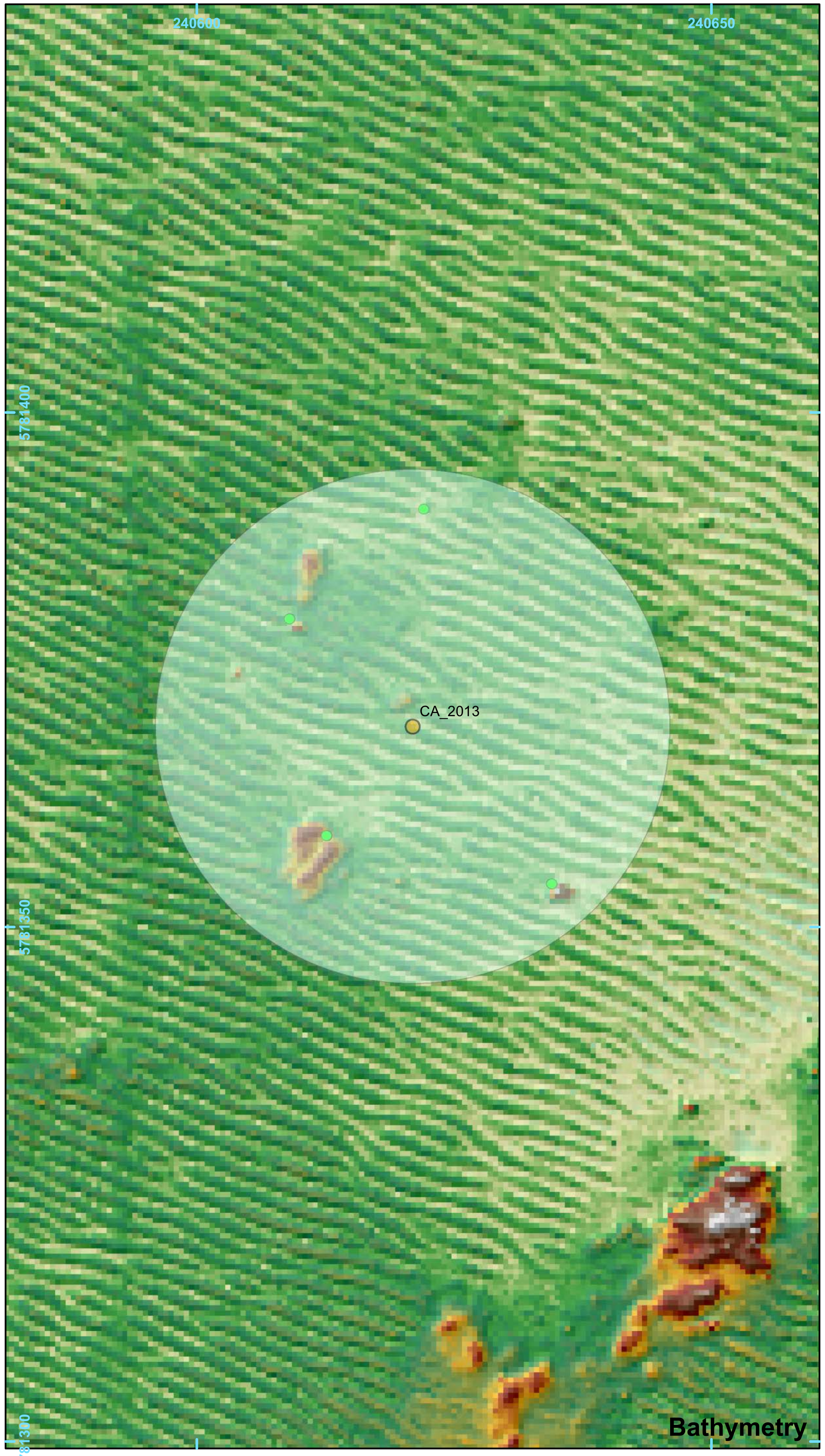
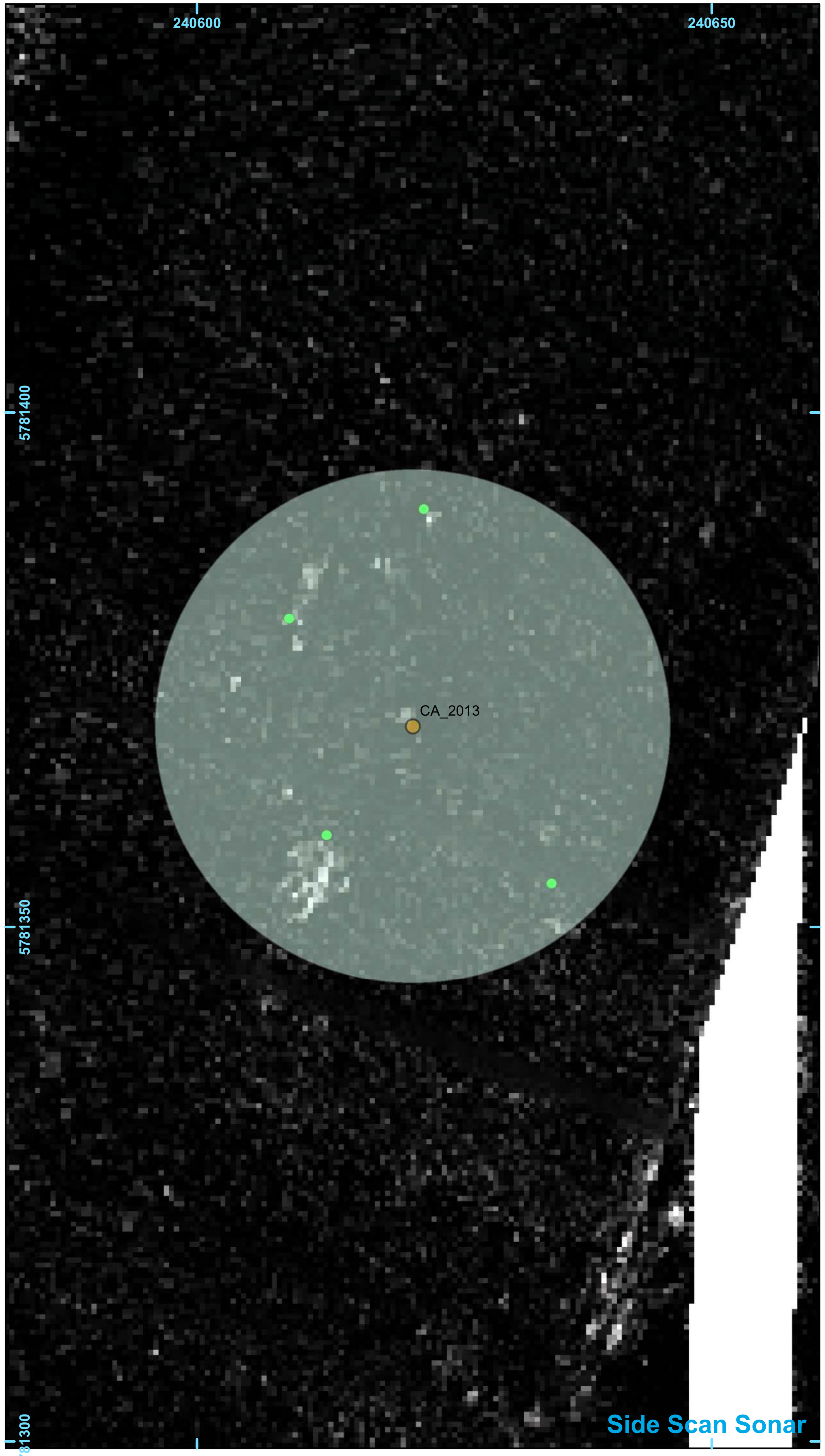
FIGURE TITLE
Archaeological Anomaly CA_2012

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.9
APPROVED BY	MW	SCALE@A3	1:500	





N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -27.026
Low : -28.396

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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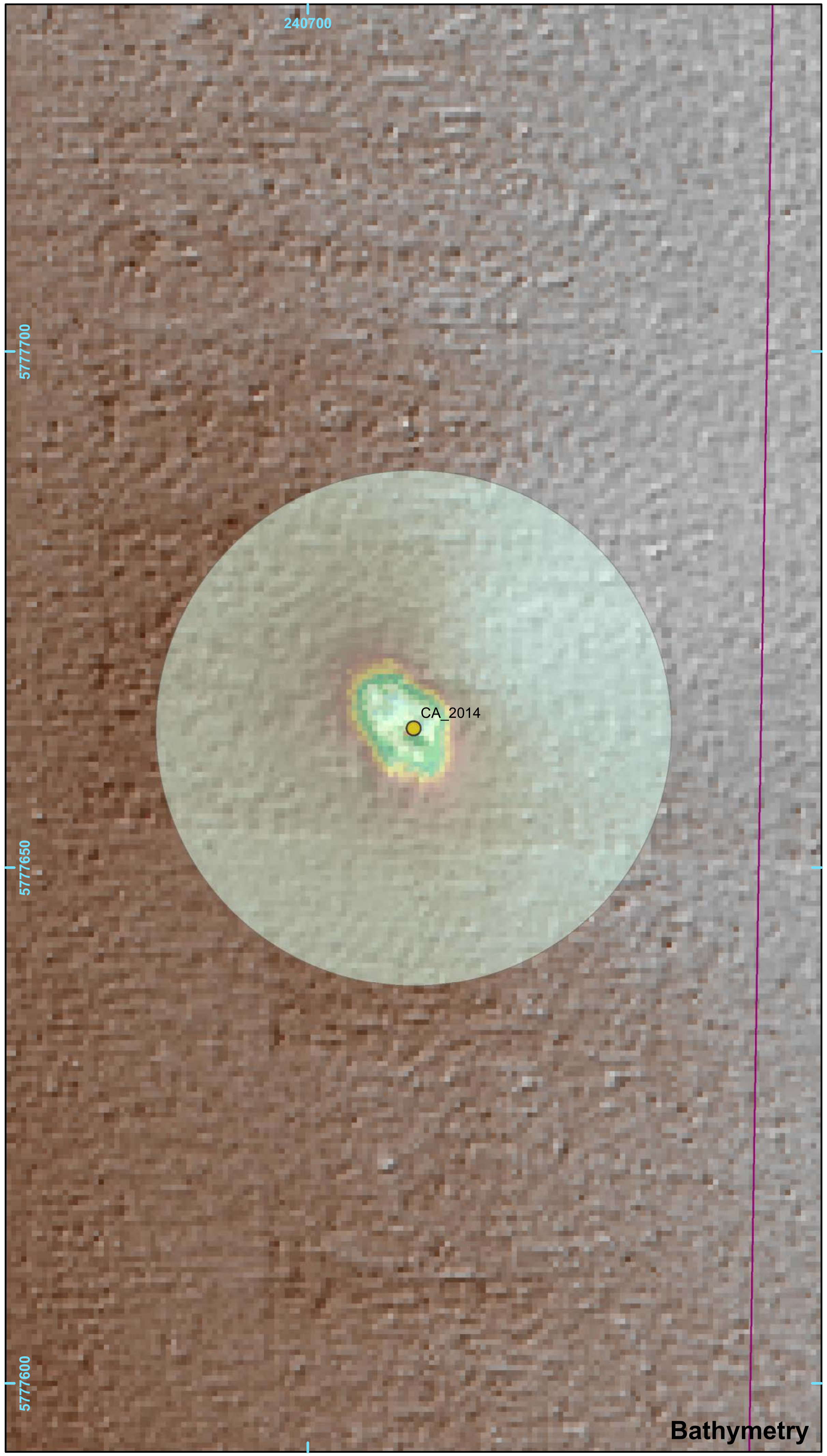
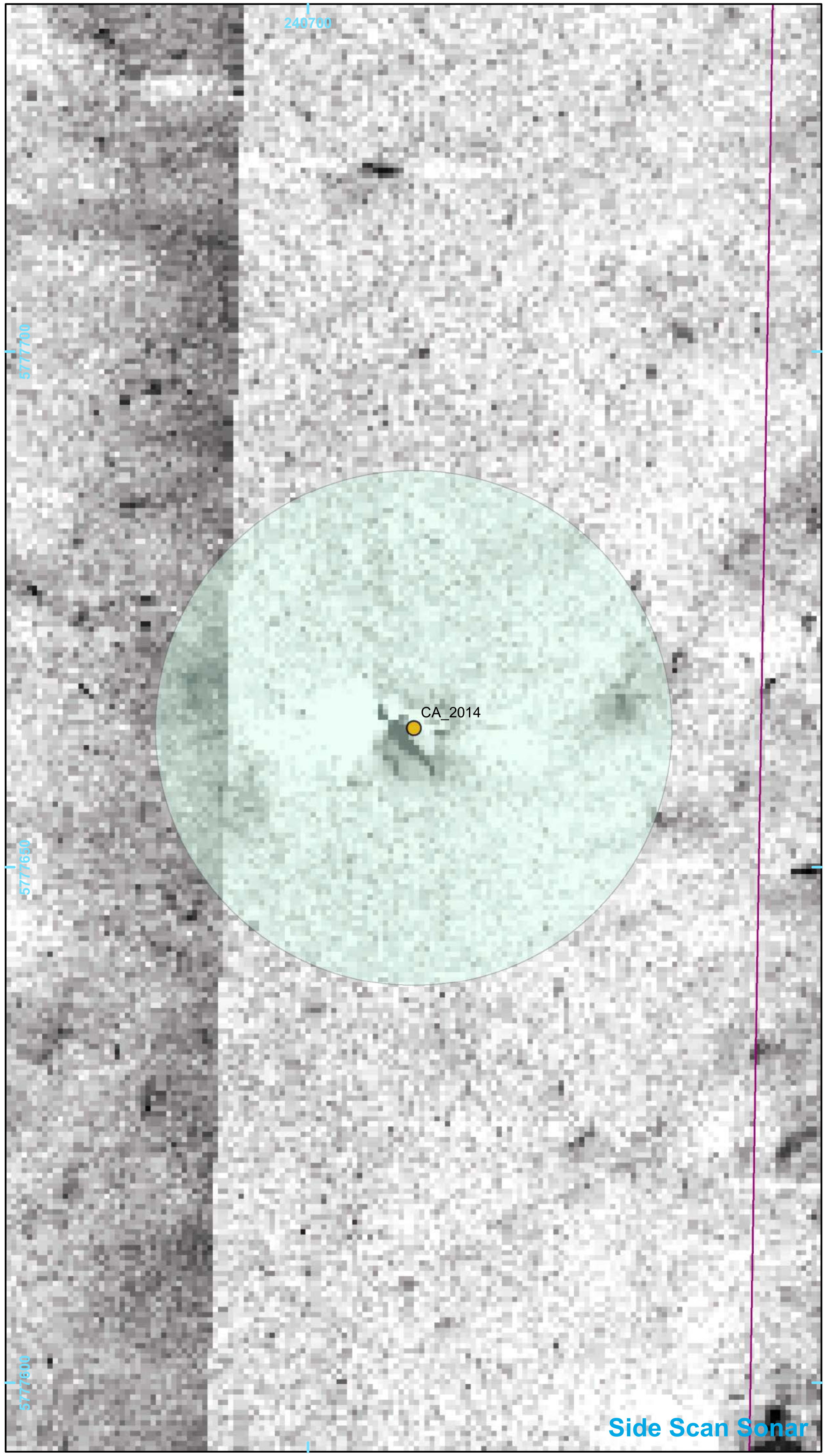
FIGURE TITLE
Archaeological Anomaly CA_2013

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.10
APPROVED BY	MW	SCALE@A3	1:500	





Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -31.293
Low : -32.251

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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FIGURE TITLE
Archaeological Anomaly CA_2014

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.11
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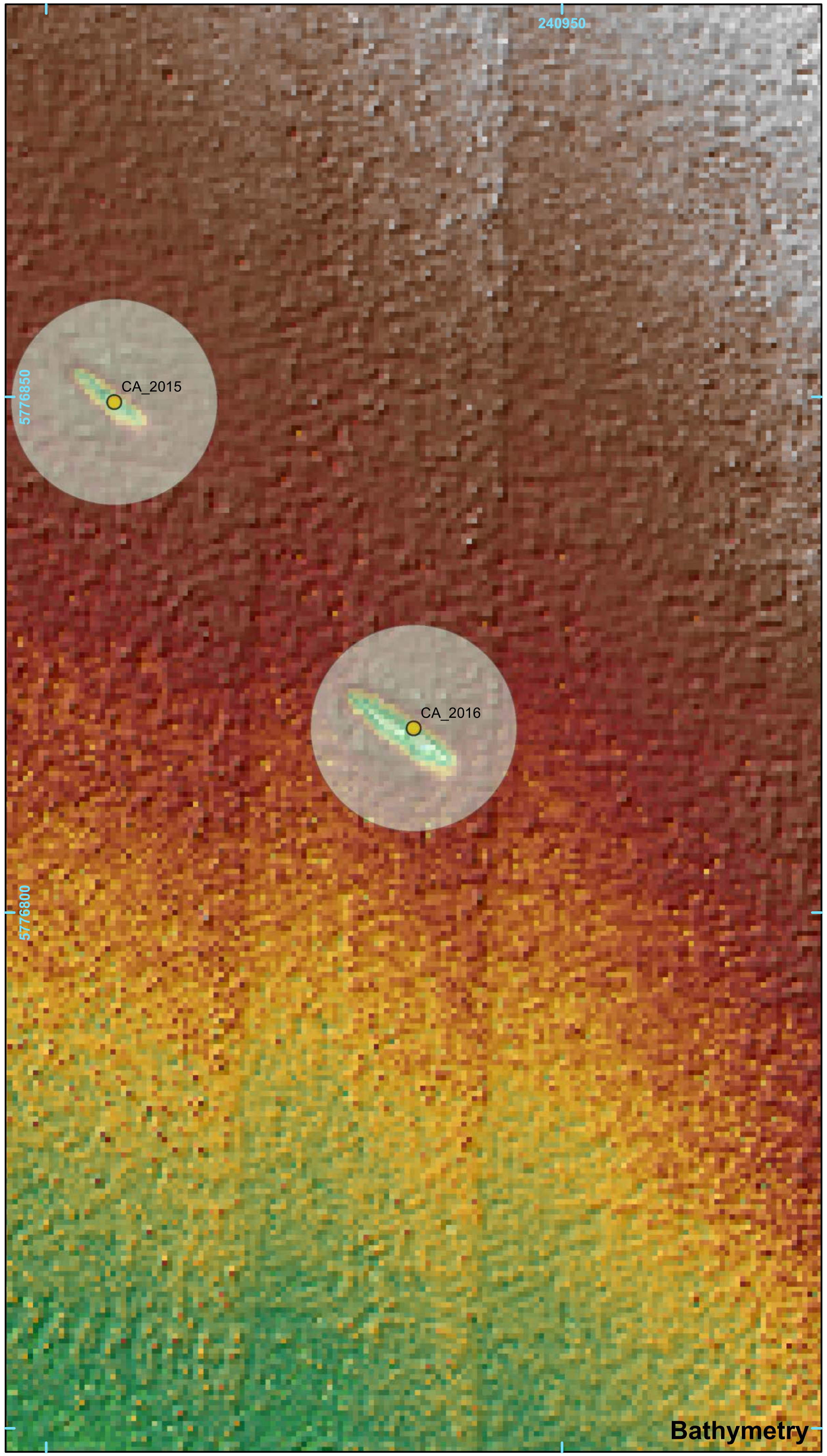

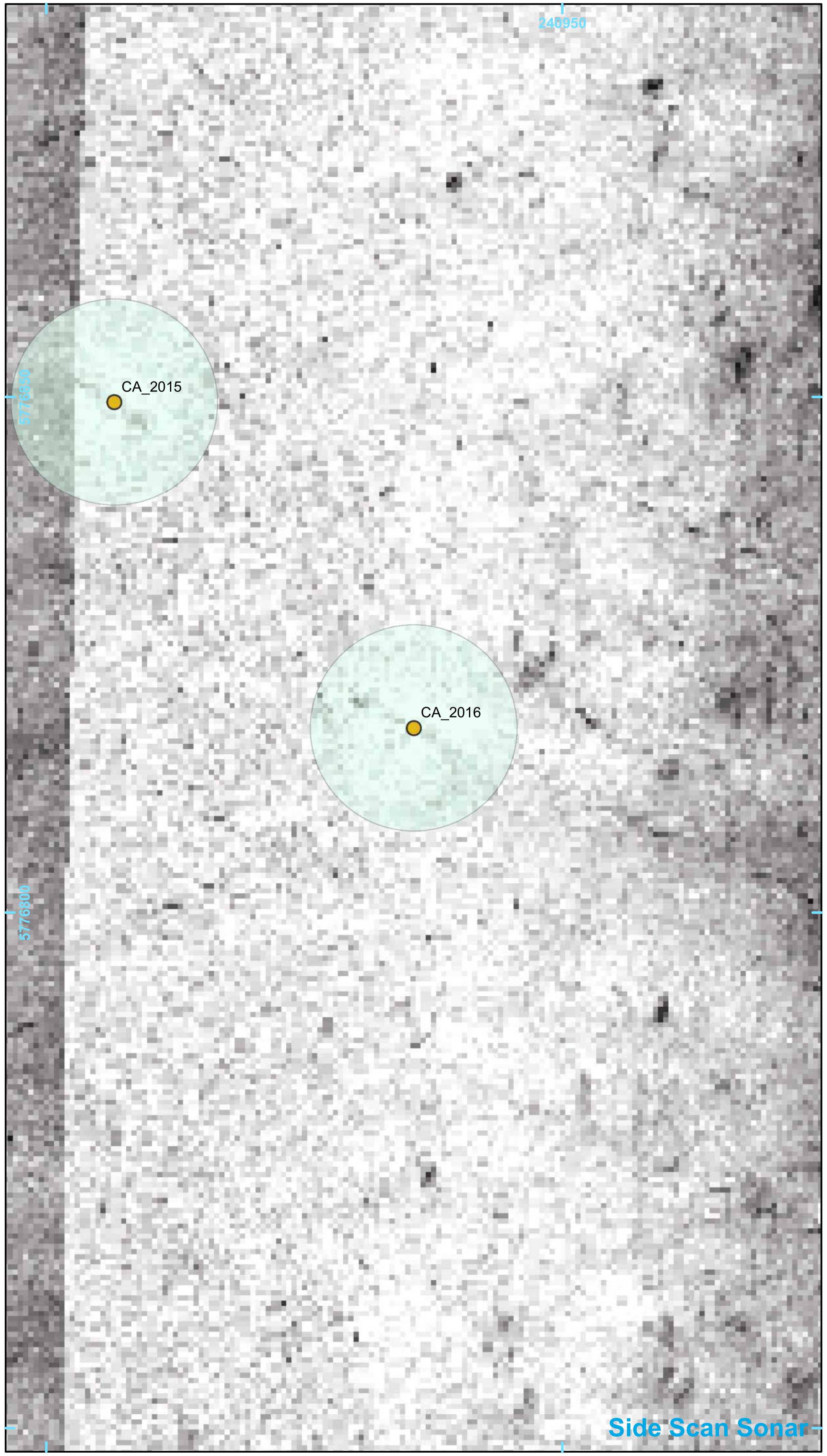

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -31.852
Low : -32.302

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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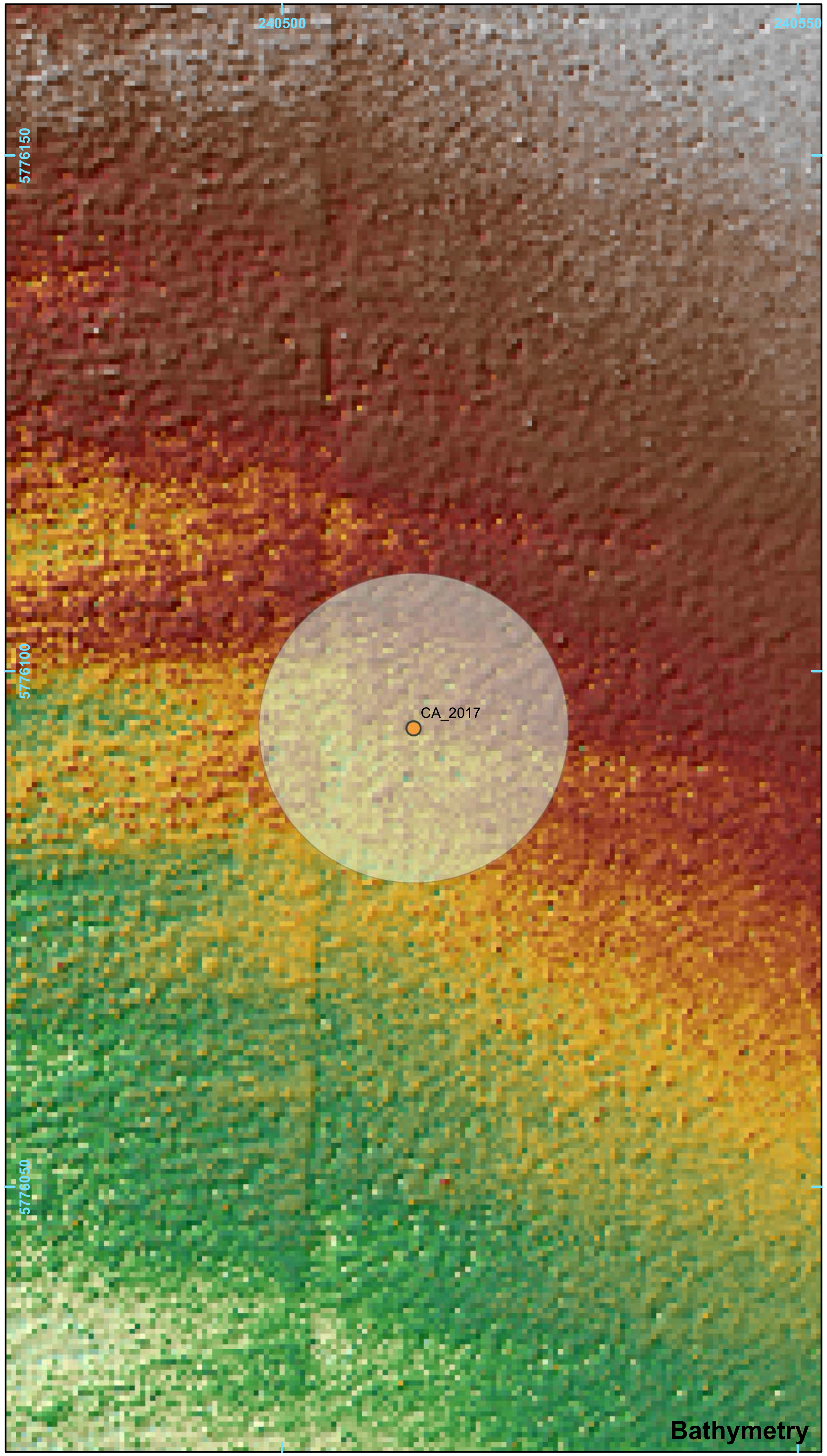
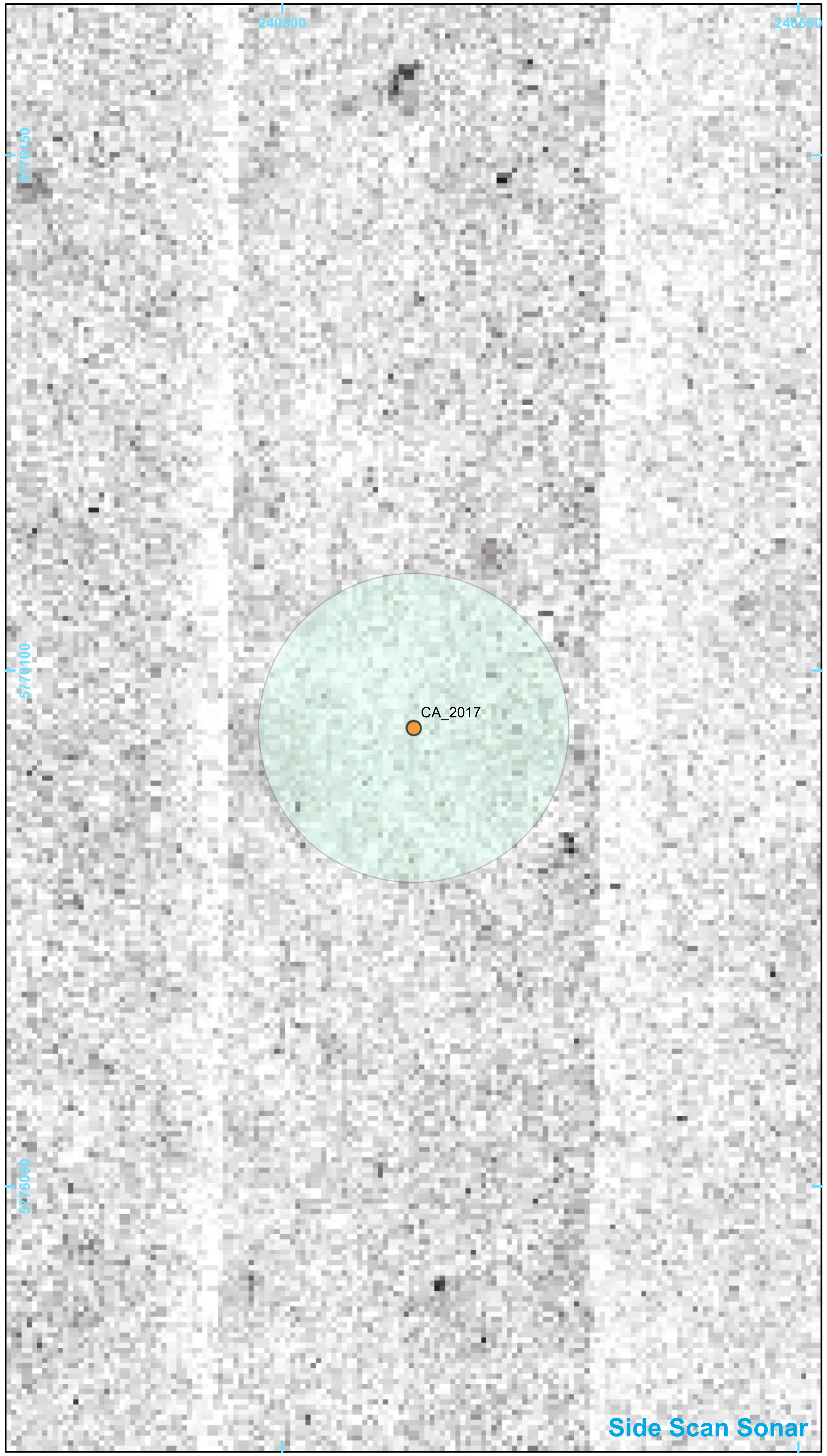
FIGURE TITLE
Archaeological Anomaly CA_2016

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.12
APPROVED BY	MW	SCALE@A3	1:500	





N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -33.476
Low : -33.936

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2017

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.13
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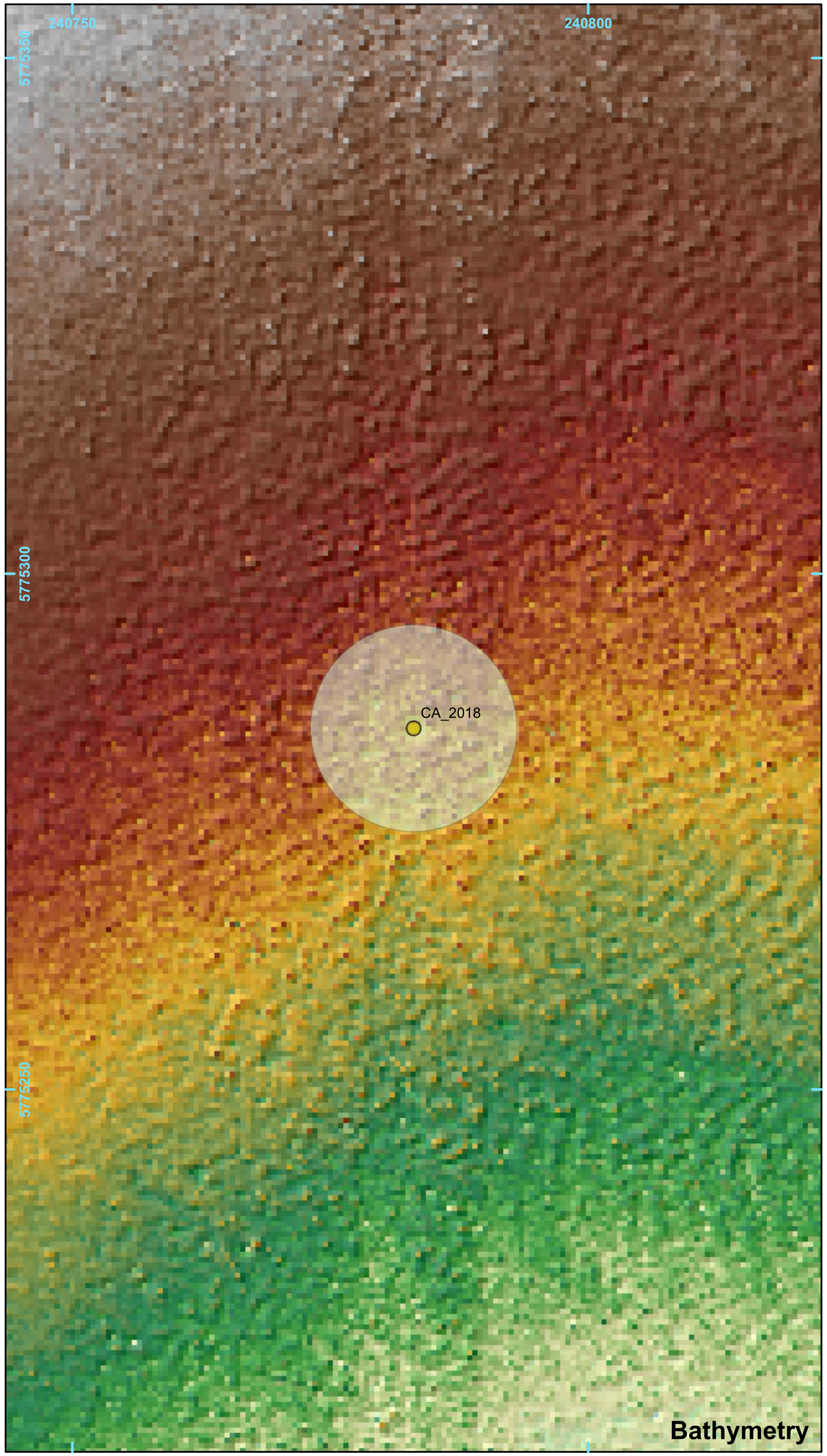

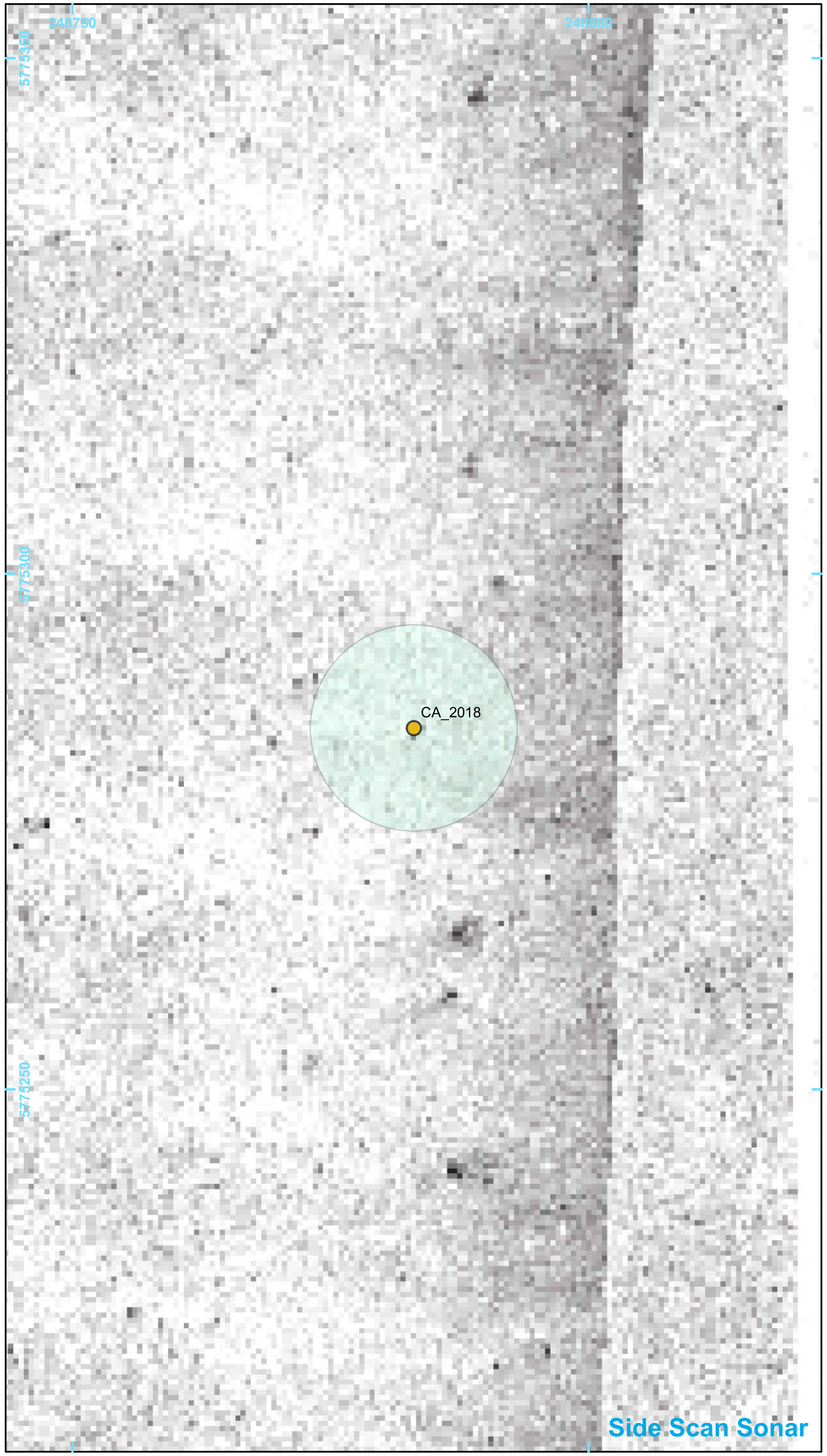

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -35.436
Low : -35.996

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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FIGURE TITLE
Archaeological Anomaly CA_2018

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.14
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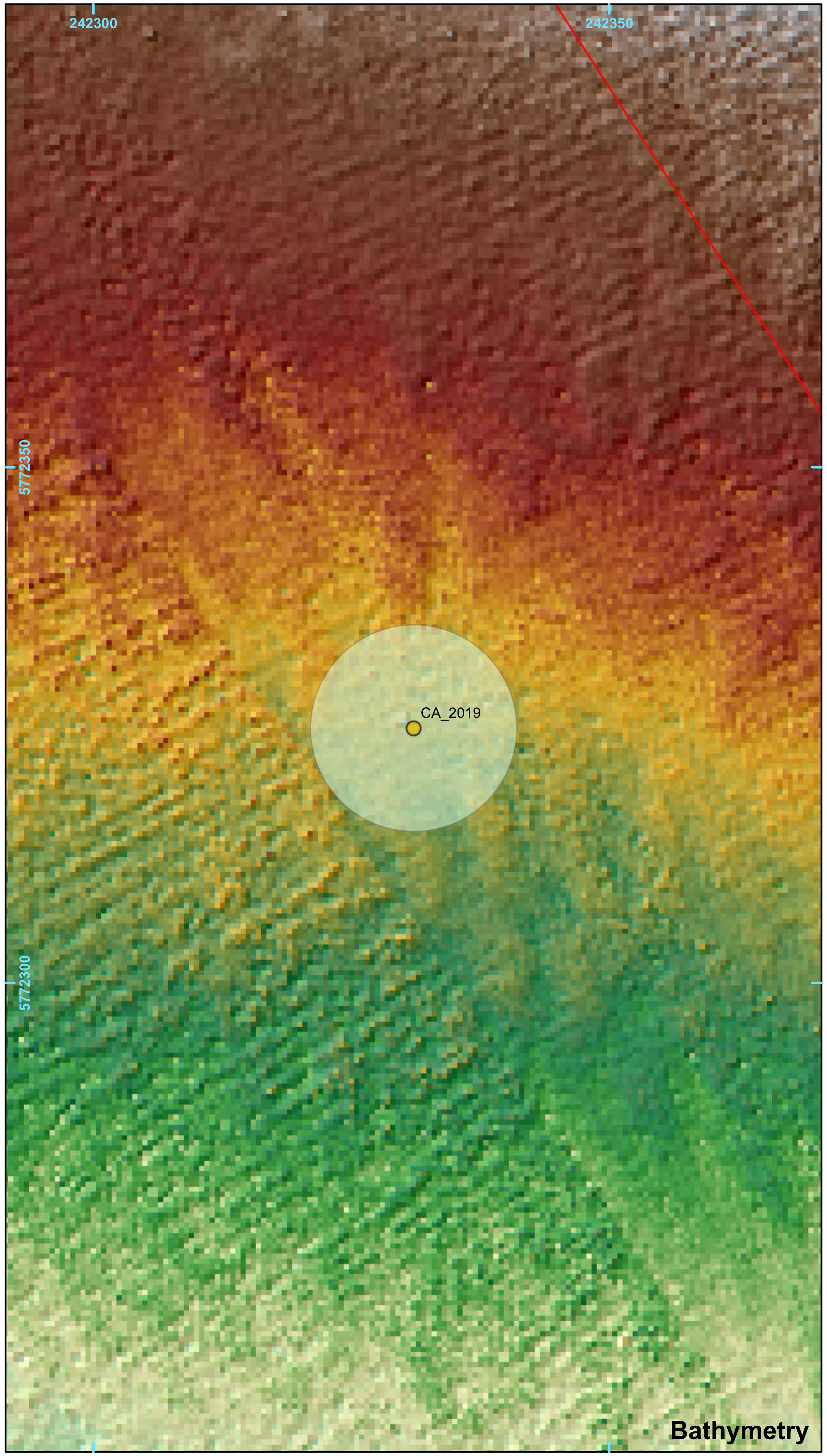

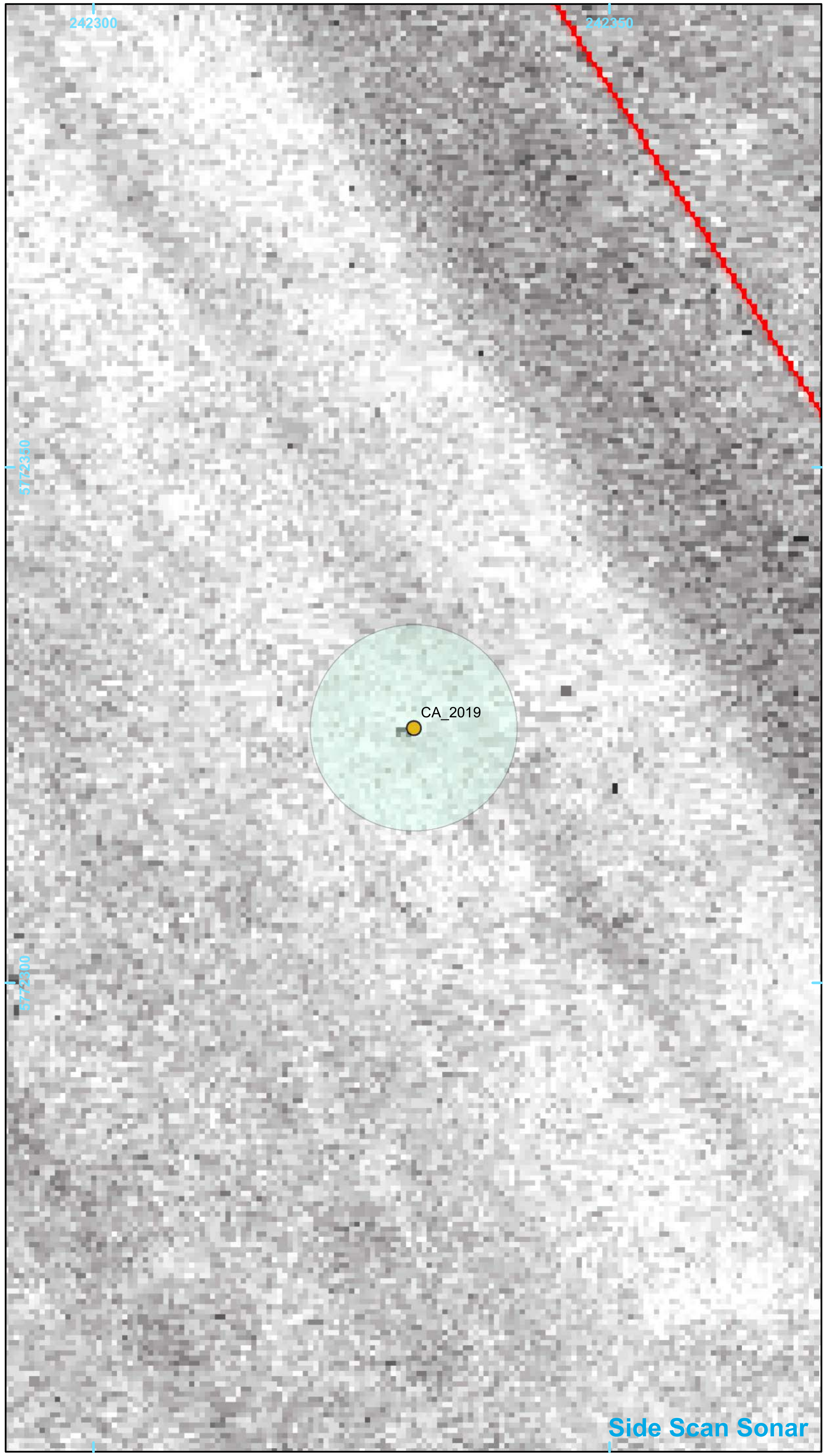

N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -41.989
Low : -42.662

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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FIGURE TITLE
Archaeological Anomaly CA_2019

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
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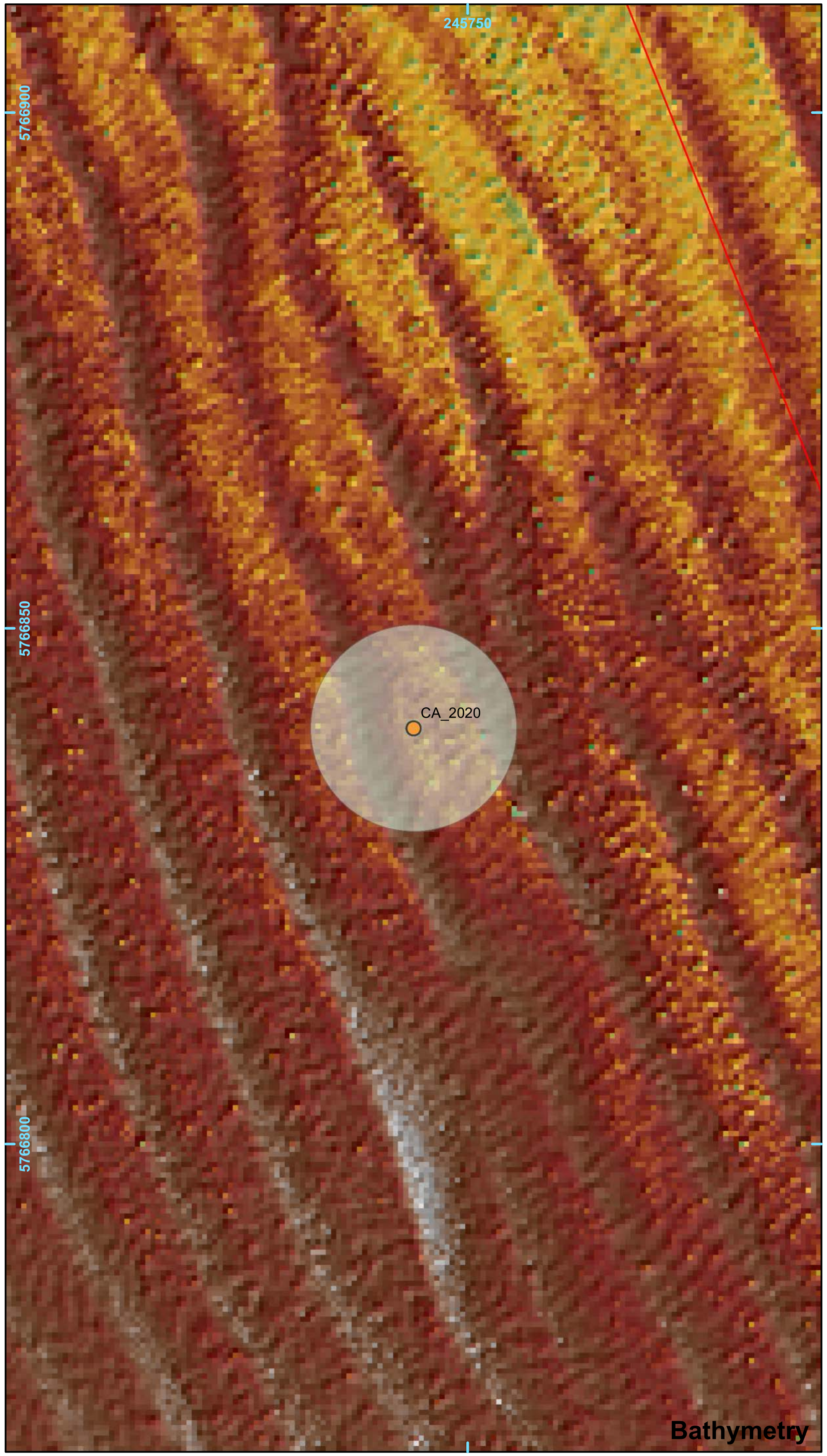

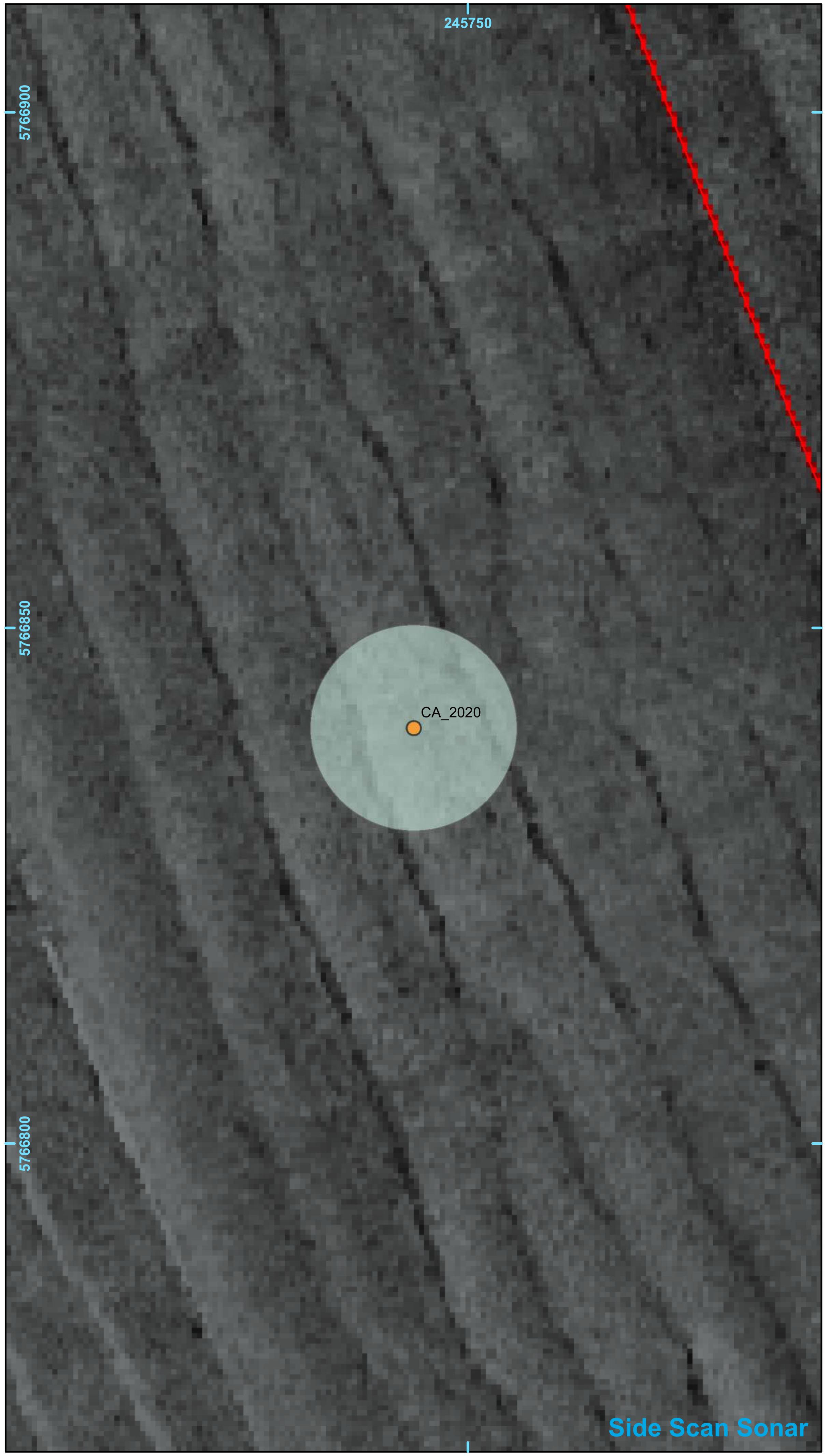

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -52.559
Low : -53.321

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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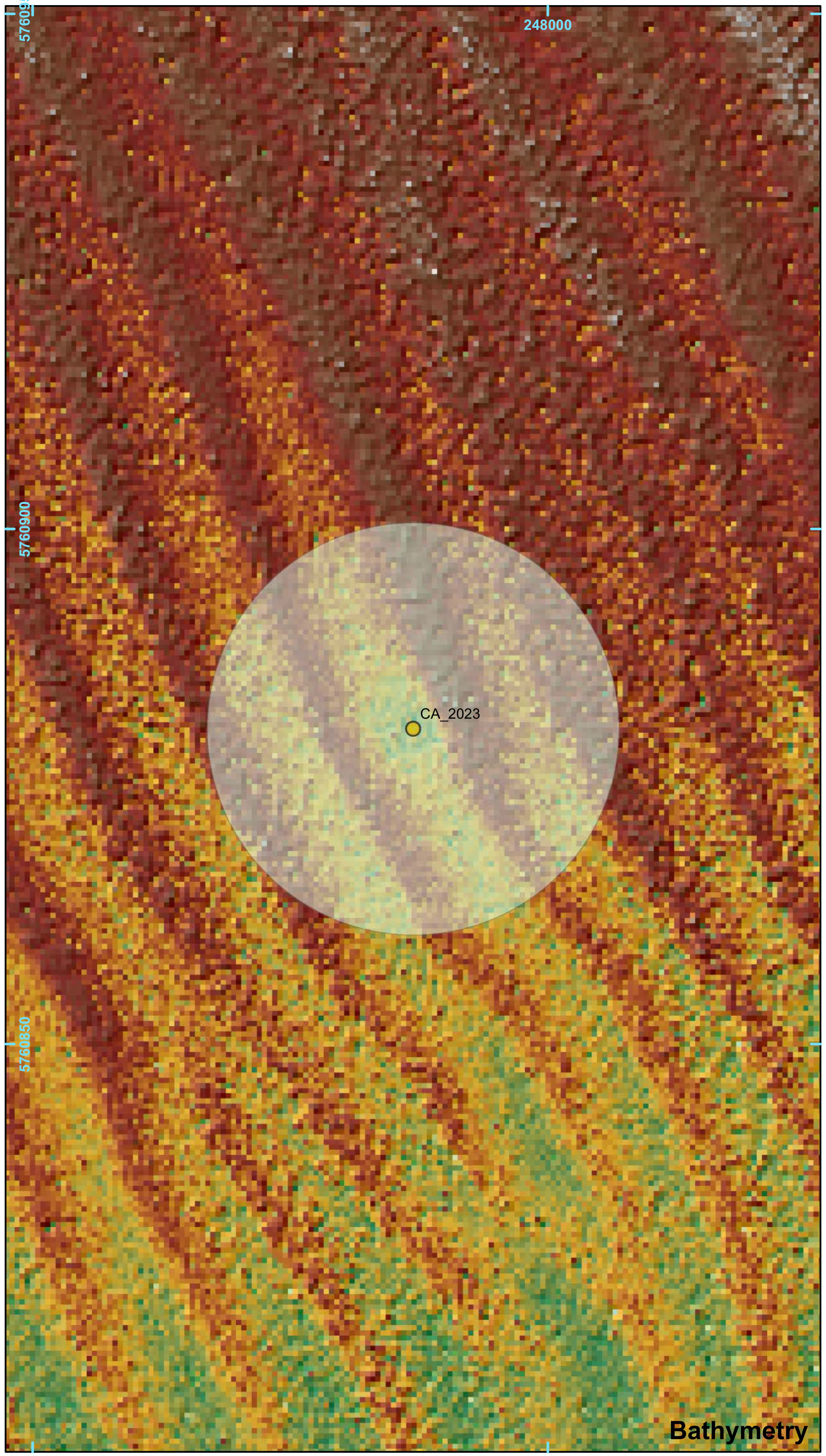
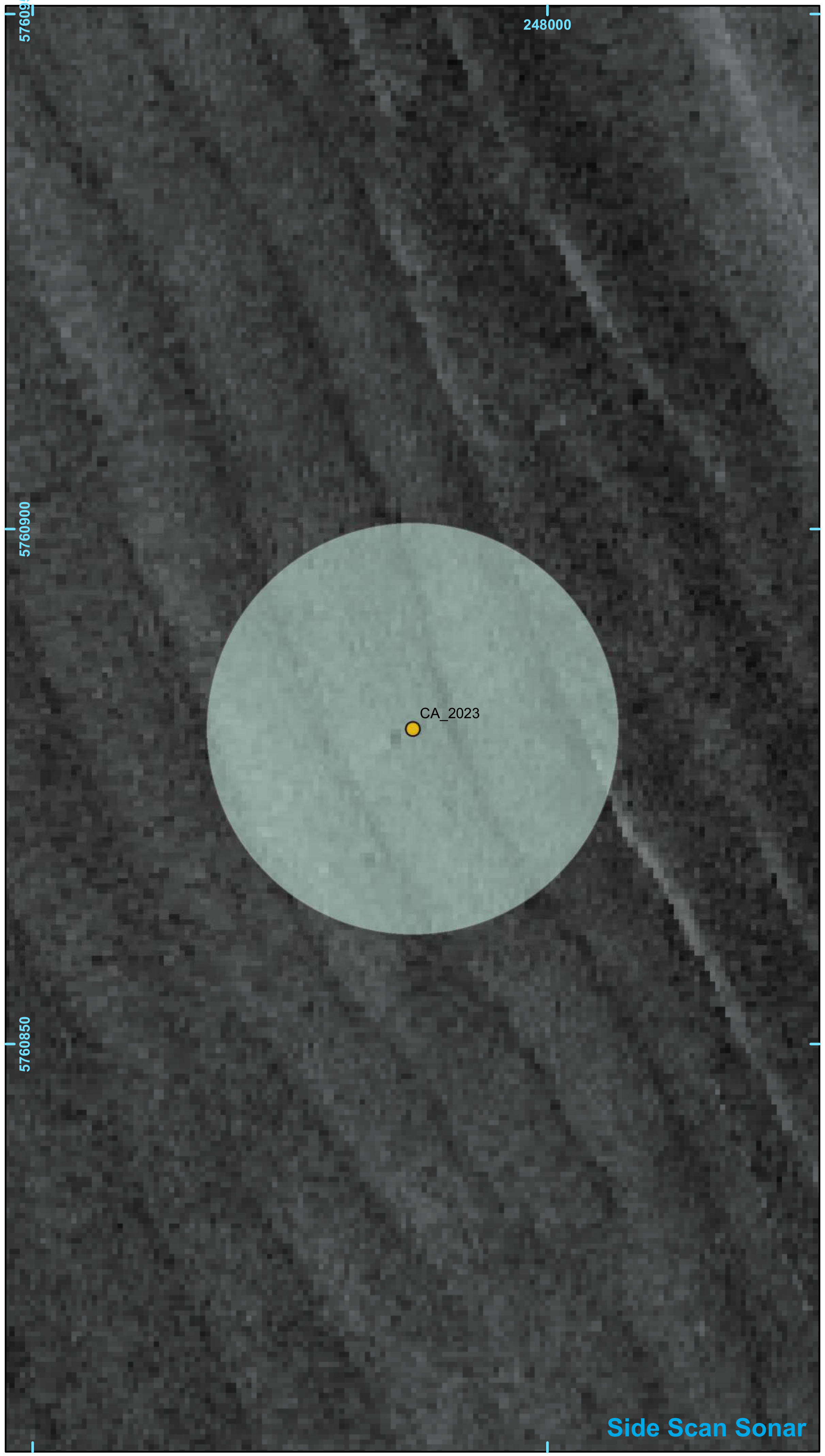
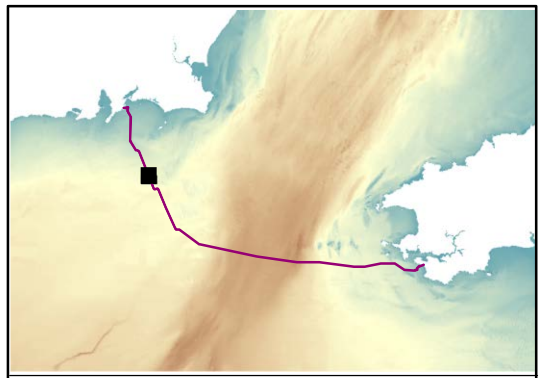
FIGURE TITLE
Archaeological Anomaly CA_2020

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.16
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -60.608
  - Low : -61.489

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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FIGURE TITLE
Archaeological Anomaly CA_2023

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.17
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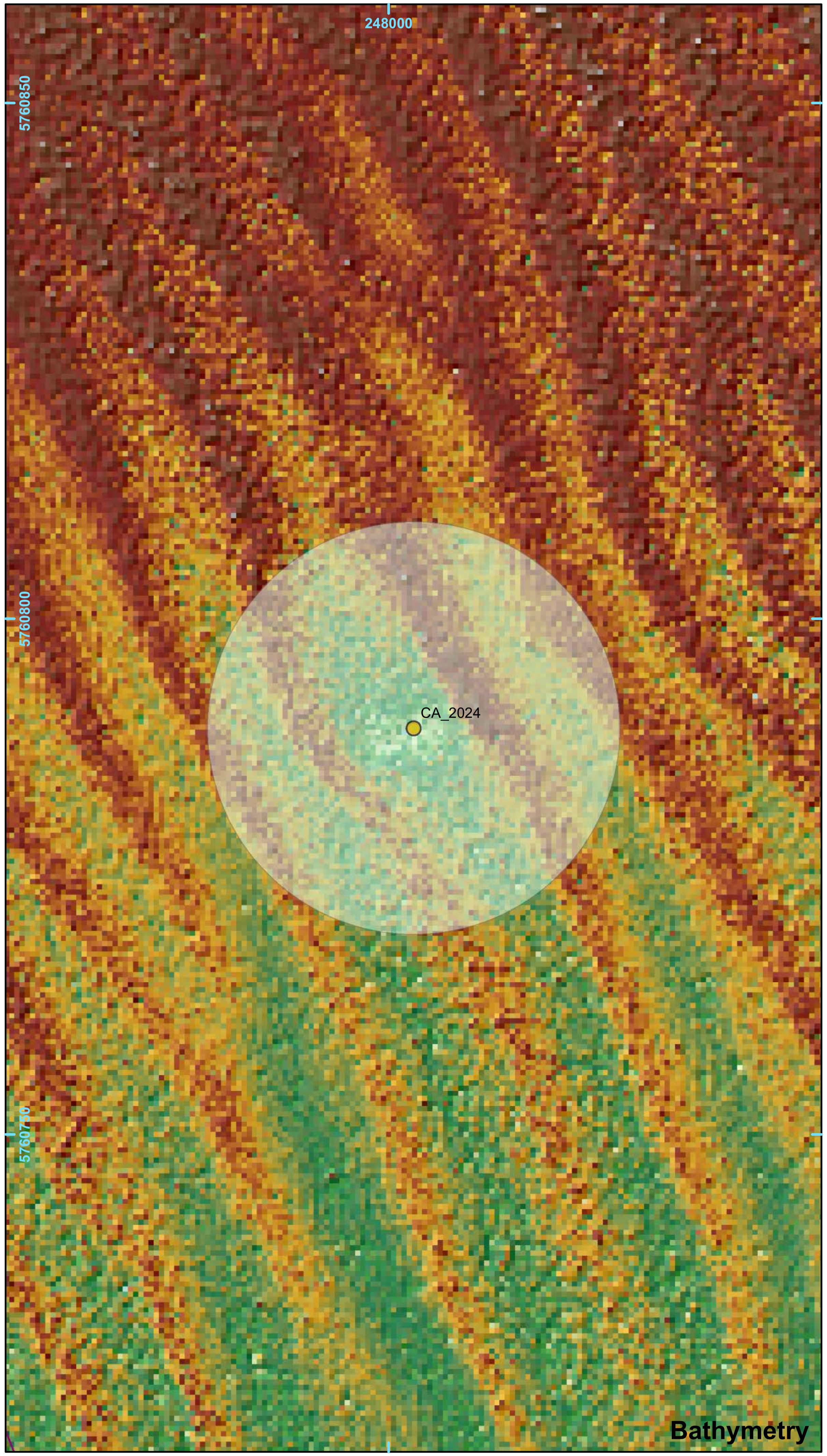

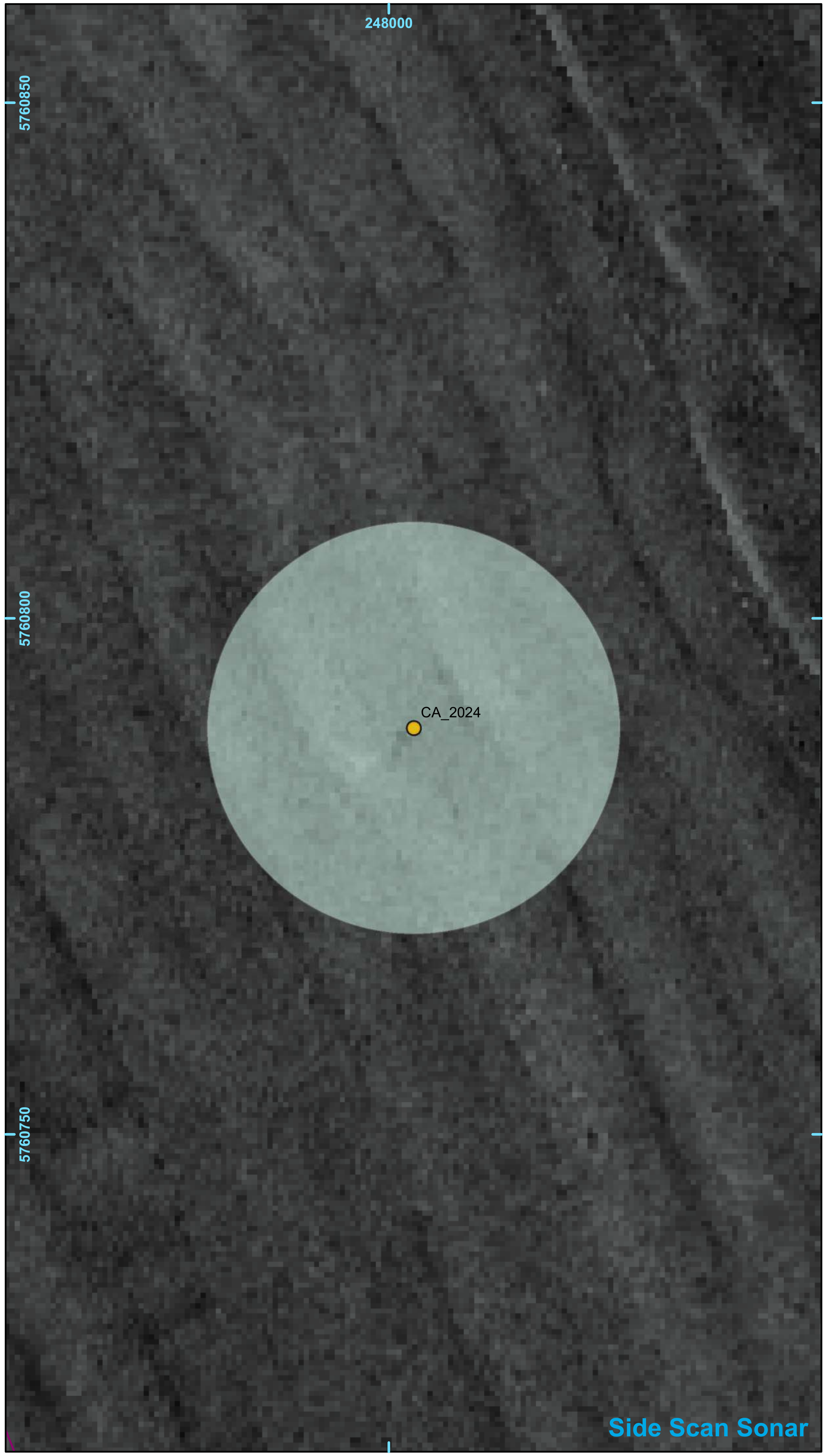

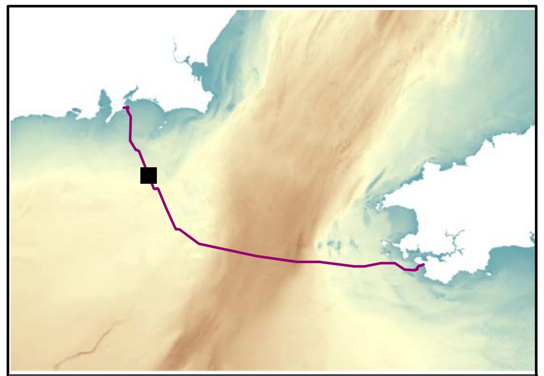

N

Legend

Route Centreline
Route Corridor
Archaeological Anomaly
High
Medium
Low
Archaeological Exclusion Zone
Side Scan Sonar Anomaly
Magnetic Anomaly
0.5 - 2 nT
2 - 5 nT
5 - 10 nT
10 - 25 nT
> 25.0 nT
Bathymetry (mLAT)
High : -60.758
Low : -61.58

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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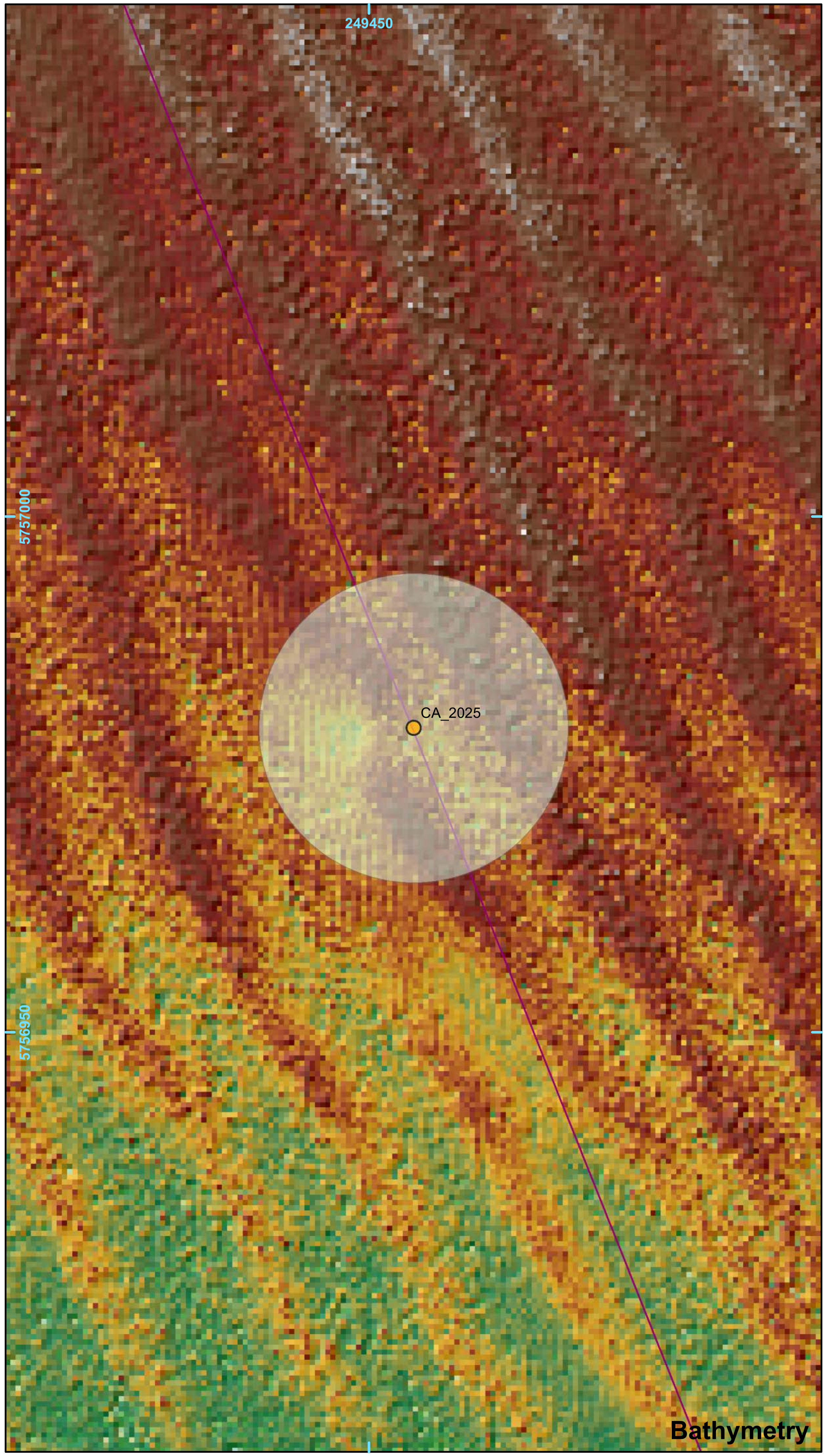
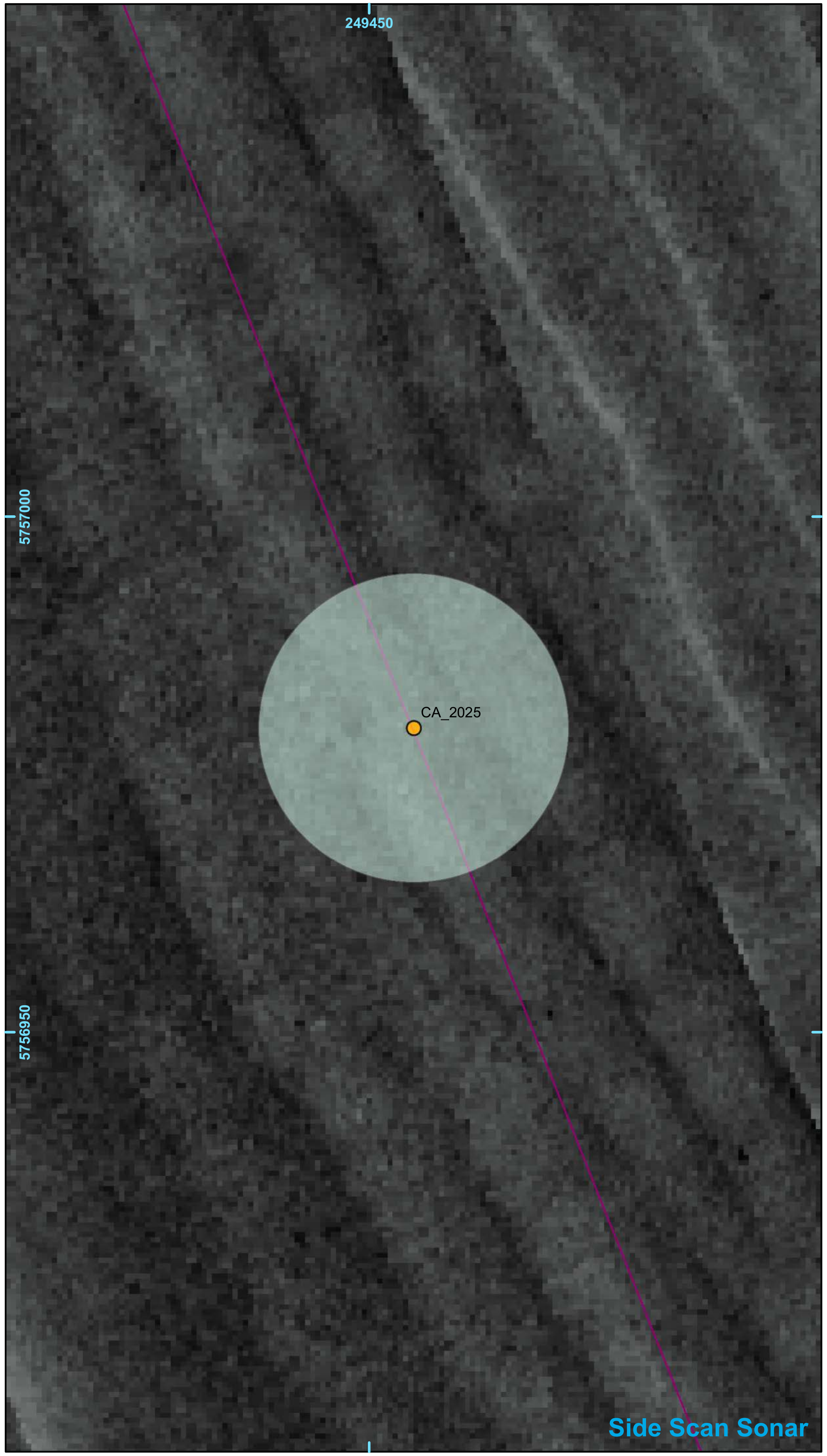
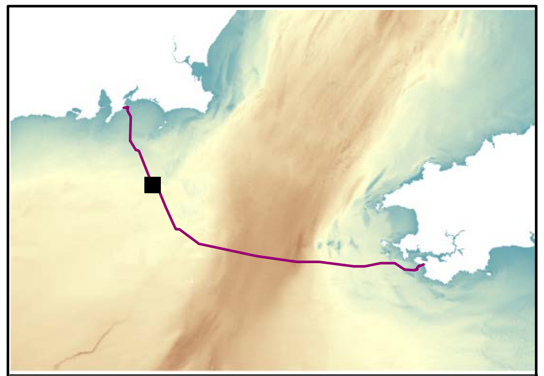
FIGURE TITLE
Archaeological Anomaly CA_2024

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.18
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -62.525
  - Low : -63.495

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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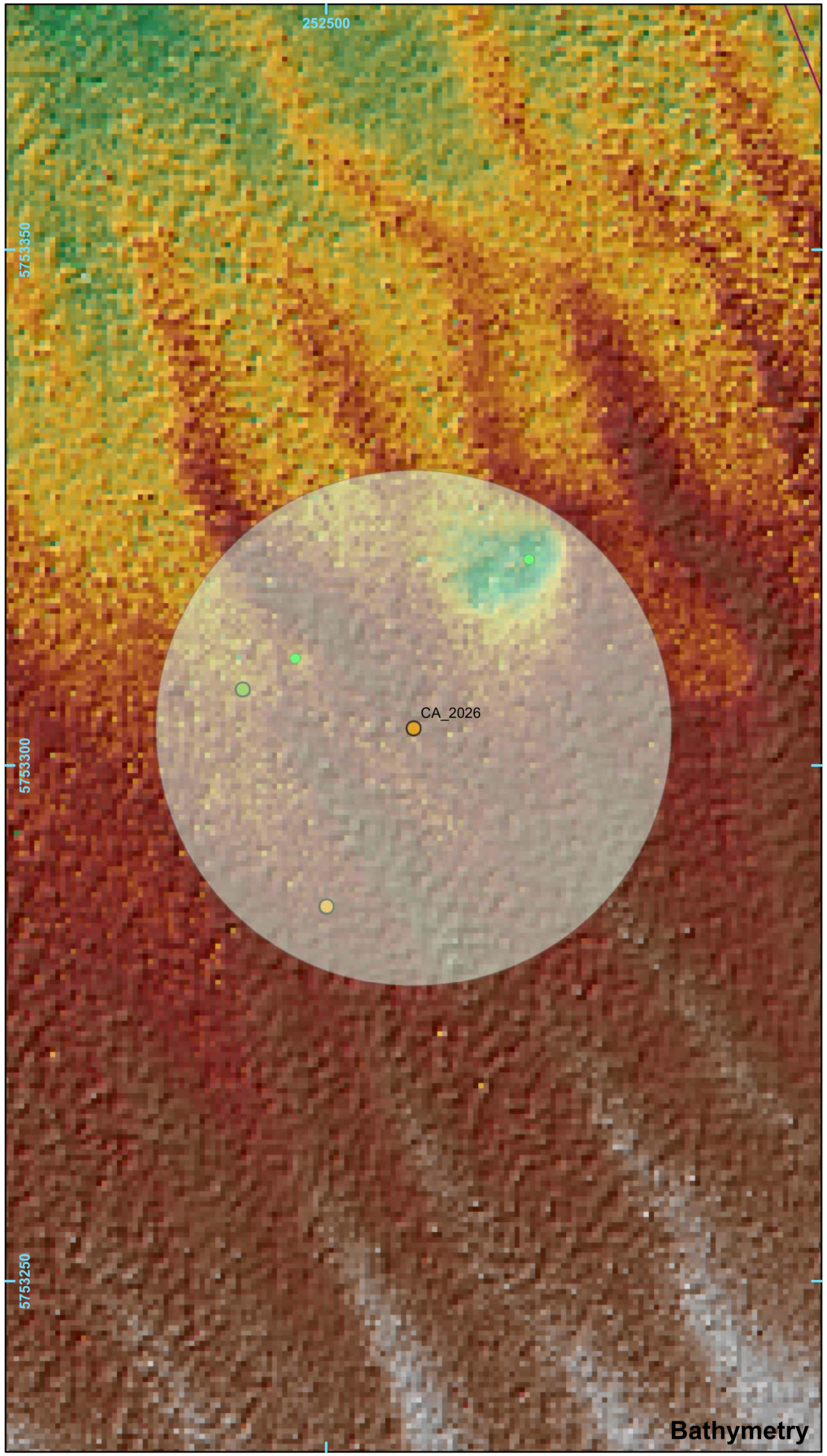
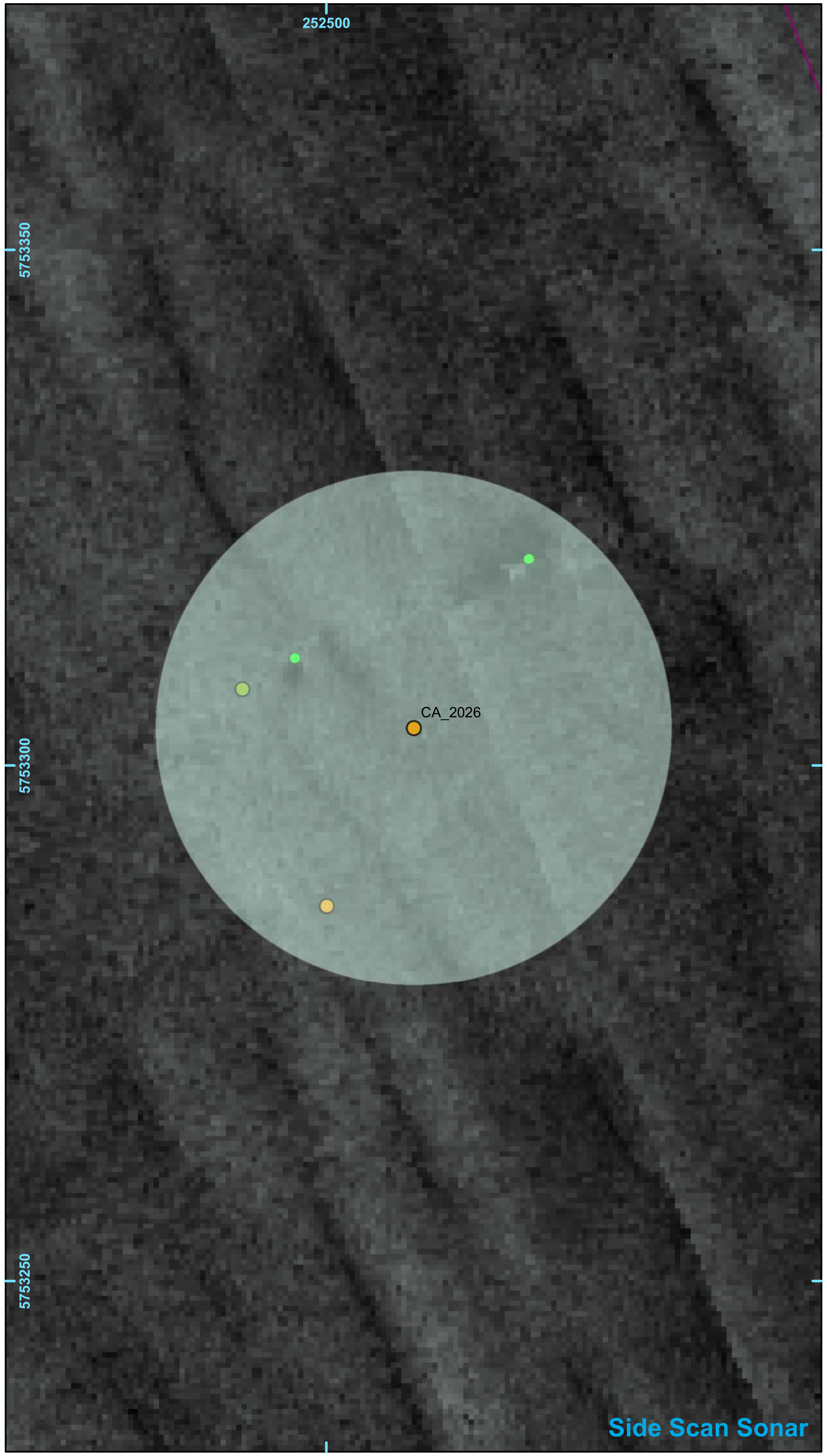
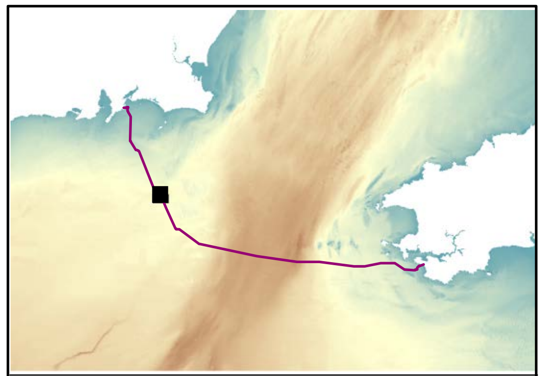
FIGURE TITLE
Archaeological Anomaly CA_2025

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.	
CHECKED BY	RK	DATE	01/04/2019		3.19
APPROVED BY	MW	SCALE@A3	1:500		







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -71.109
Low : -72.461

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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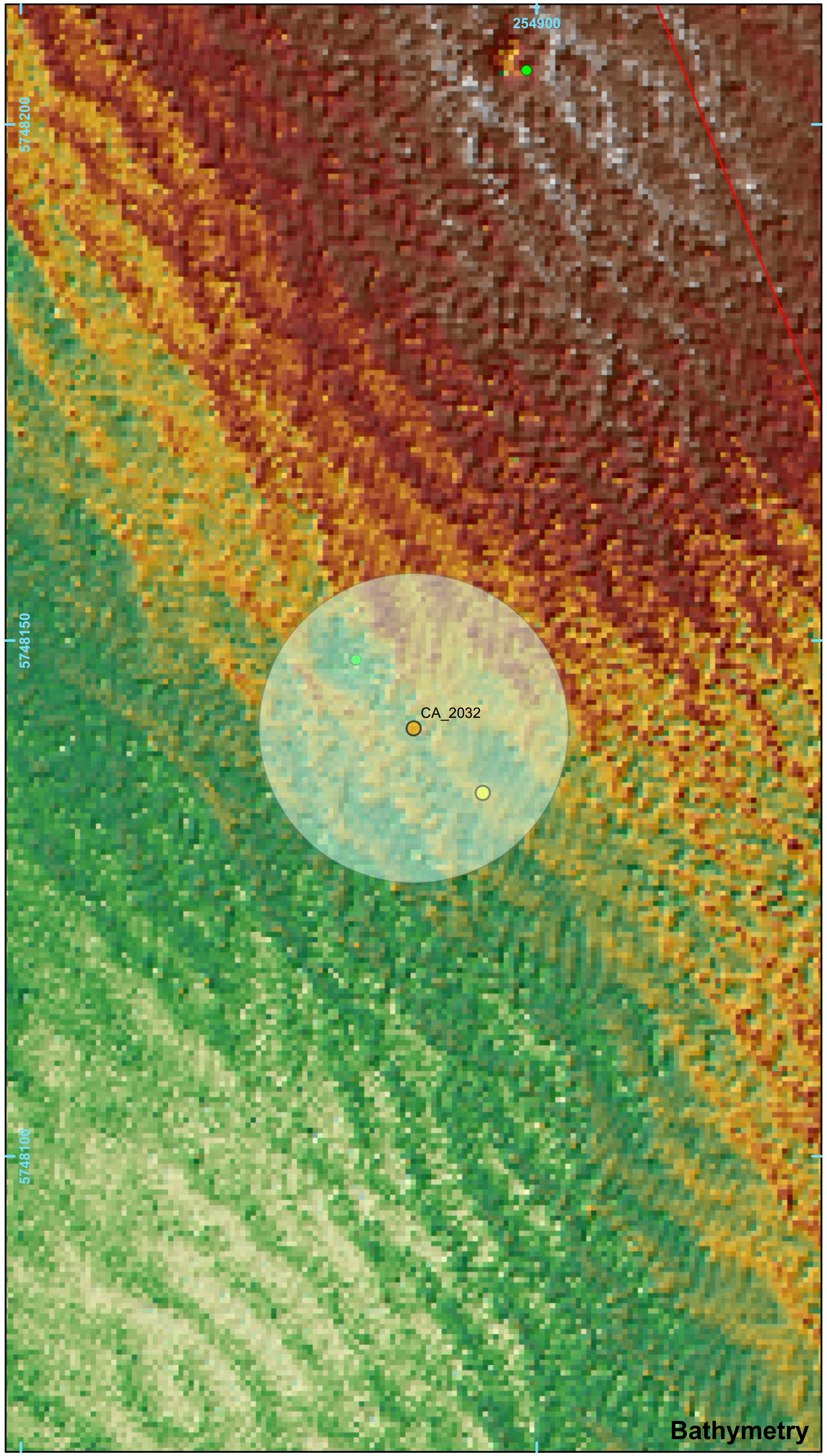
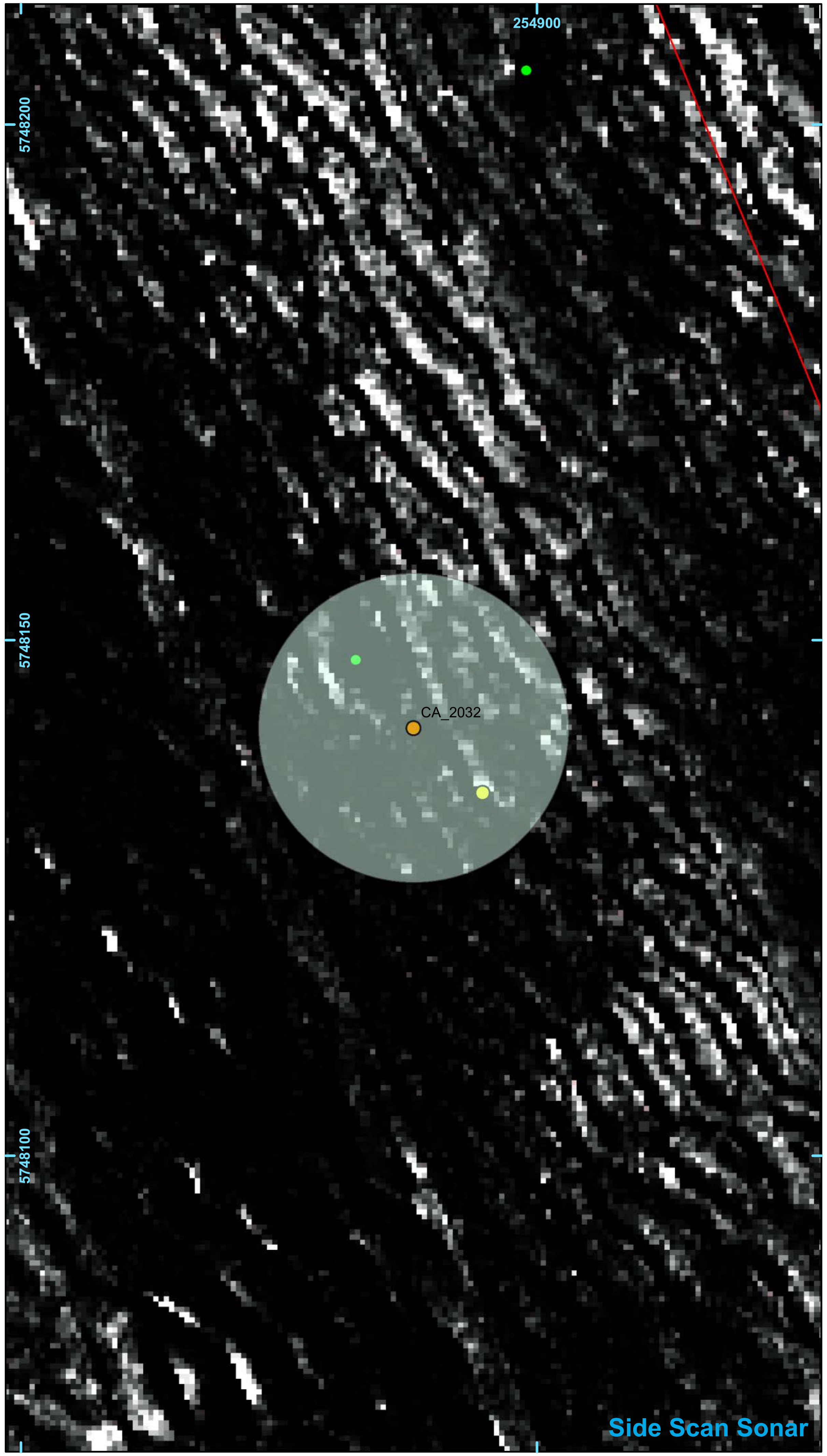
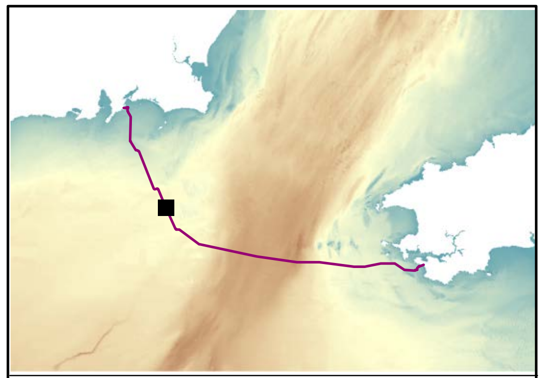
FIGURE TITLE
Archaeological Anomaly CA_2026

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.20
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -66.272

Low : -67.626

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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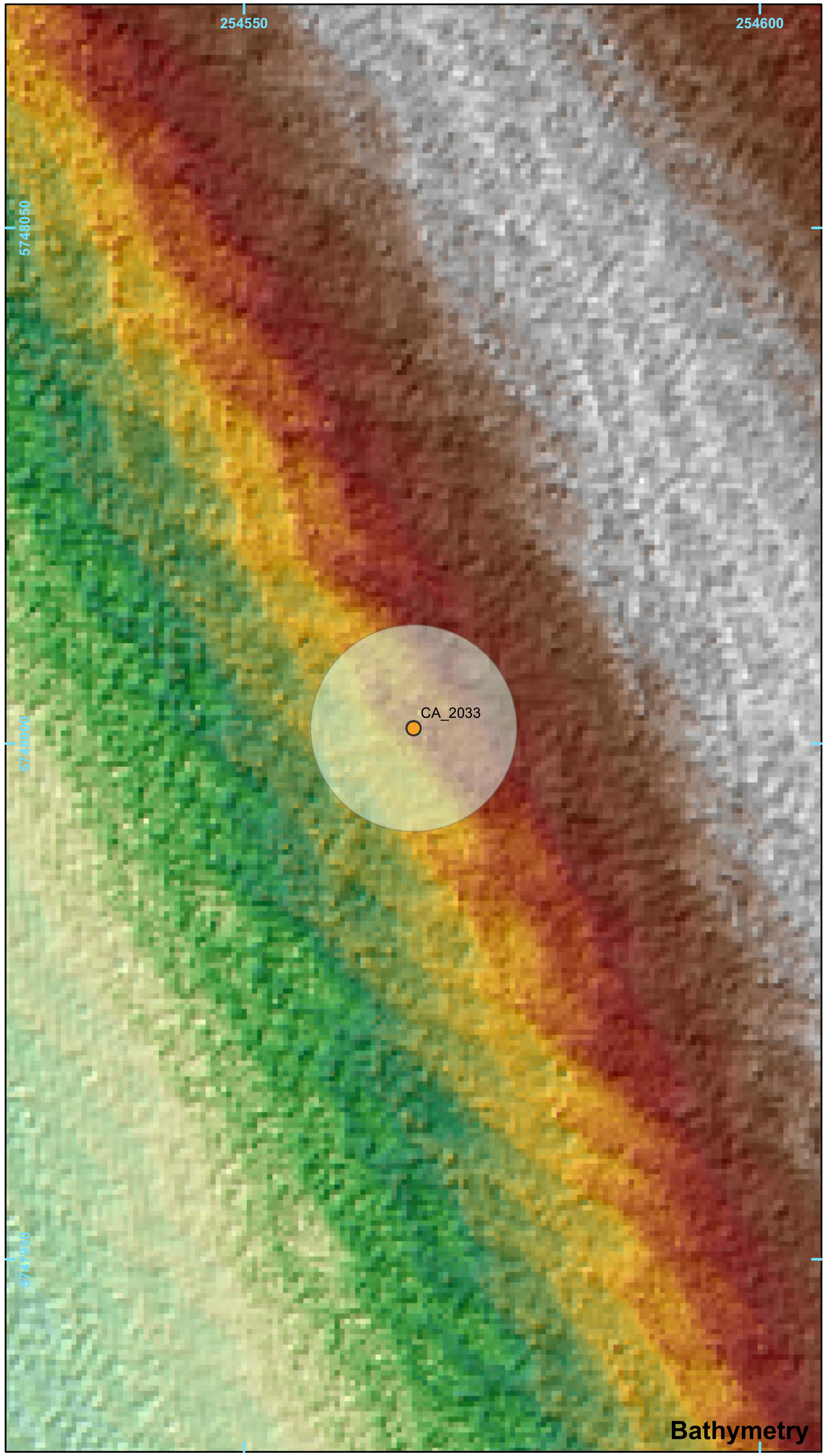
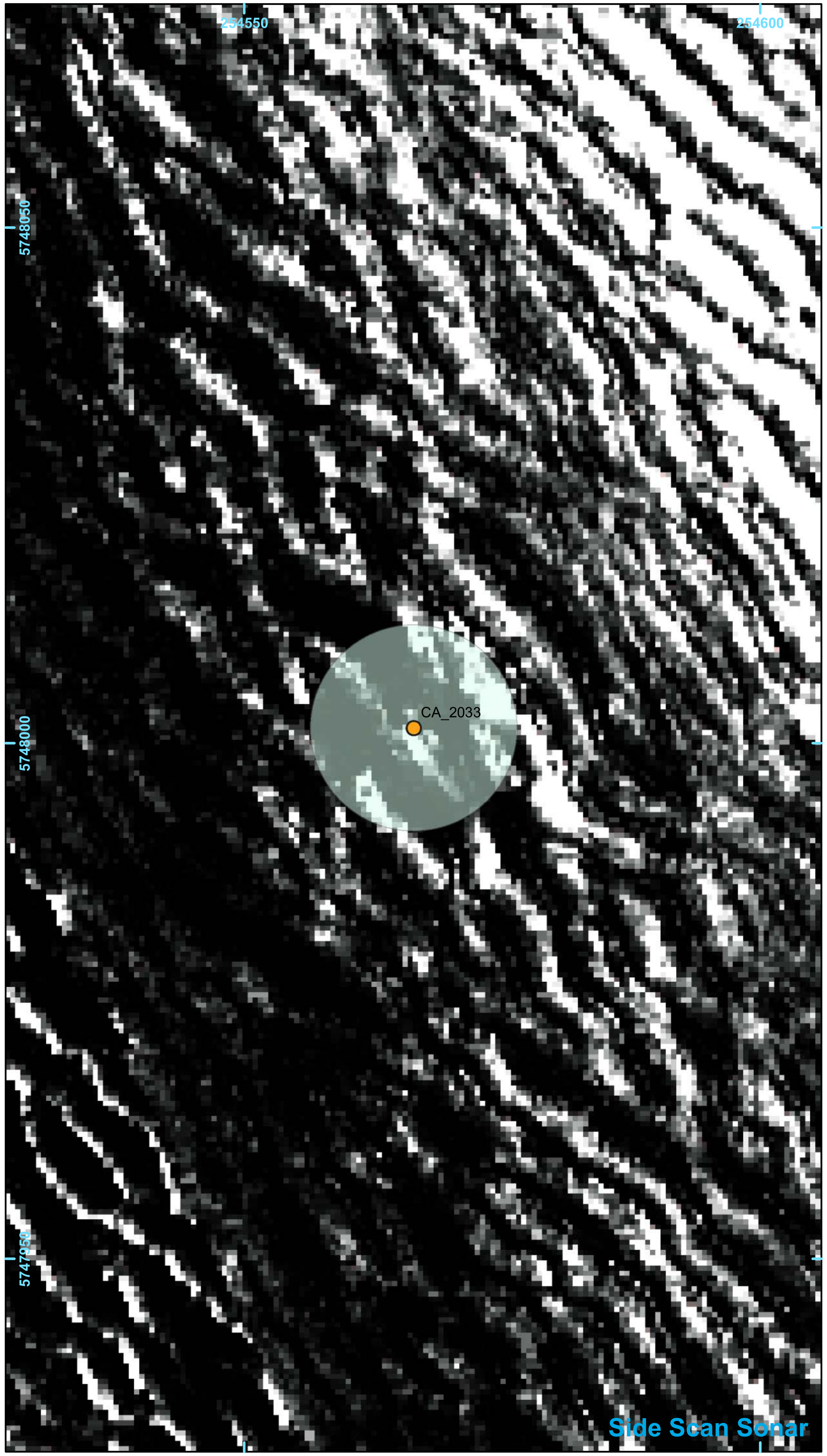
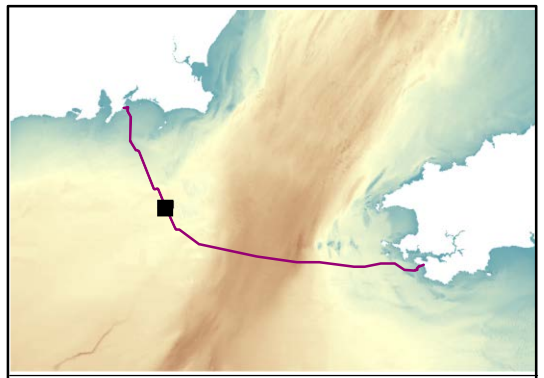
FIGURE TITLE
Archaeological Anomaly CA_2032

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.21
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -62.611
Low : -66.828

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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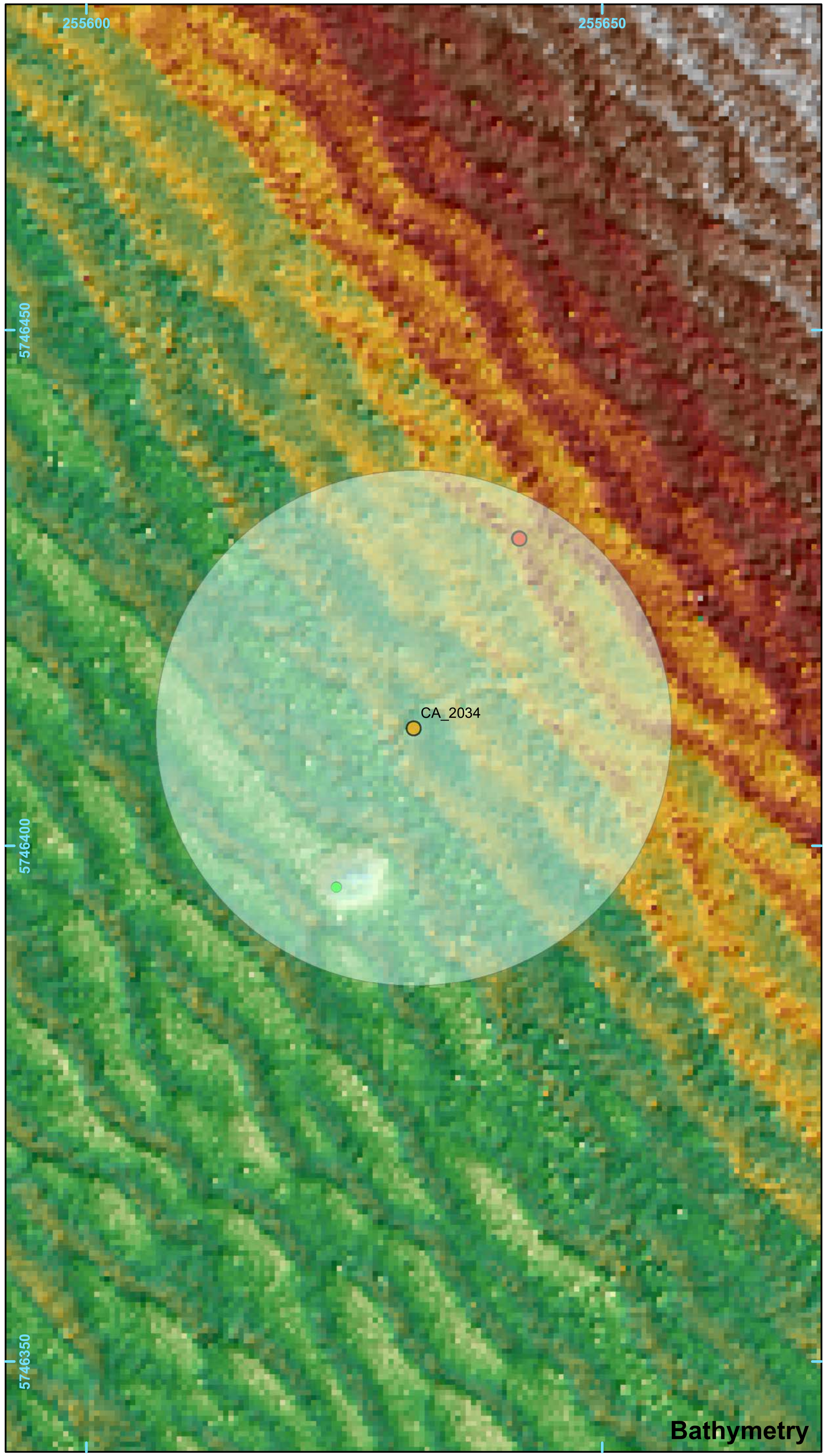
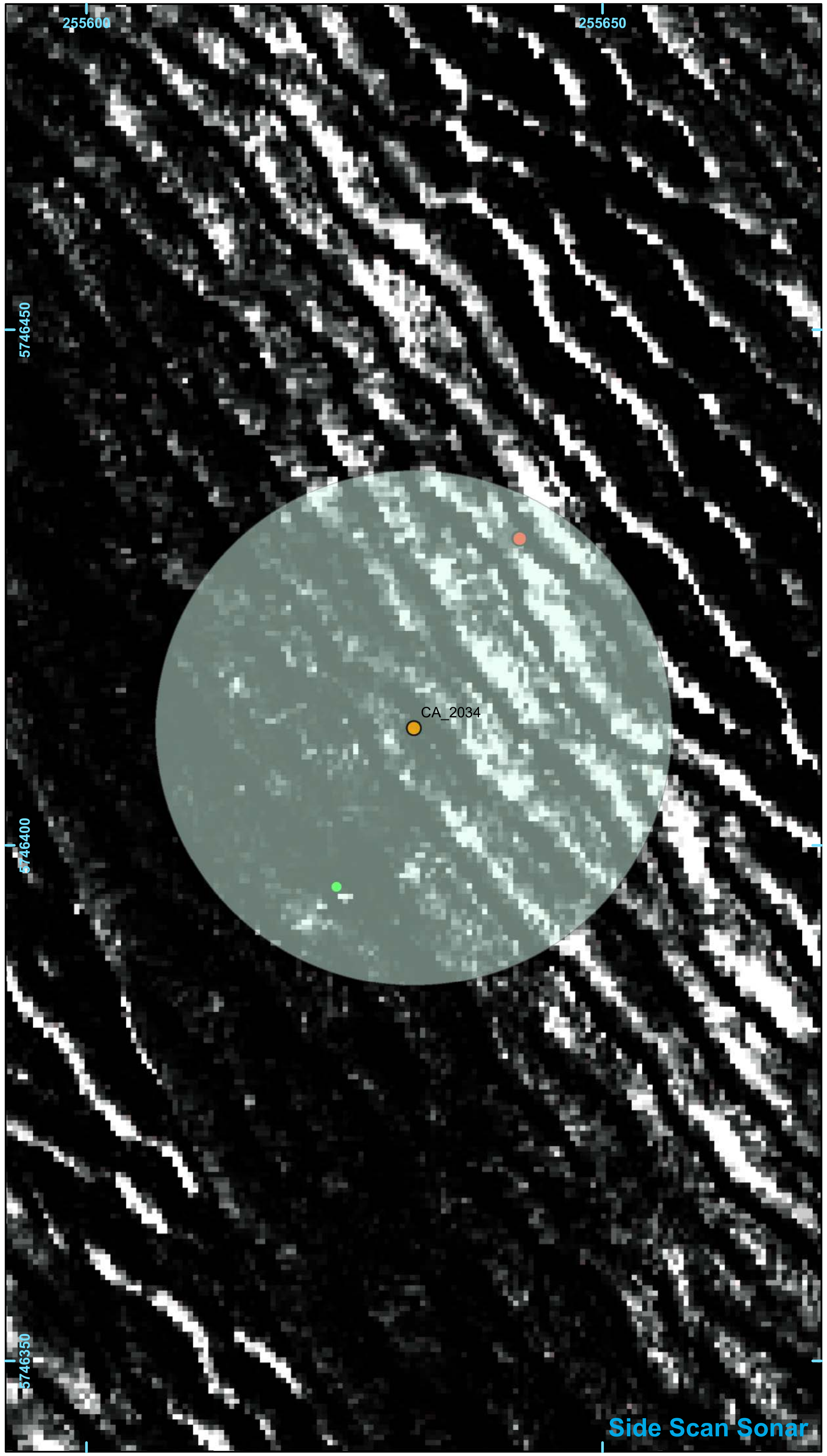
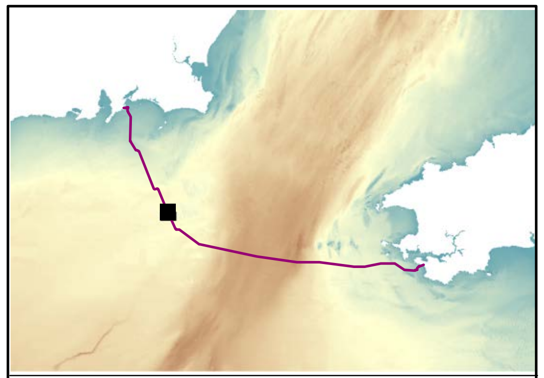
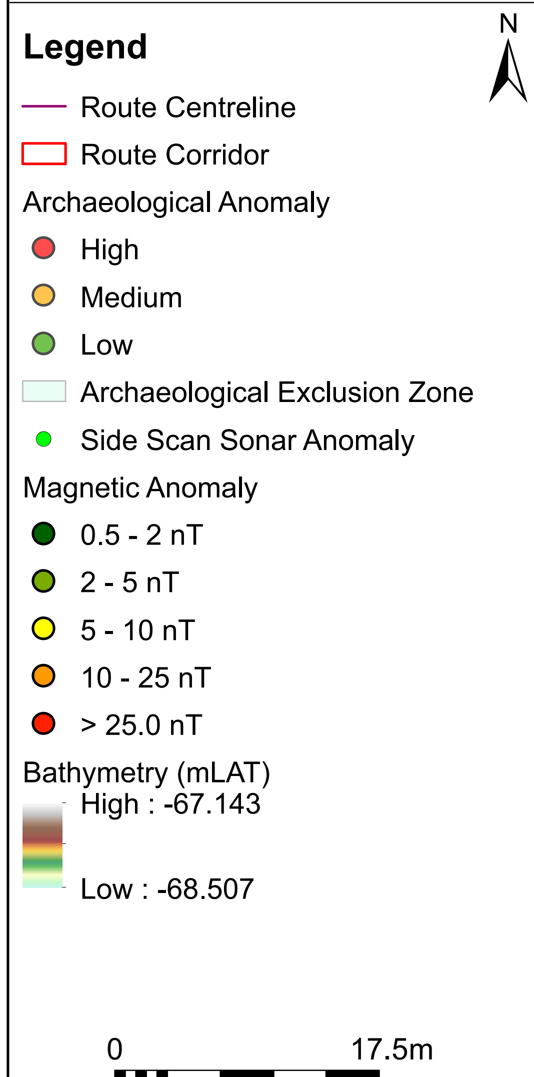
FIGURE TITLE
Archaeological Anomaly CA_2033

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.22
APPROVED BY	MW	SCALE@A3	1:500	









Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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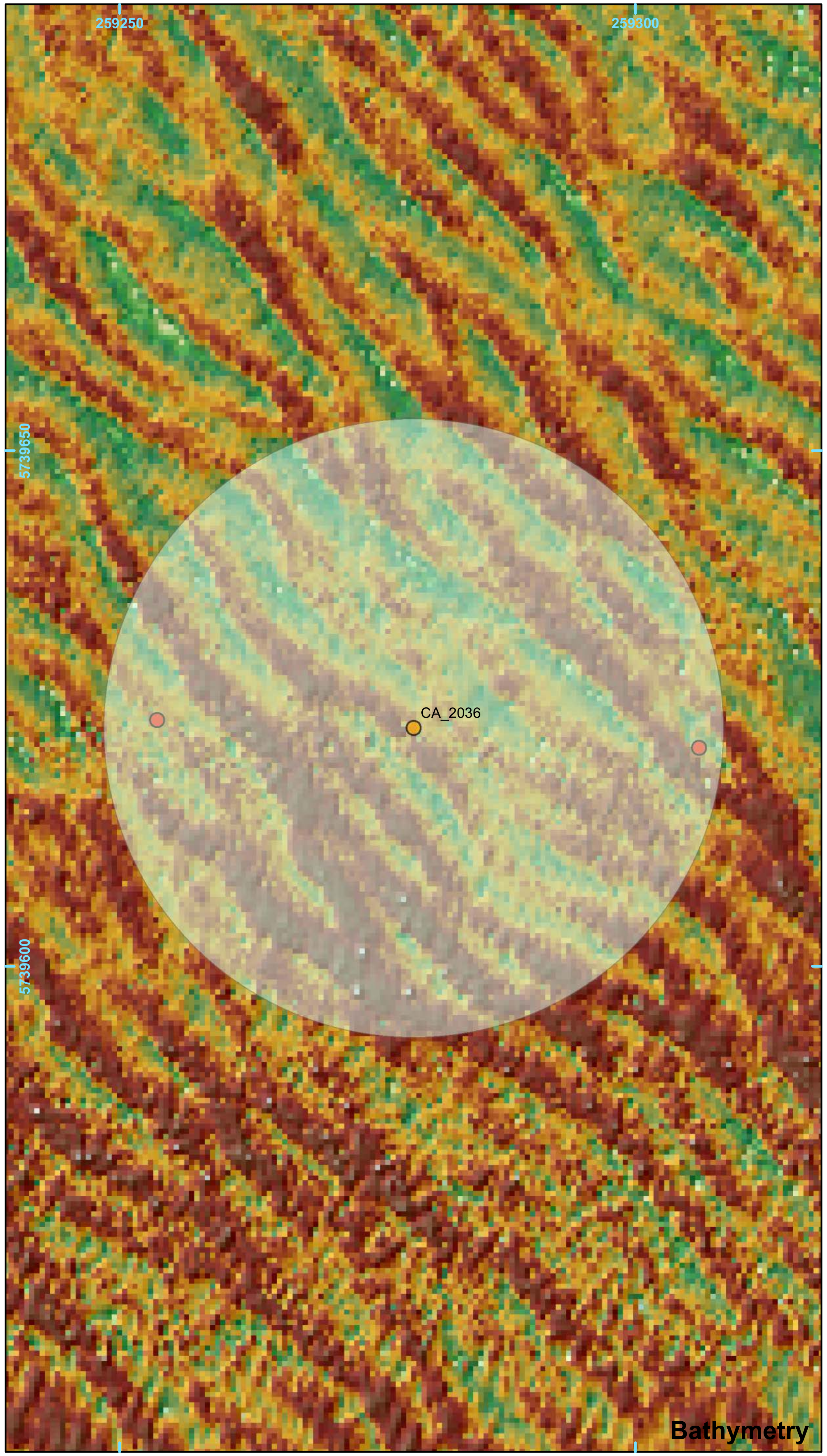
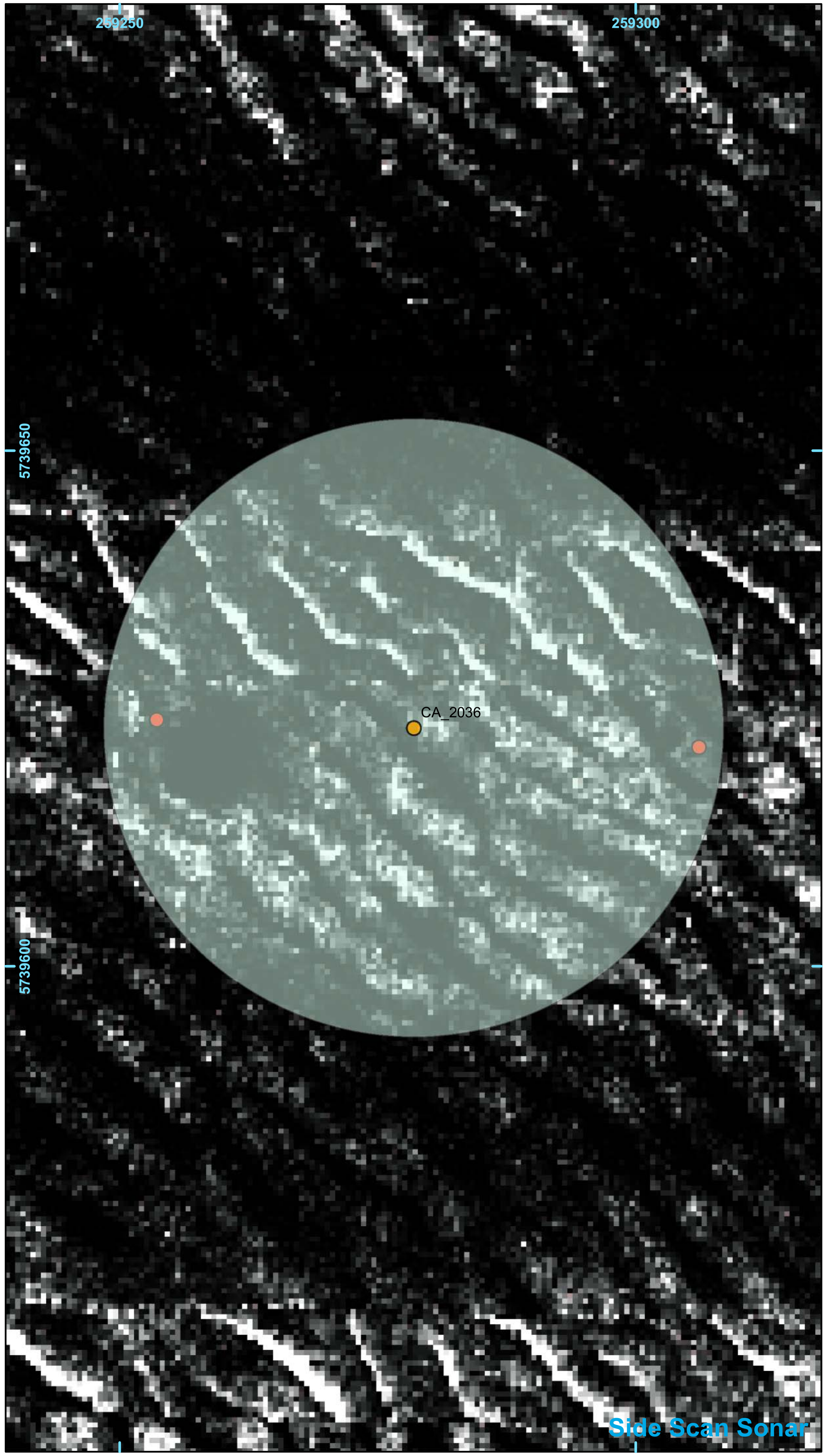
FIGURE TITLE
Archaeological Anomaly CA_2034

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.23
APPROVED BY	MW	SCALE@A3	1:500	





Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -68.017
  - Low : -68.644

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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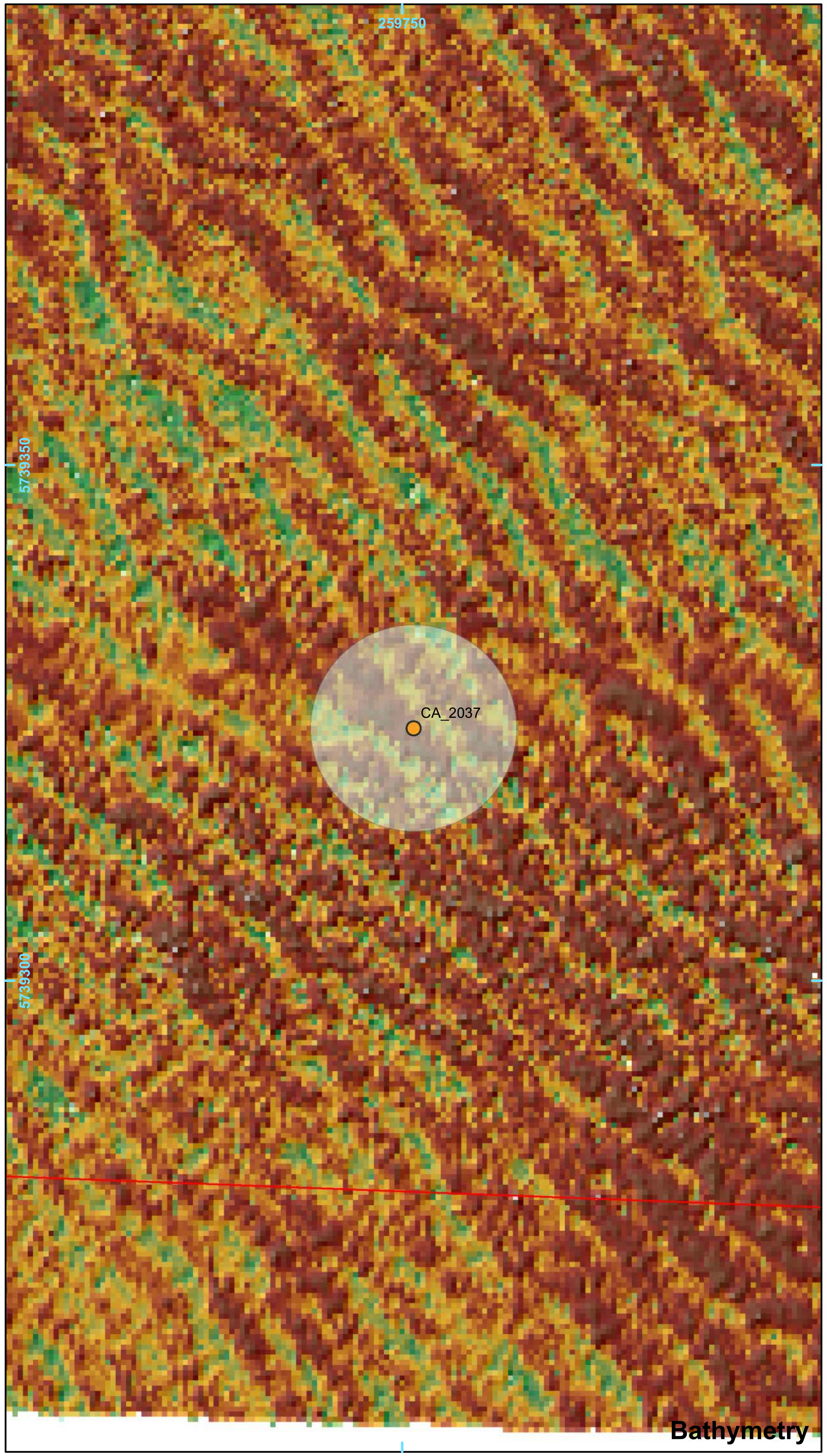
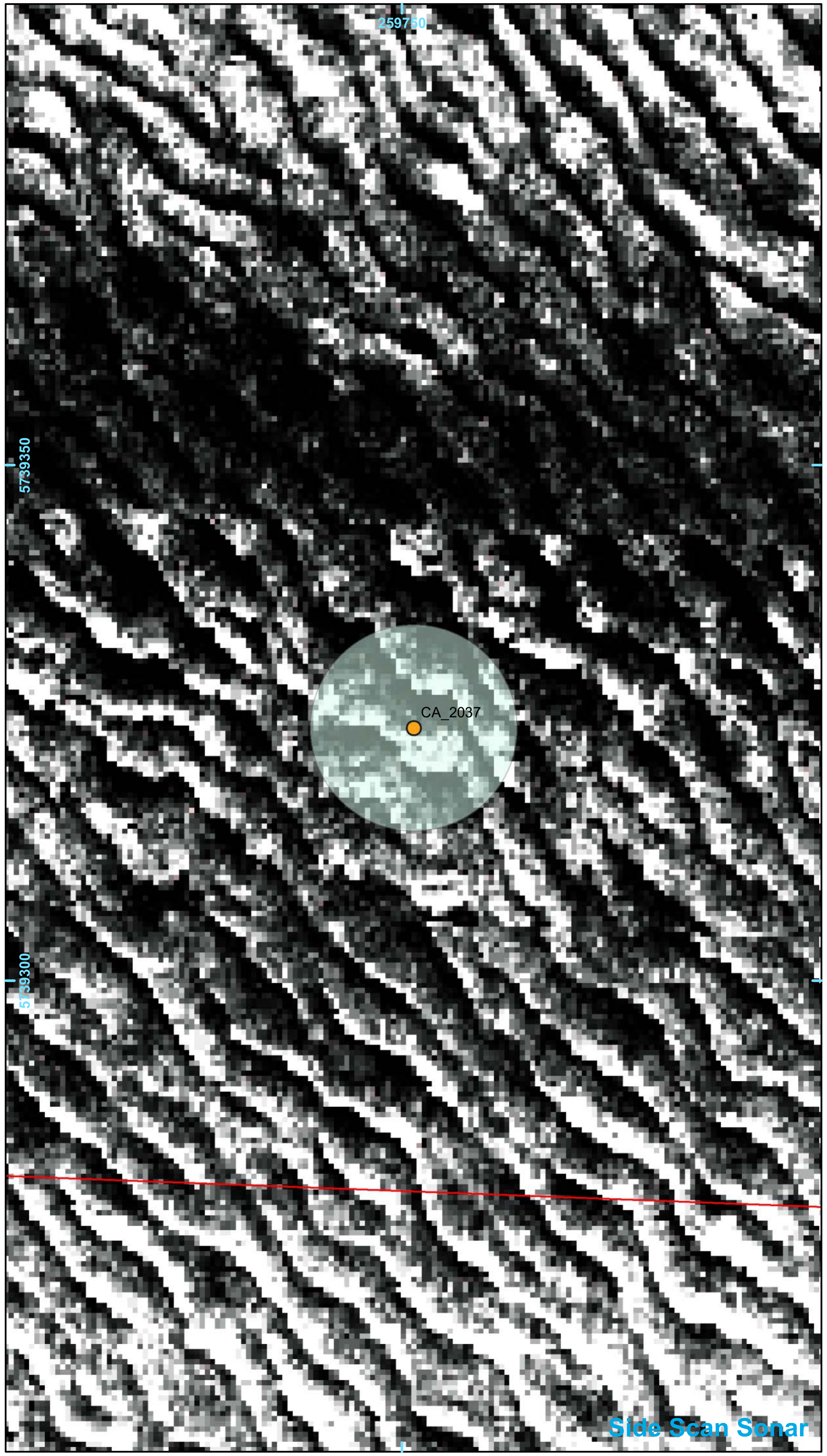
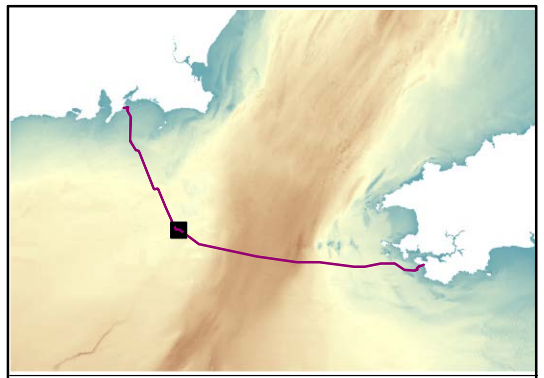
FIGURE TITLE
Archaeological Anomaly CA_2036

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.24
APPROVED BY	MW	SCALE@A3	1:500	







N

Legend

Route Centreline

Route Corridor

Archaeological Anomaly

- High
- Medium
- Low

Archaeological Exclusion Zone

Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)

High : -67.904

Low : -68.696

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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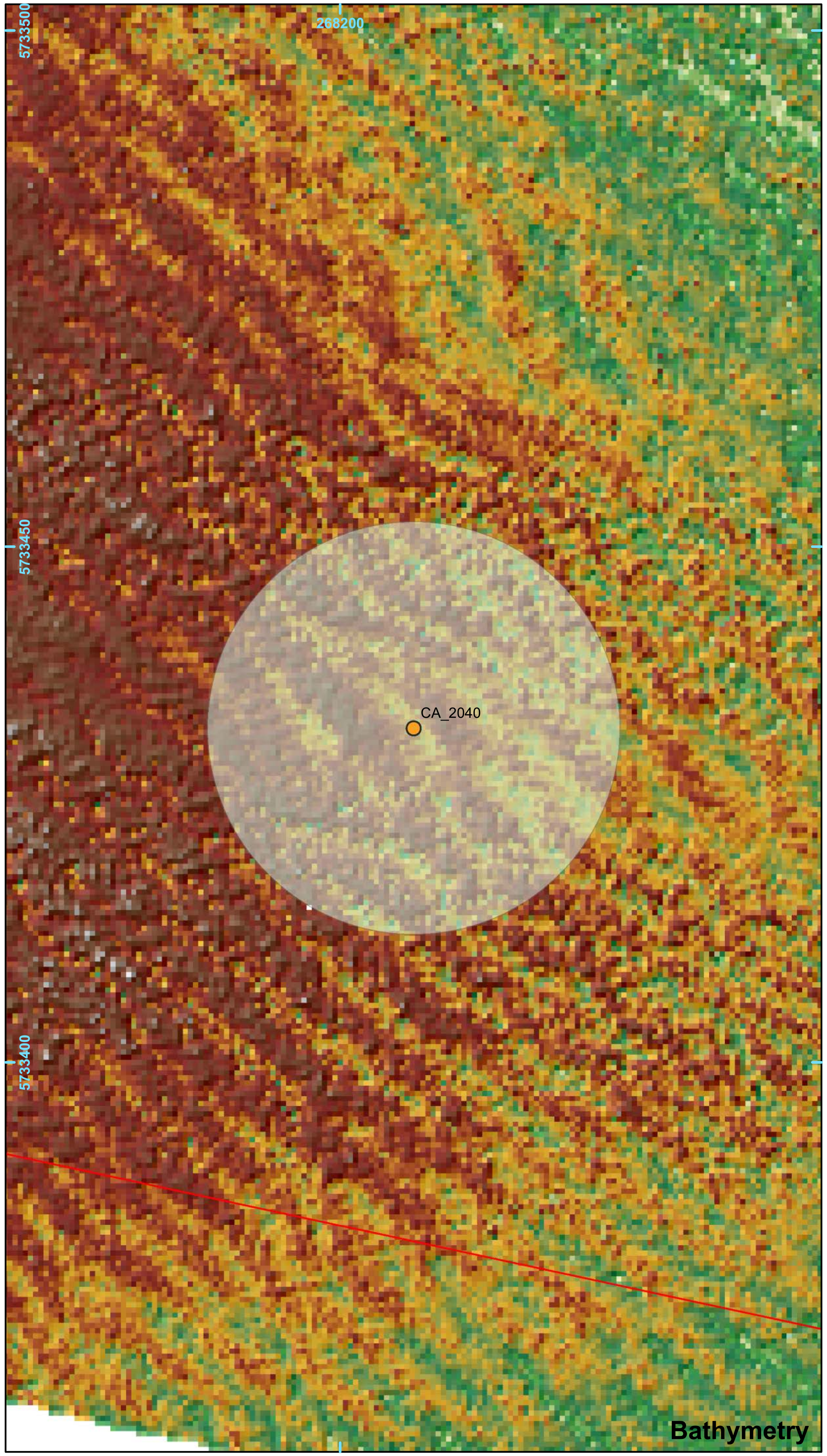
PROJECT TITLE

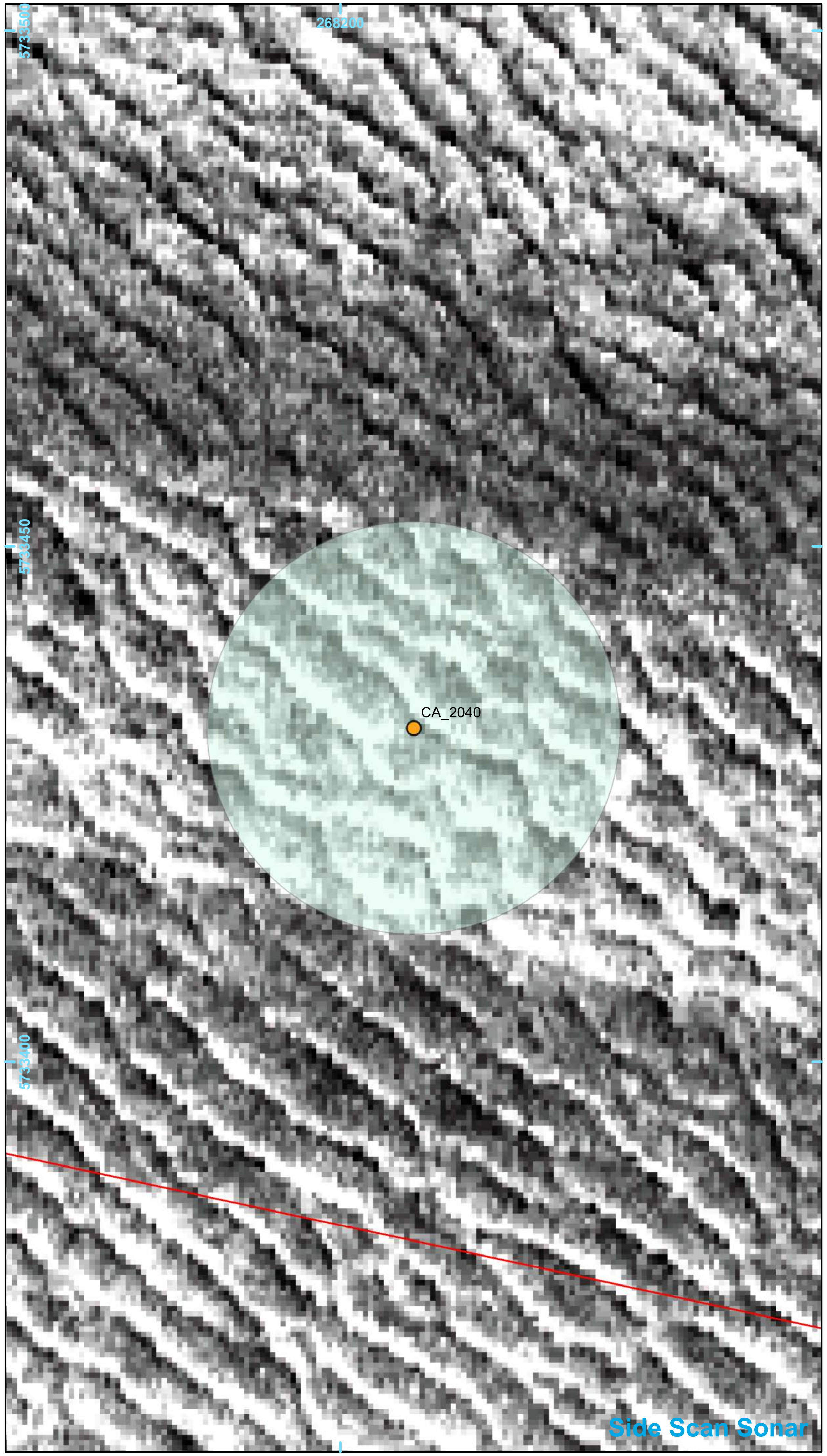
Greenlink Interconnector project

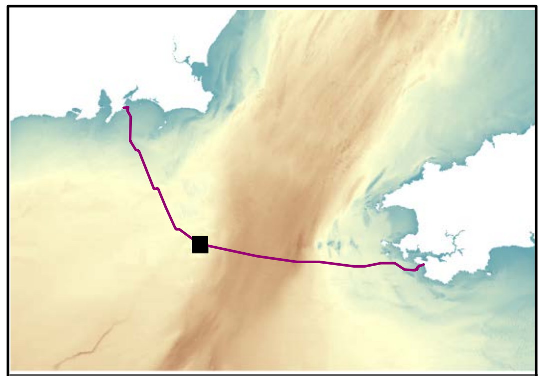
FIGURE TITLE

Archaeological Anomaly CA_2037

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.25
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)

High : -68.485

Low : -69.444

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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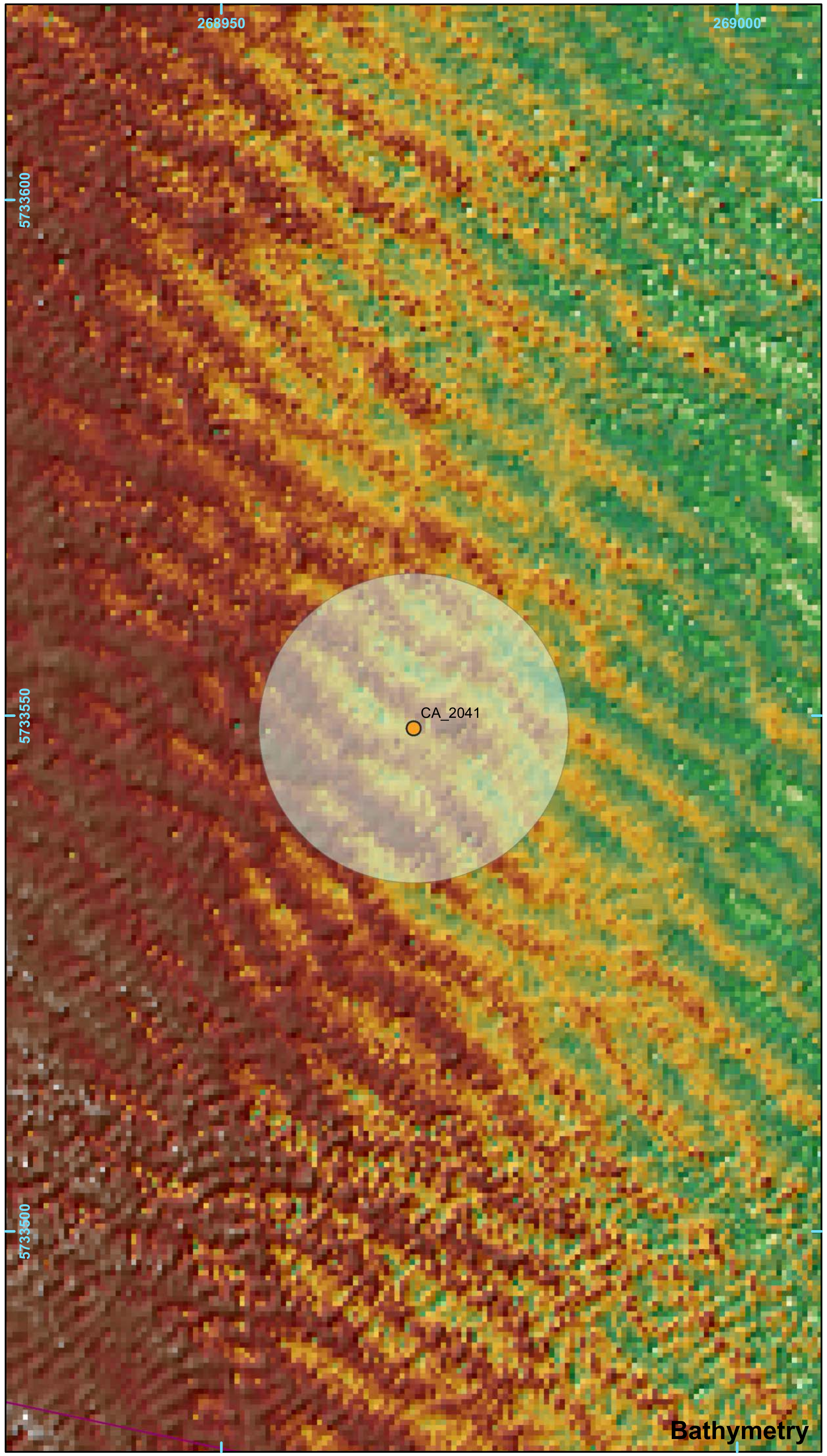
PROJECT TITLE

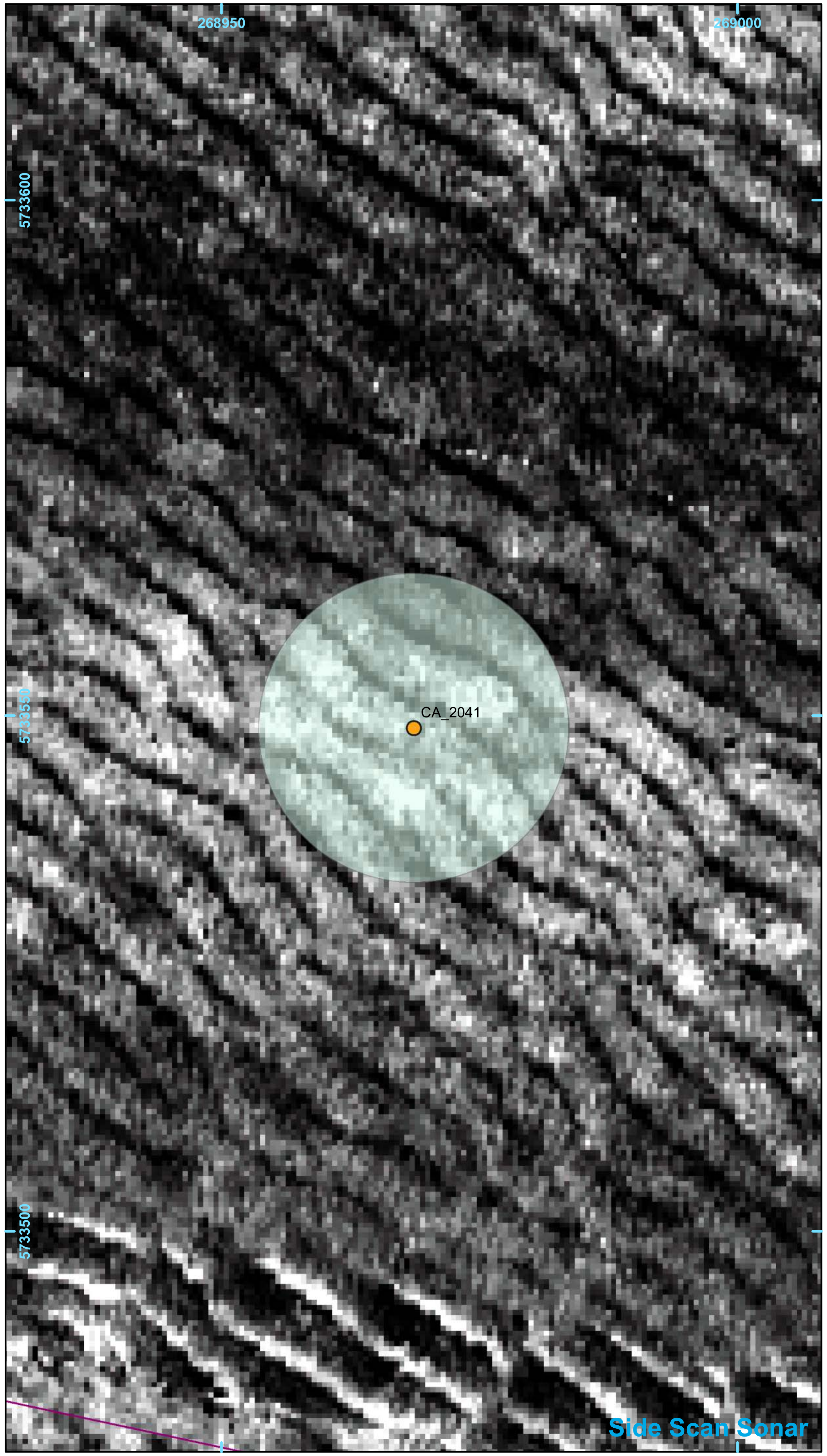
Greenlink Interconnector project

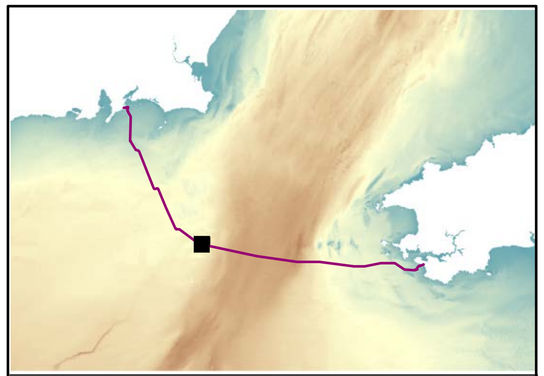
FIGURE TITLE

Archaeological Anomaly CA_2040

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.26
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -70.972
Low : -71.965

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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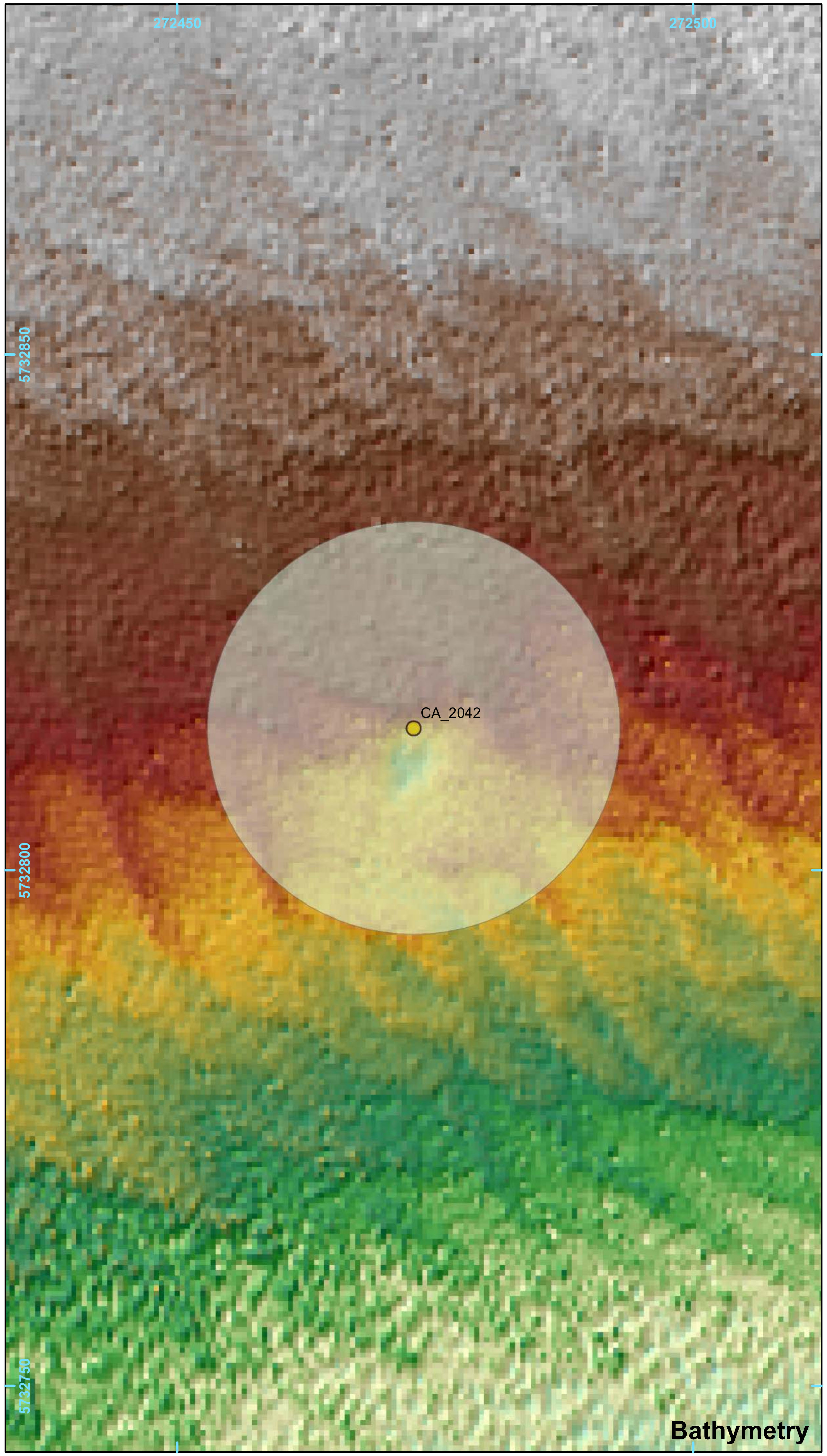
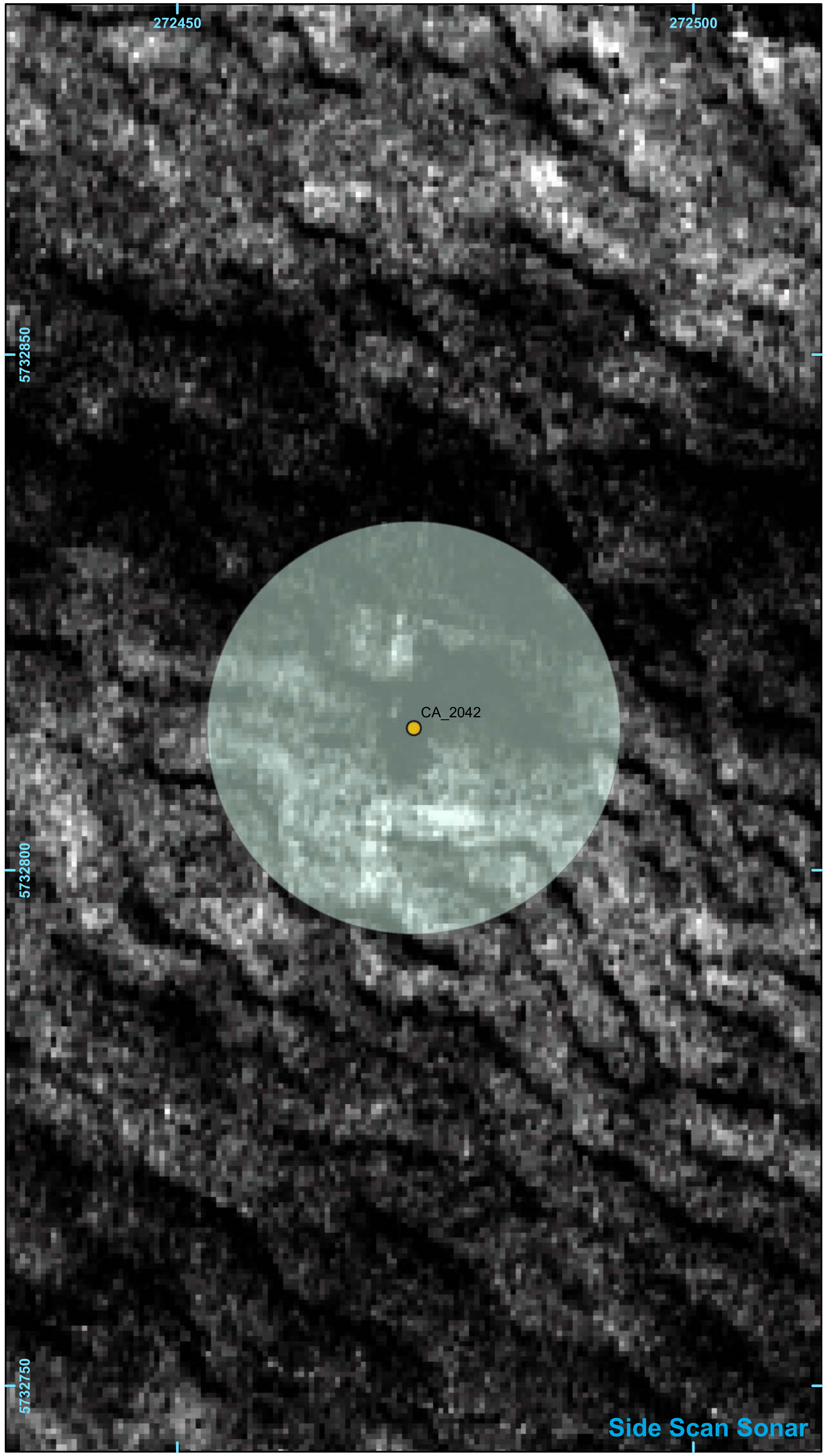
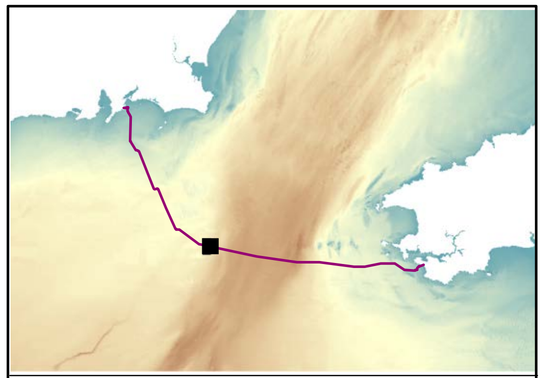
FIGURE TITLE
Archaeological Anomaly CA_2041

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.27
APPROVED BY	MW	SCALE@A3	1:500	







Legend

N

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -78.817
  - Low : -81.054

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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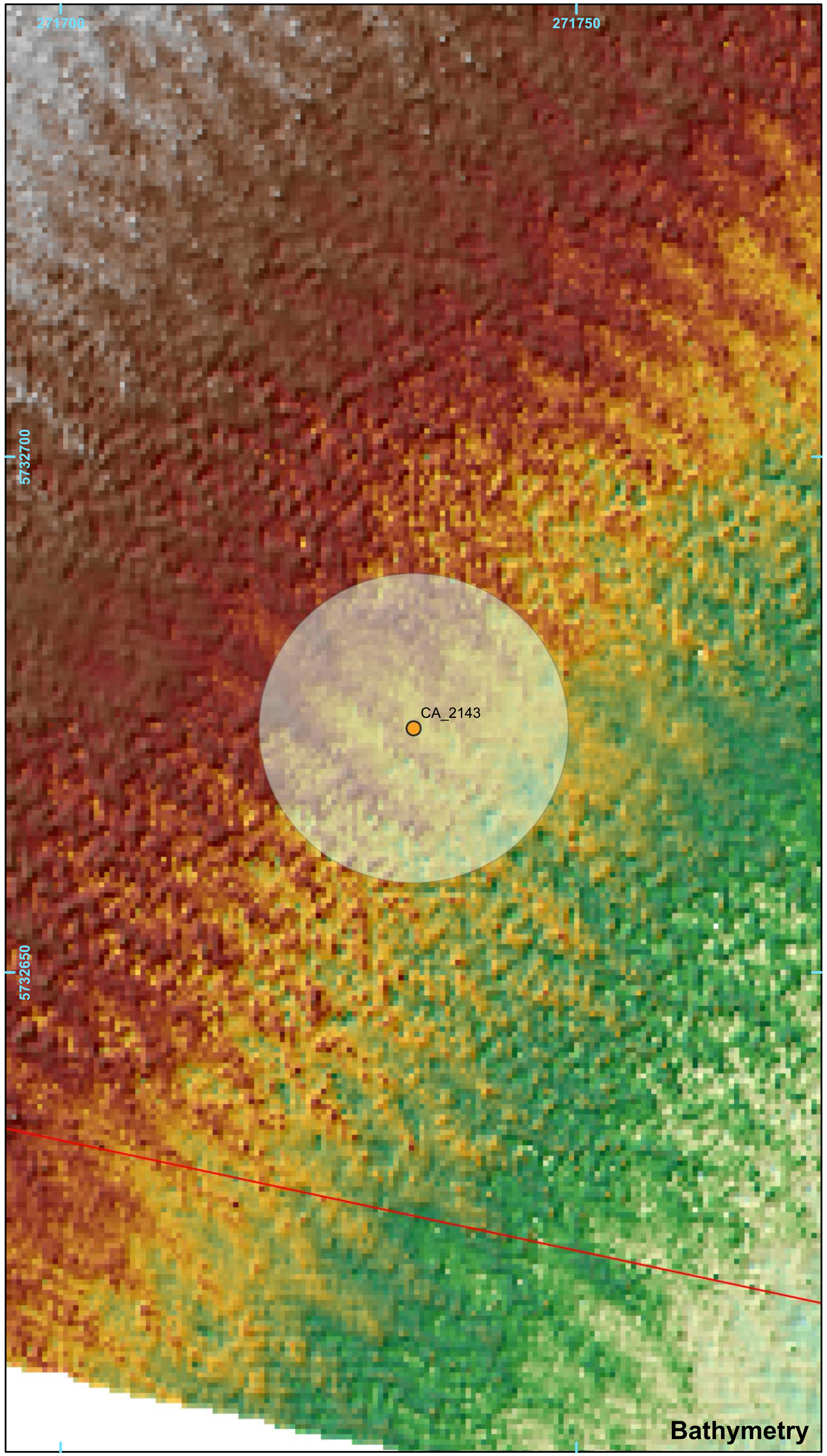
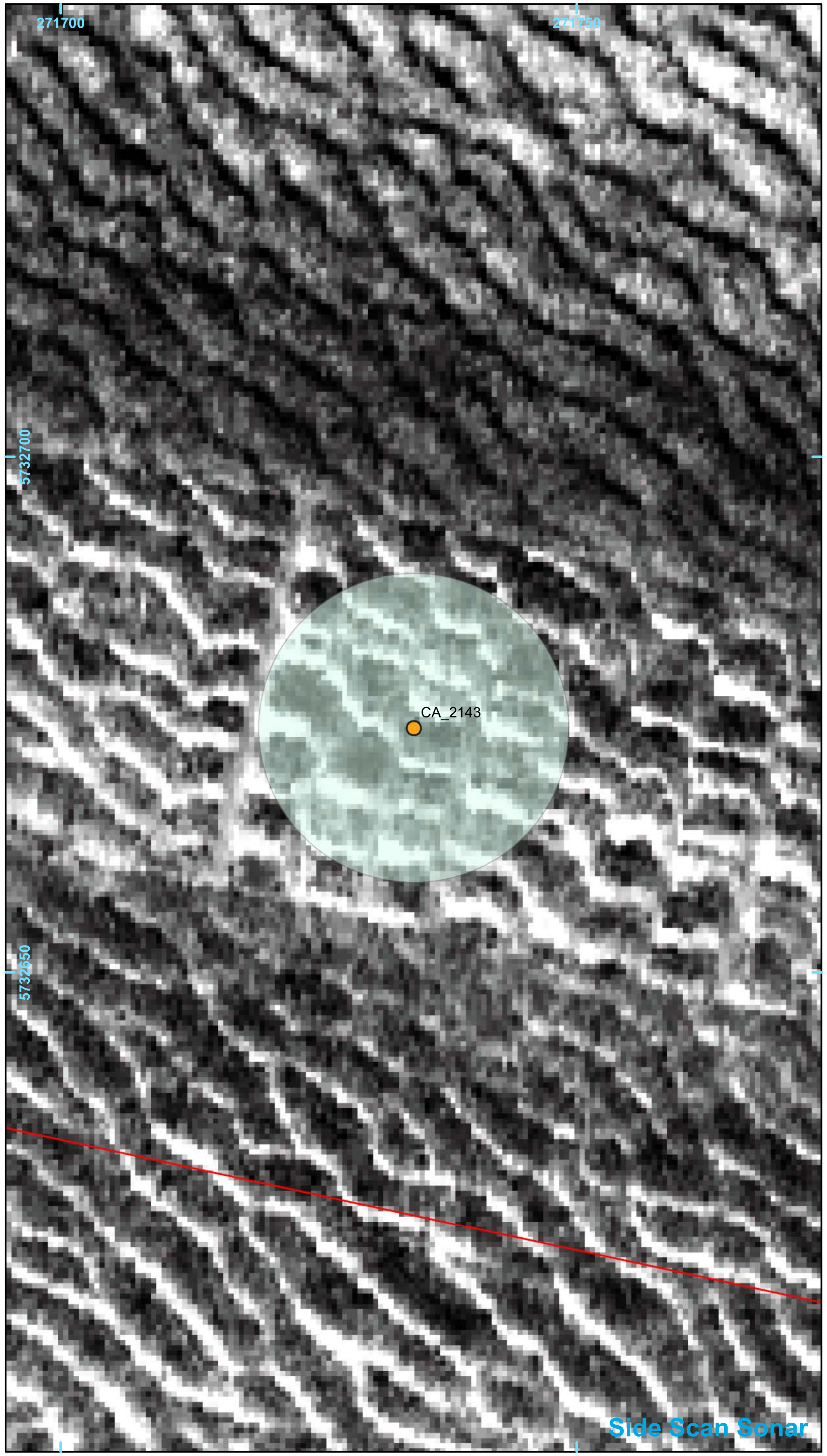
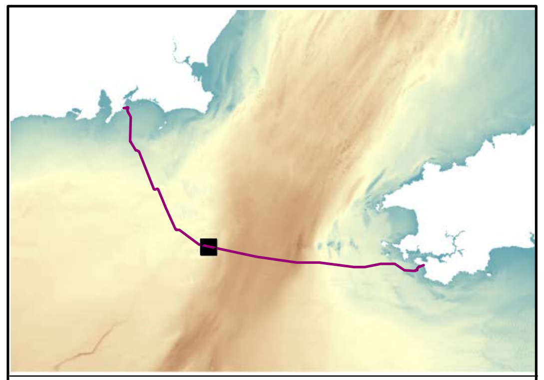
FIGURE TITLE
Archaeological Anomaly CA_2042

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.28
APPROVED BY	MW	SCALE@A3	1:500	







N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -75.306
Low : -77.056

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine
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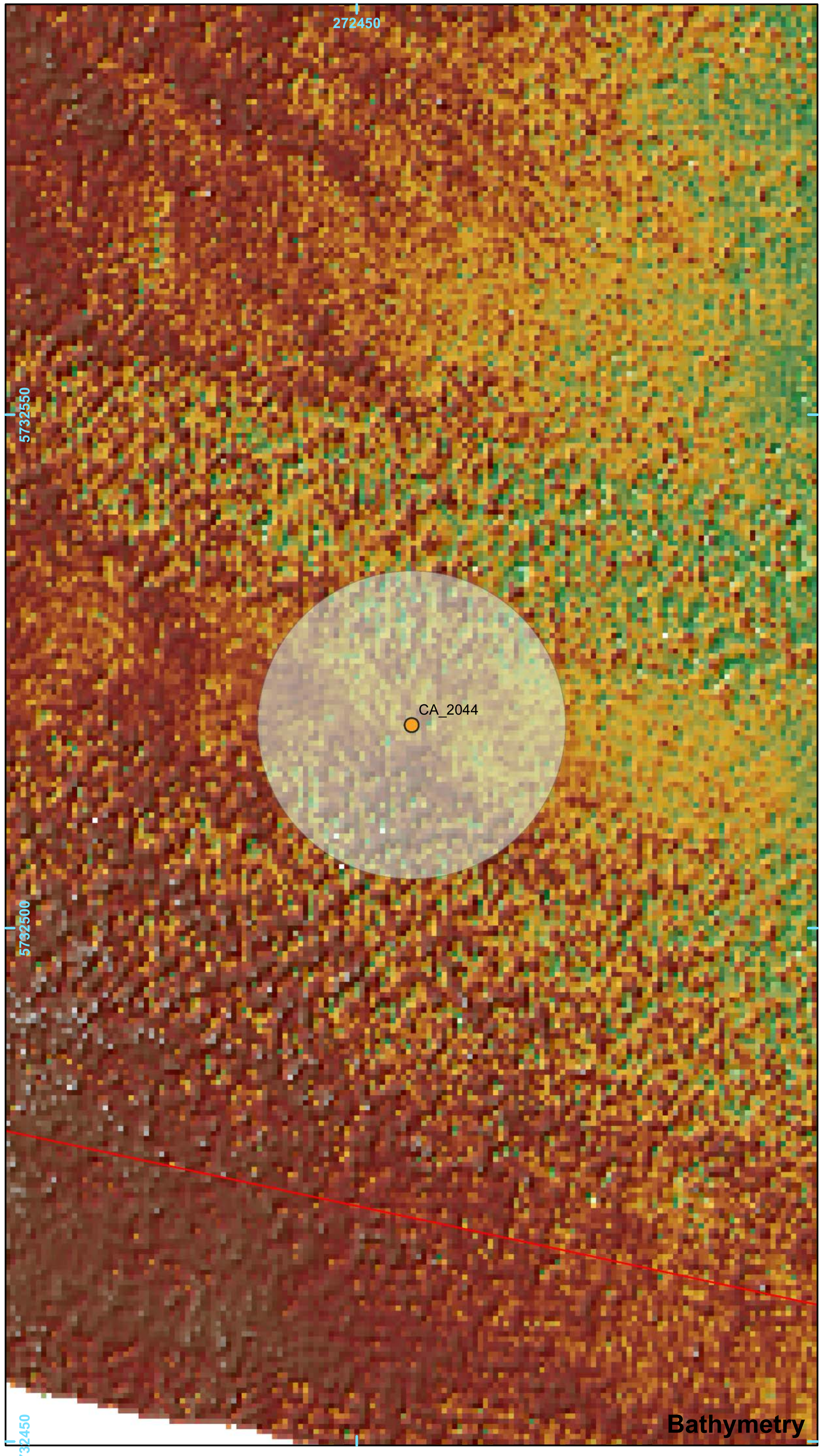
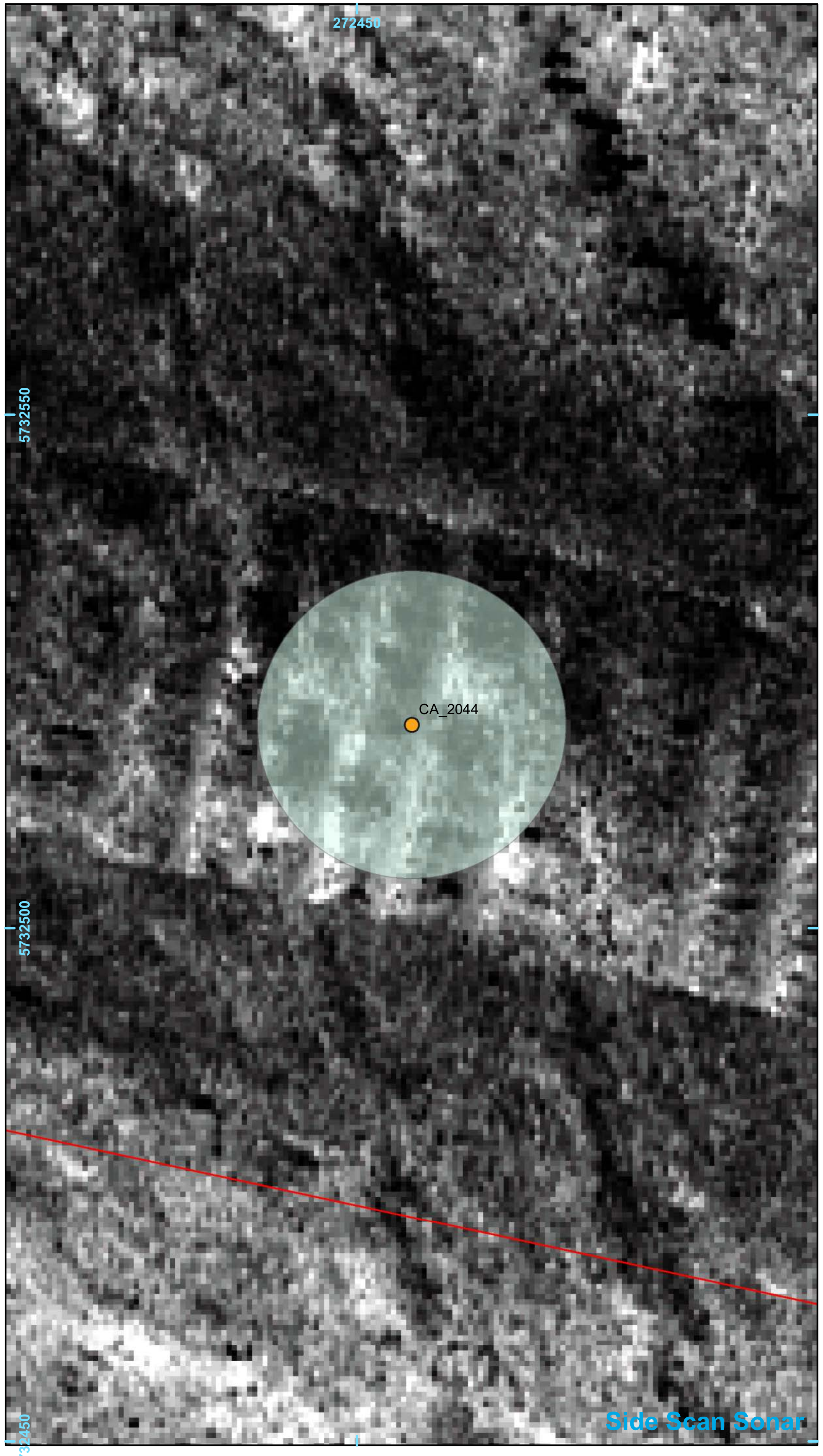
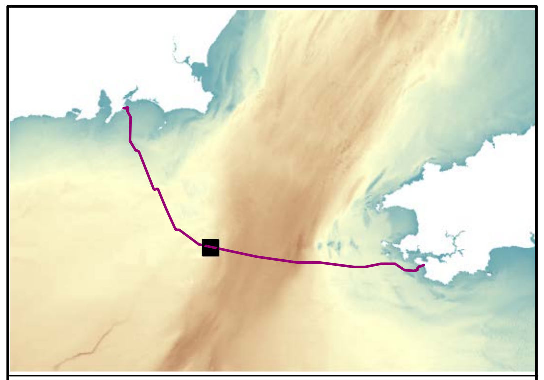
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2143

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.29
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -80.357
Low : -81.096

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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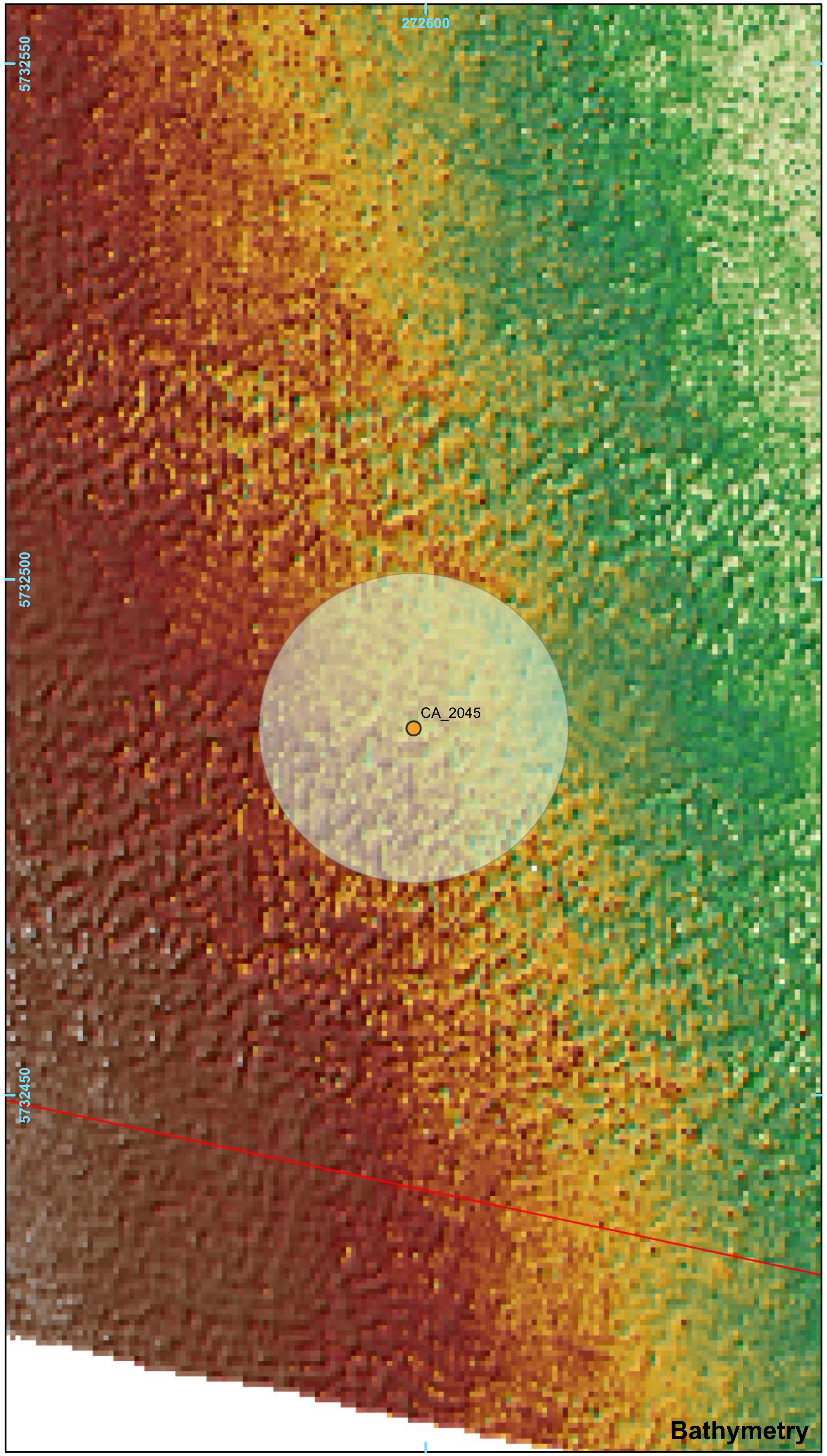
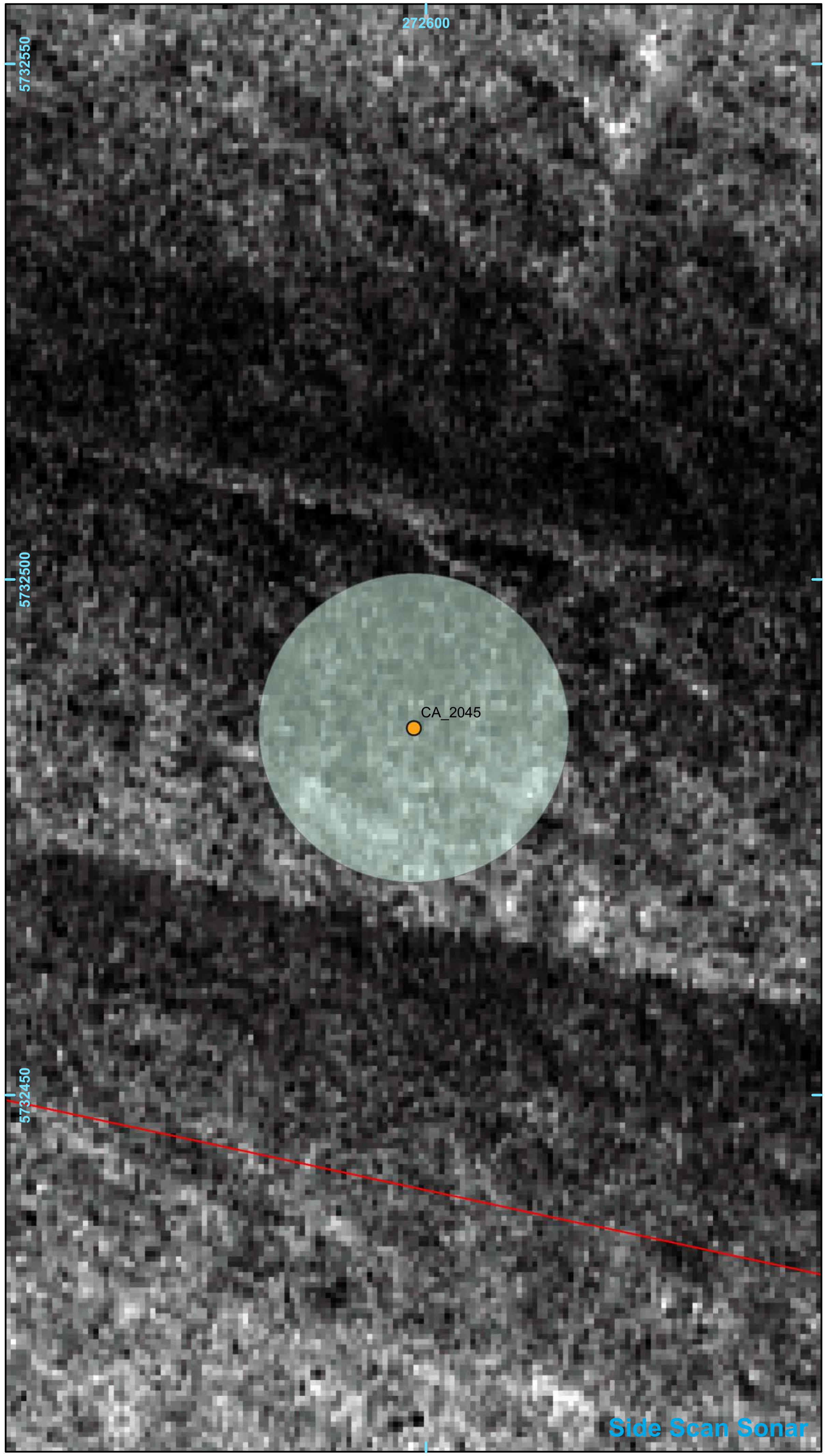
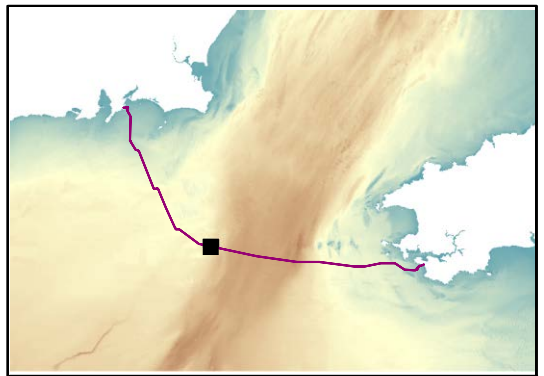
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2044

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.30
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -80.718
Low : -81.916

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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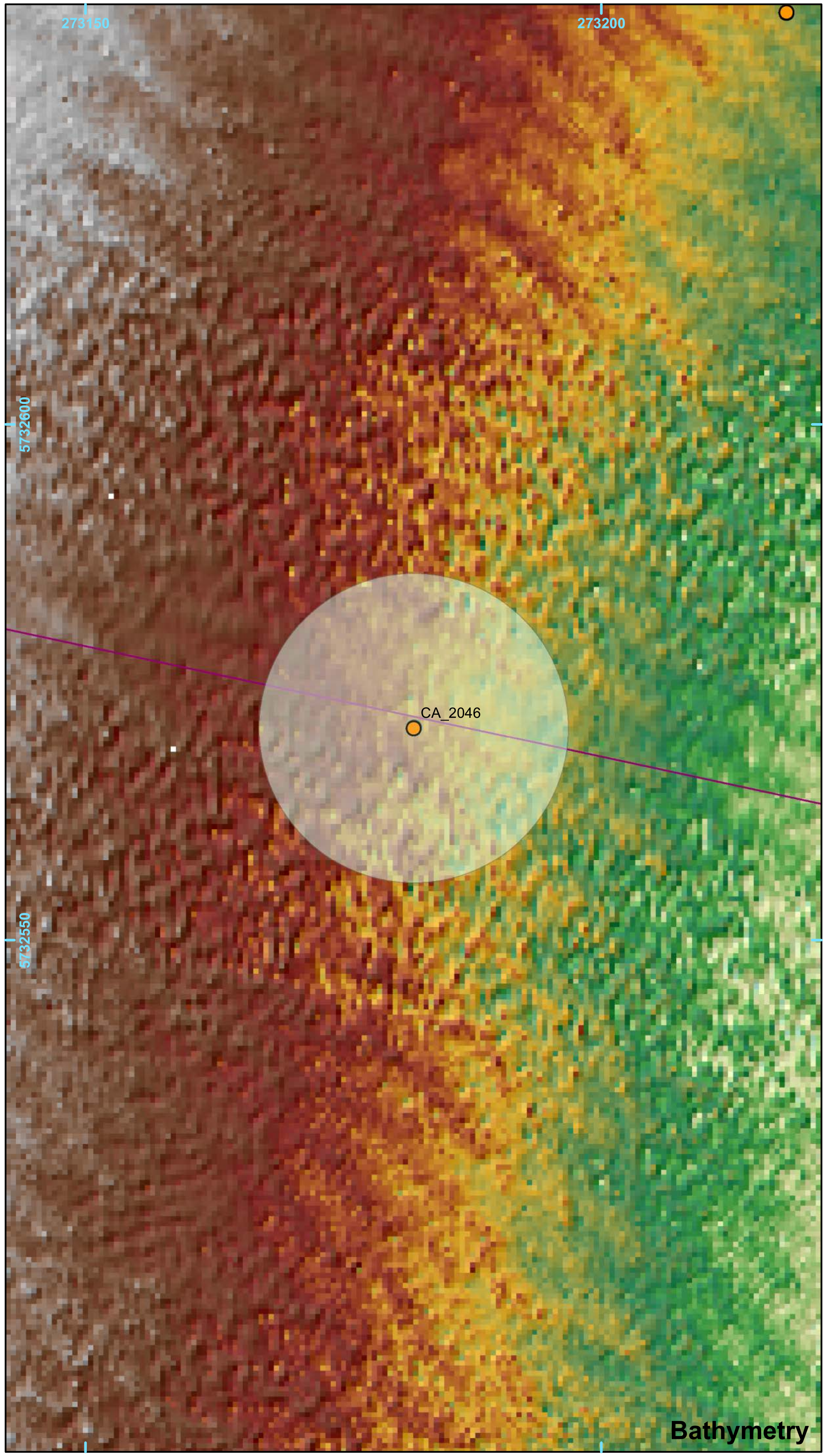
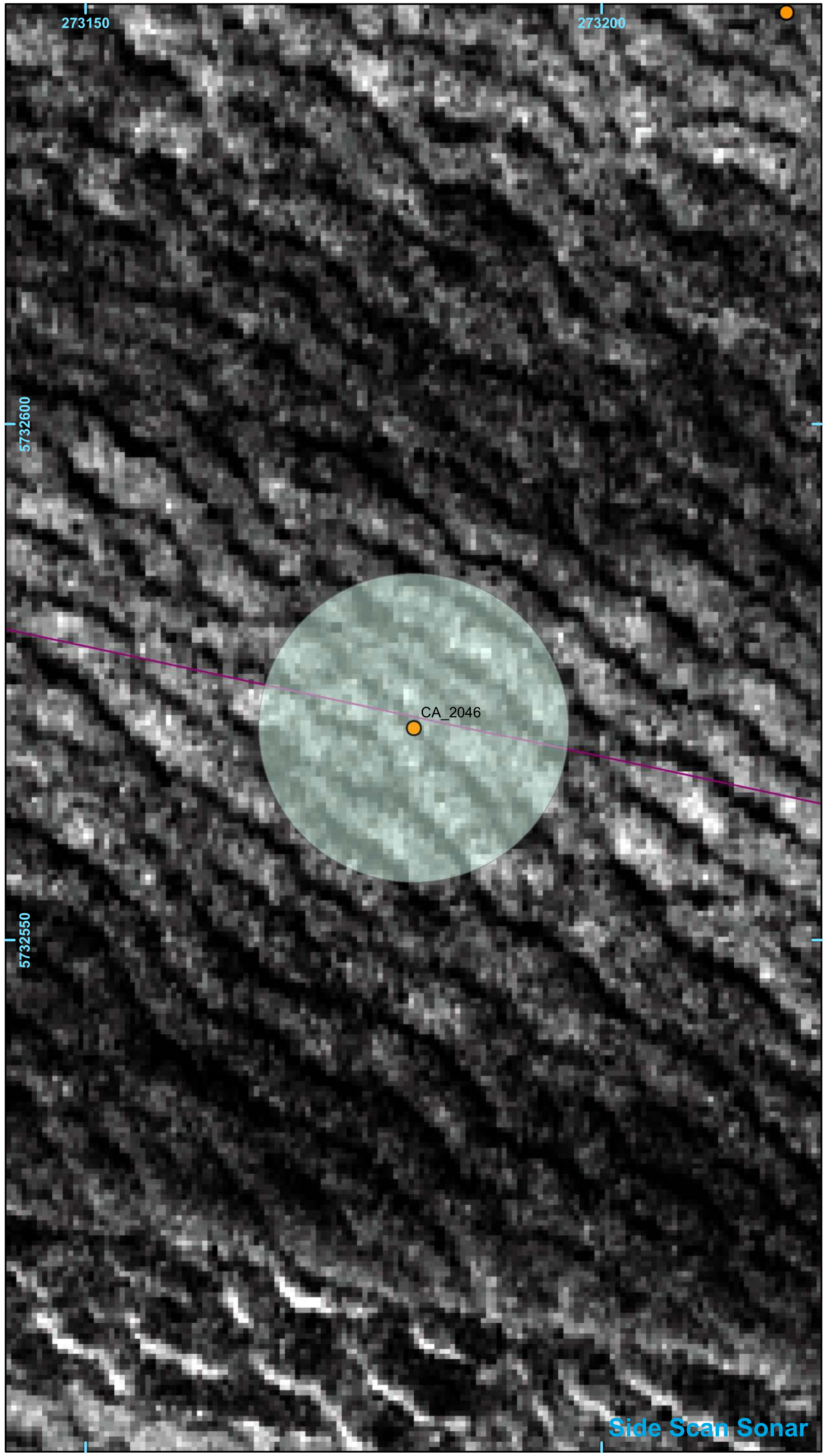
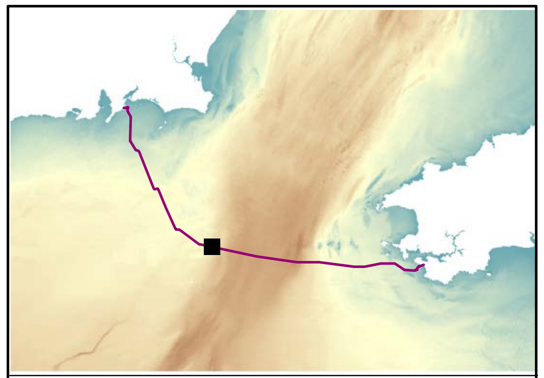
FIGURE TITLE
Archaeological Anomaly CA_2045

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.31
APPROVED BY	MW	SCALE@A3	1:500	







N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)

High : -82.381

Low : -83.783

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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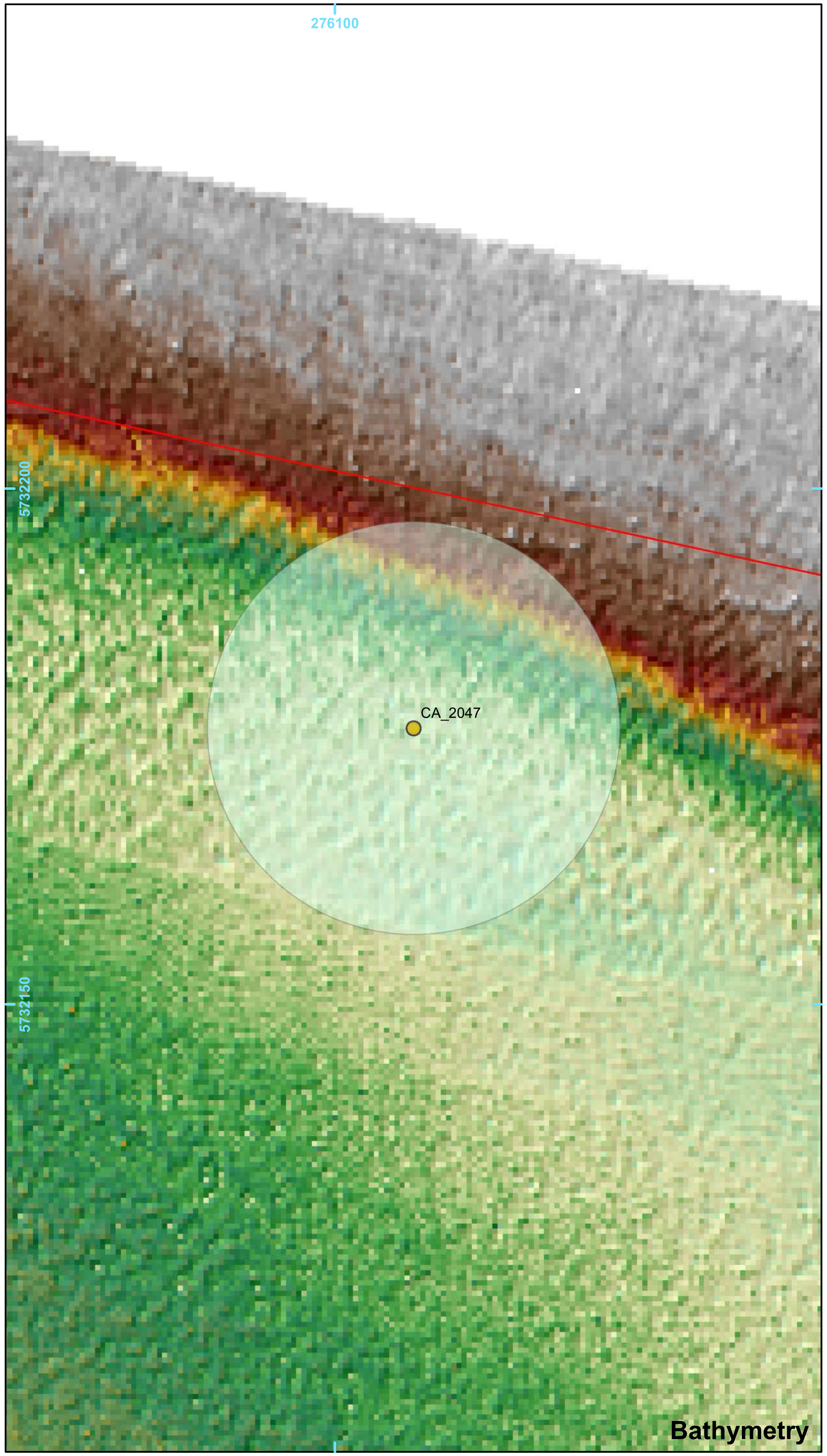
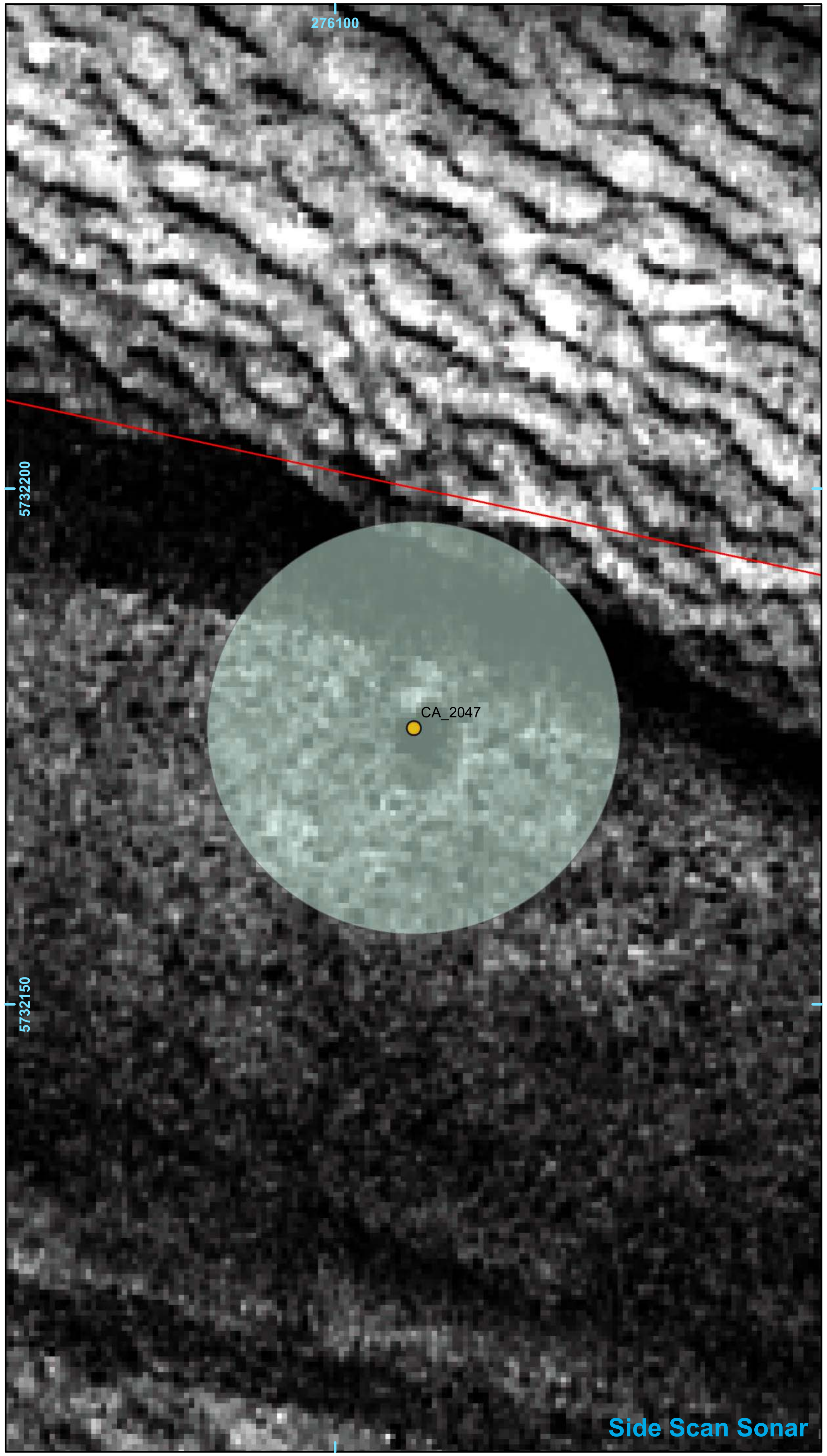
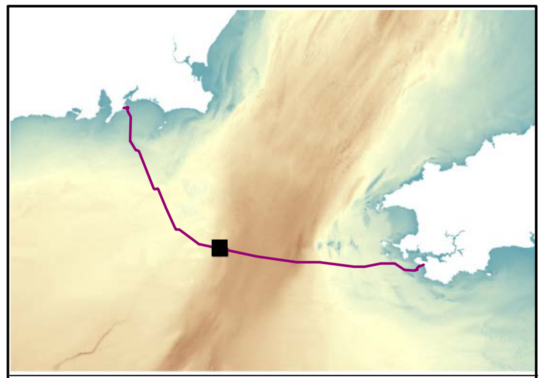
FIGURE TITLE
Archaeological Anomaly CA_2046

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.32
APPROVED BY	MW	SCALE@A3	1:500	







Legend

N

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -89.967
Low : -92.338

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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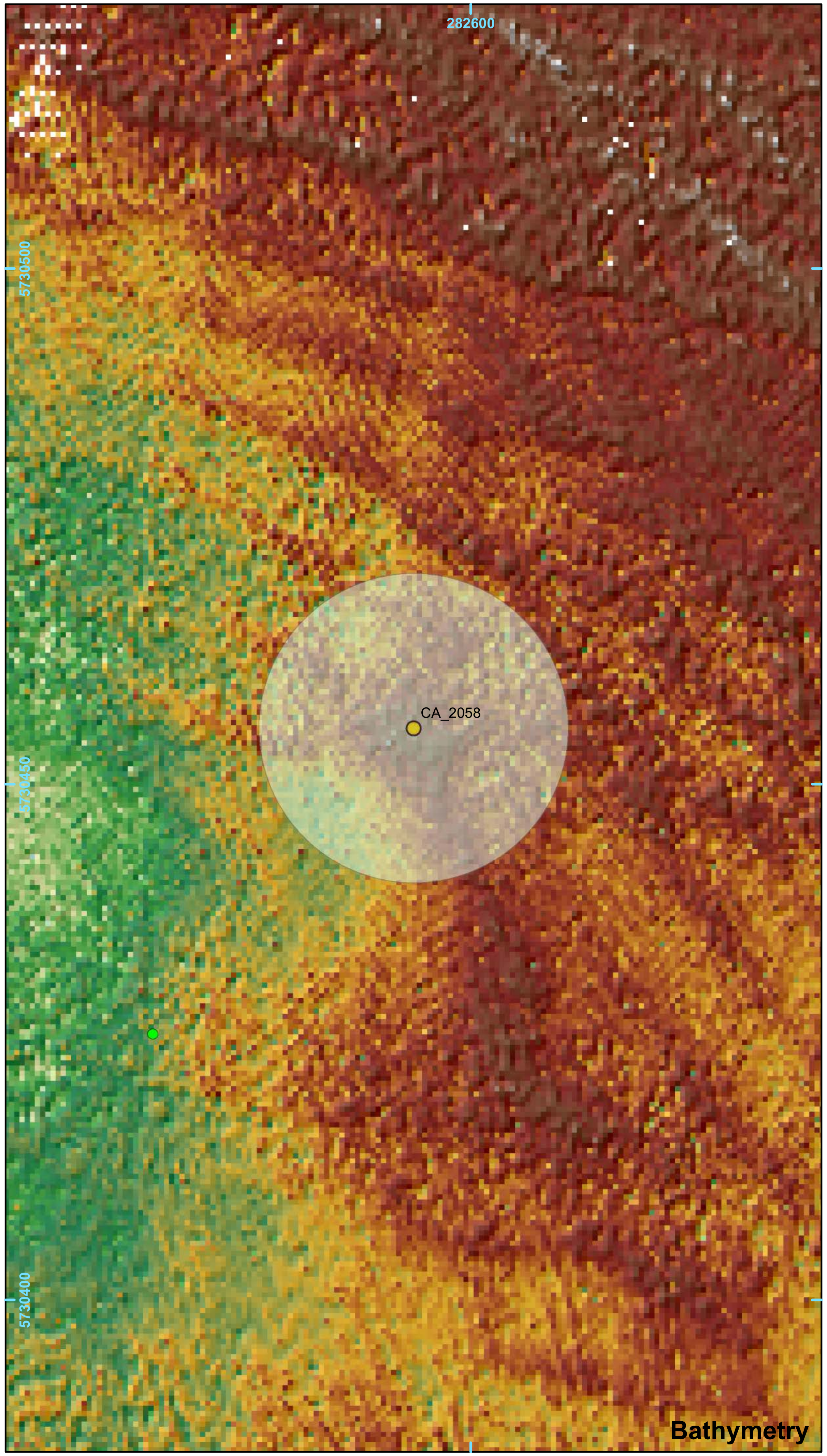
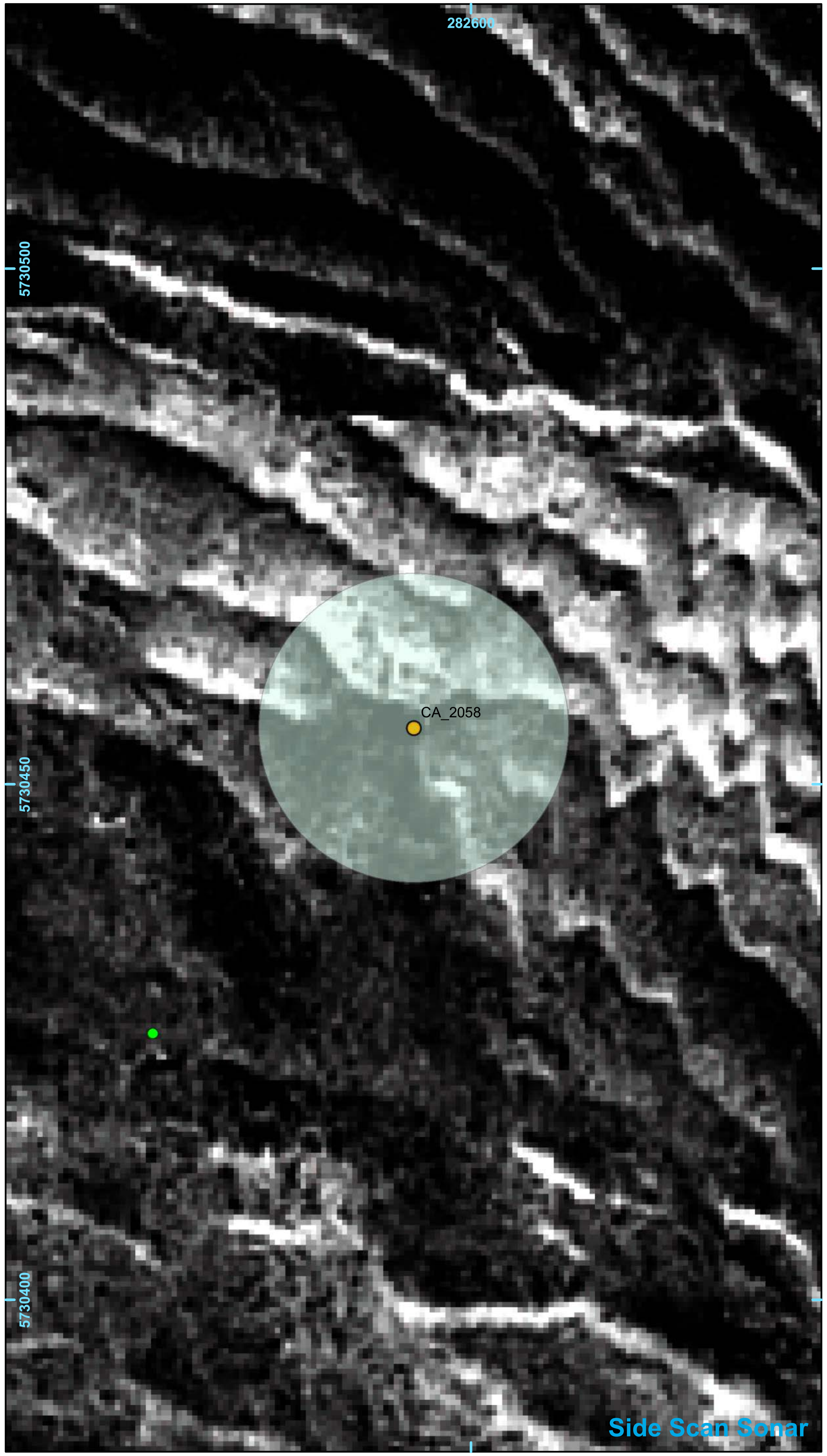
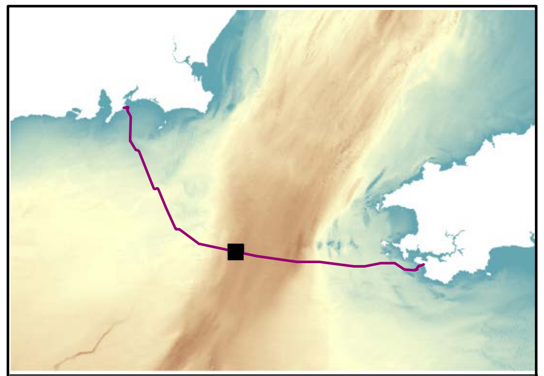
FIGURE TITLE
Archaeological Anomaly CA_2047

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.33
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)

High : -110.631

Low : -112.169

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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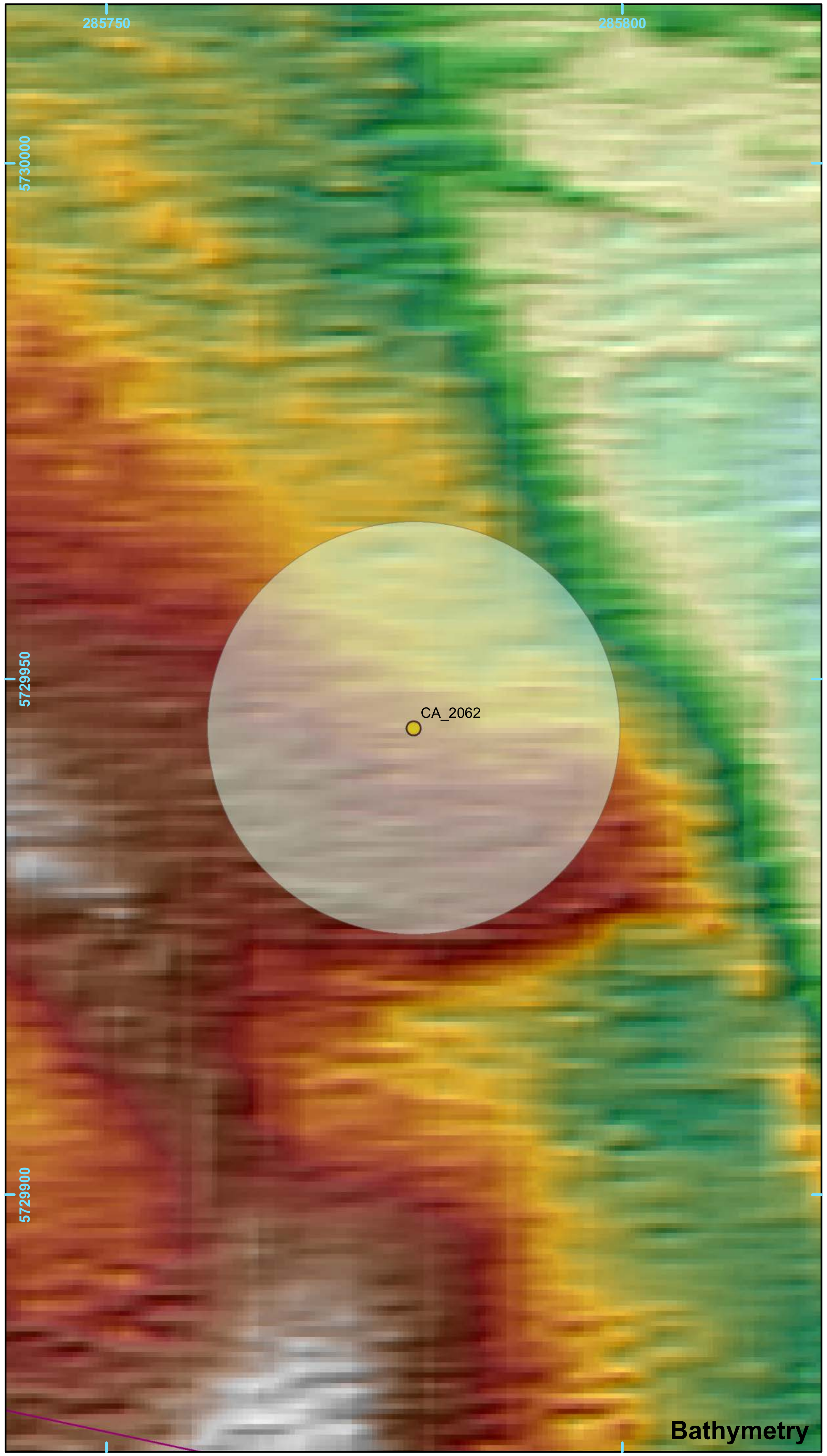
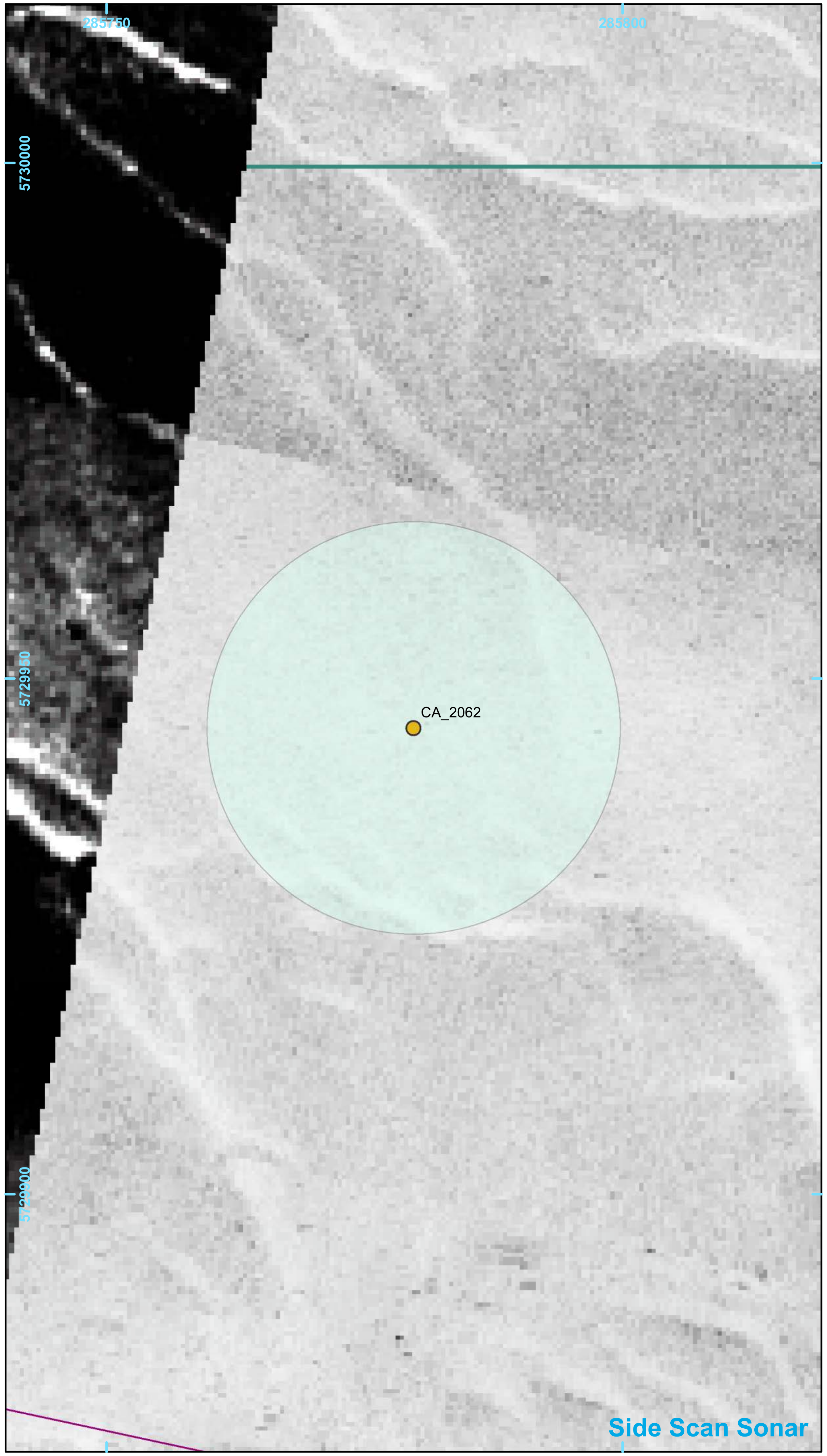
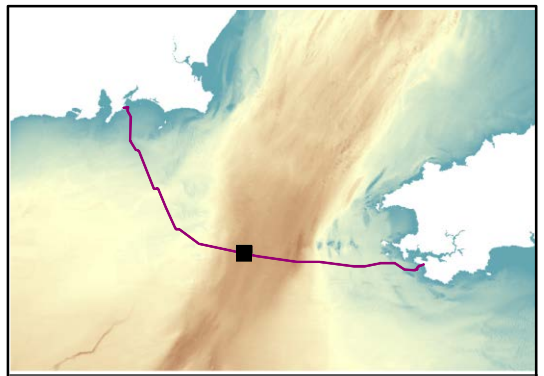
FIGURE TITLE
Archaeological Anomaly CA_2058

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.34
APPROVED BY	MW	SCALE@A3	1:500	







N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -113.034
Low : -114.882

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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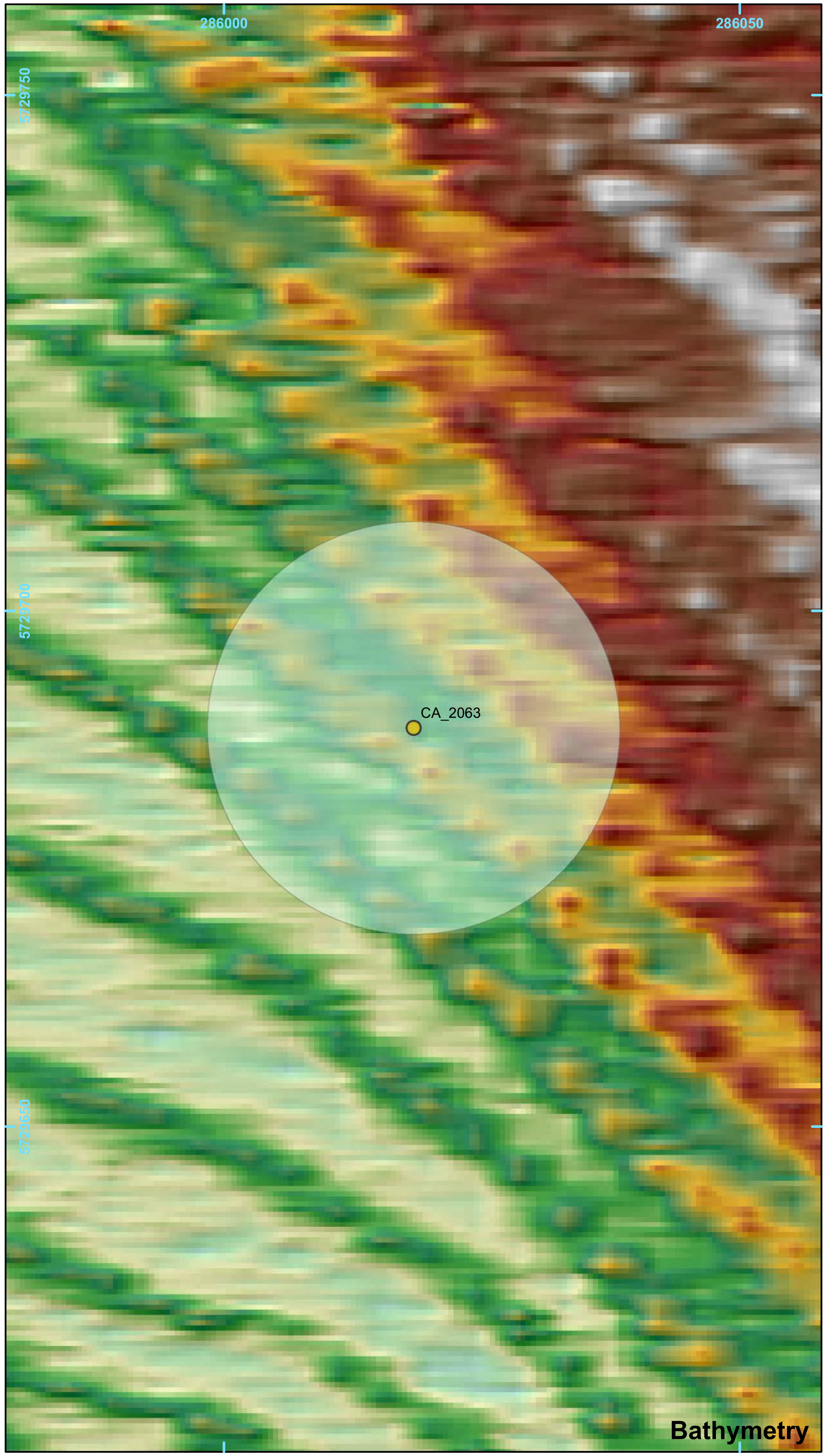
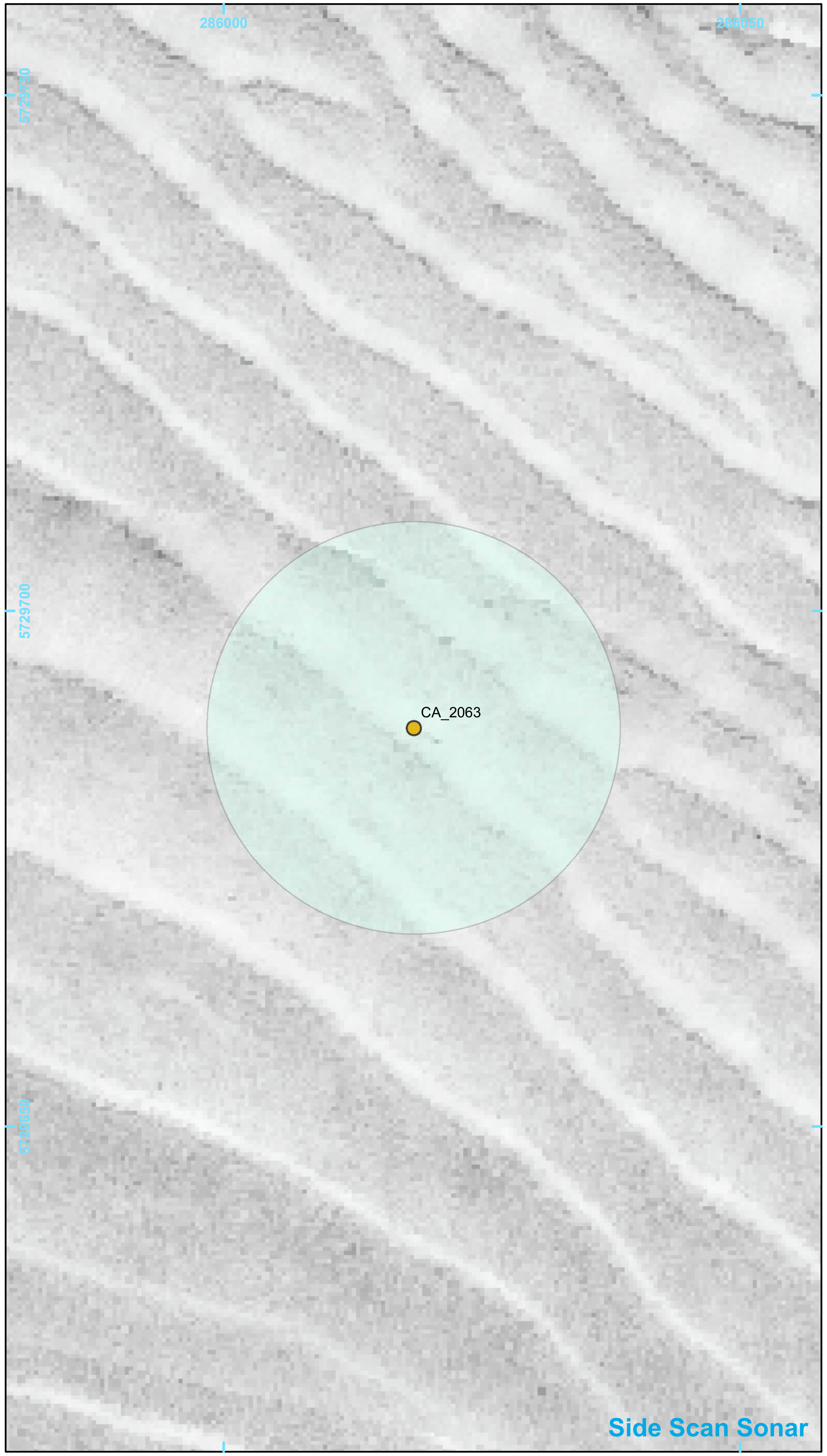
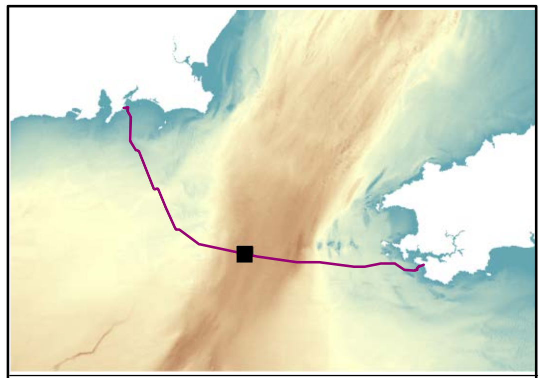
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2062

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.35
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -113.653
  - Low : -114.56

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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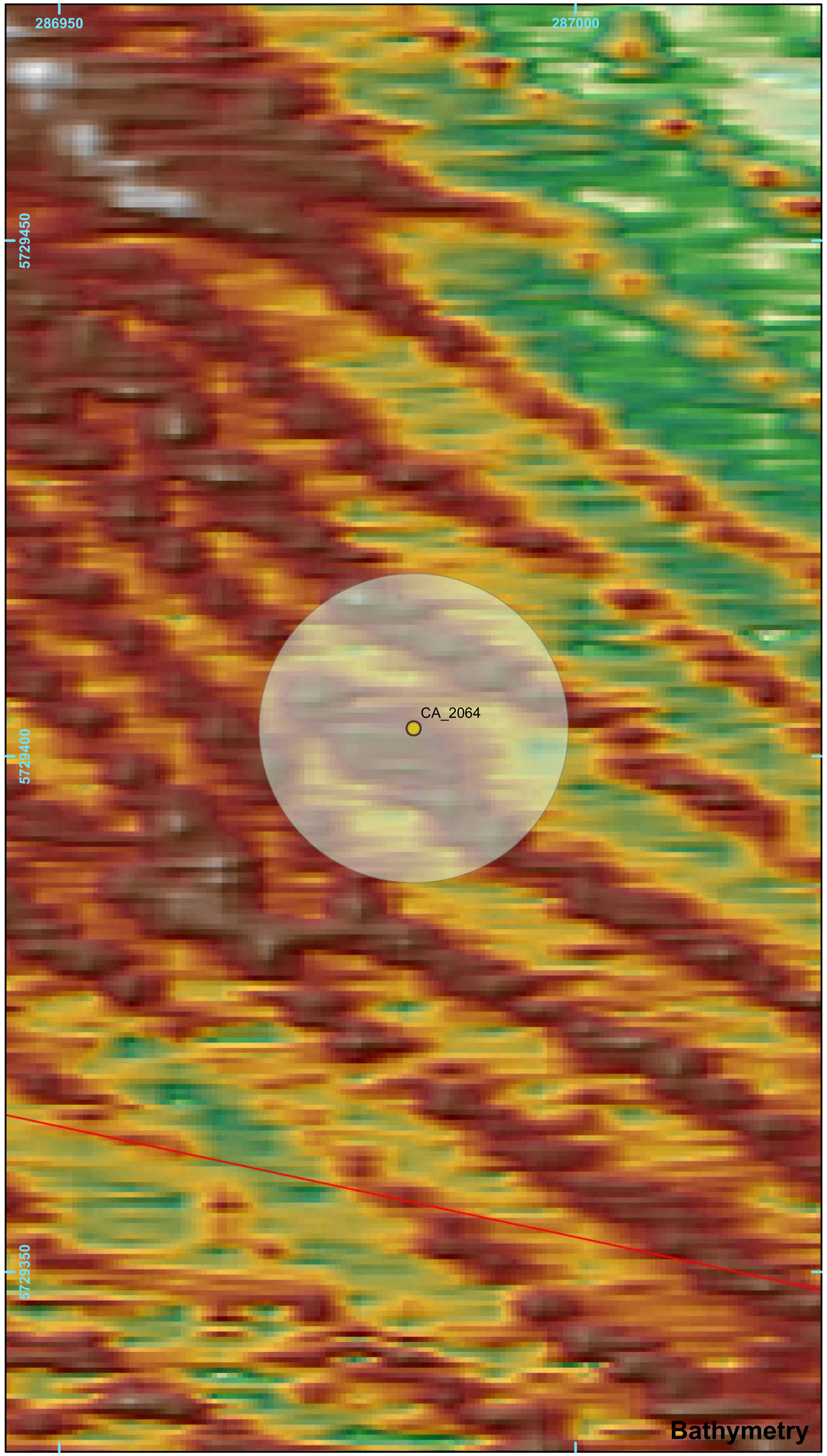
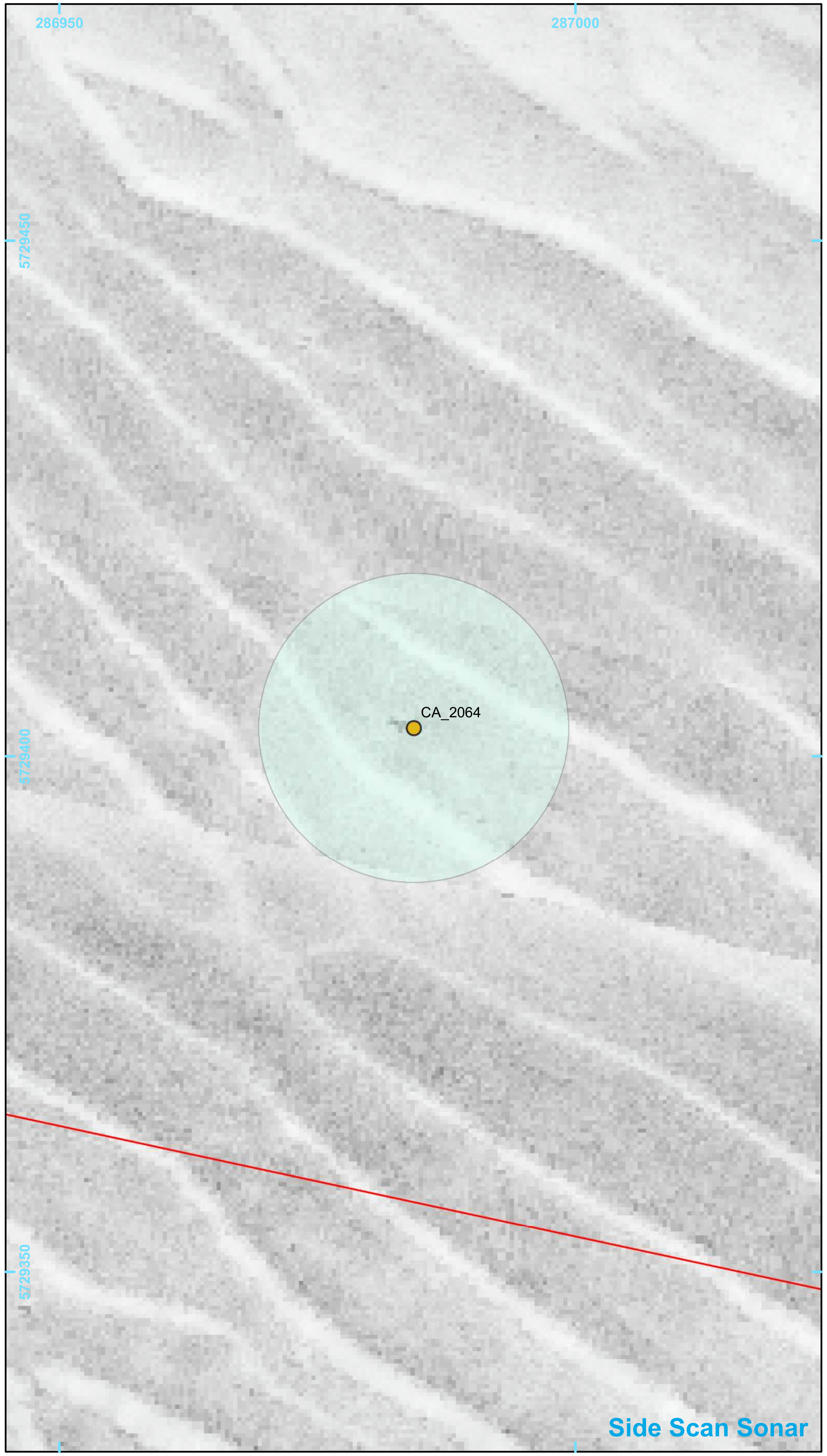
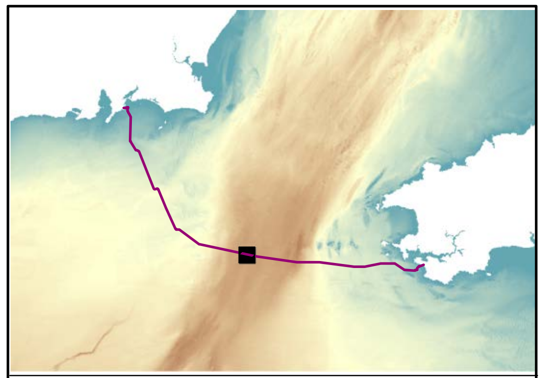
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2063

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.36
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -113.357
Low : -114.057

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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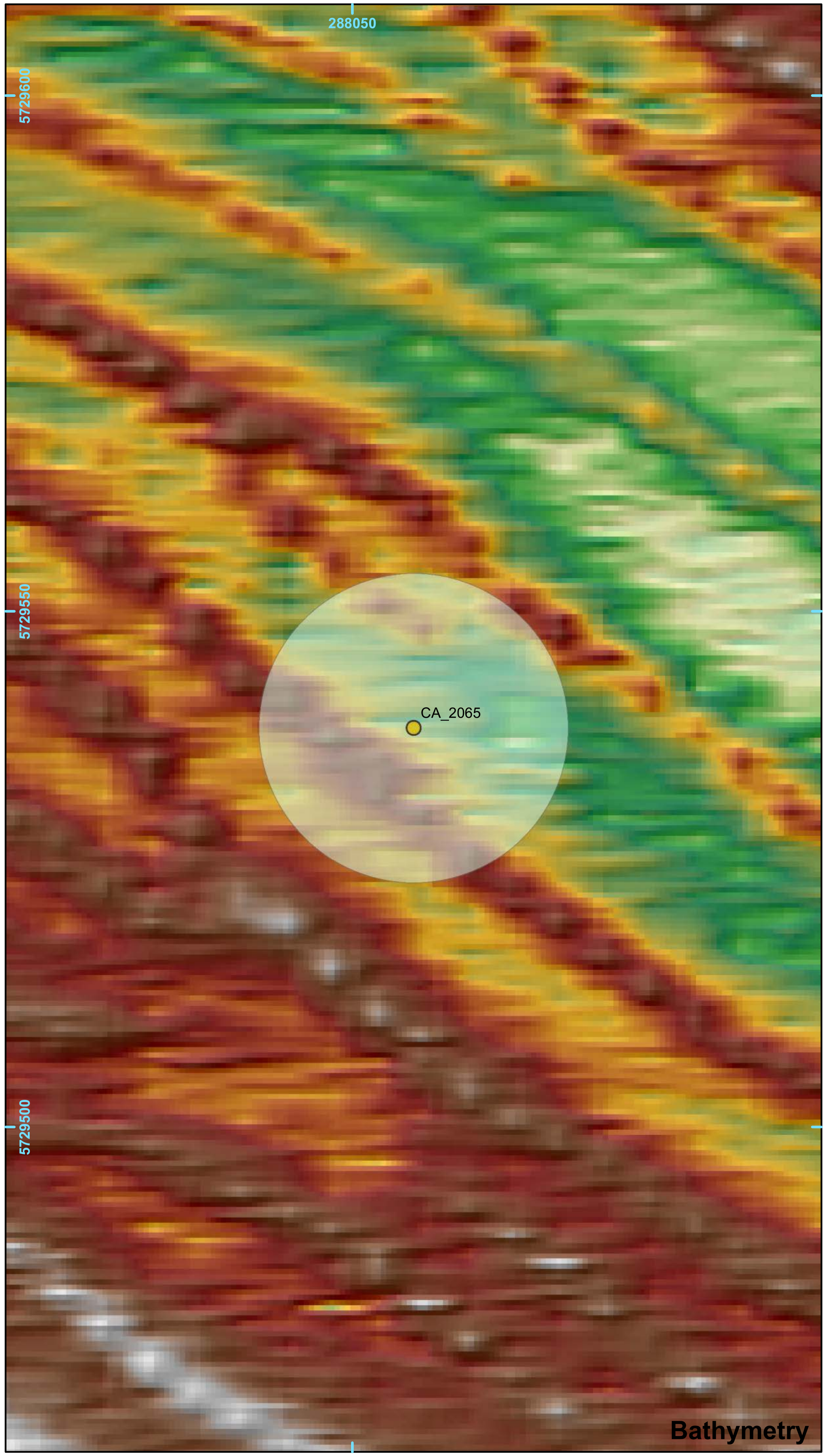
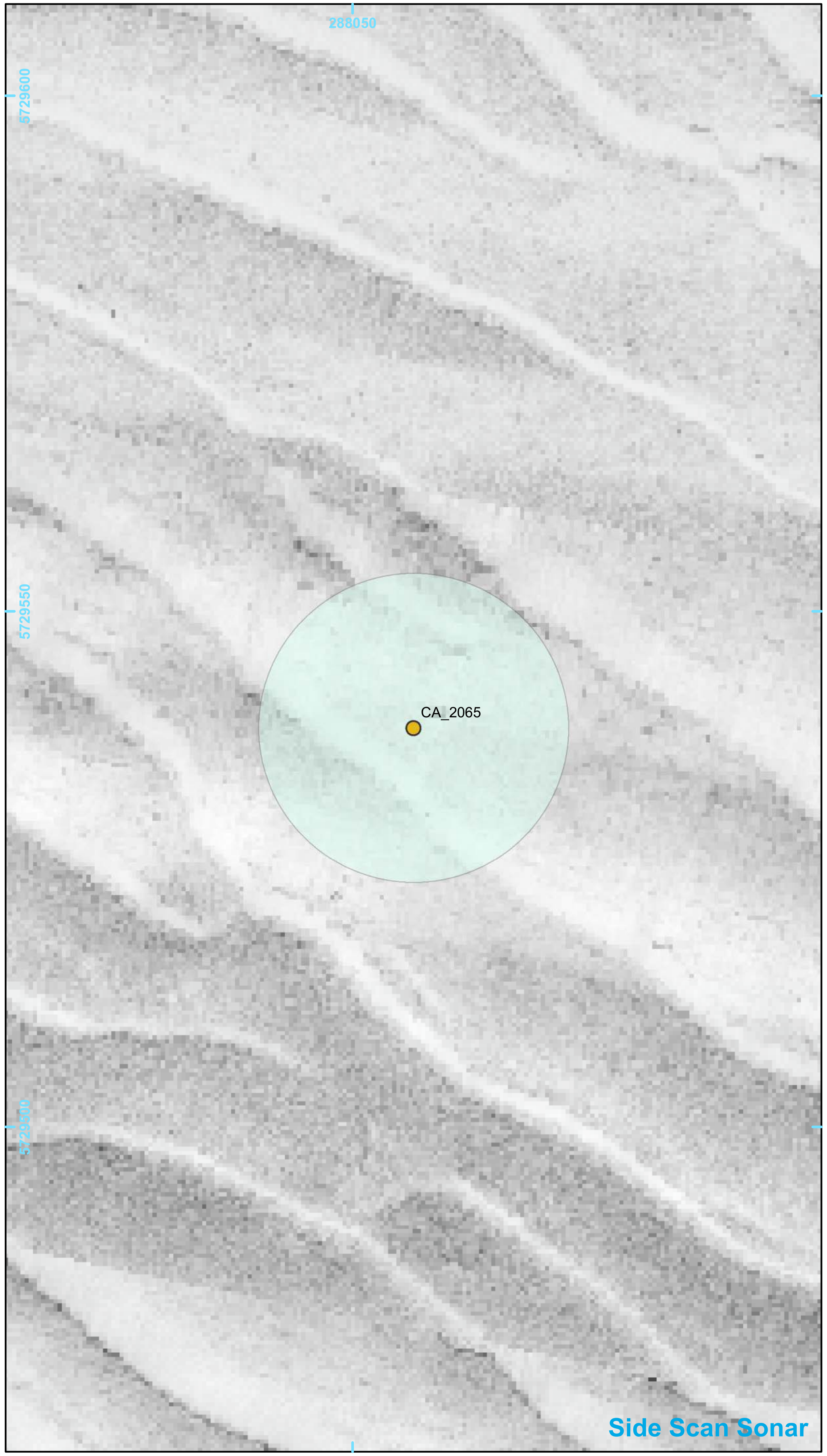
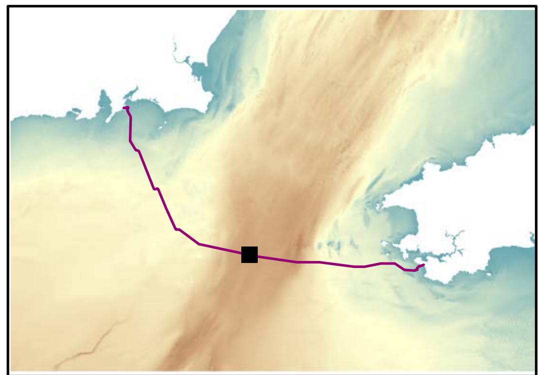
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2064

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.	
CHECKED BY	RK	DATE	01/04/2019		3.37
APPROVED BY	MW	SCALE@A3	1:500		







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -113.598
Low : -114.588

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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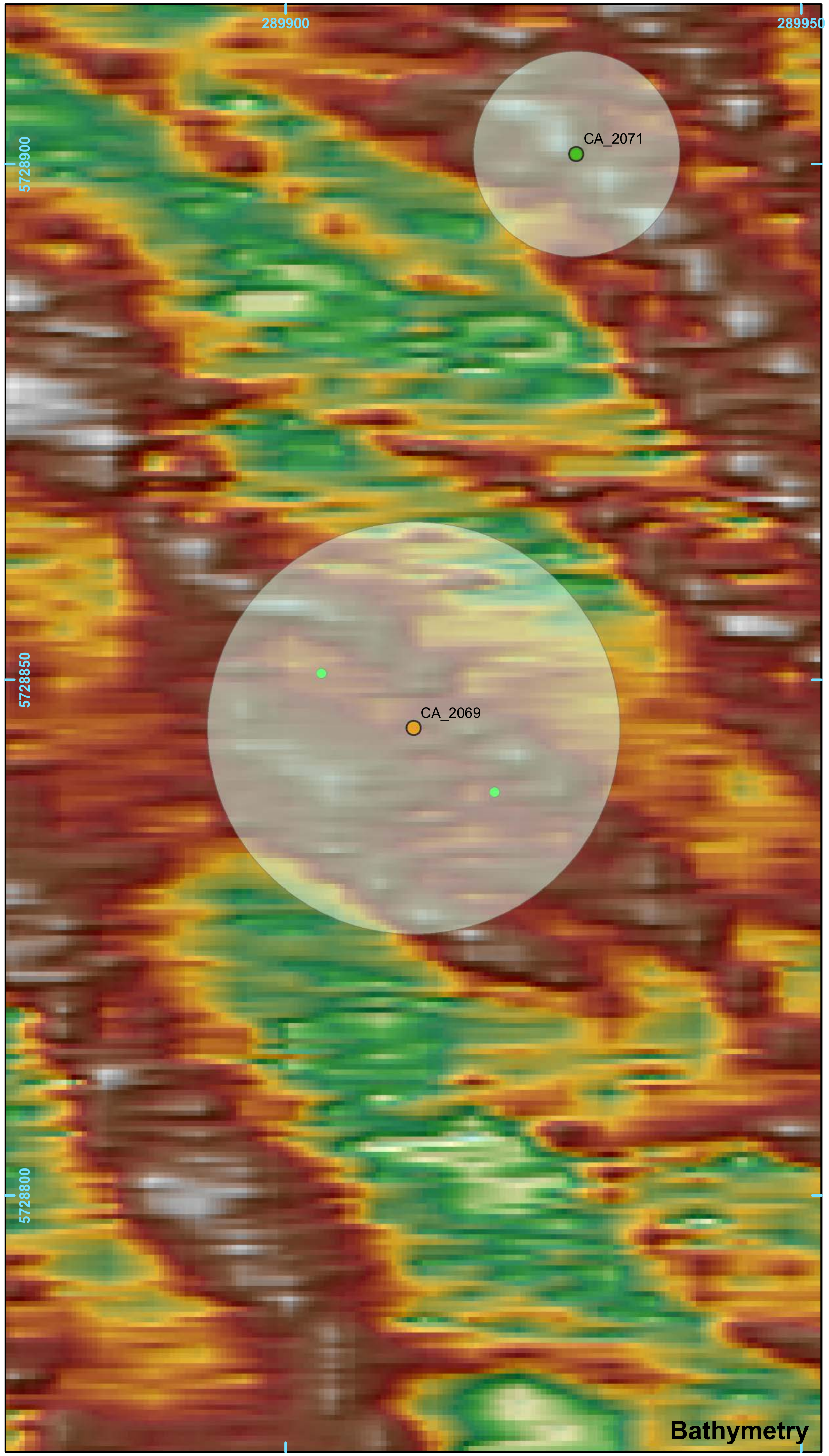
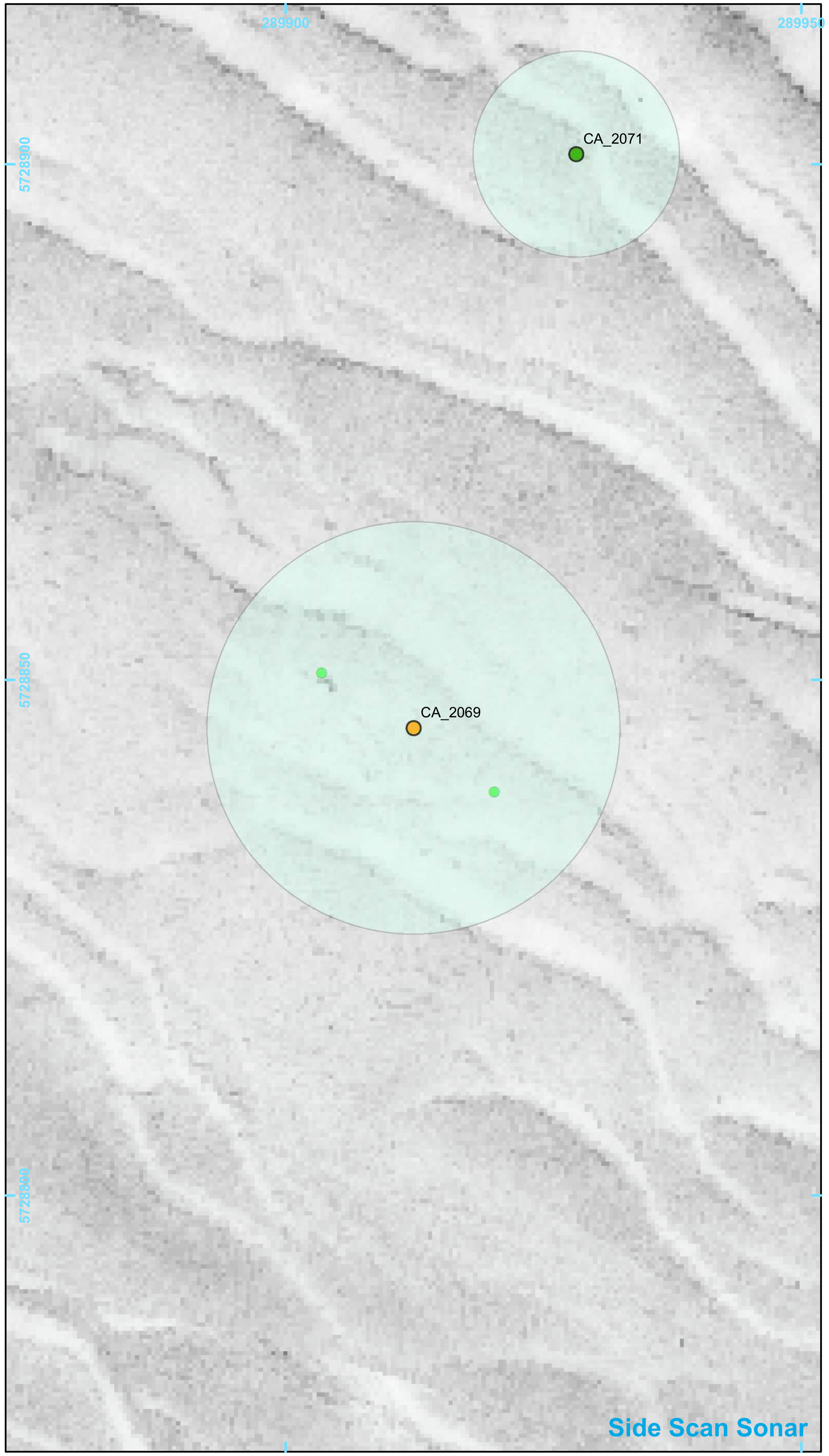
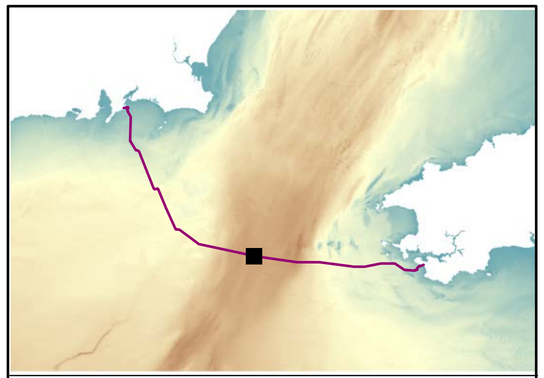
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2065

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.38
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -114.377
Low : -115.108

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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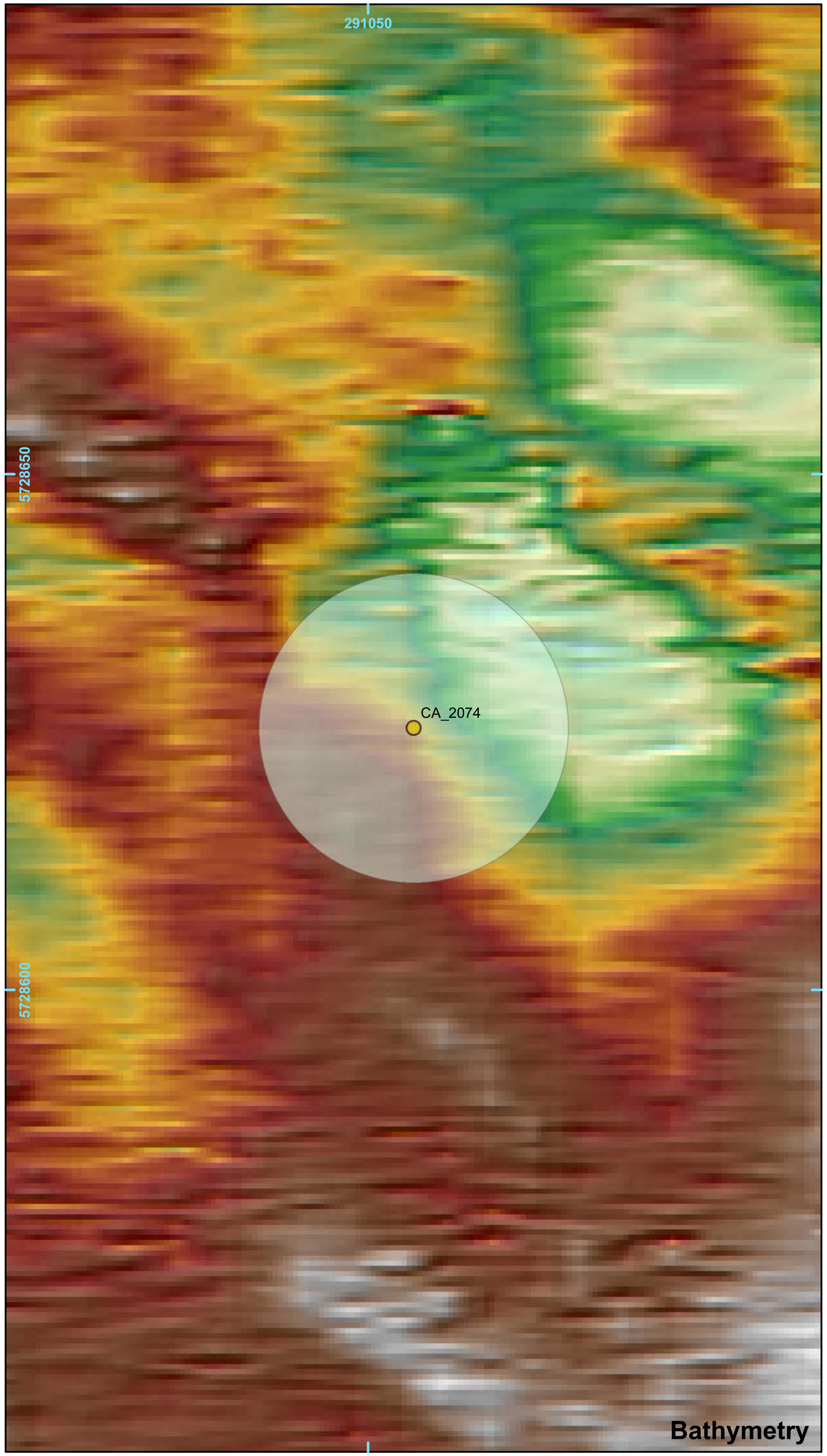
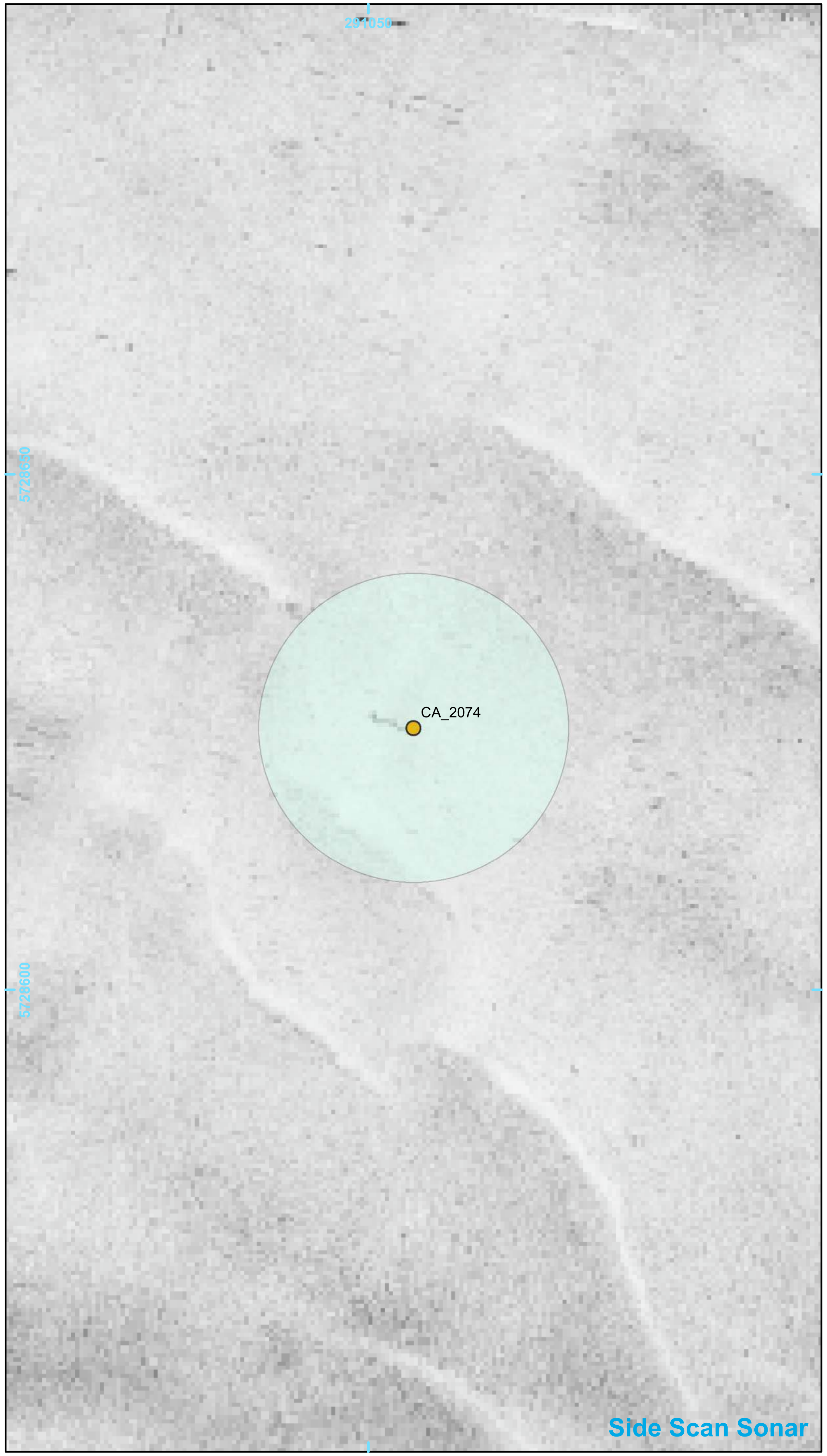
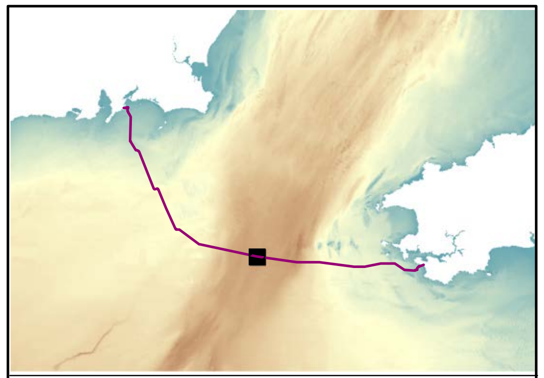
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2069

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.39
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -114.792
Low : -116.034

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

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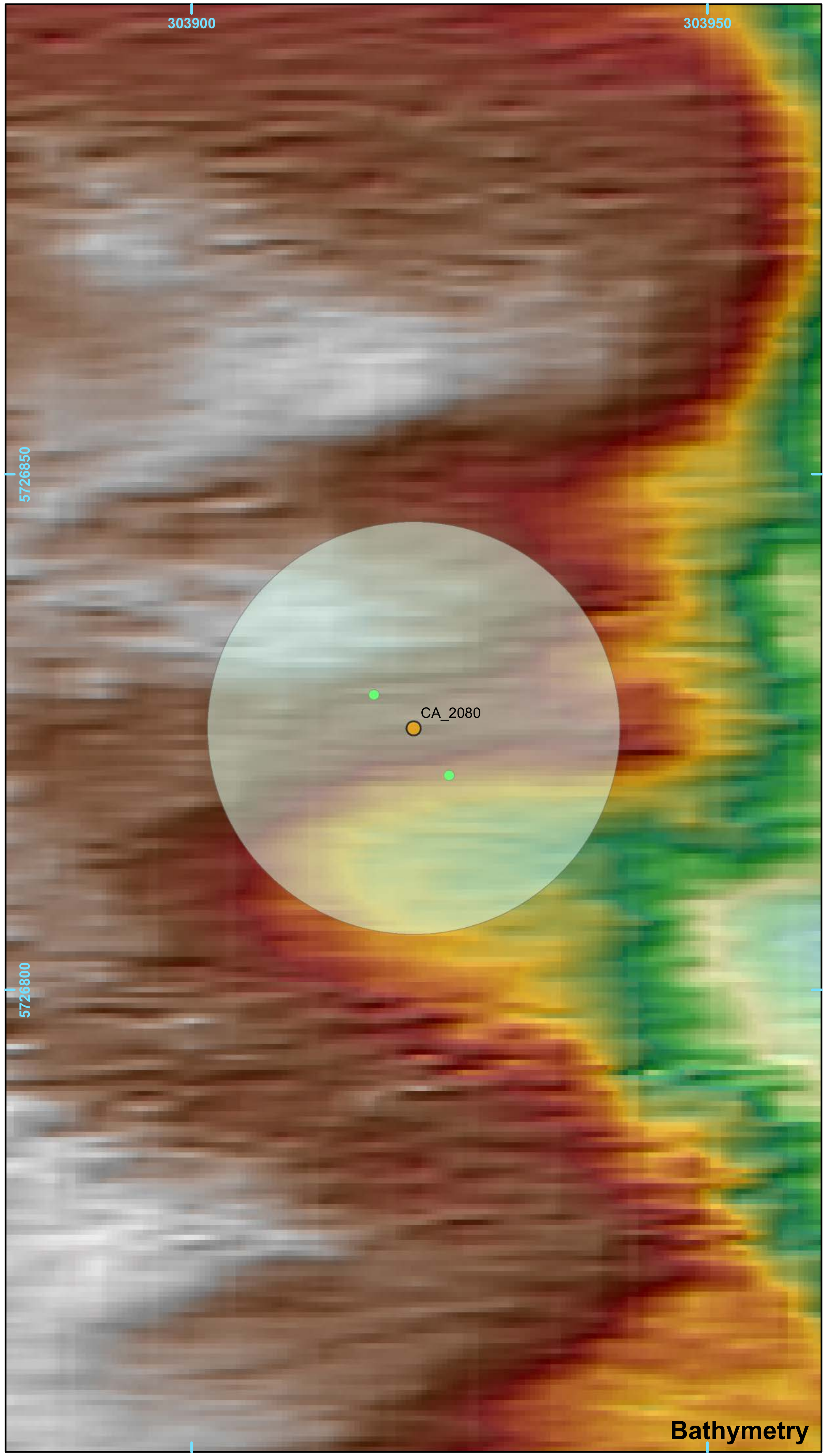
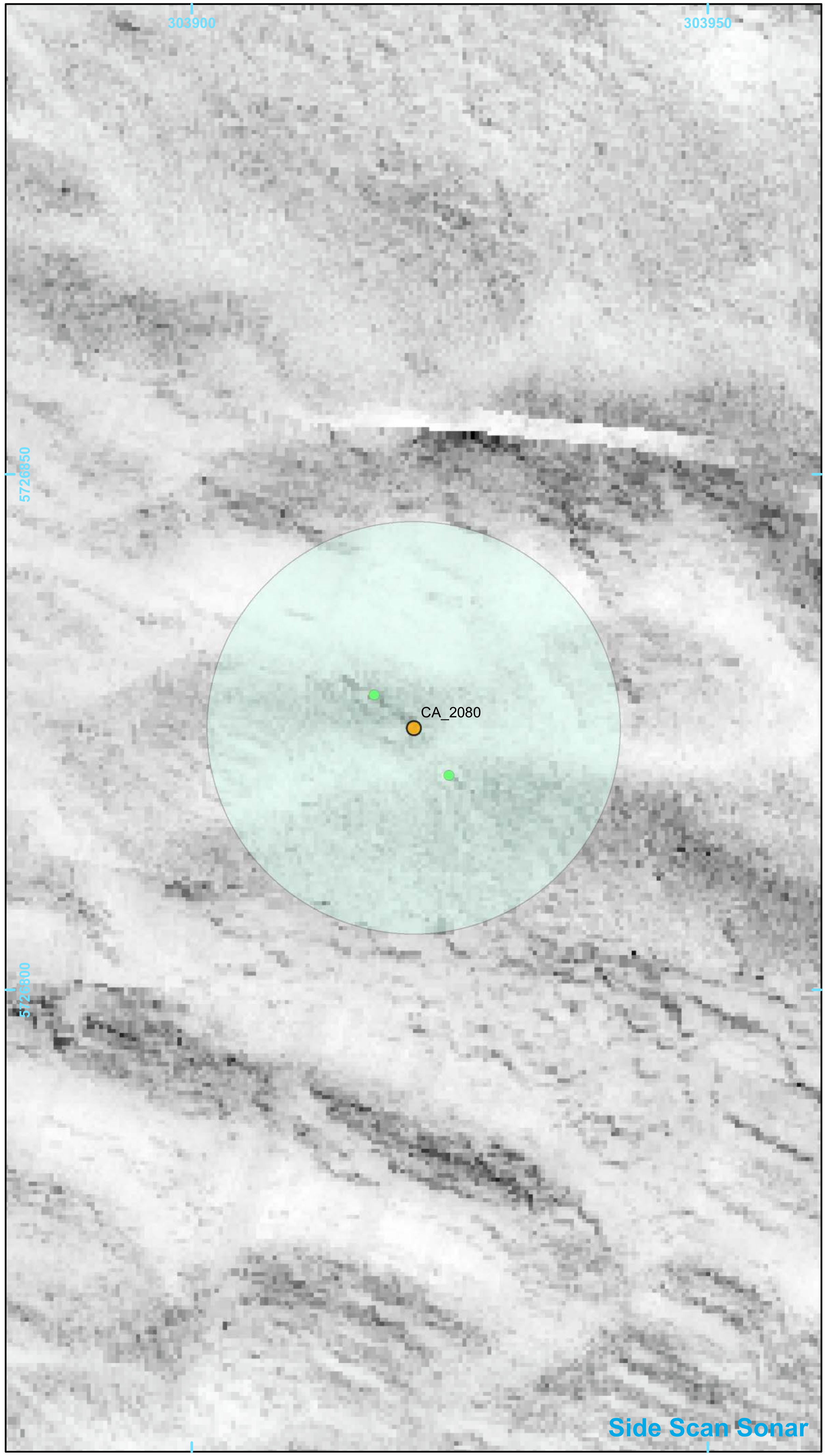
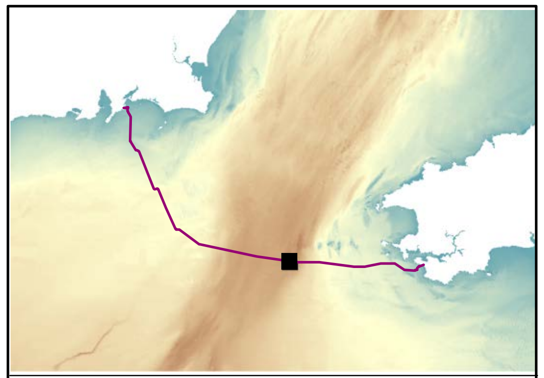
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2074

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.40
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -114.187
Low : -117.033

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

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Cirencester	01285 771022
Exeter	01392 826185
Milton Keynes	01908 564660

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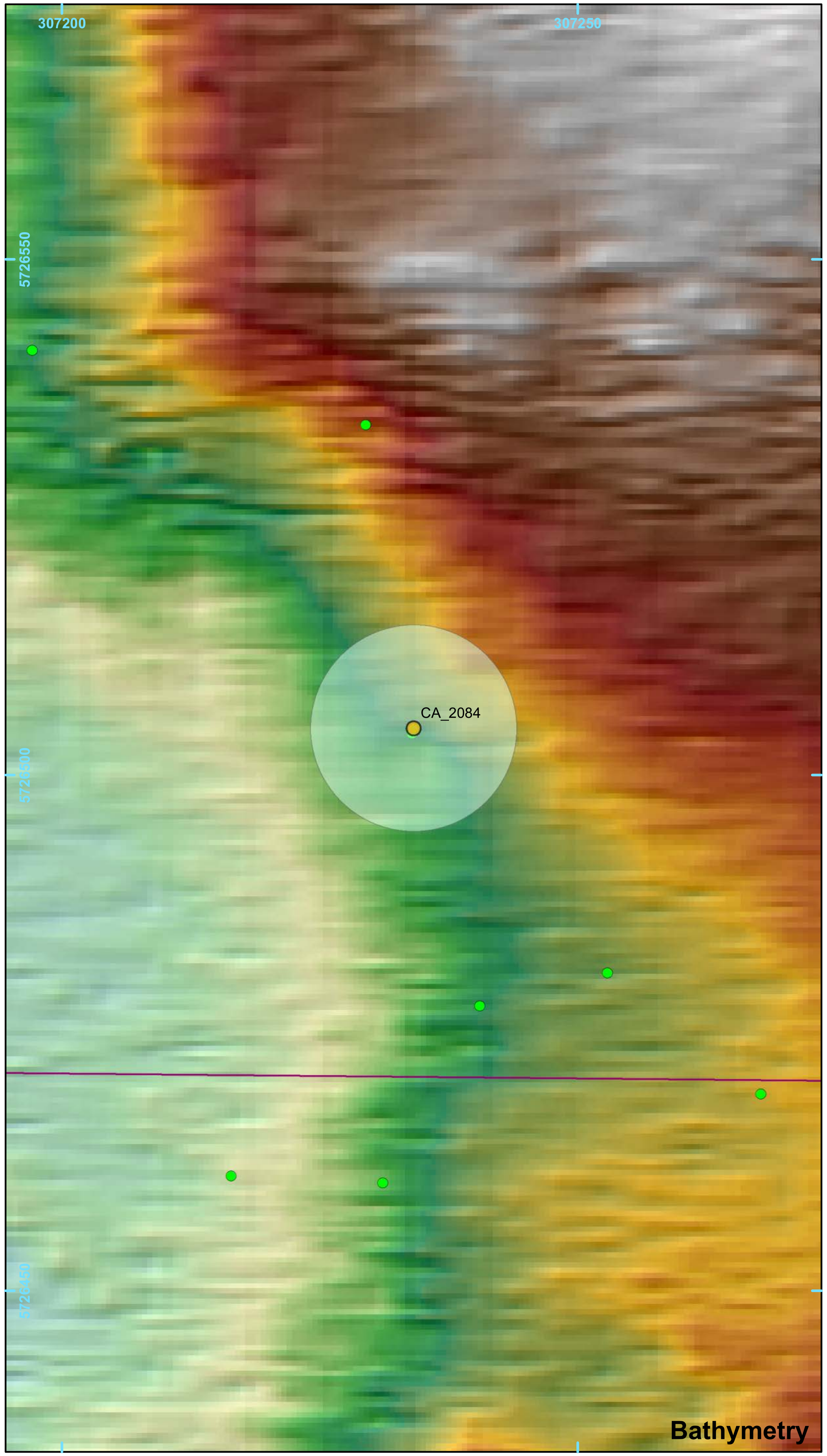
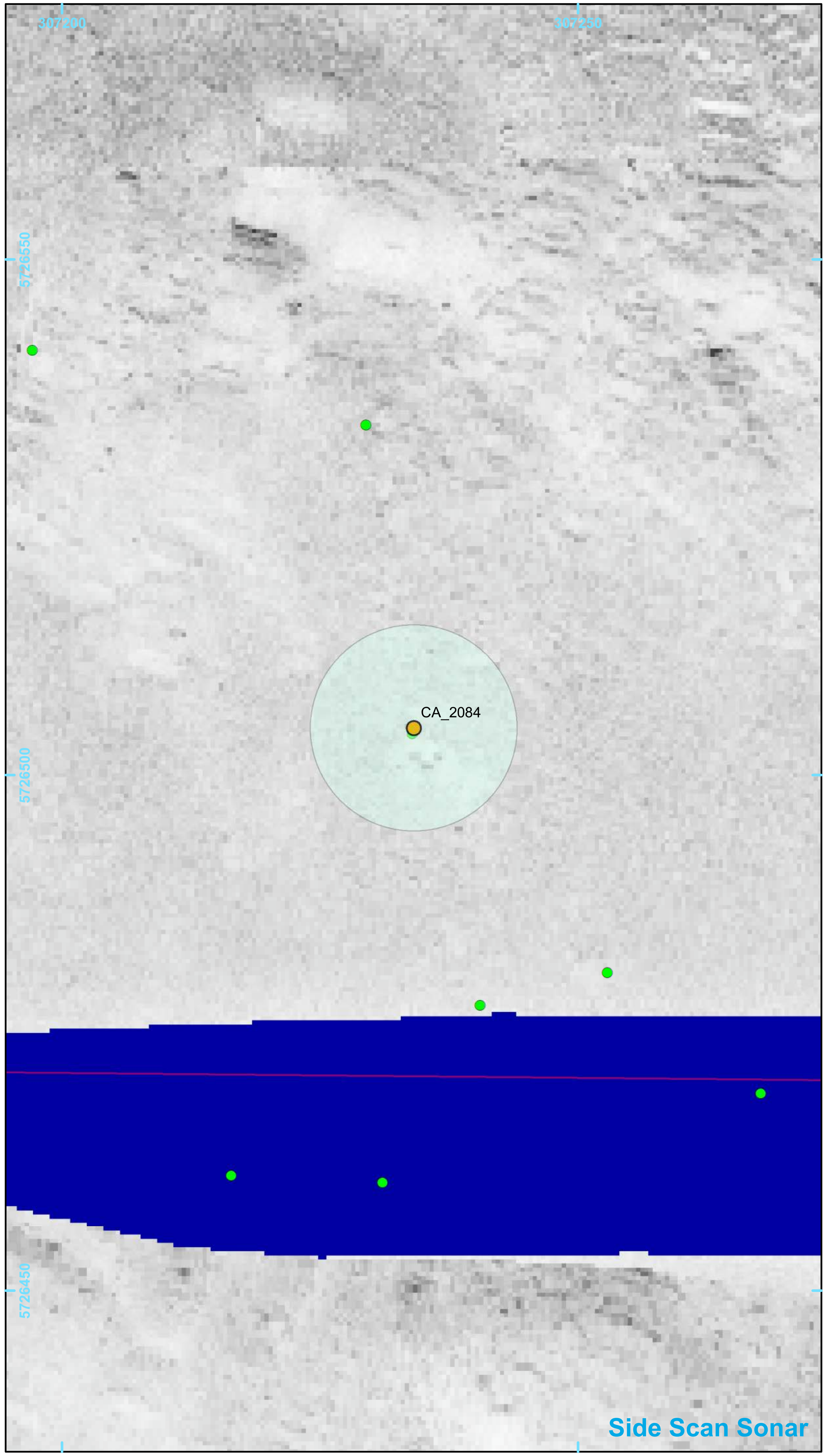
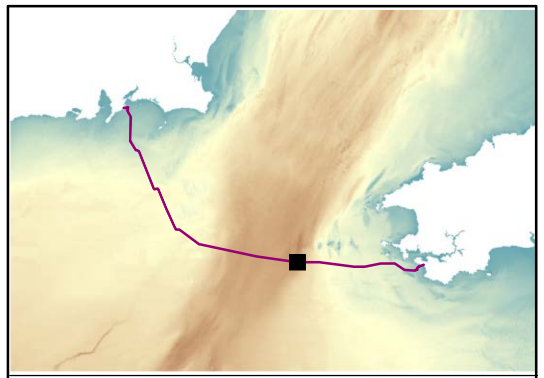
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2080

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.41
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -112.925
Low : -115.726

0 17.5m

N

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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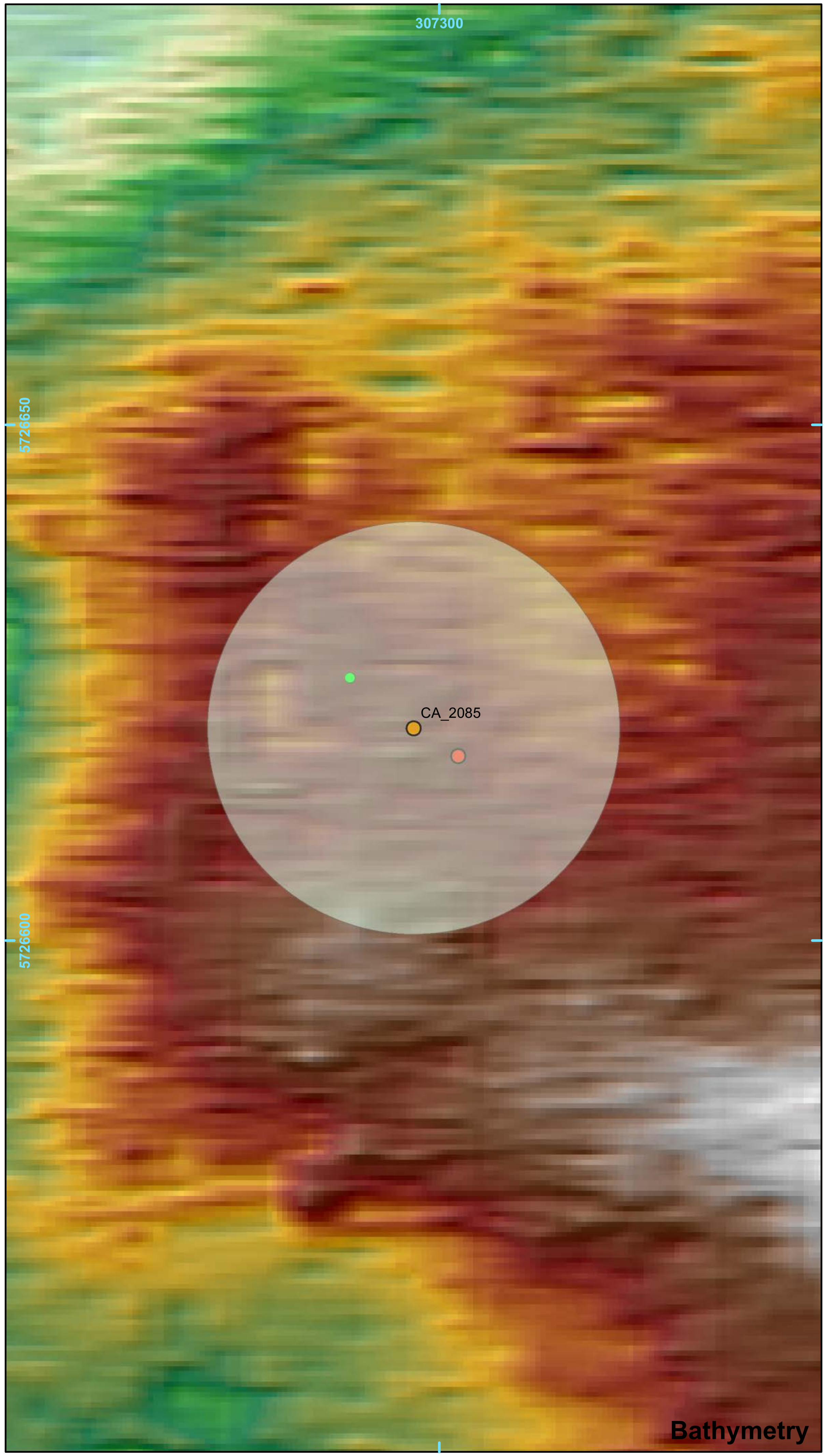
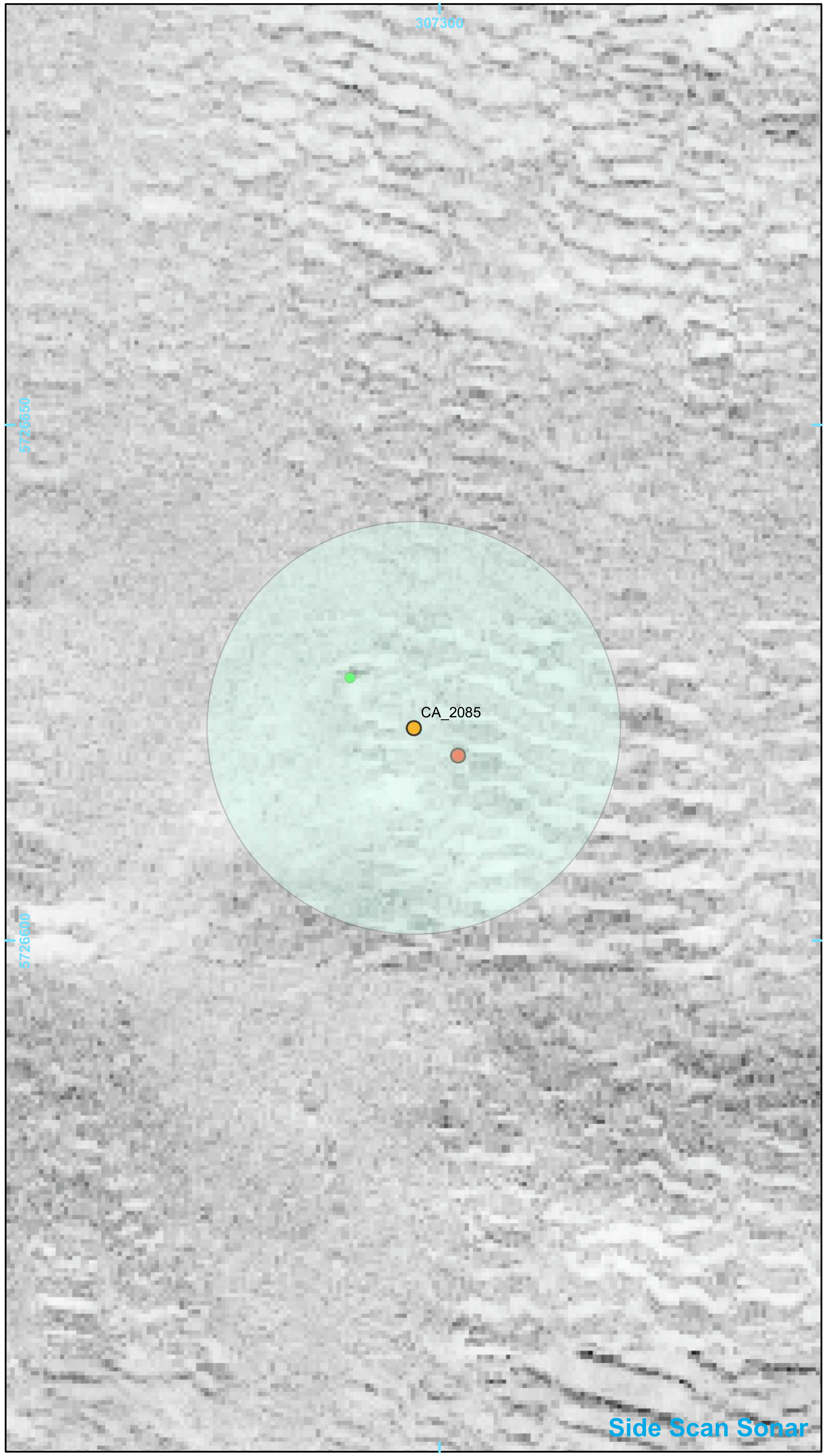
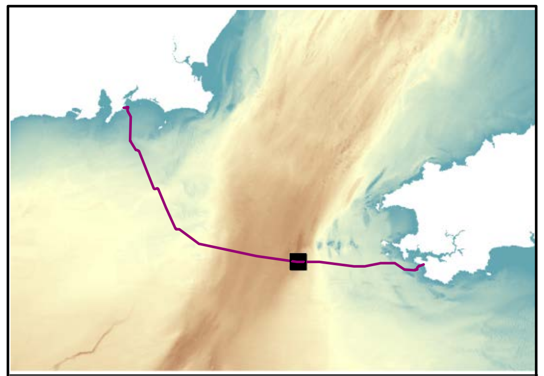
FIGURE TITLE
Archaeological Anomaly CA_2084

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.42
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -111.716
Low : -114.033

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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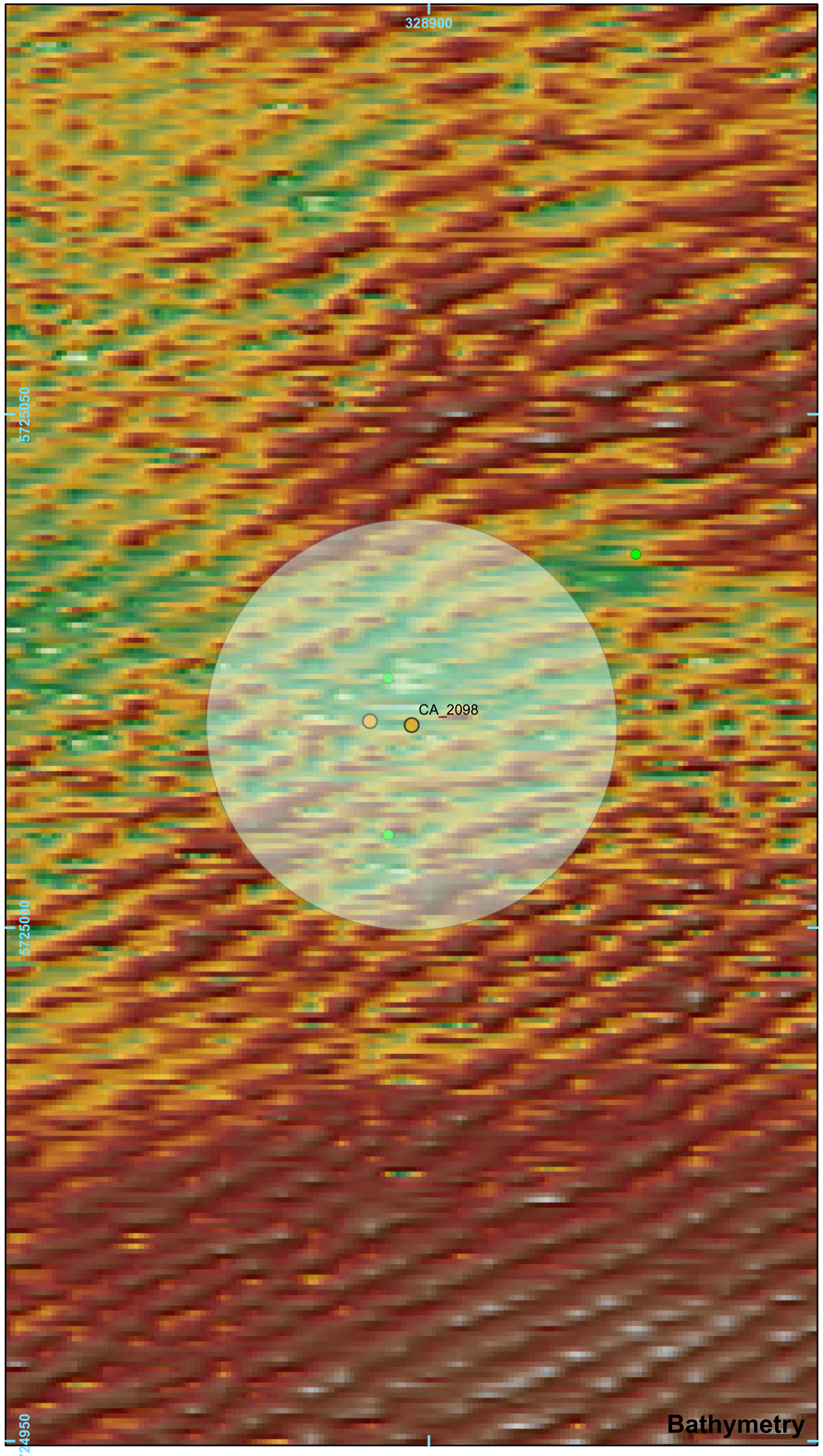
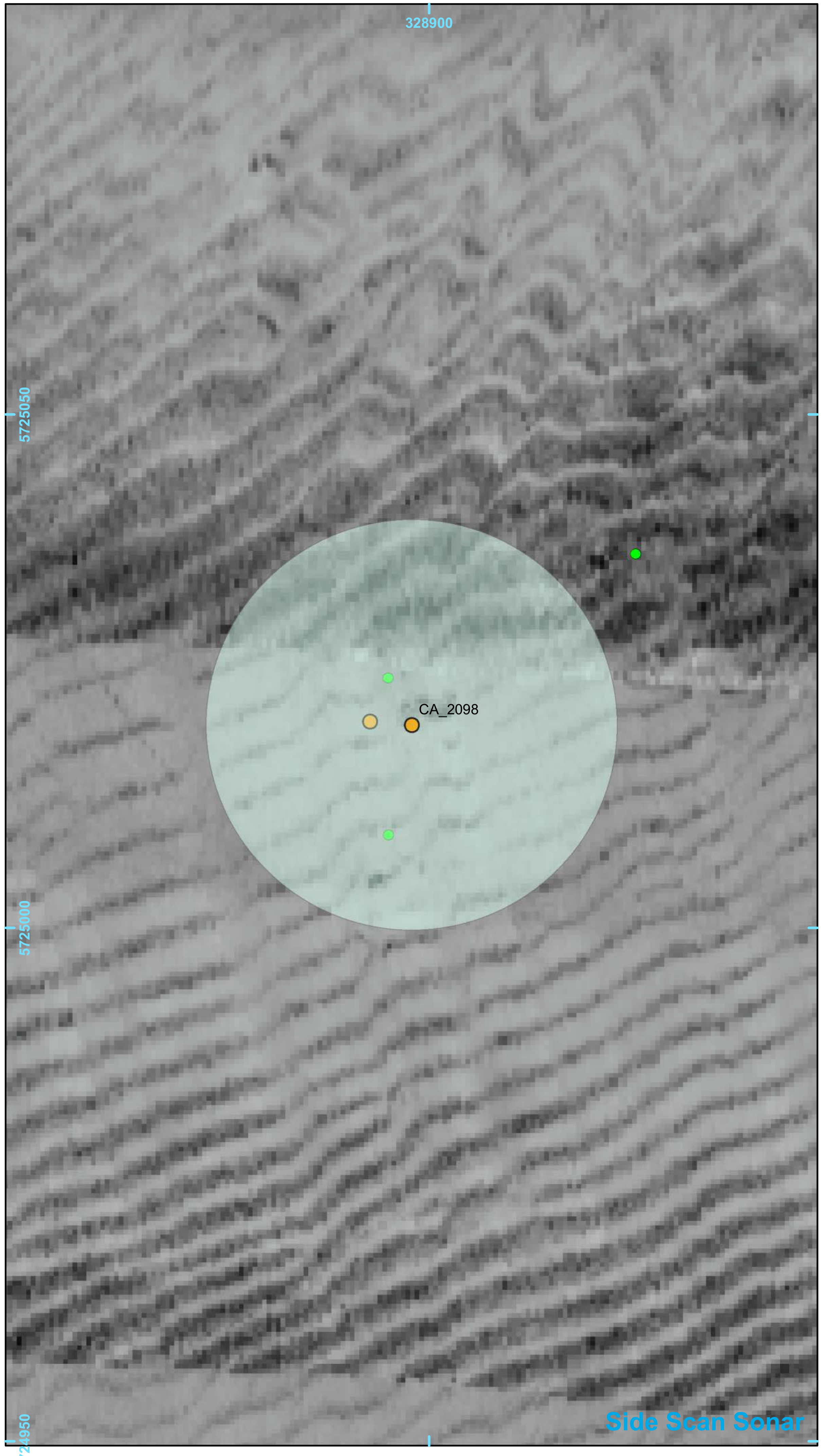
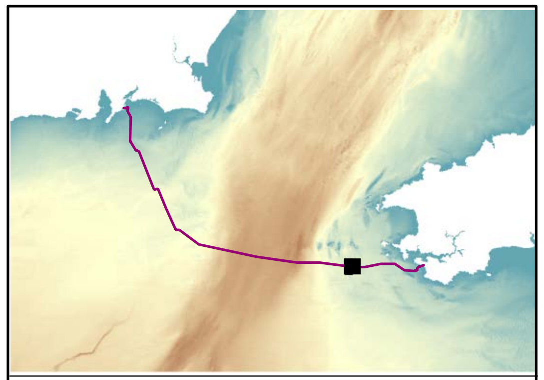
FIGURE TITLE
Archaeological Anomaly CA_2085

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.43
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -60.0292
Low : -60.7752

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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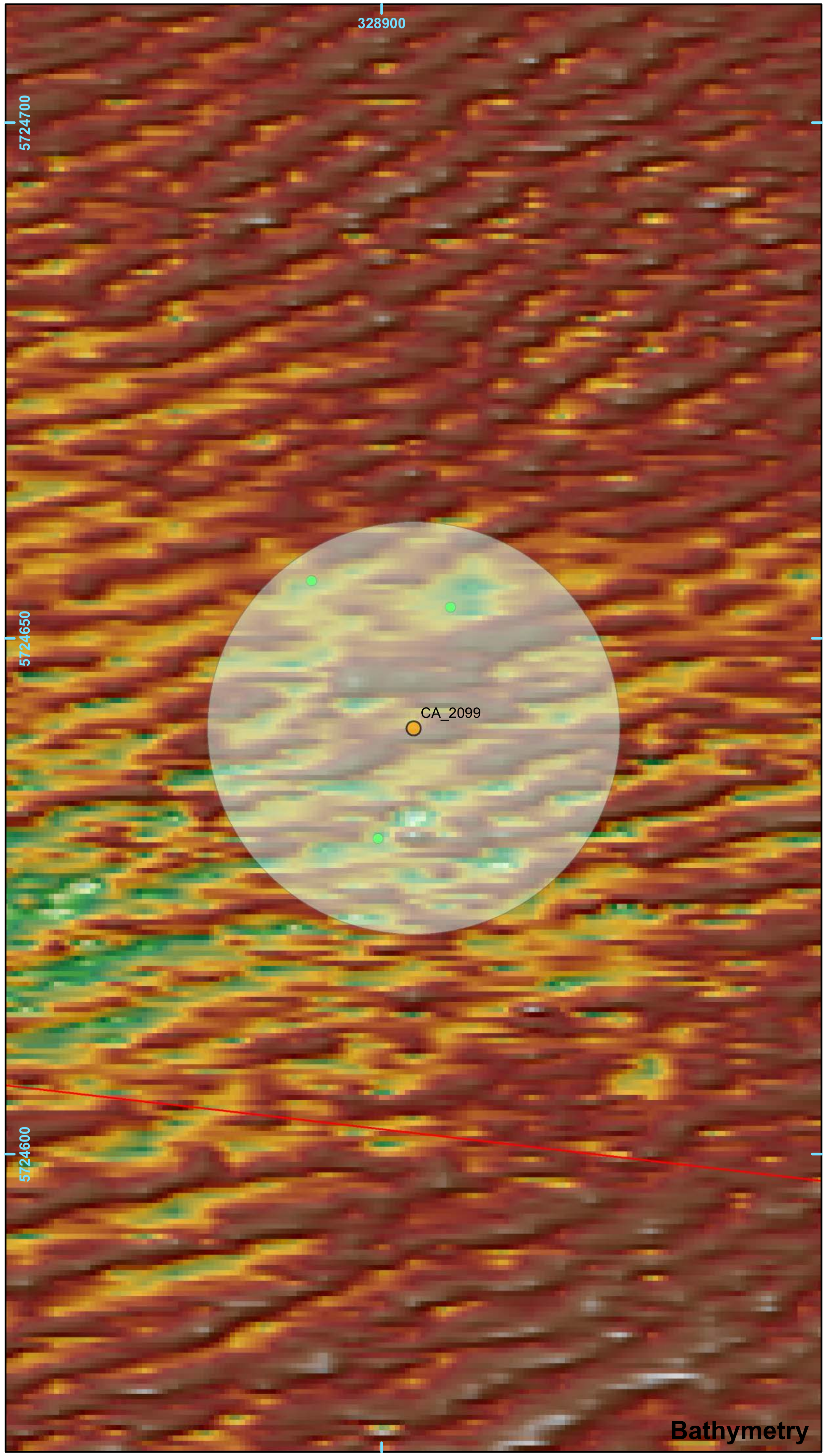
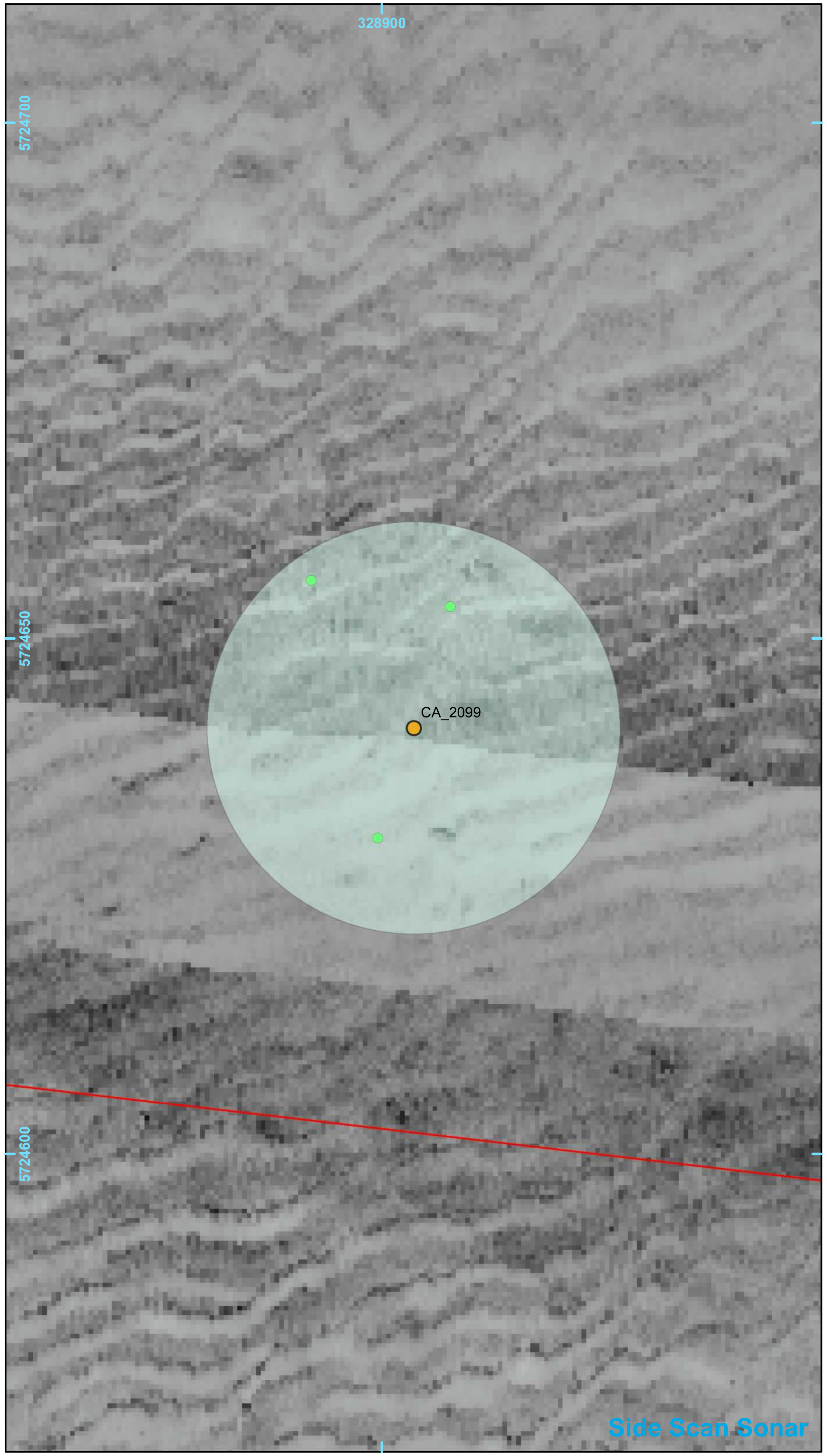
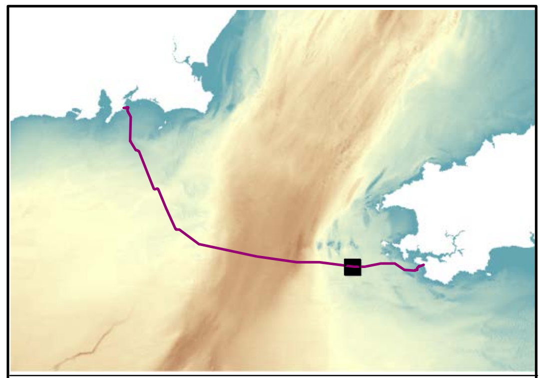
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2098

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.44
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -60.2509
  - Low : -60.9634

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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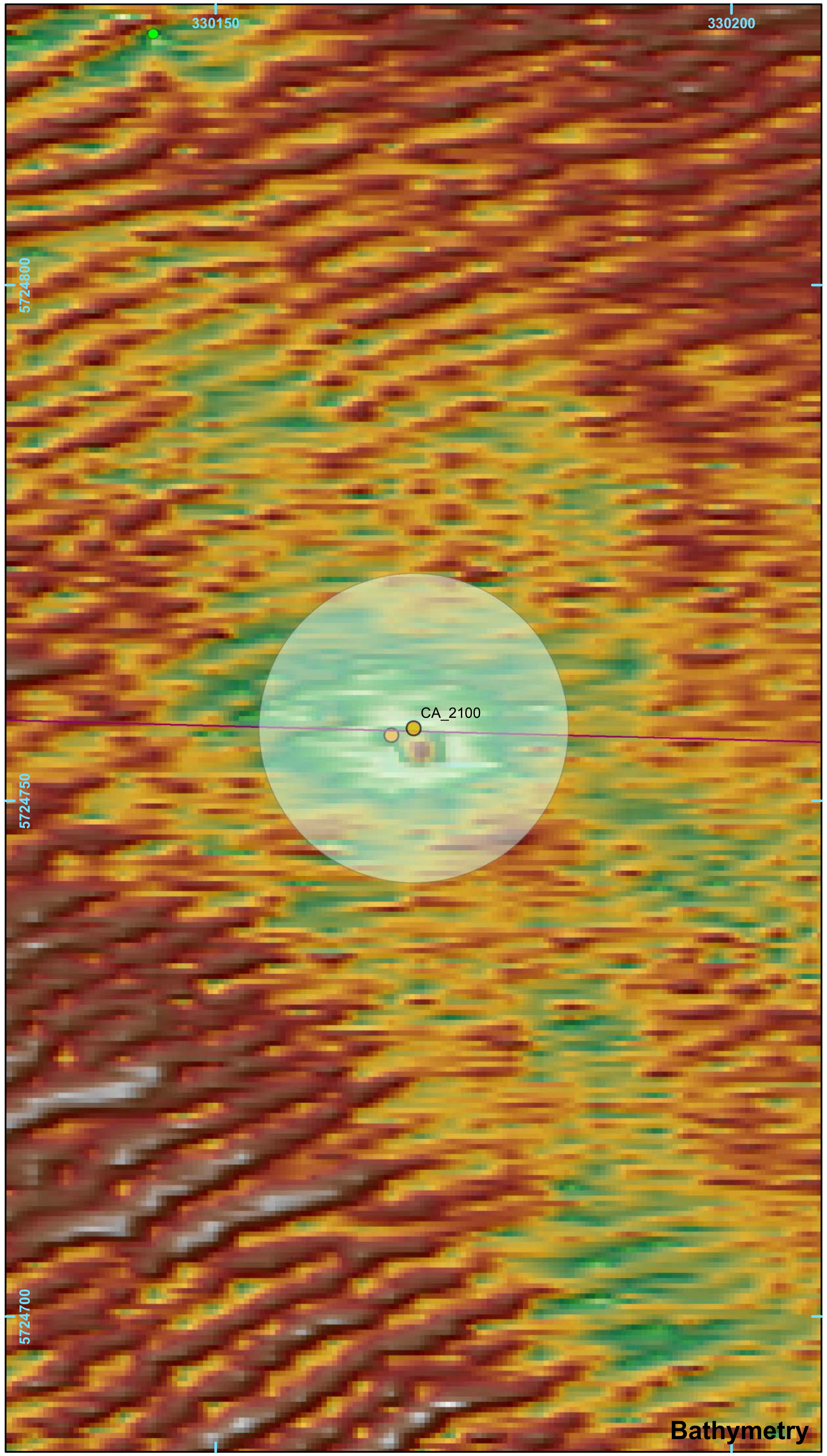
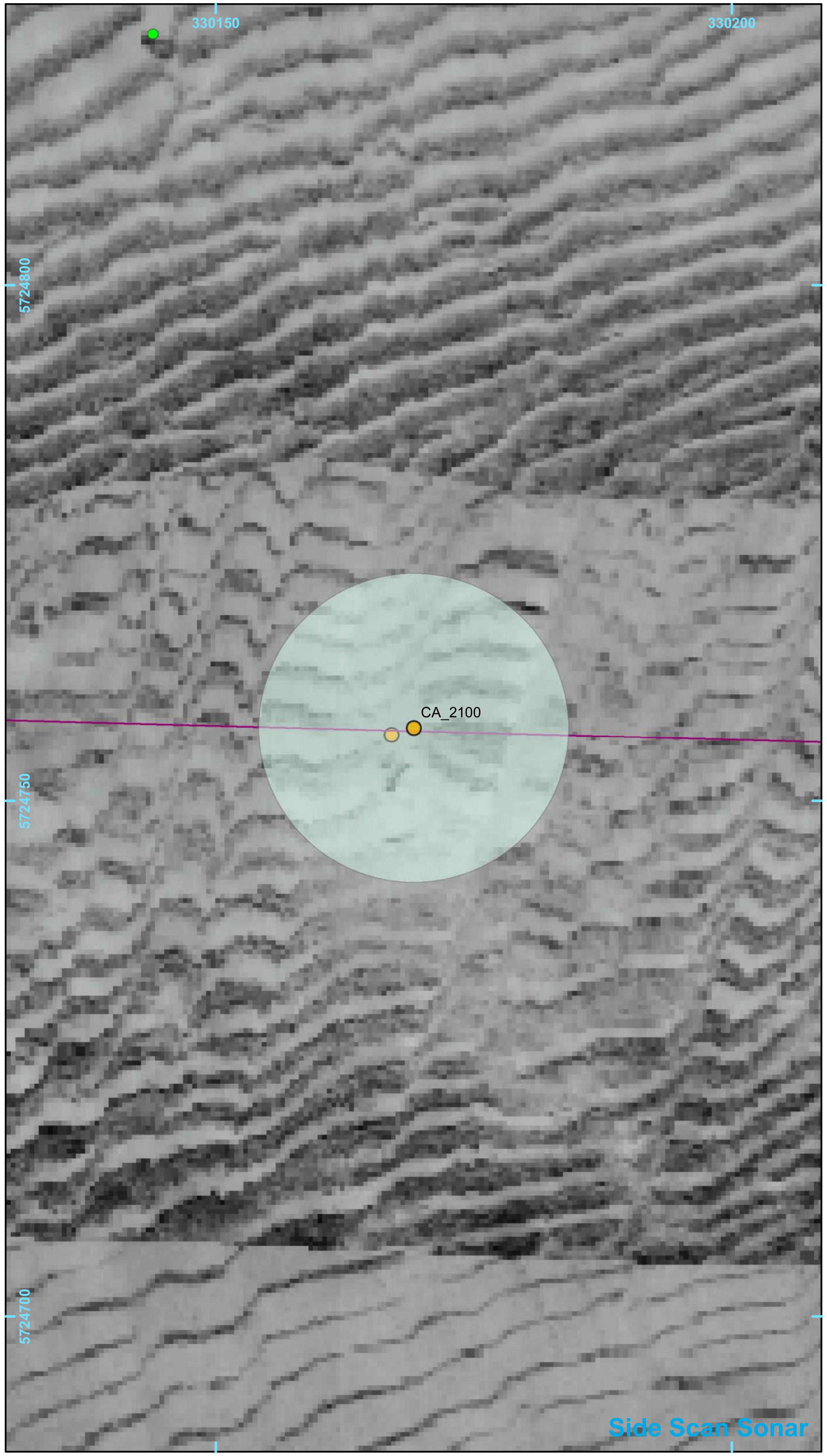
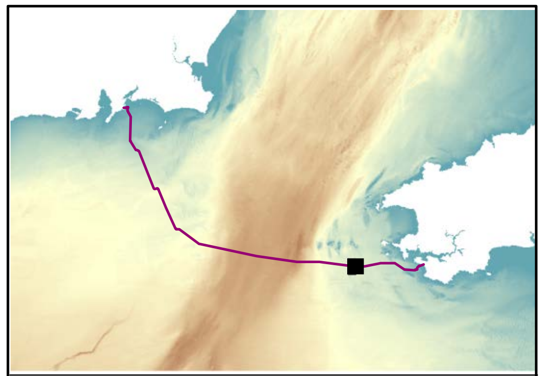
FIGURE TITLE
Archaeological Anomaly CA_2099

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.45
APPROVED BY	MW	SCALE@A3	1:500	







N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -59.3631
Low : -60.2191

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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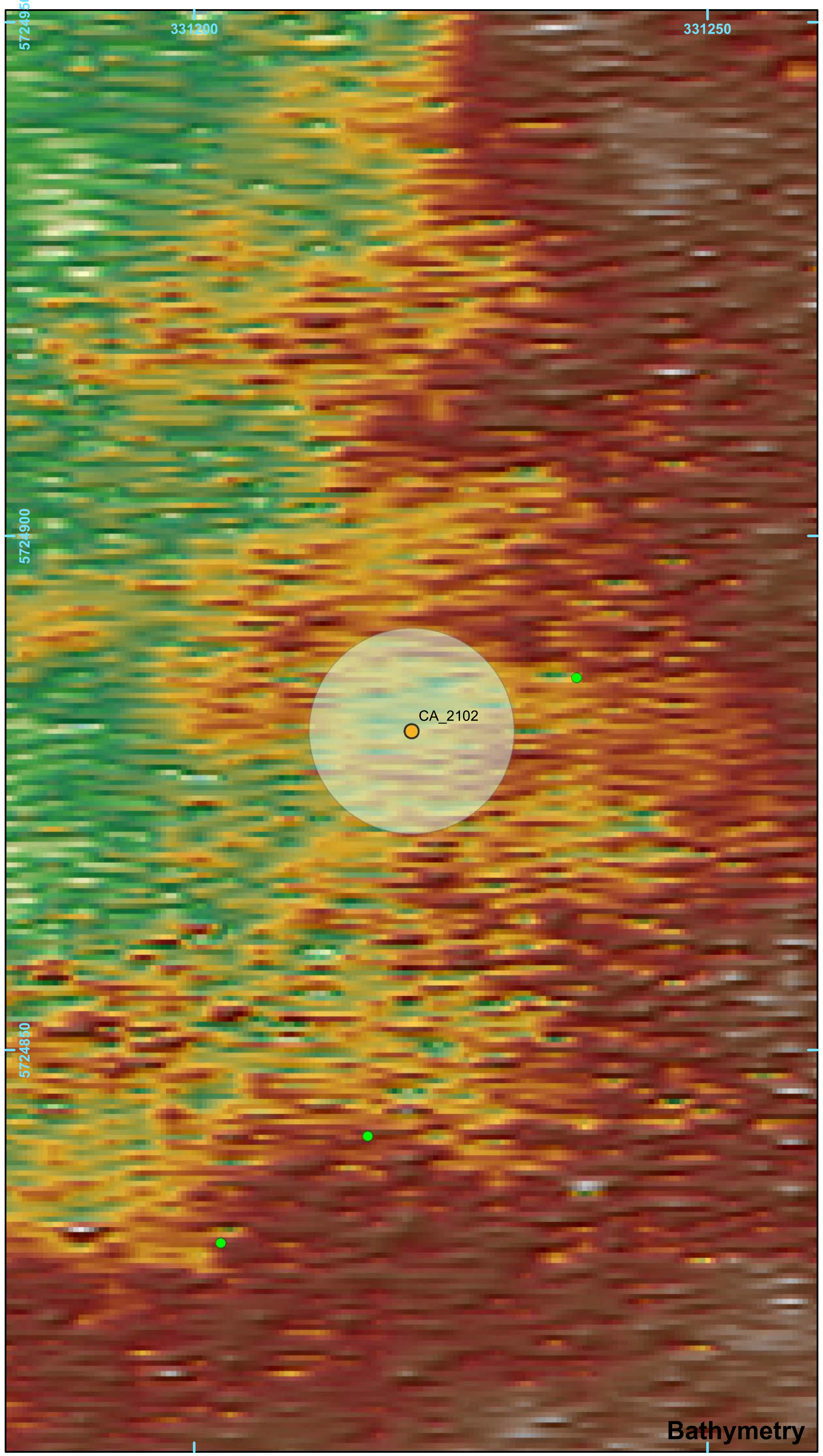
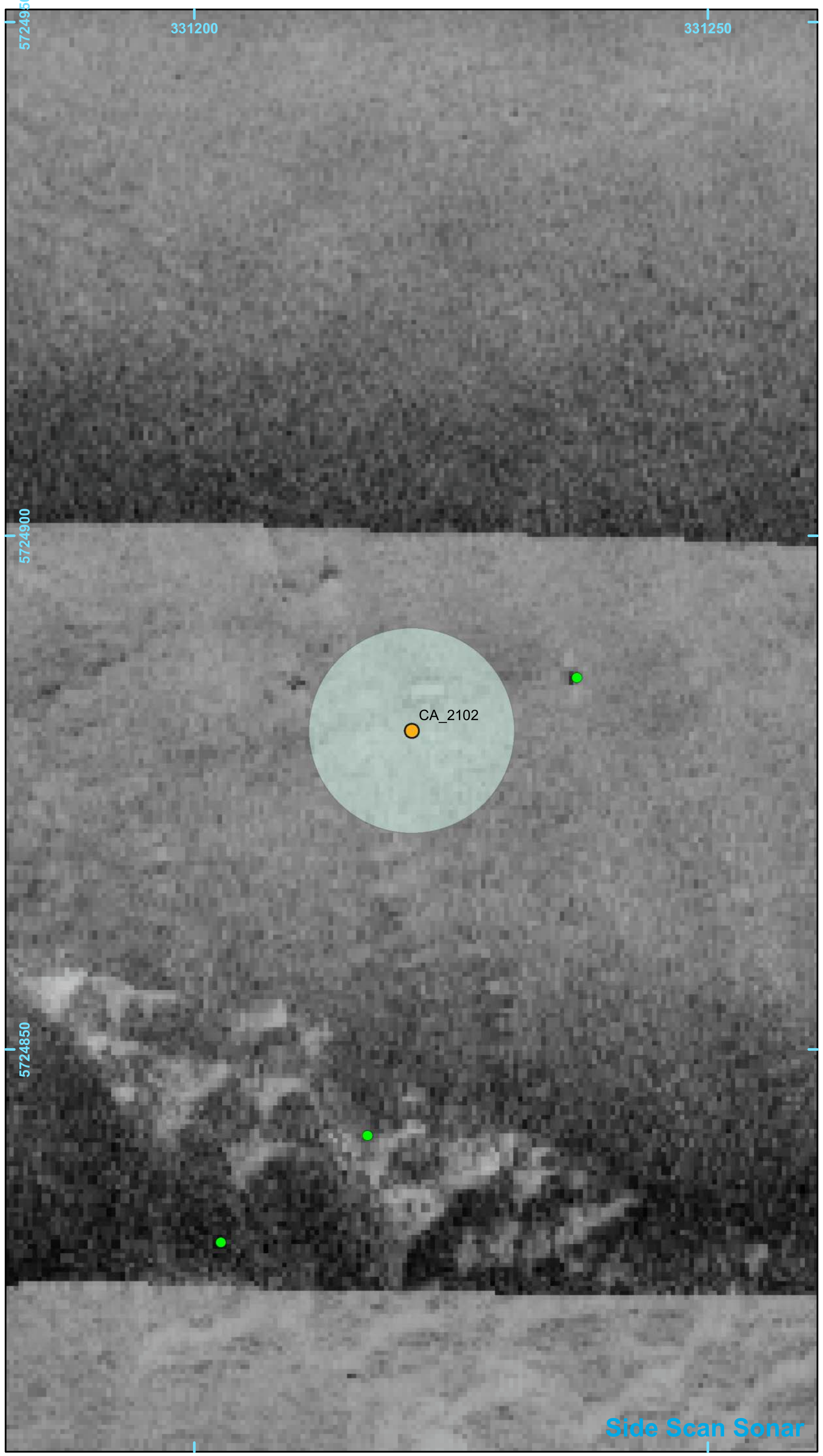
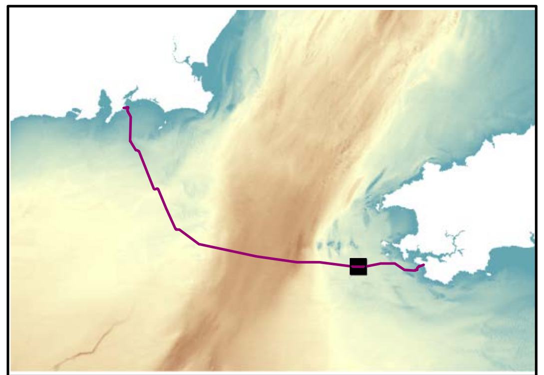
FIGURE TITLE
Archaeological Anomaly CA_2100

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.46
APPROVED BY	MW	SCALE@A3	1:500	







N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -58.9702
Low : -59.6354

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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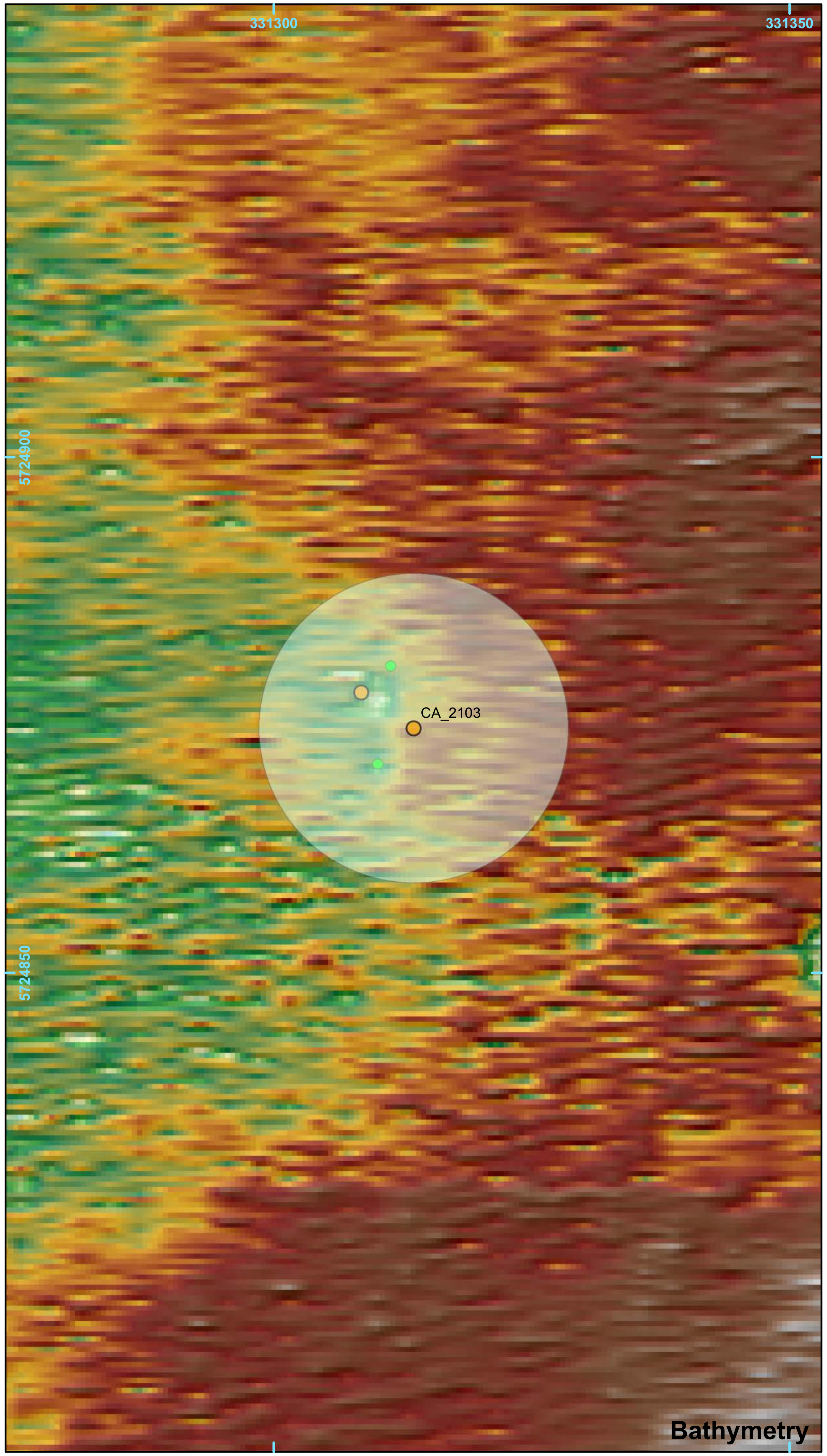
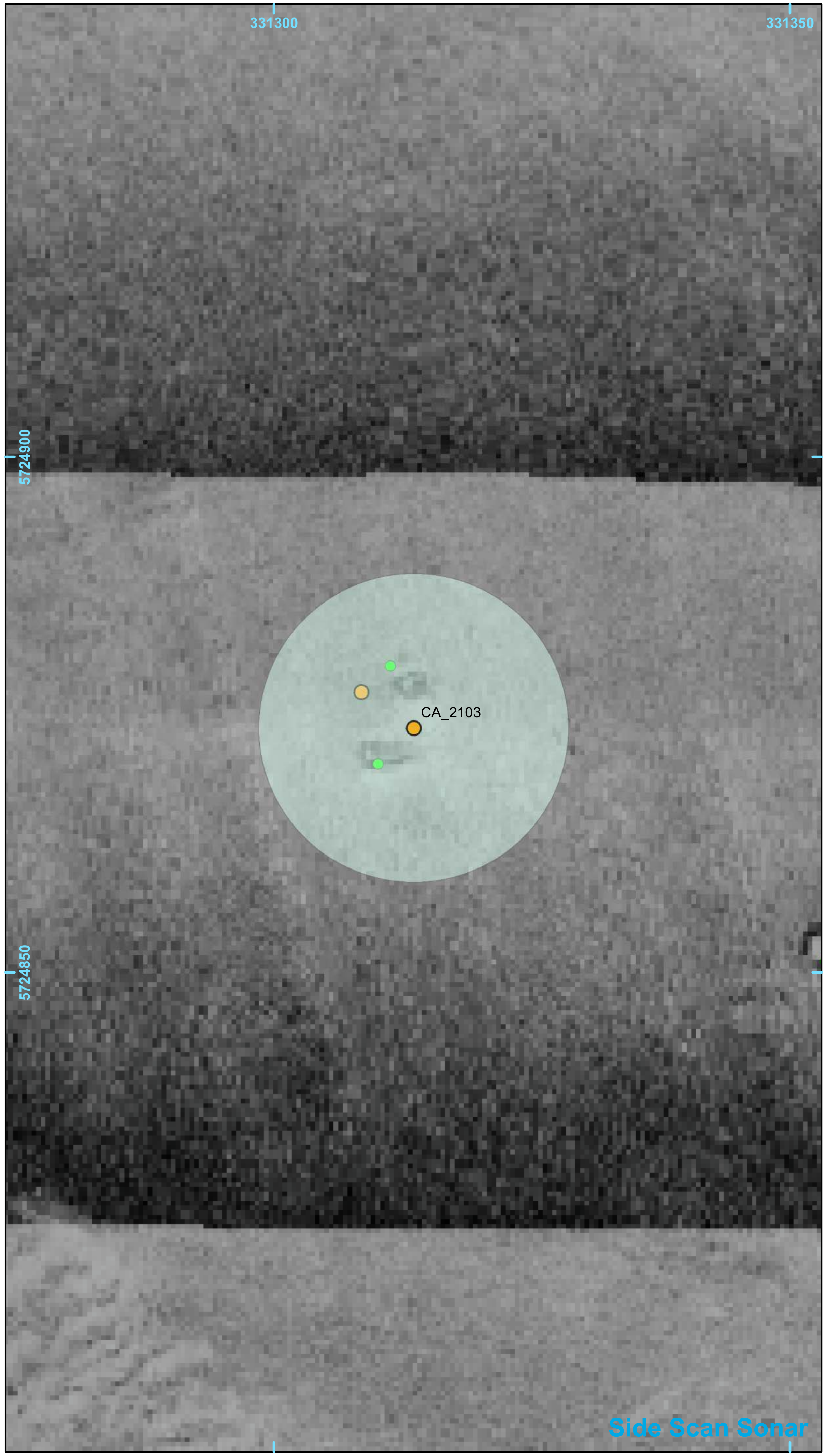
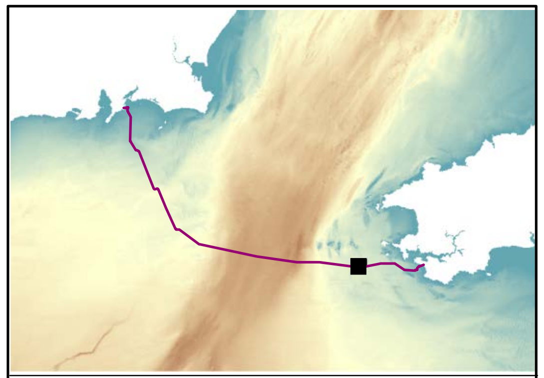
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2102

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.47
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -58.7025
Low : -59.3714

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

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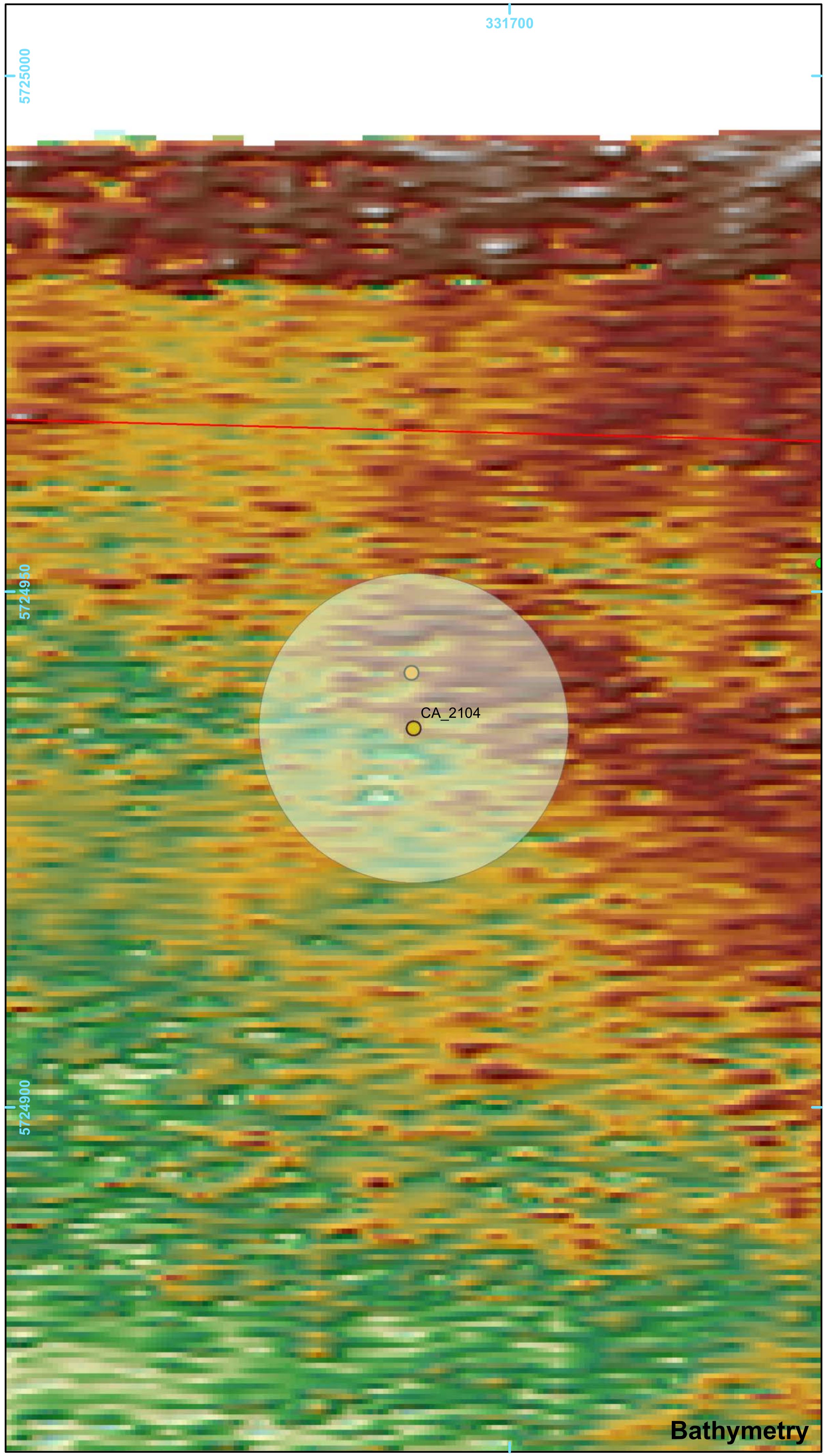
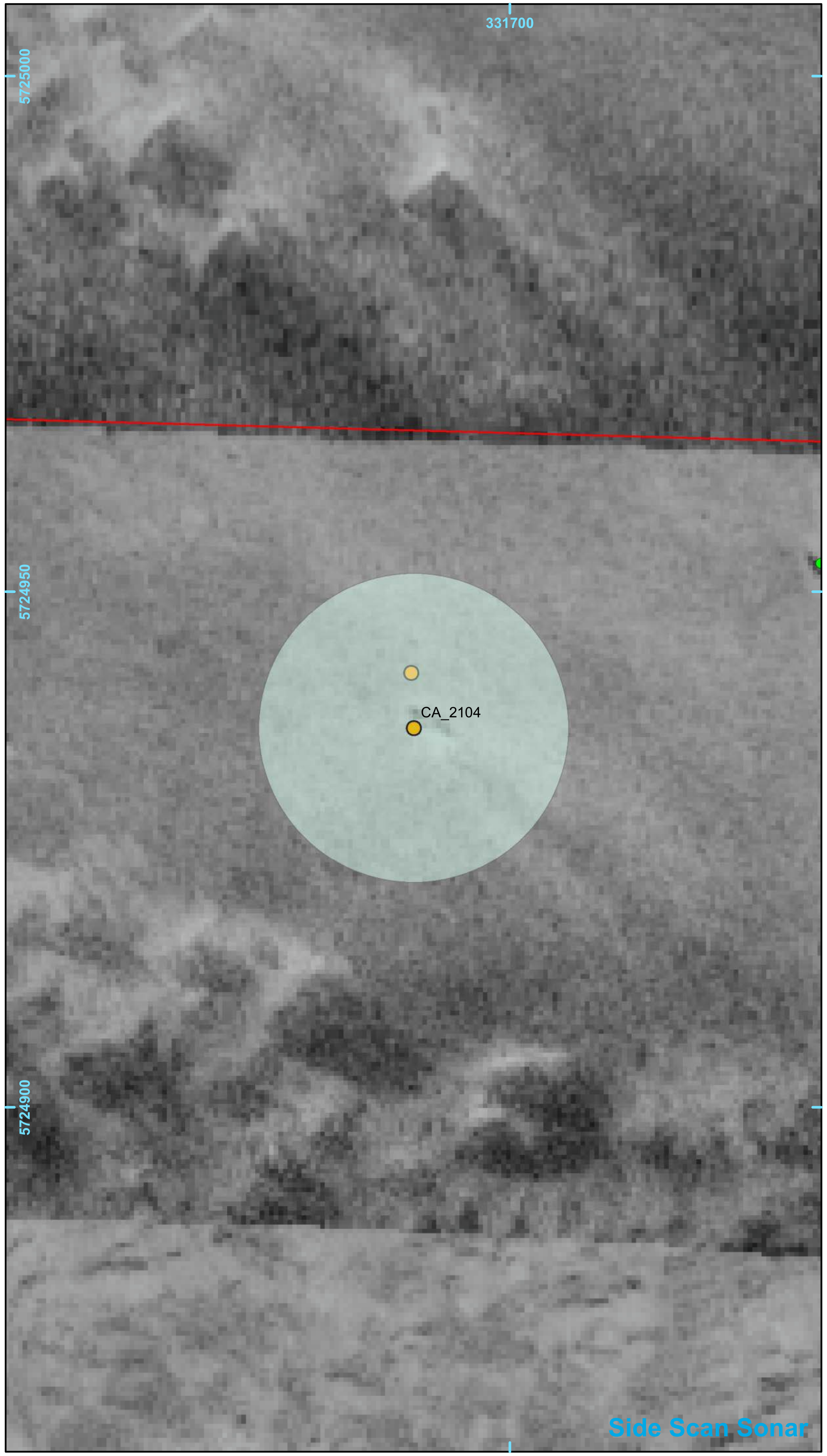
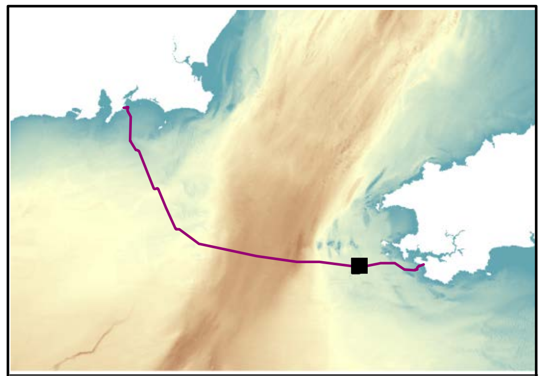
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2103

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.48
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -58.1557
Low : -58.8537

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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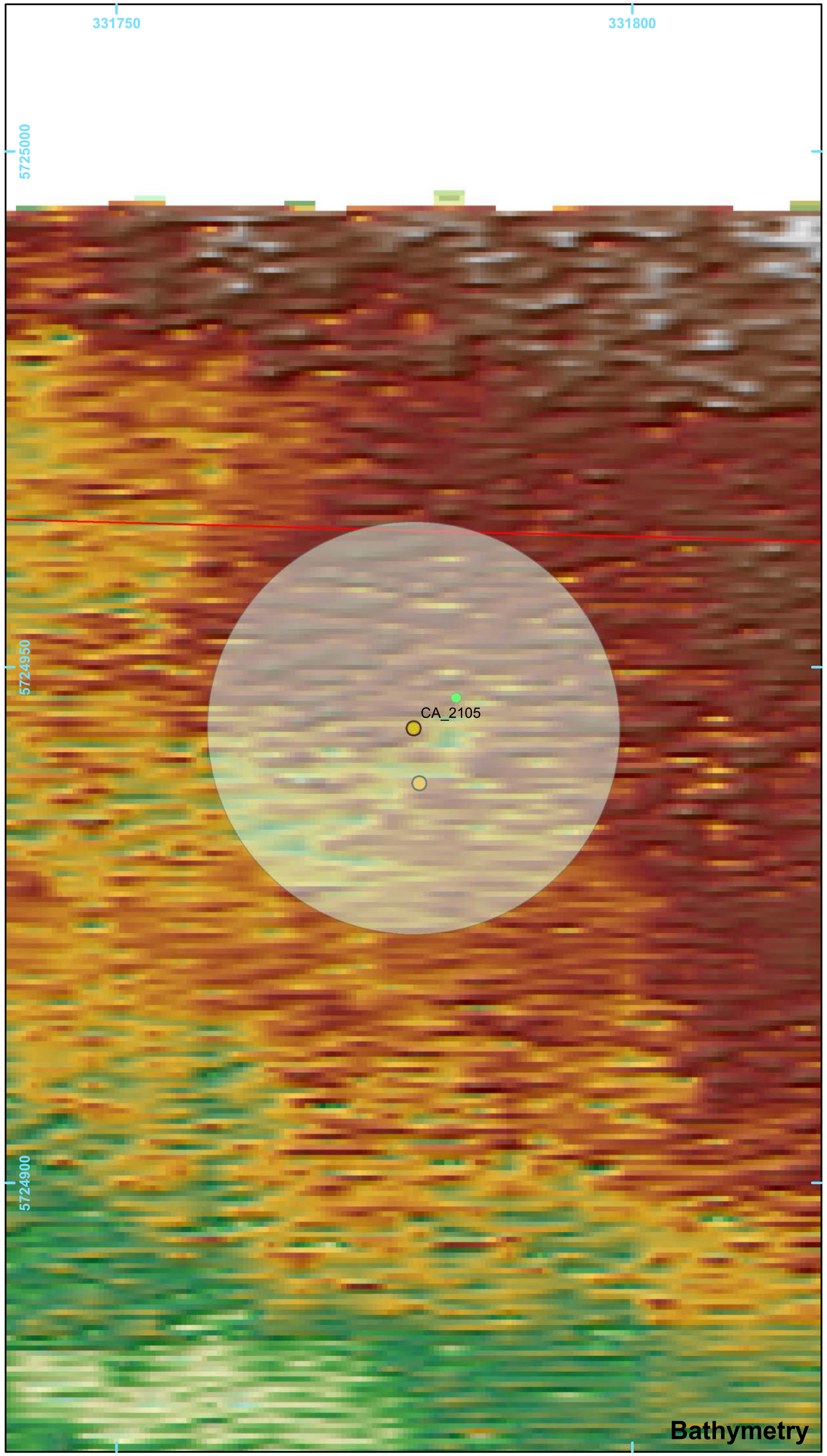
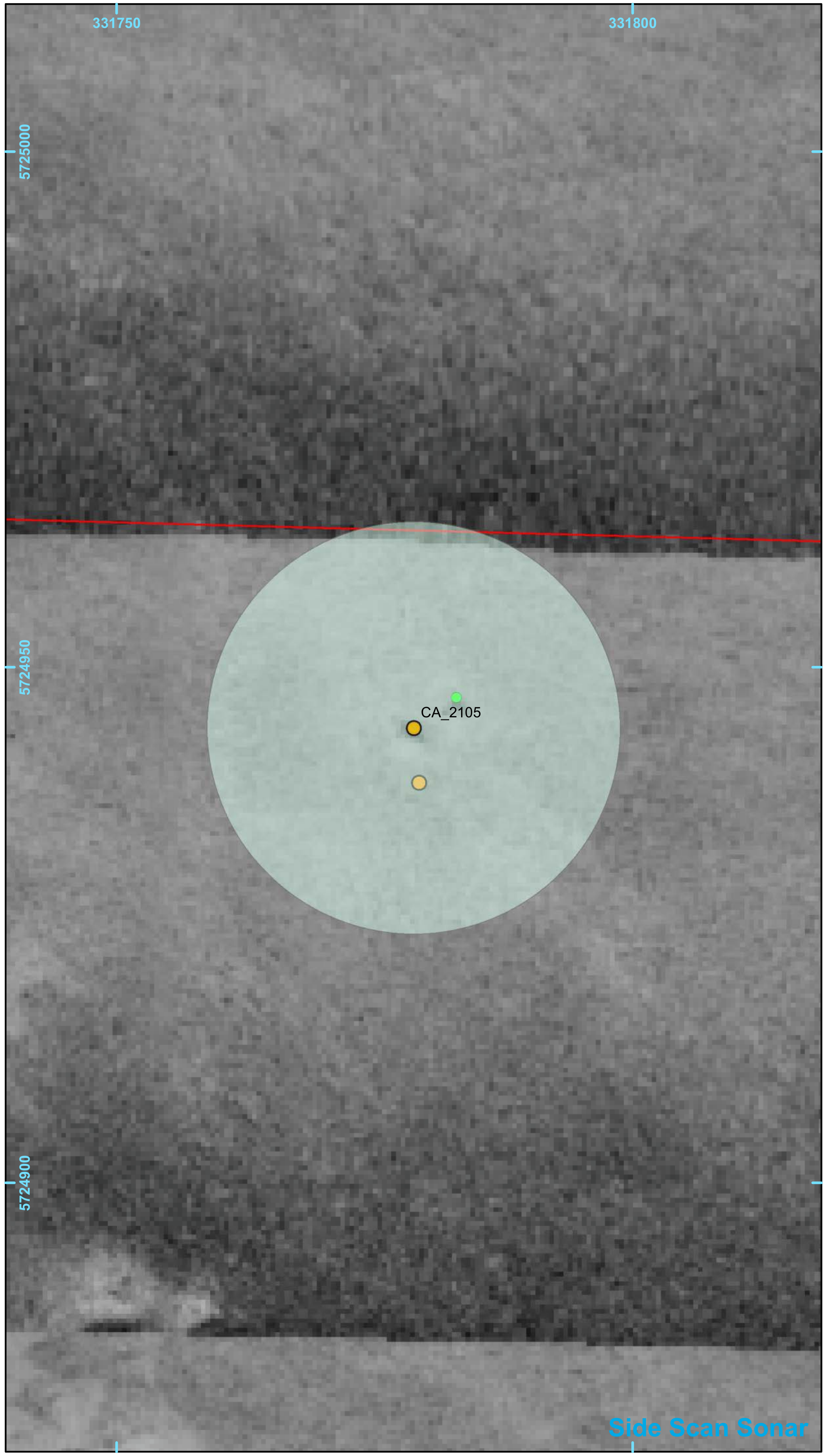
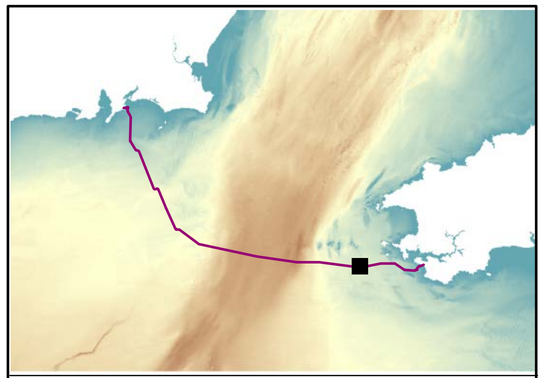
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2104

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.49
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -58.036
Low : -58.8101

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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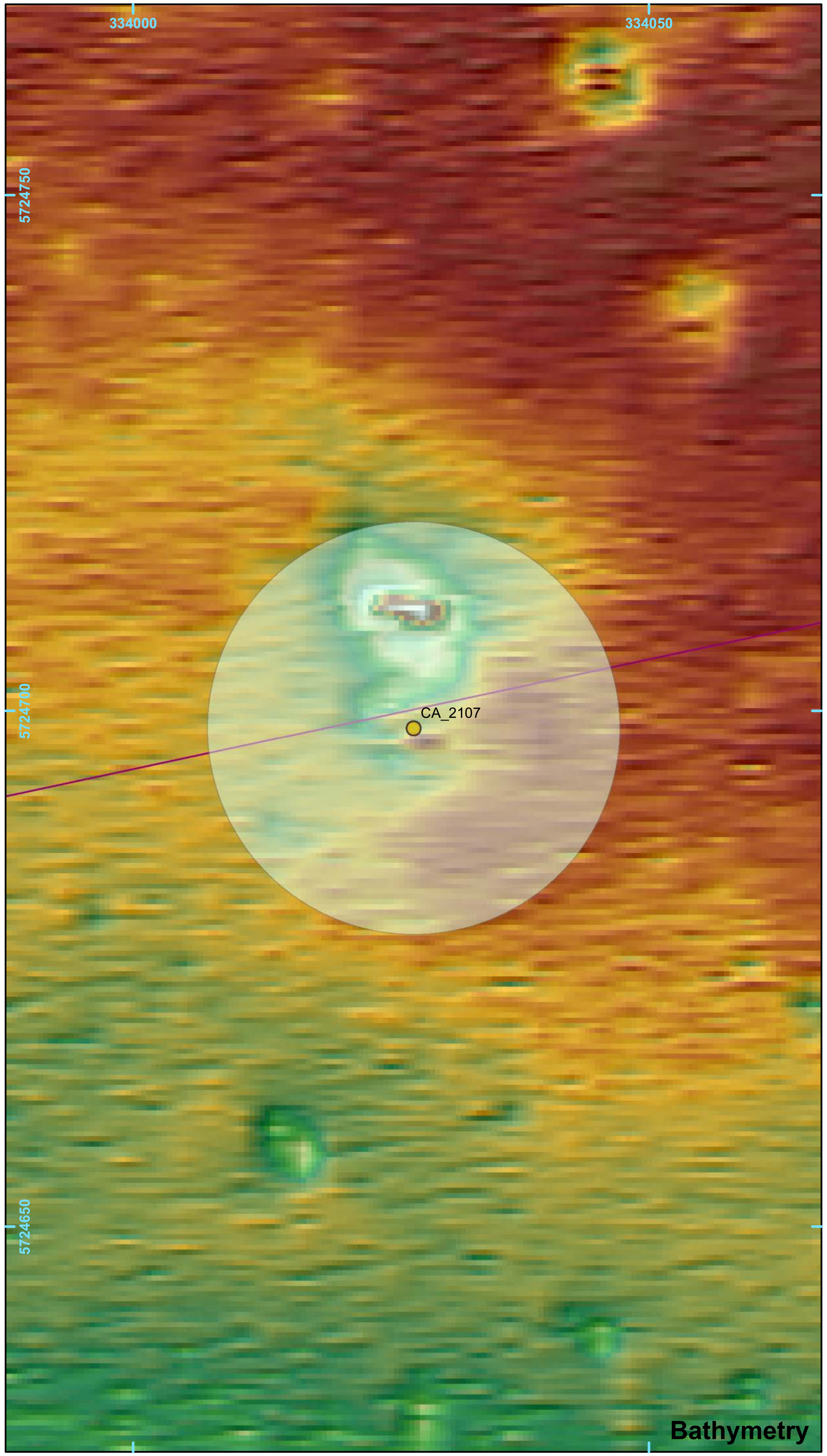
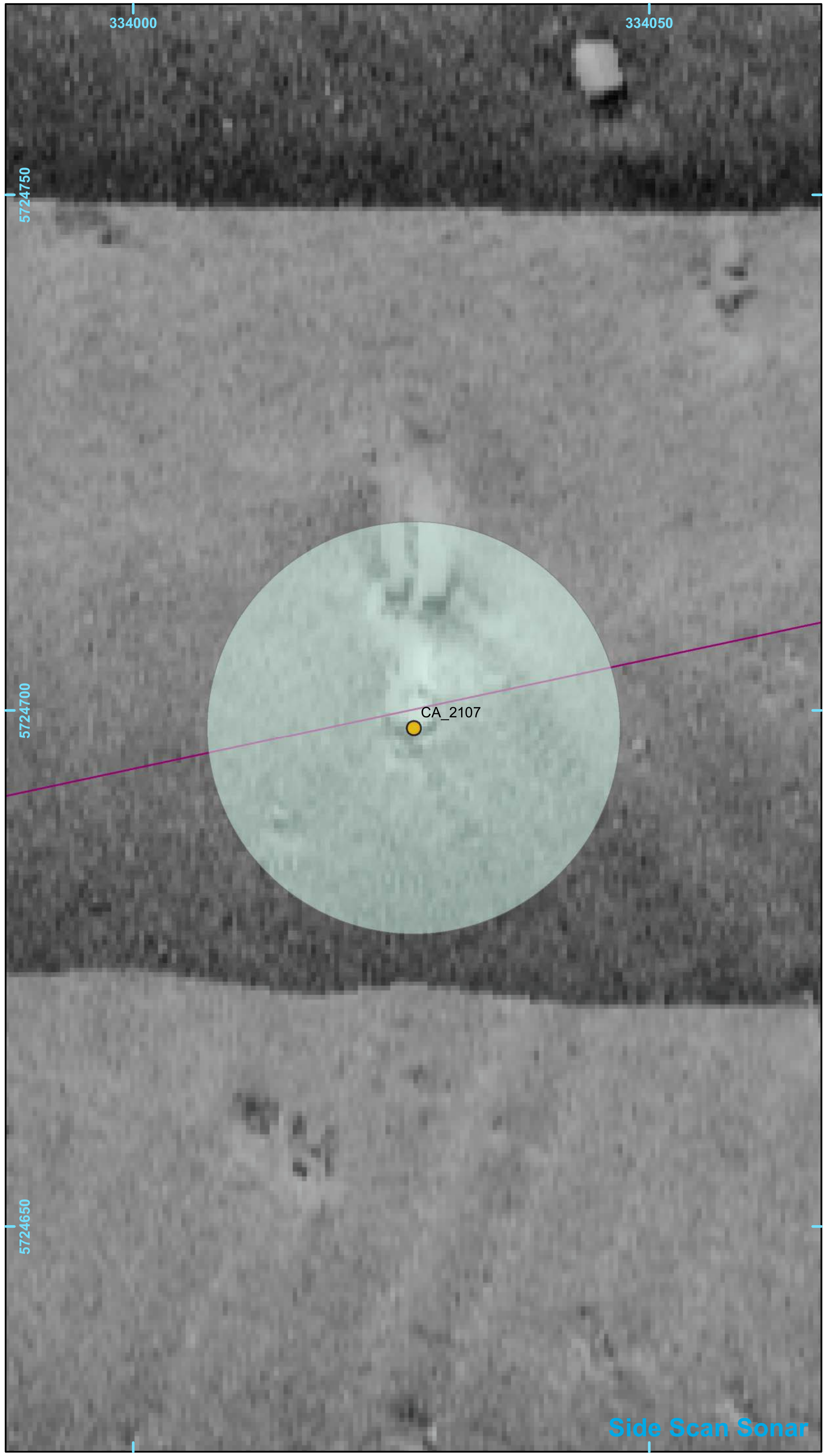
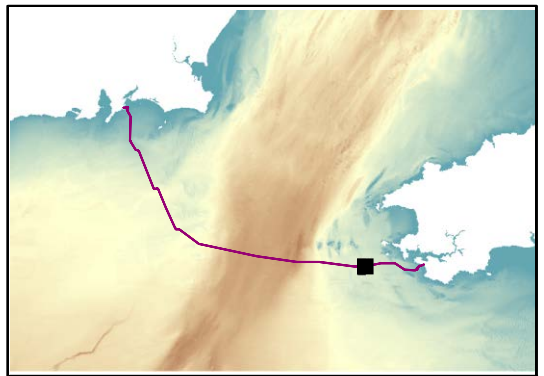
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2105

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	
APPROVED BY	MW	SCALE@A3	1:500	3.50







N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -58.4217
Low : -59.9202

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine
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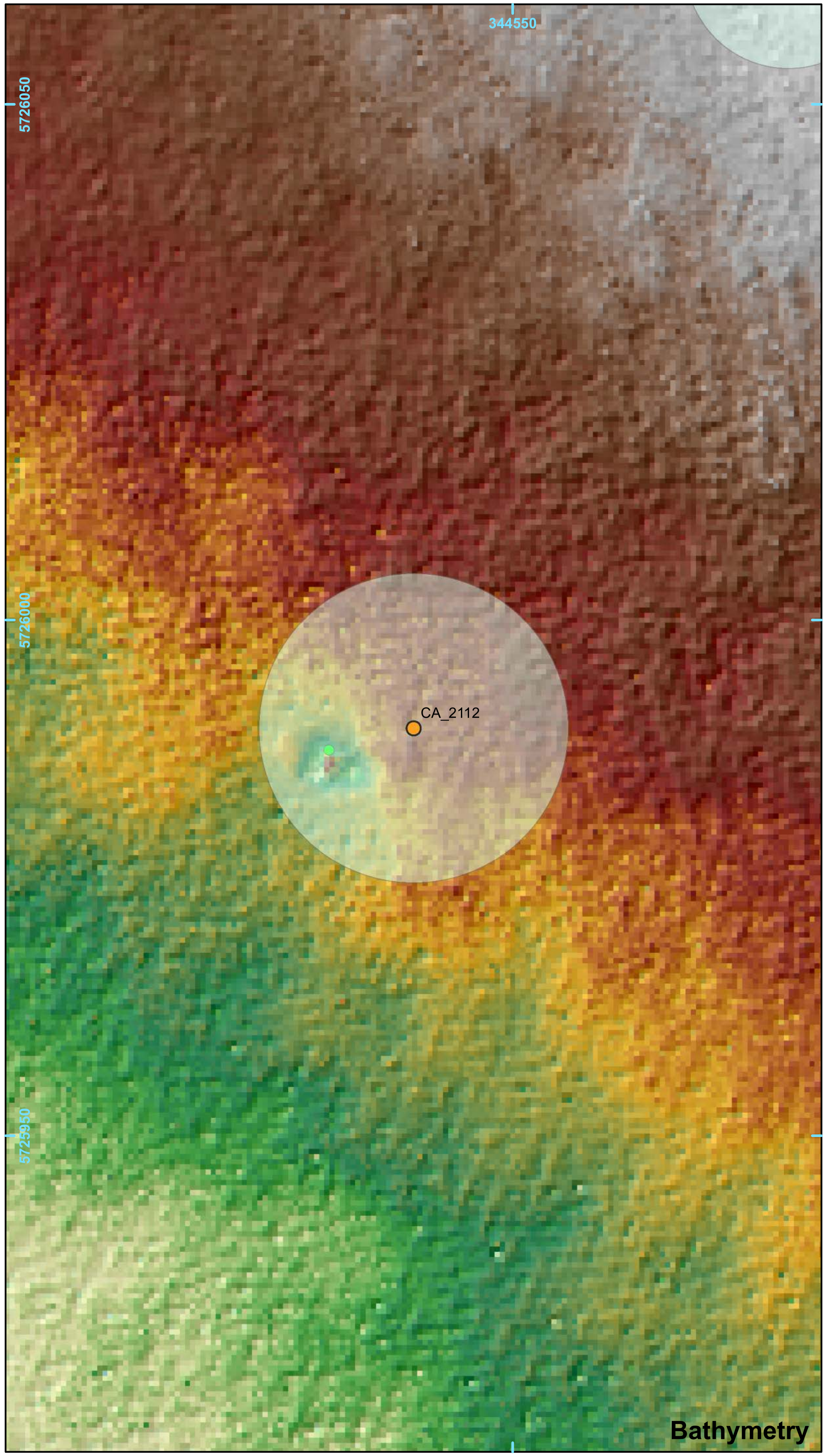
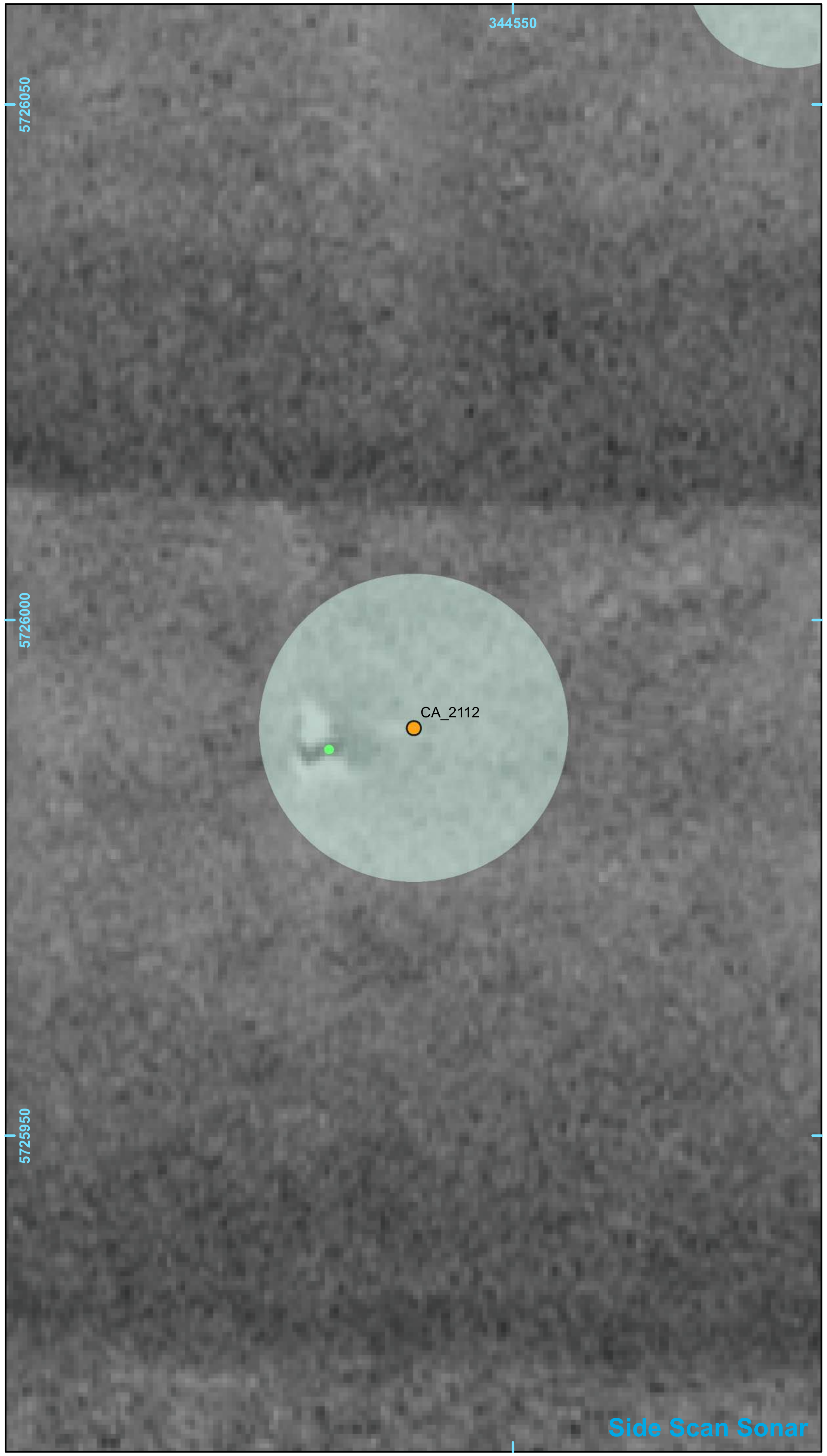
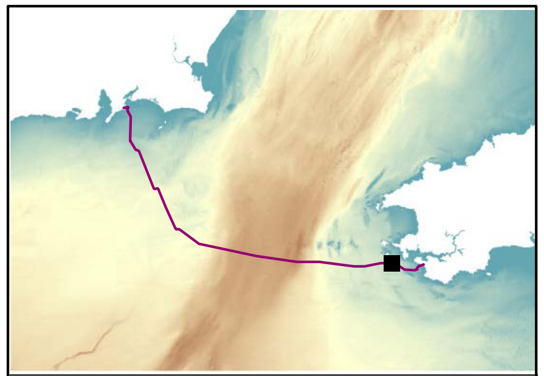
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2107

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.51
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -50.368
Low : -51.672

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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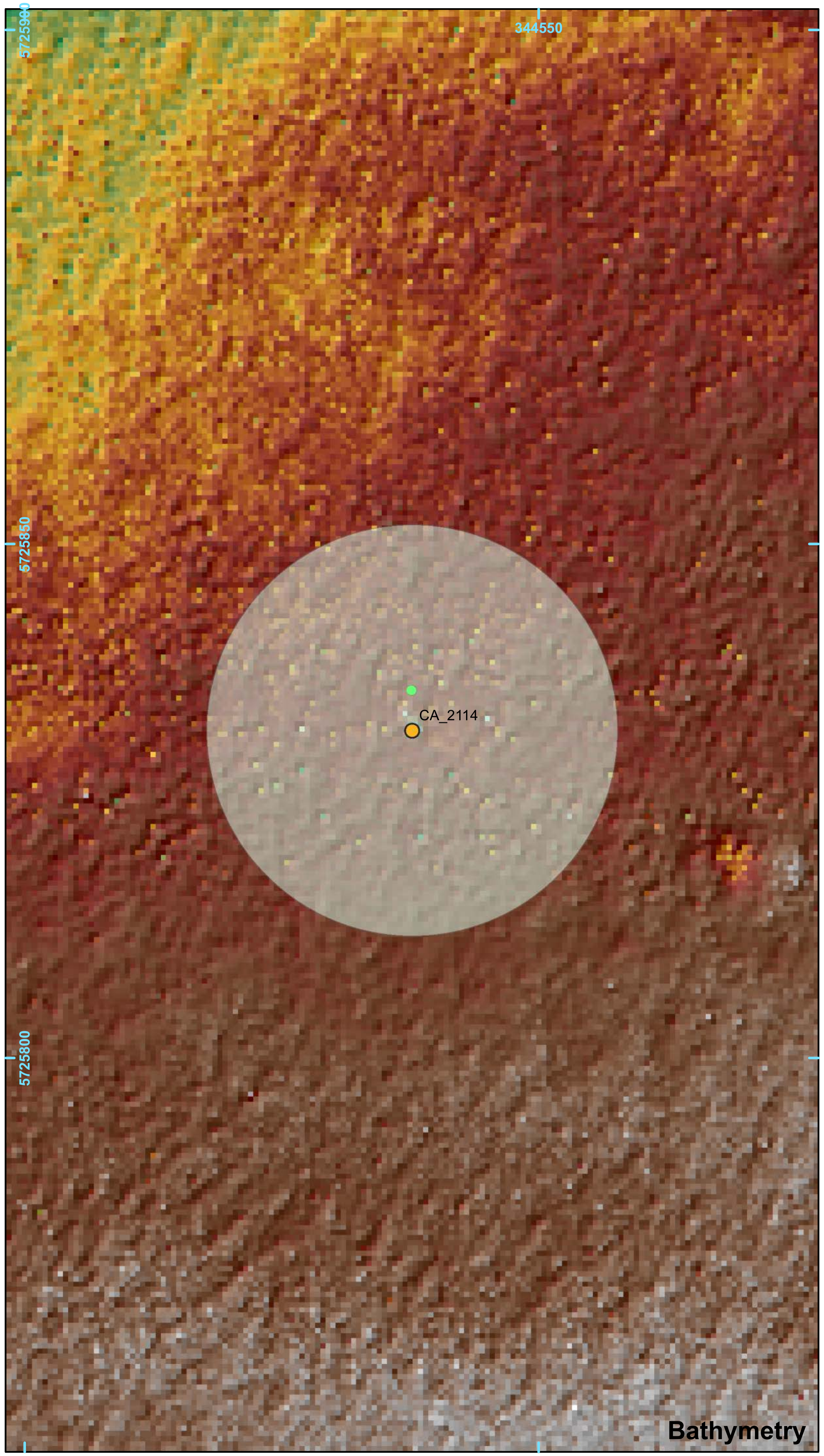
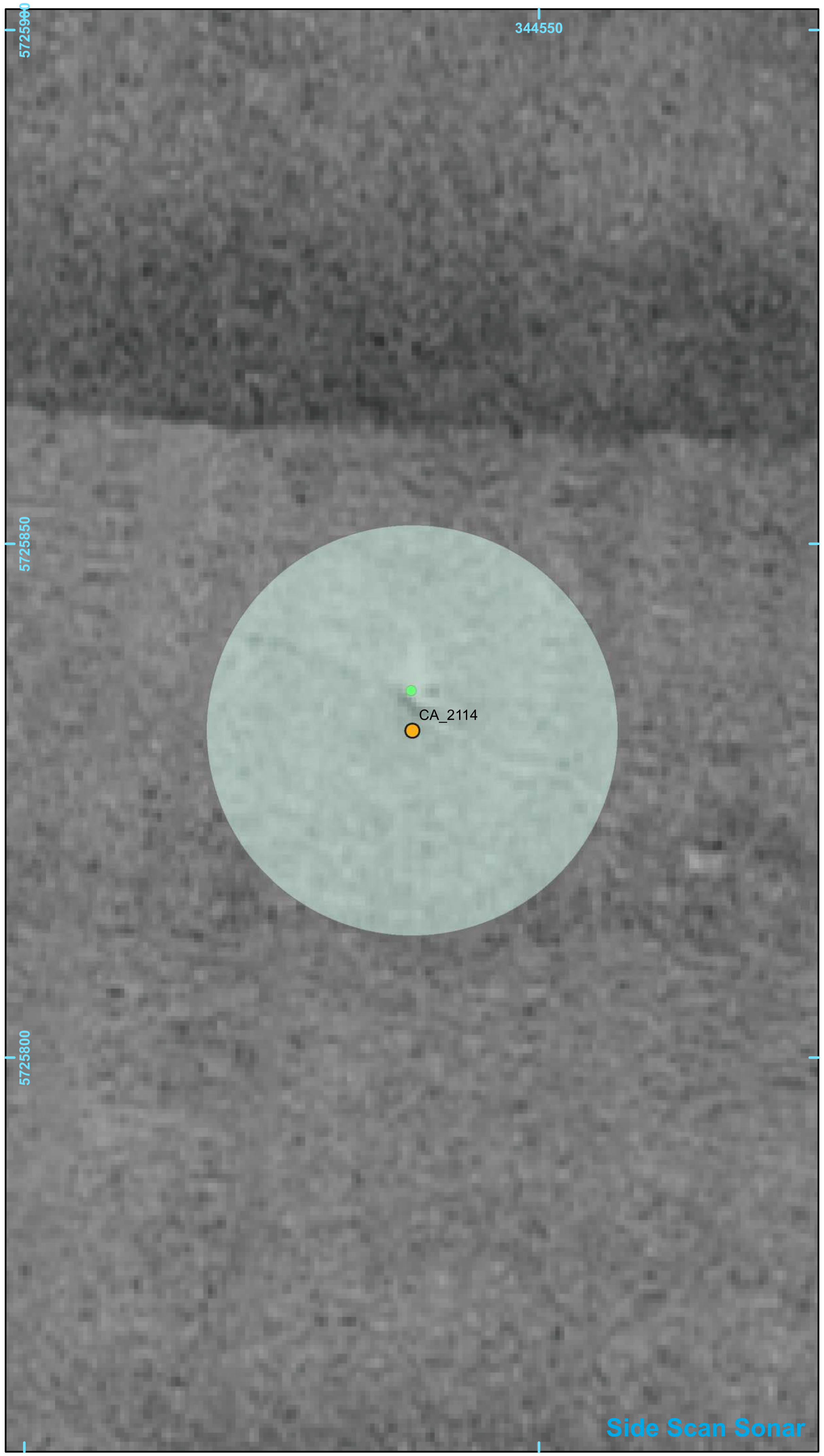
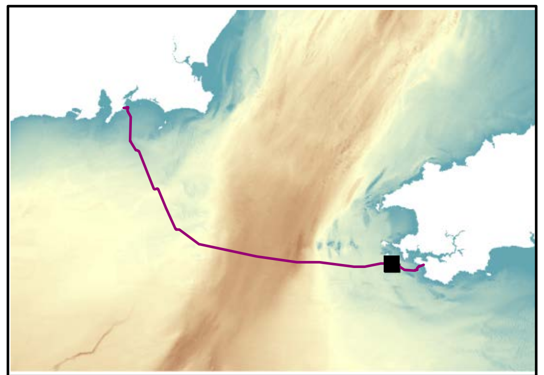
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2112

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.52
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -51.014
Low : -51.645

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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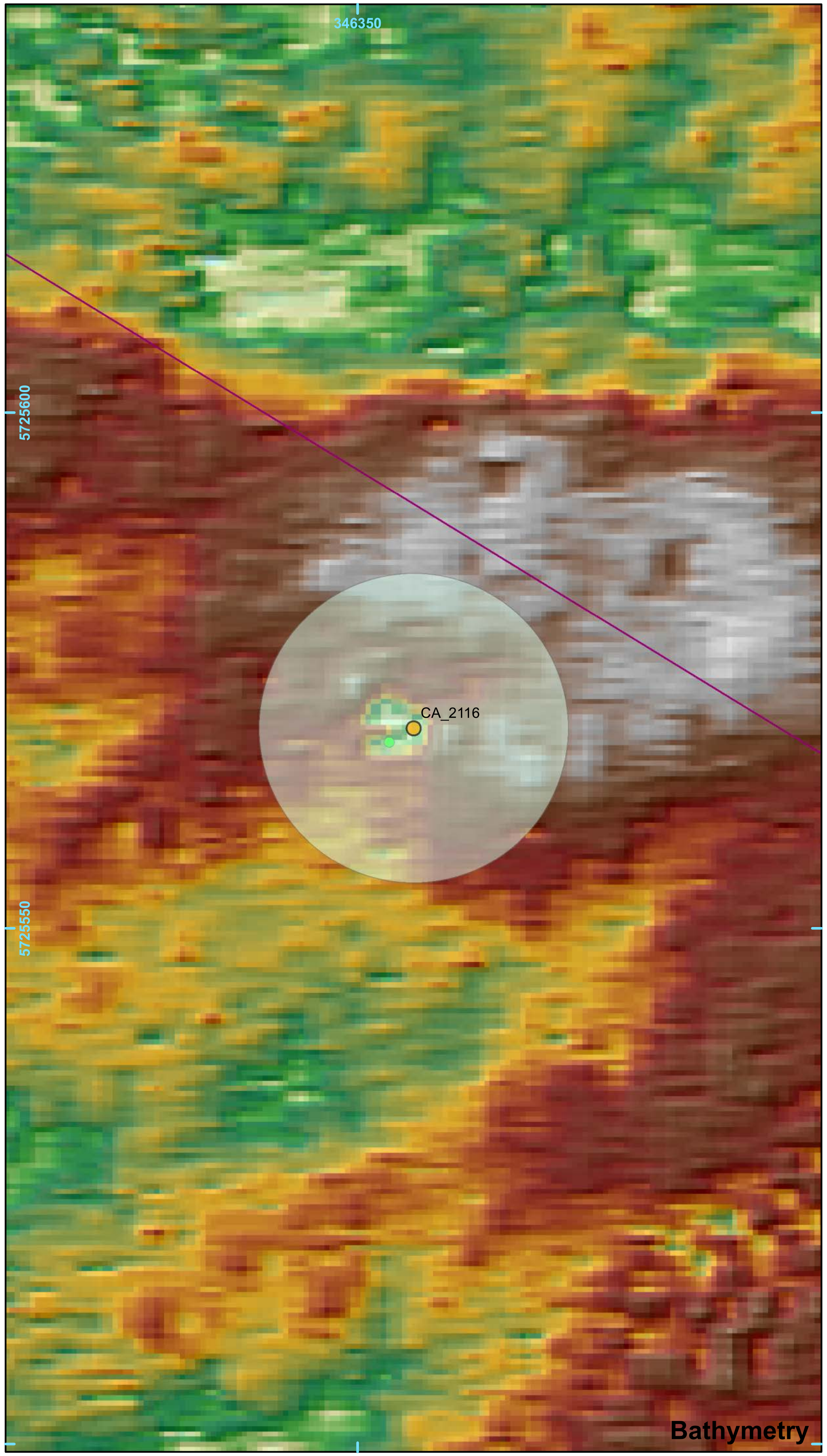
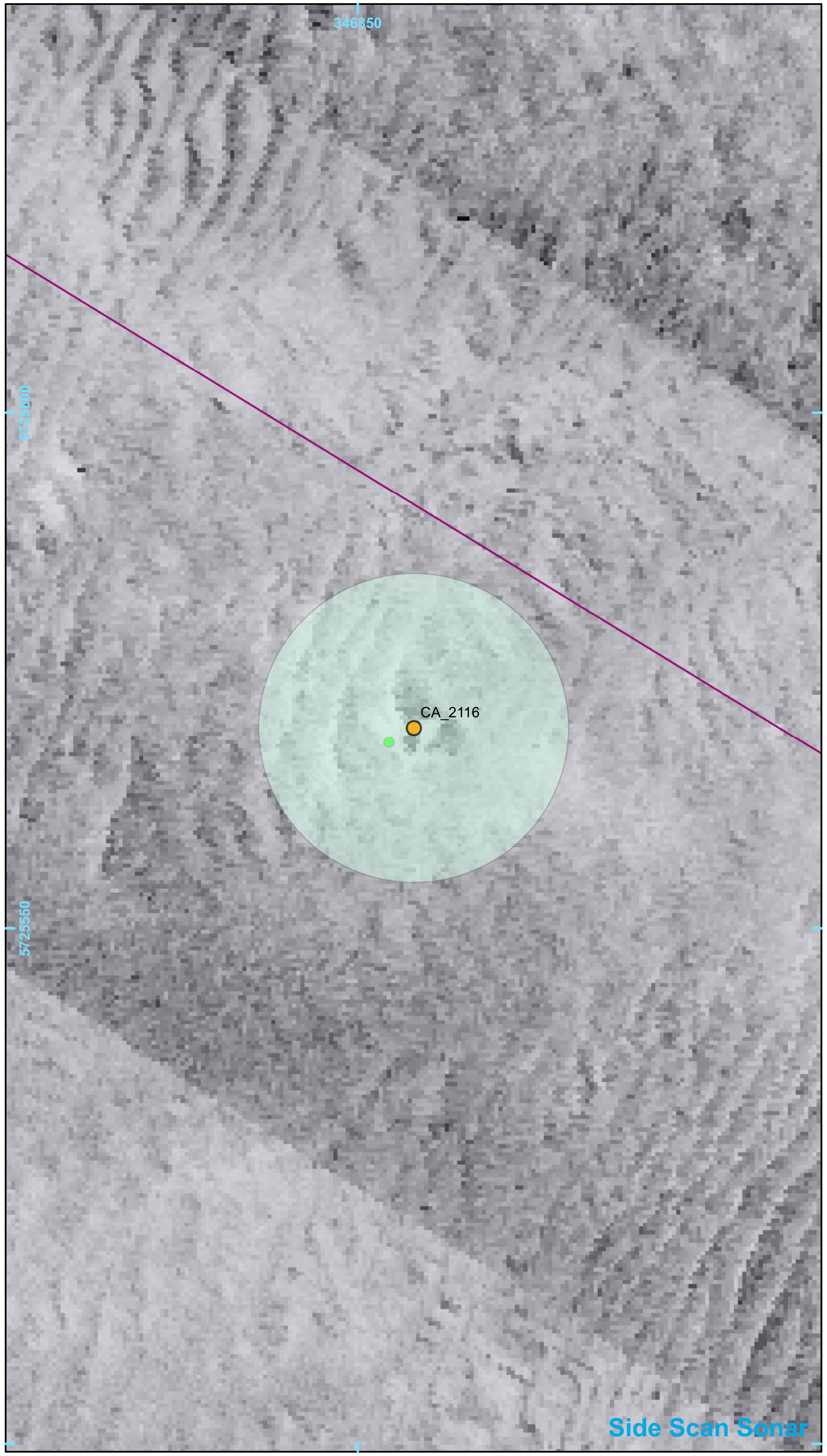
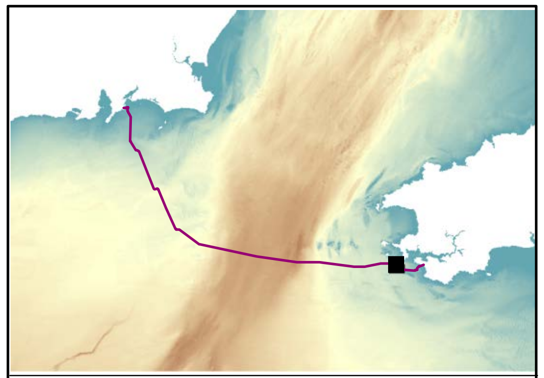
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2114

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.53
APPROVED BY	MW	SCALE@A3	1:500	







Legend

N

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -48.8155
  - Low : -49.3288

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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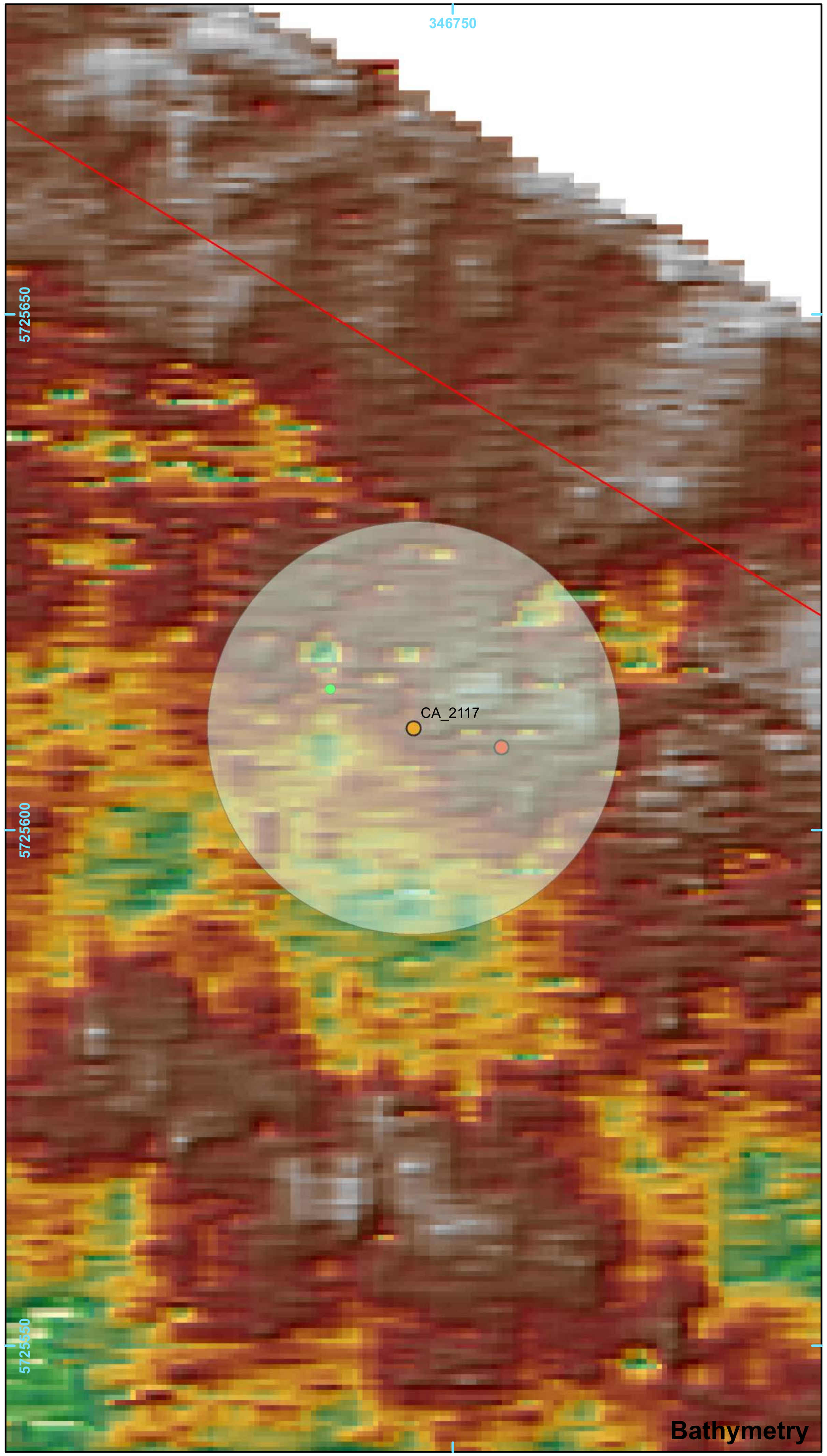
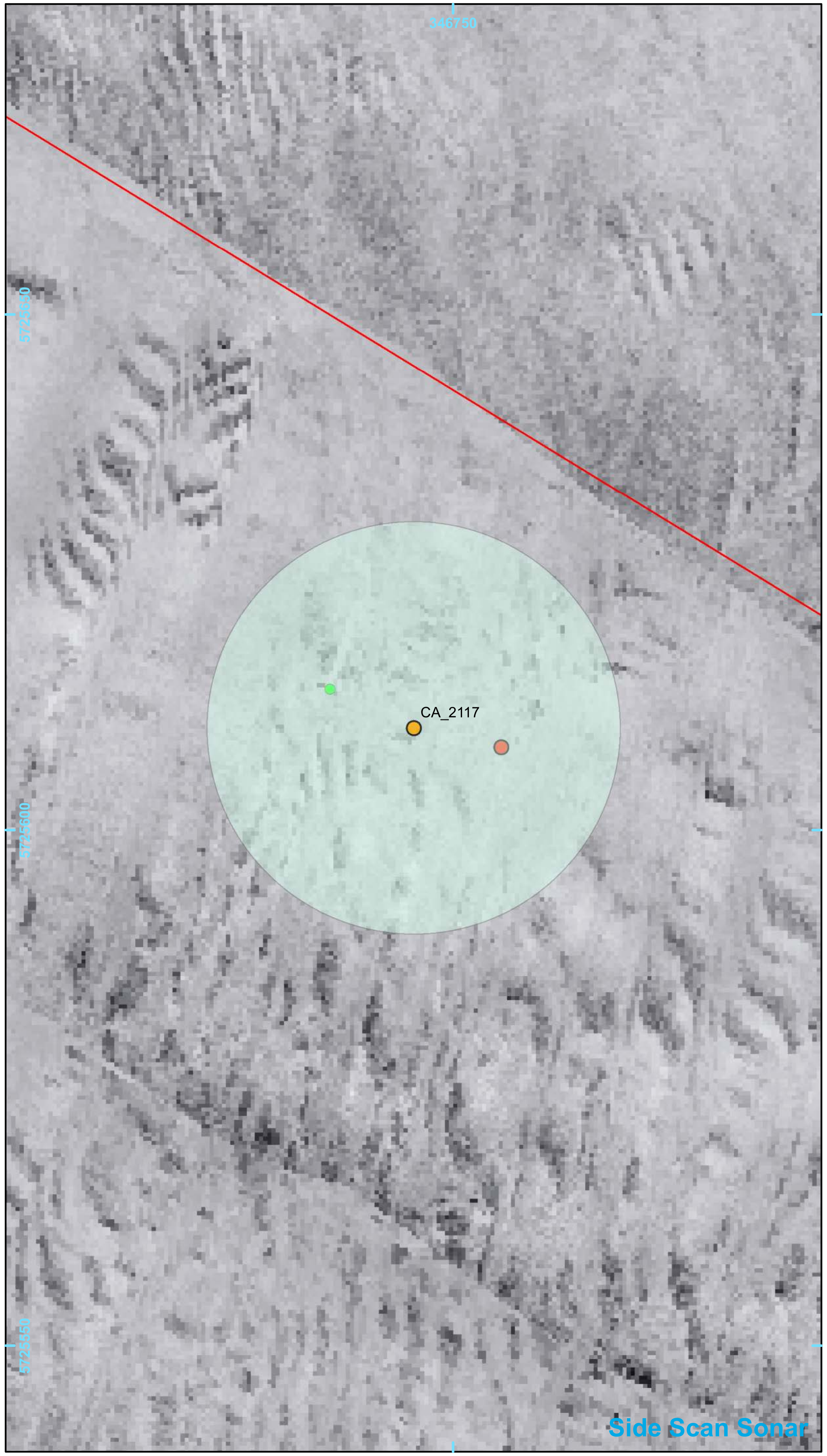
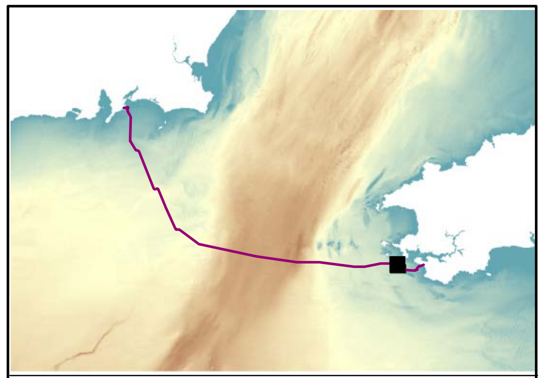
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2116

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.54
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor
- Archaeological Anomaly
  - High
  - Medium
  - Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly
- Magnetic Anomaly
  - 0.5 - 2 nT
  - 2 - 5 nT
  - 5 - 10 nT
  - 10 - 25 nT
  - > 25.0 nT
- Bathymetry (mLAT)
  - High : -48.5316
  - Low : -48.9962

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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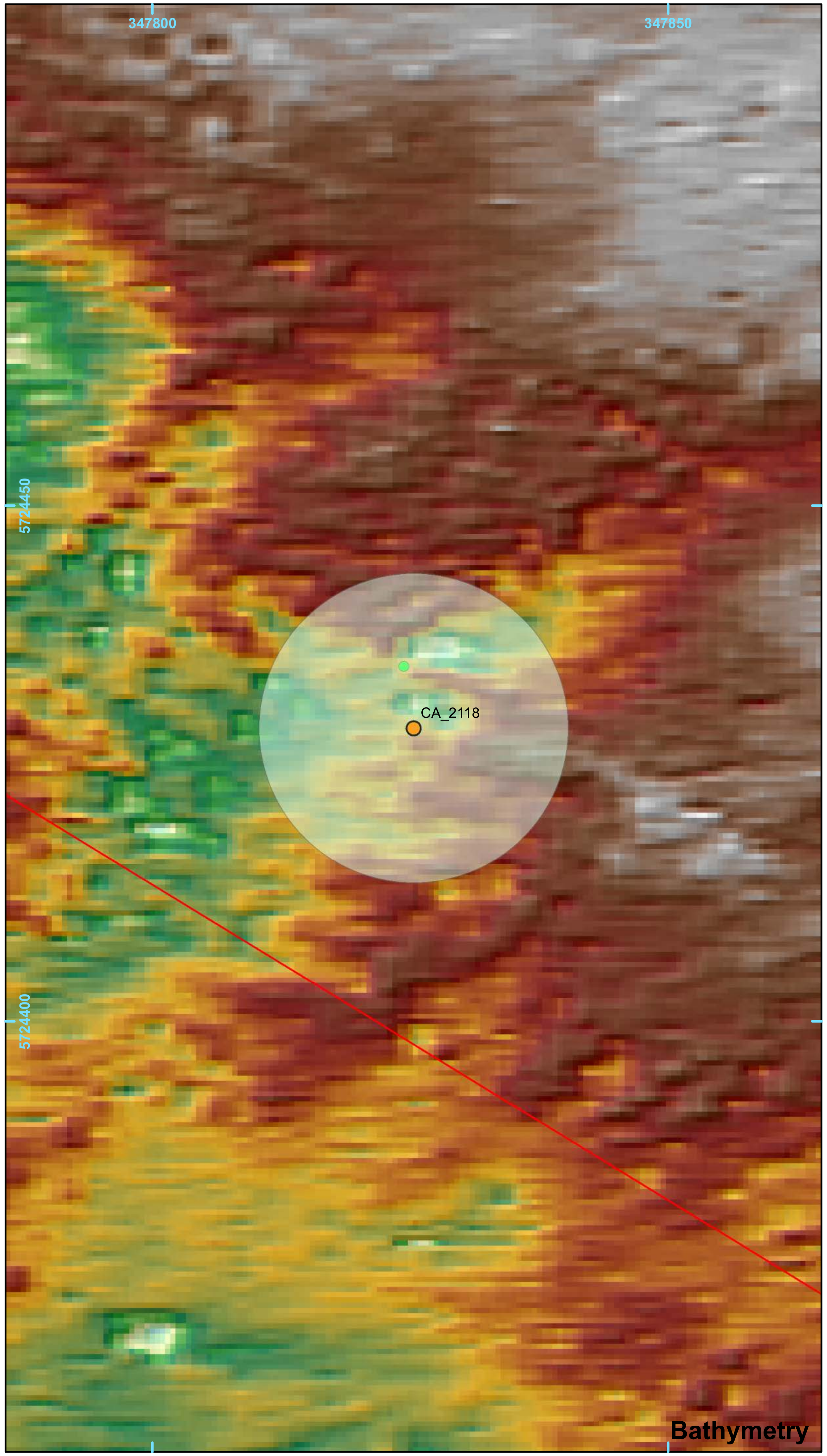
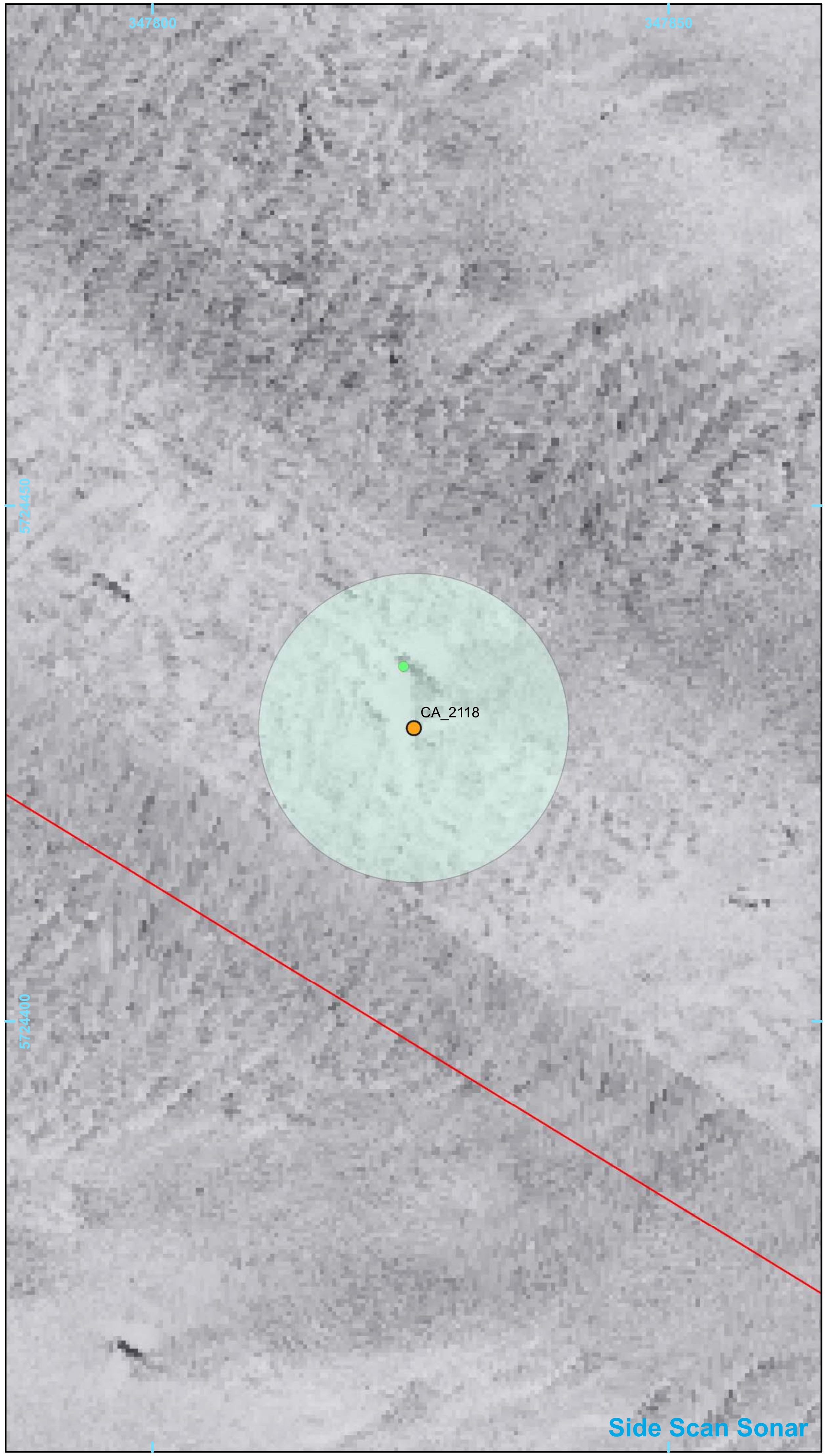
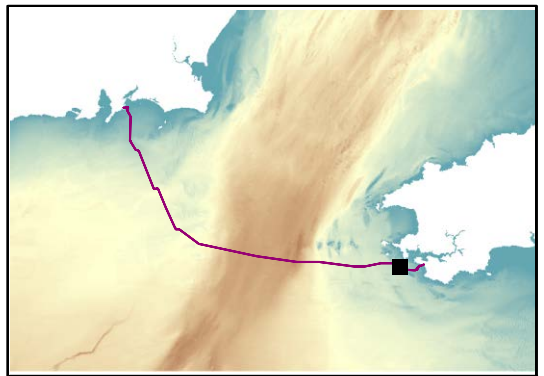
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2117

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.55
APPROVED BY	MW	SCALE@A3	1:500	







Legend

N

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low

- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -47.9941
Low : -48.6658

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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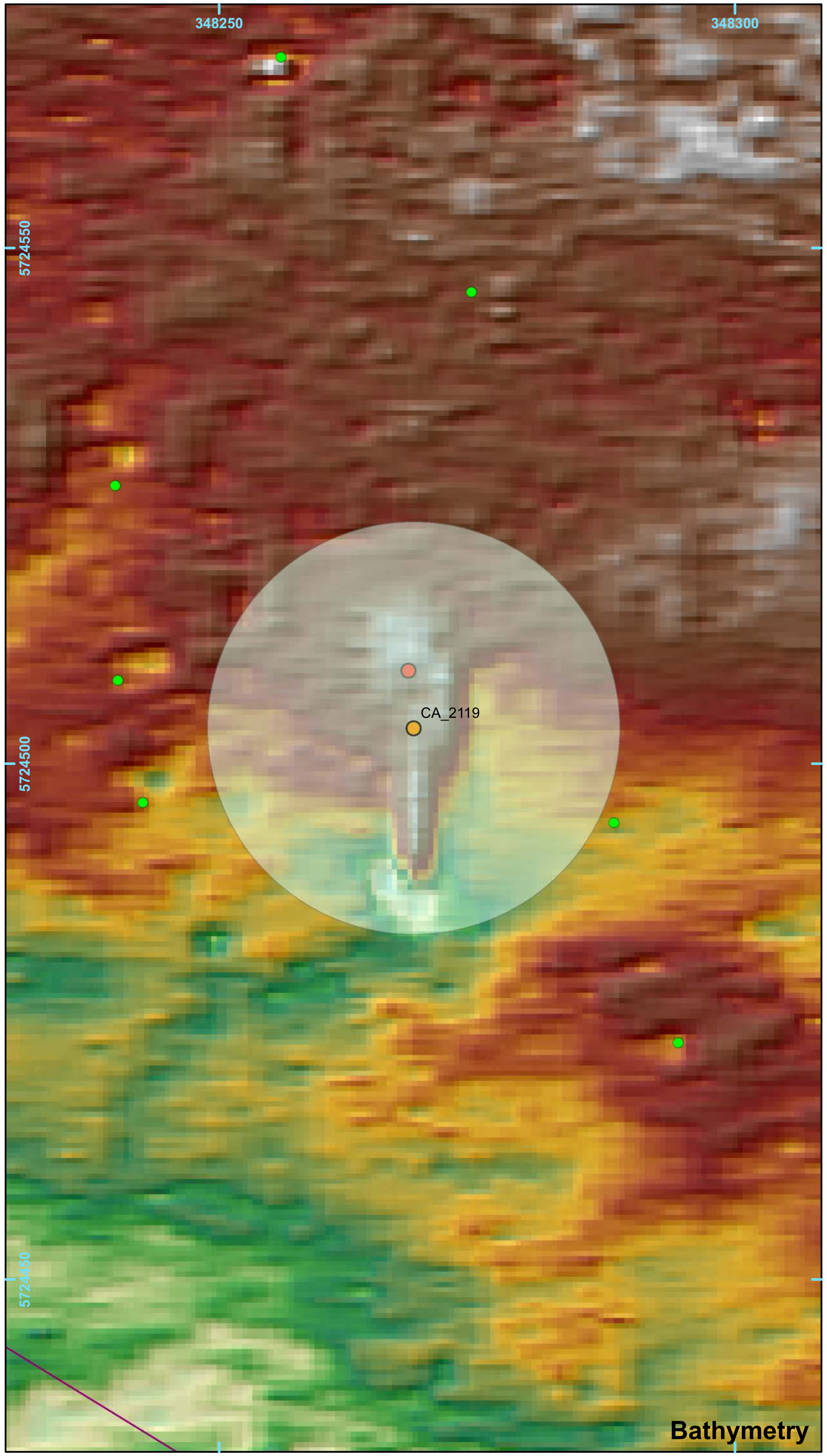
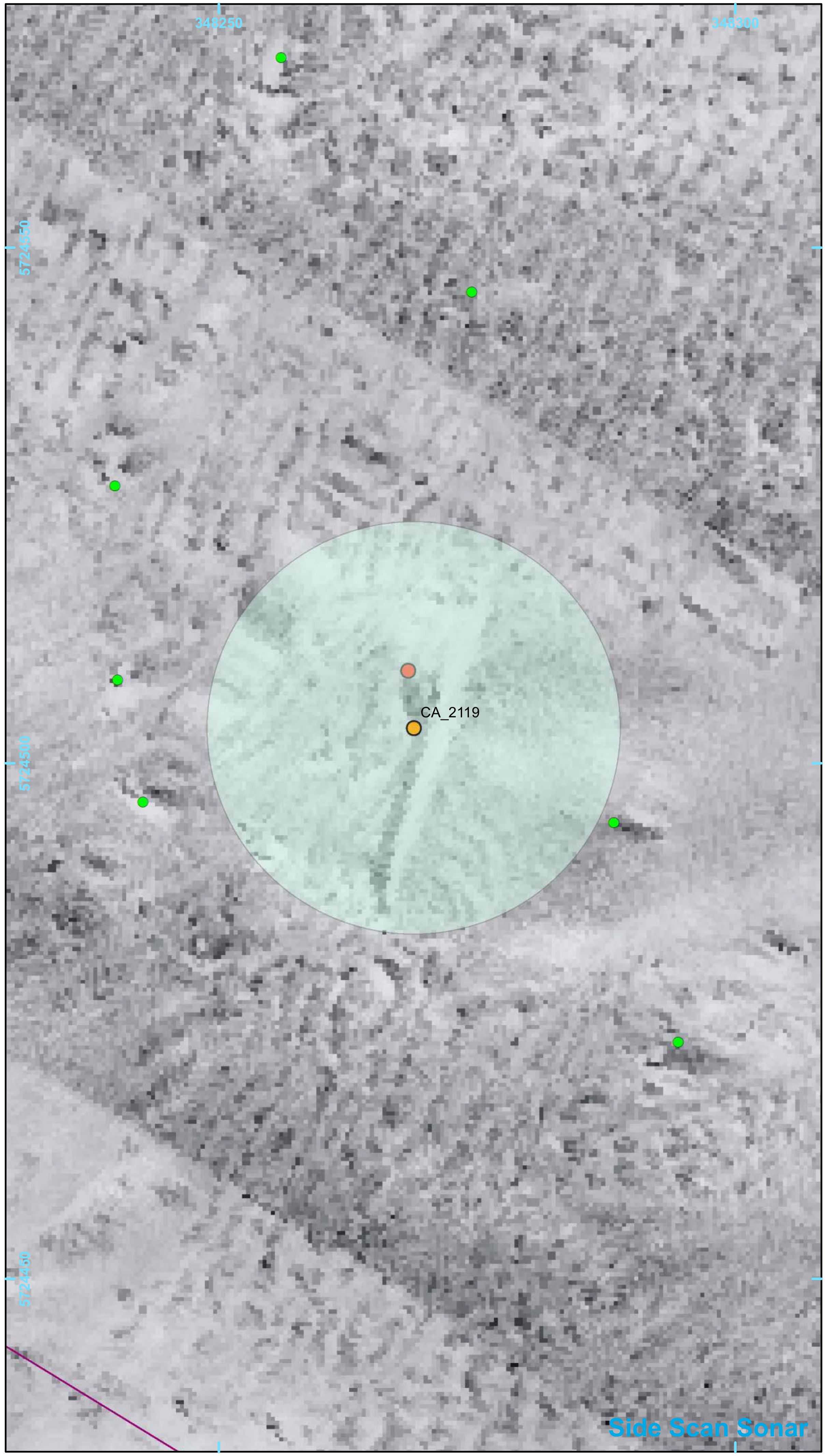
FIGURE TITLE
Archaeological Anomaly CA_2118

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.56
APPROVED BY	MW	SCALE@A3	1:500	





Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly
- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly
- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -47.2699
Low : -48.2584

N

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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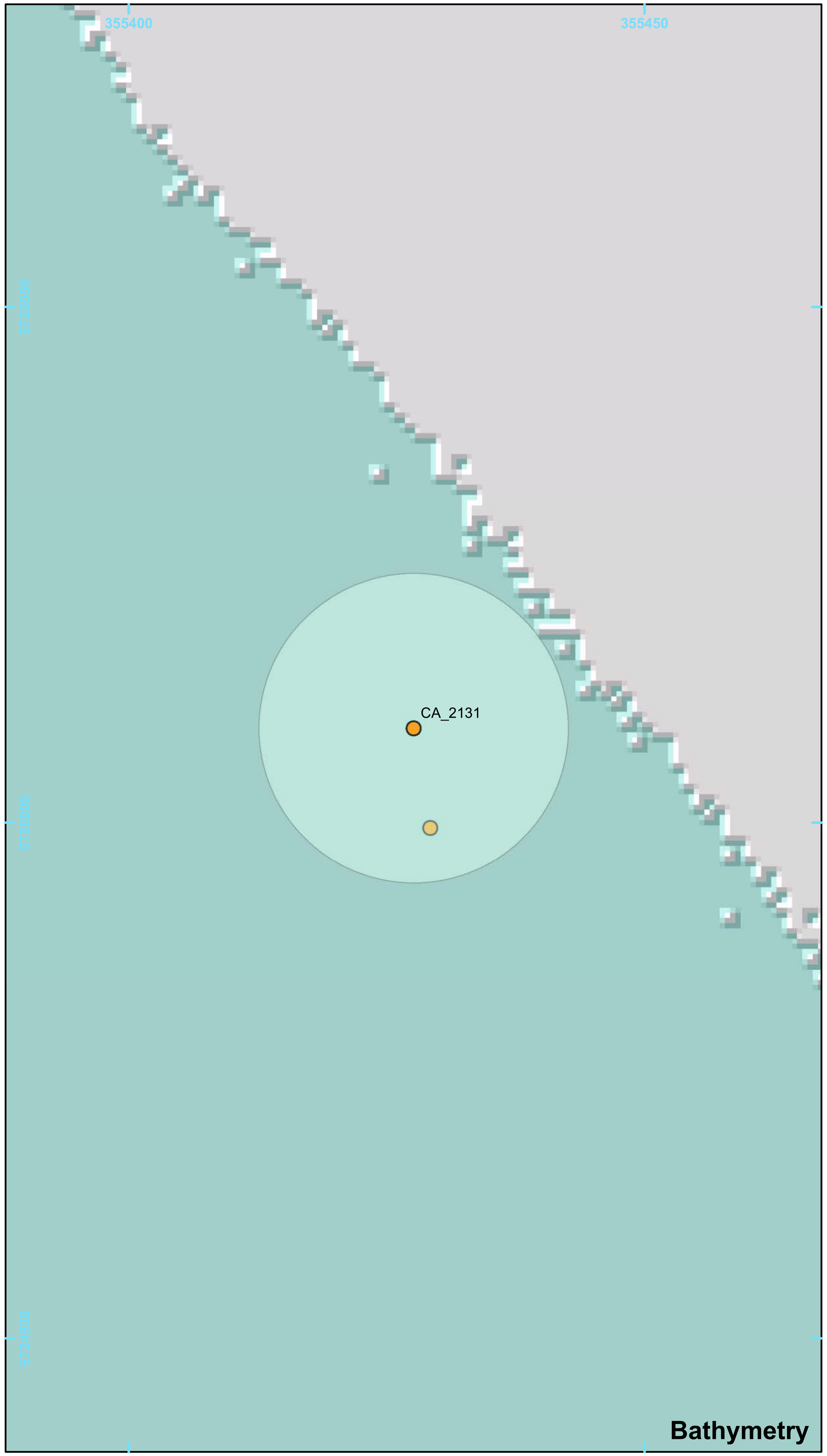
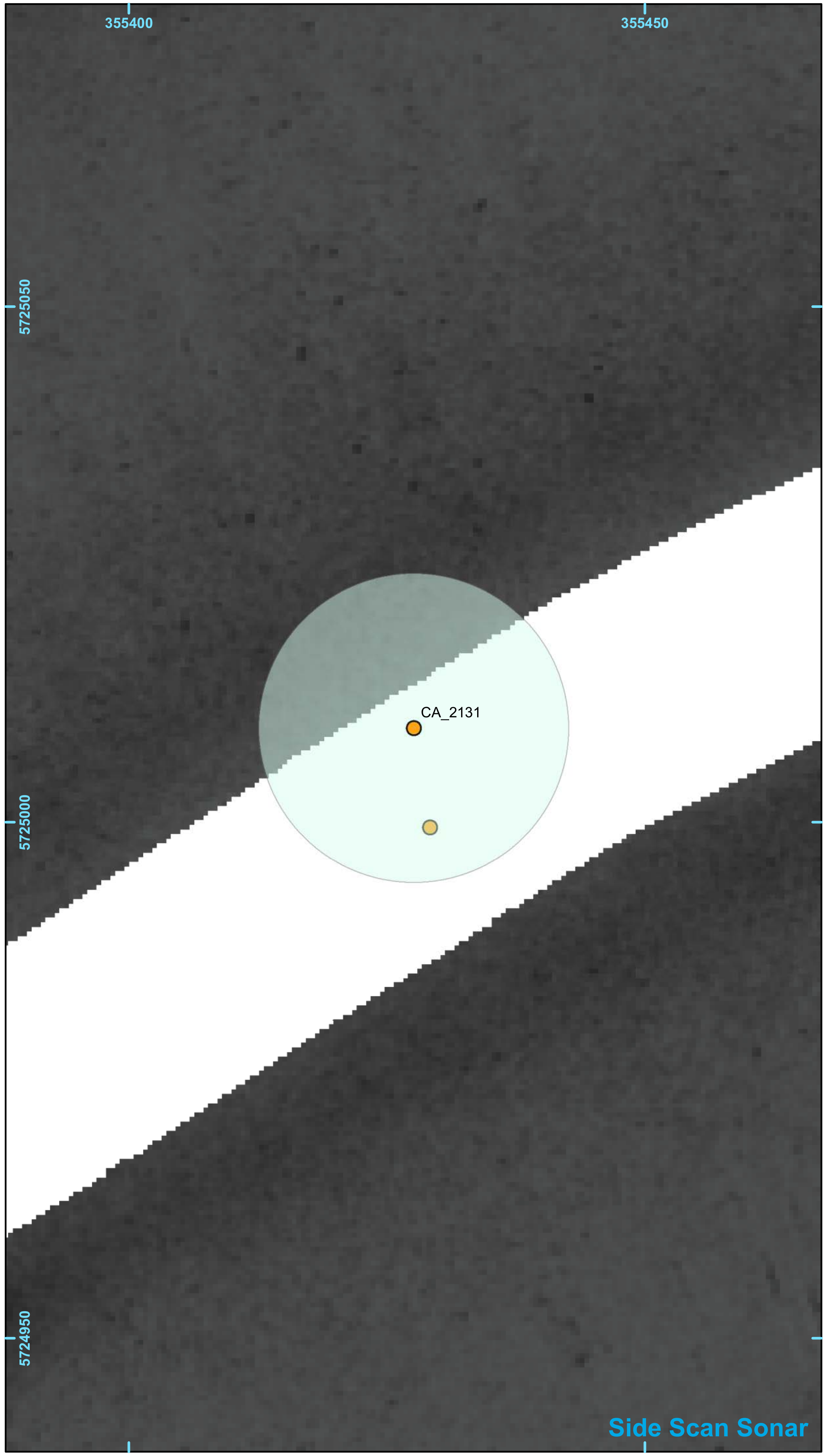
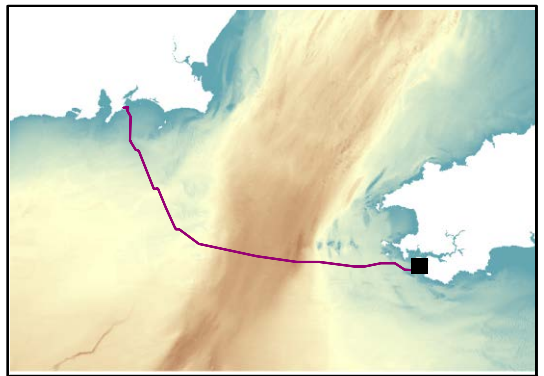
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2119

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.57
APPROVED BY	MW	SCALE@A3	1:500	







N

Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)

High : -17

Low : -18

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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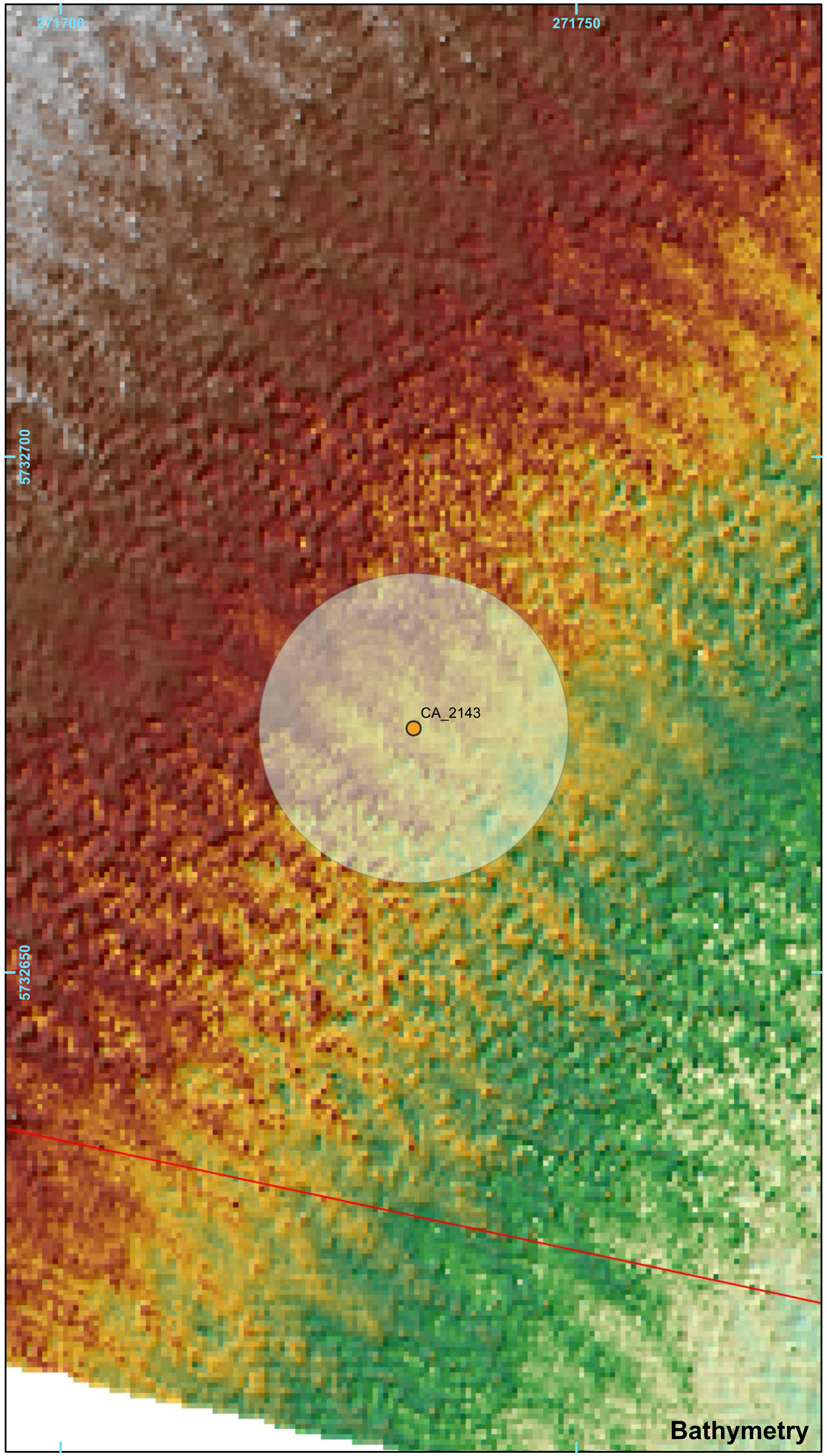
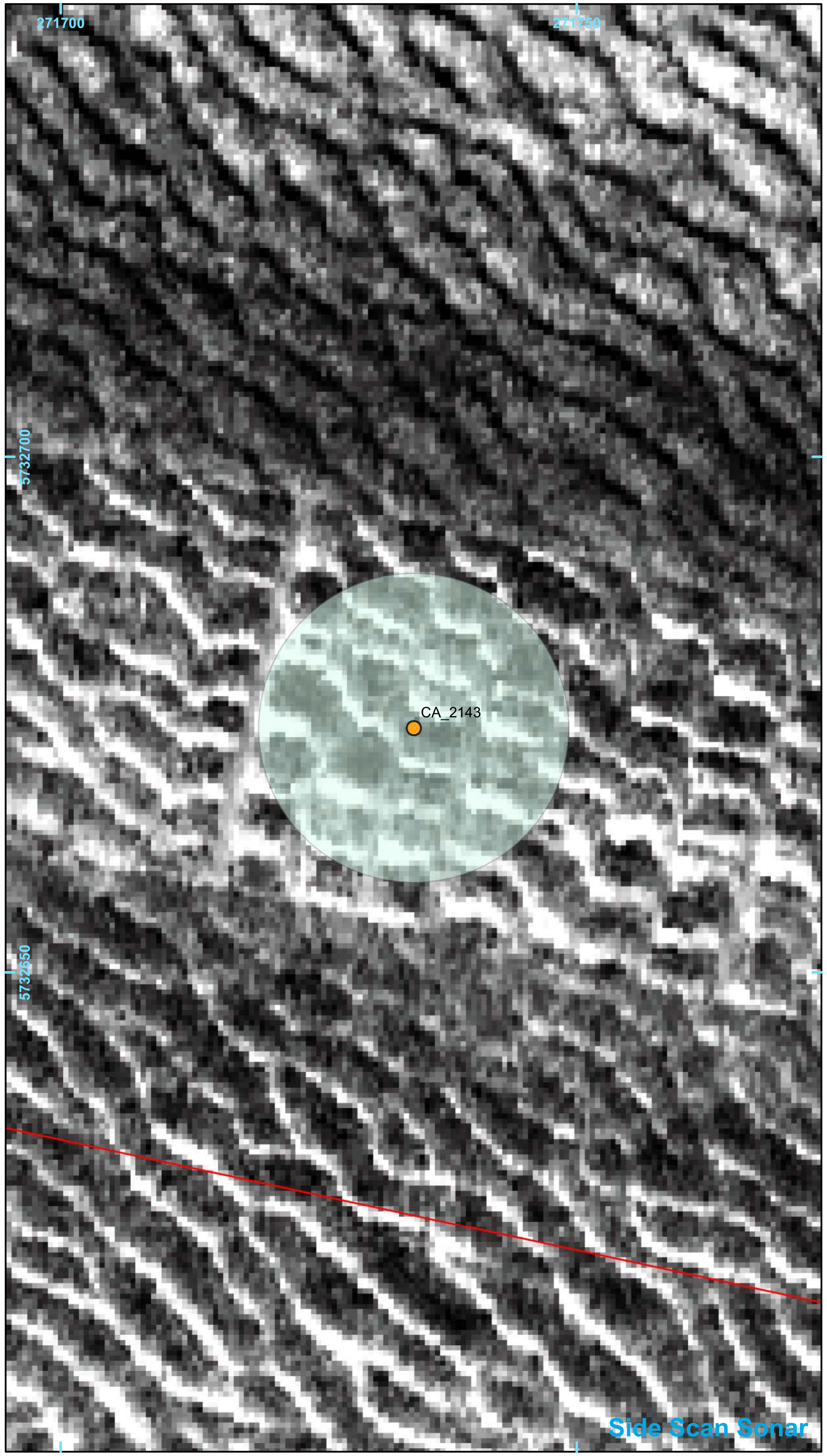
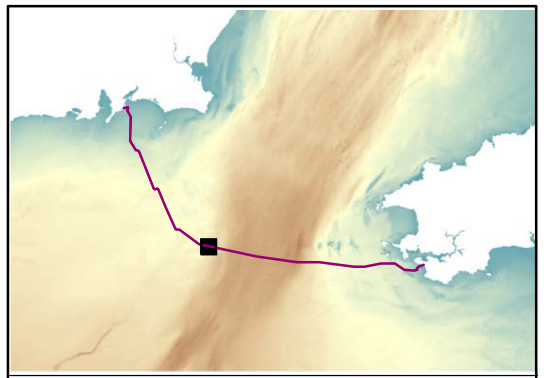
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2131

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.58
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -75.306
Low : -77.056

0 17.5m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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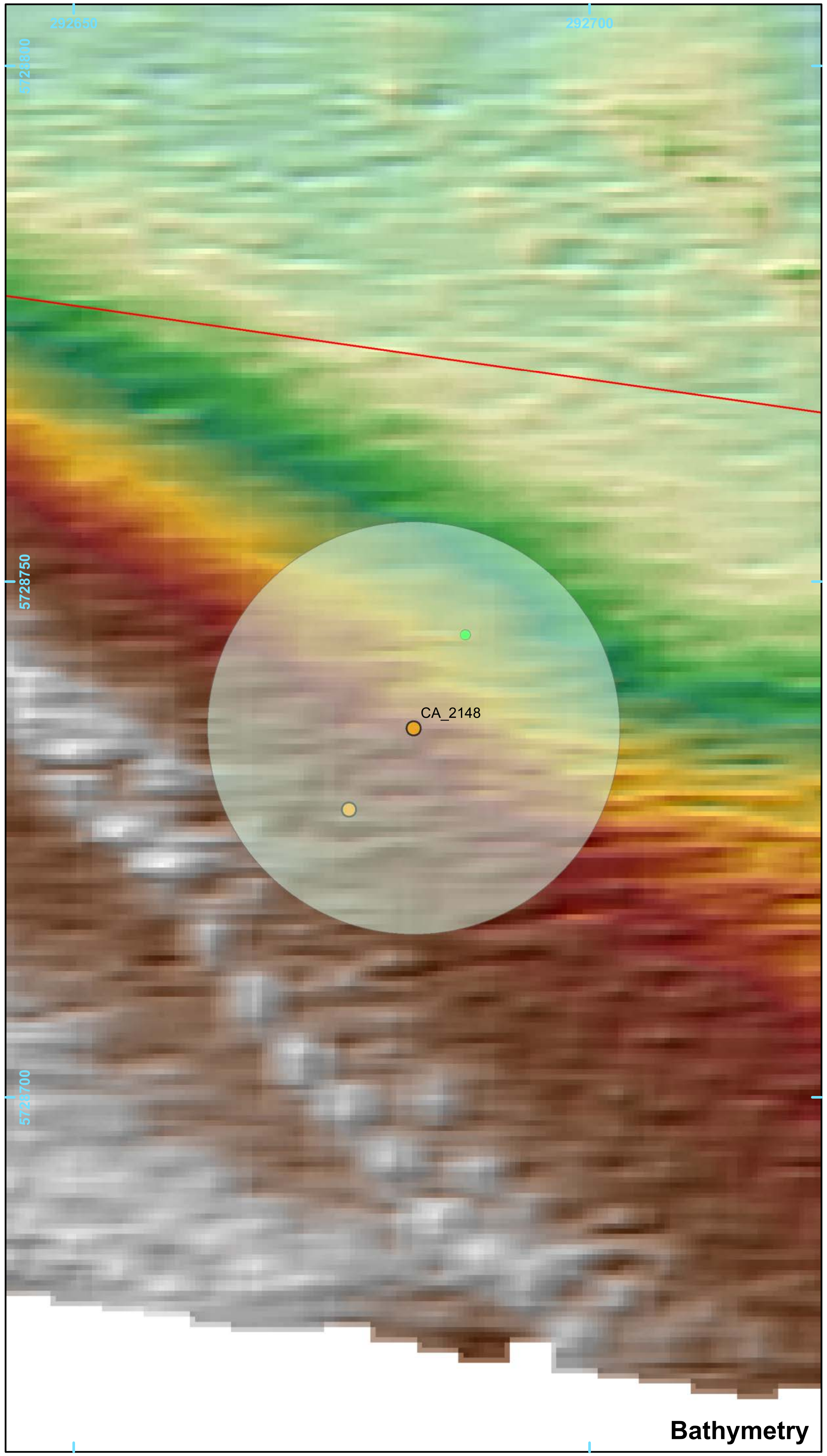
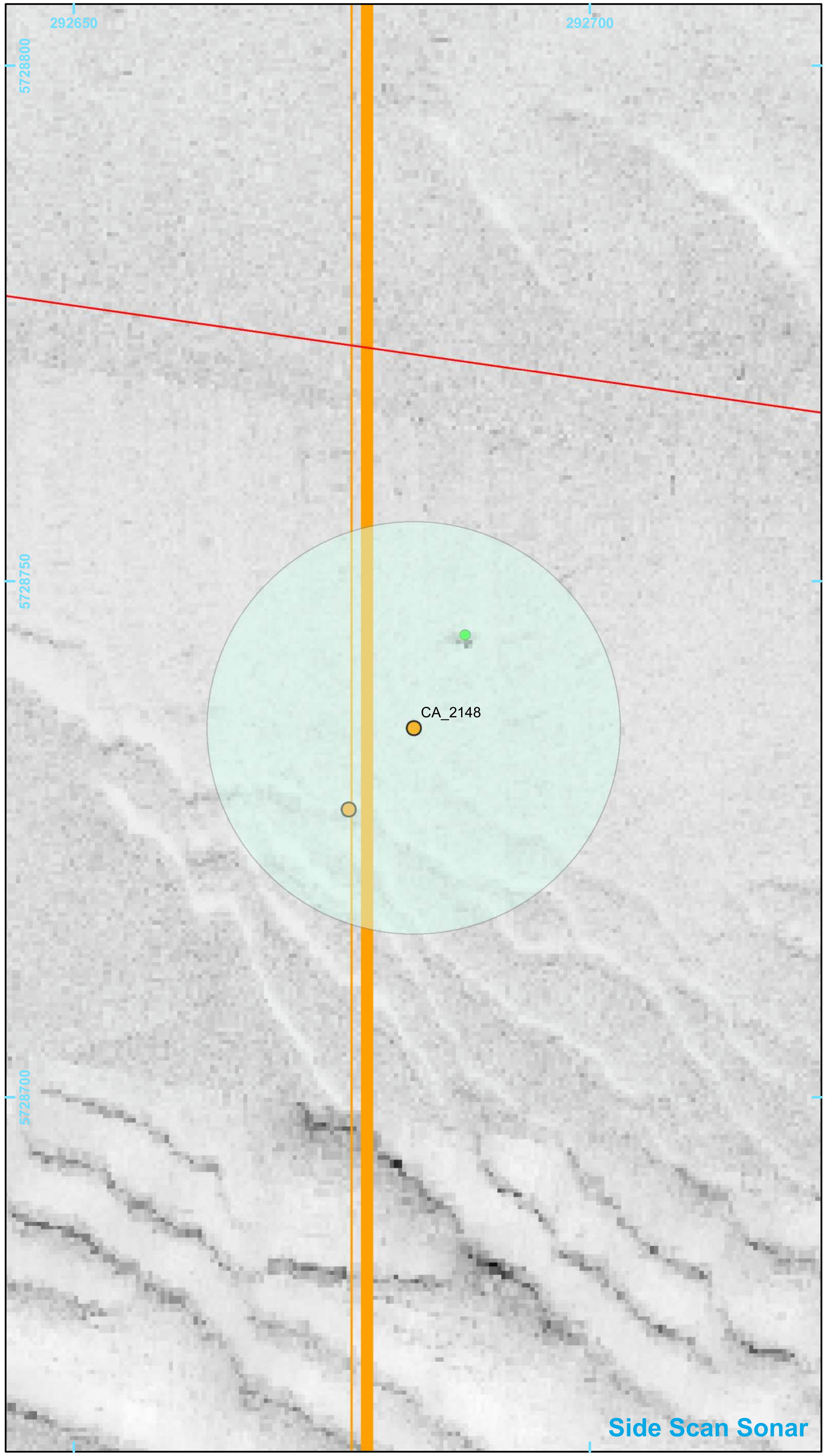
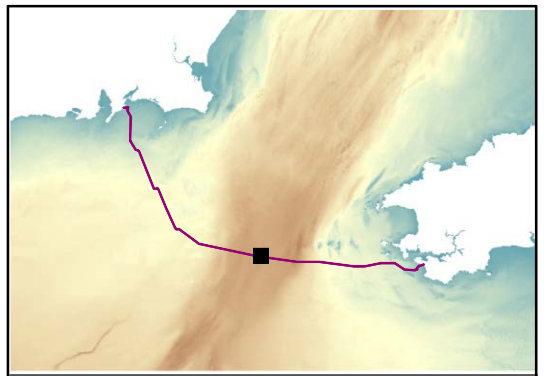
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Archaeological Anomaly CA_2143

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.59
APPROVED BY	MW	SCALE@A3	1:500	







Legend

- Route Centreline
- Route Corridor

Archaeological Anomaly

- High
- Medium
- Low
- Archaeological Exclusion Zone
- Side Scan Sonar Anomaly

Magnetic Anomaly

- 0.5 - 2 nT
- 2 - 5 nT
- 5 - 10 nT
- 10 - 25 nT
- > 25.0 nT

Bathymetry (mLAT)
High : -113.753
Low : -115.875

0 17.5m

N

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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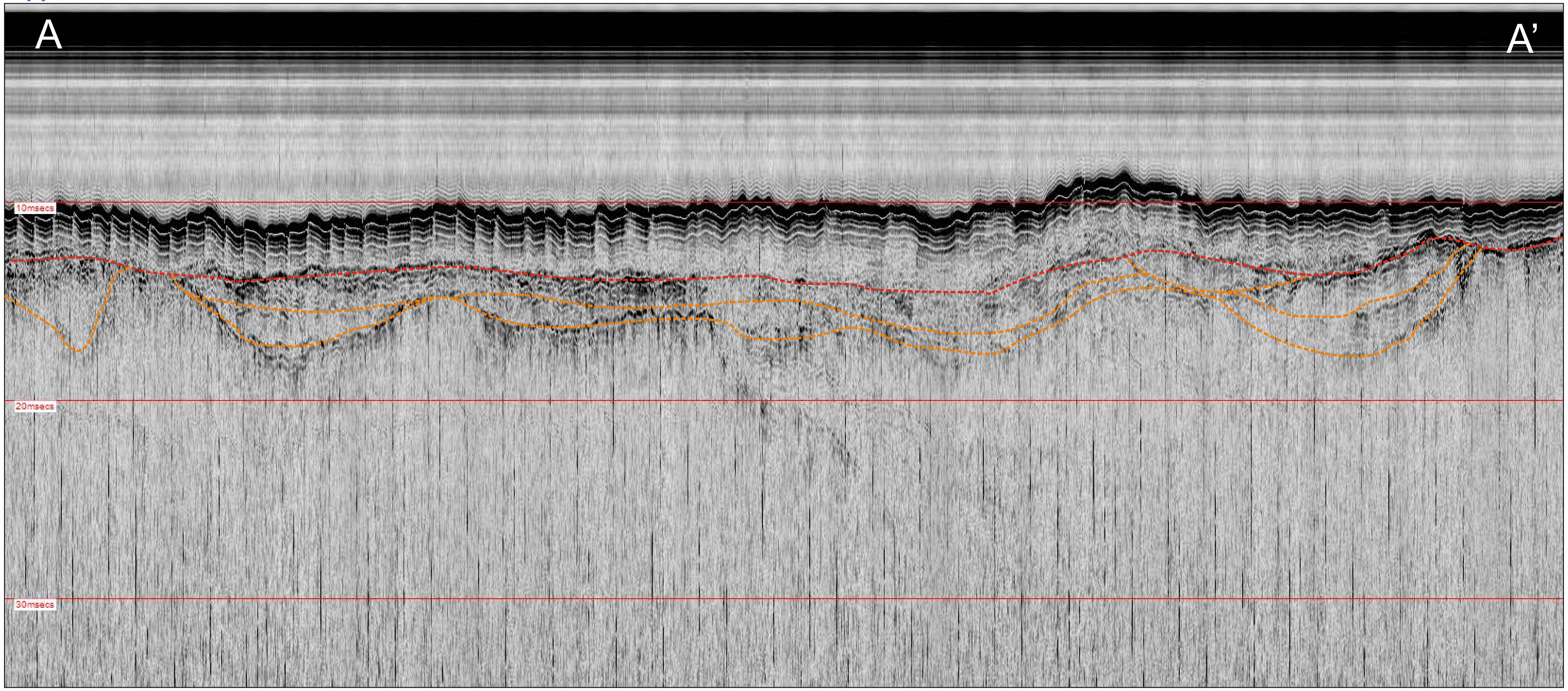
PROJECT TITLE
Greenlink Interconnector project

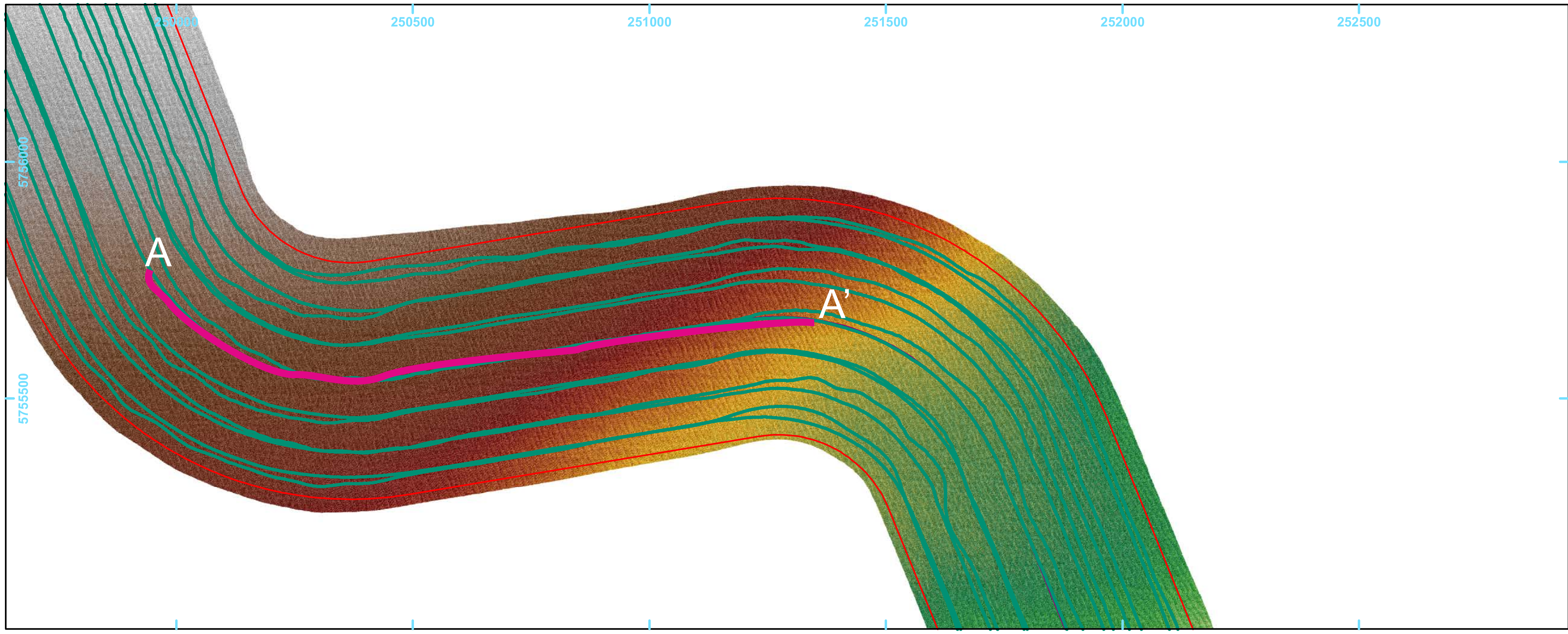
FIGURE TITLE
Archaeological Anomaly CA_2148

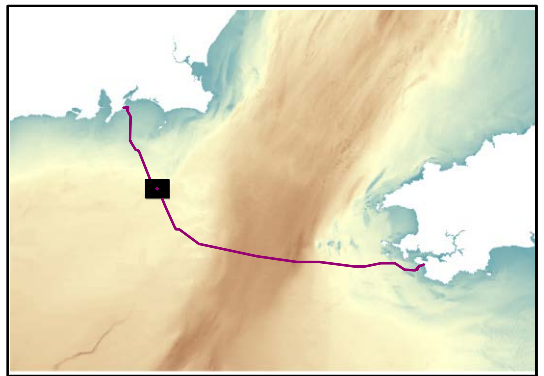
DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	3.60
APPROVED BY	MW	SCALE@A3	1:500	

APPENDIX 4: SUB-BOTTOM FEATURES WITHIN THE CSC

Appendix 4: Sub-bottom features within the CSC







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -63.99
Low : -69.766

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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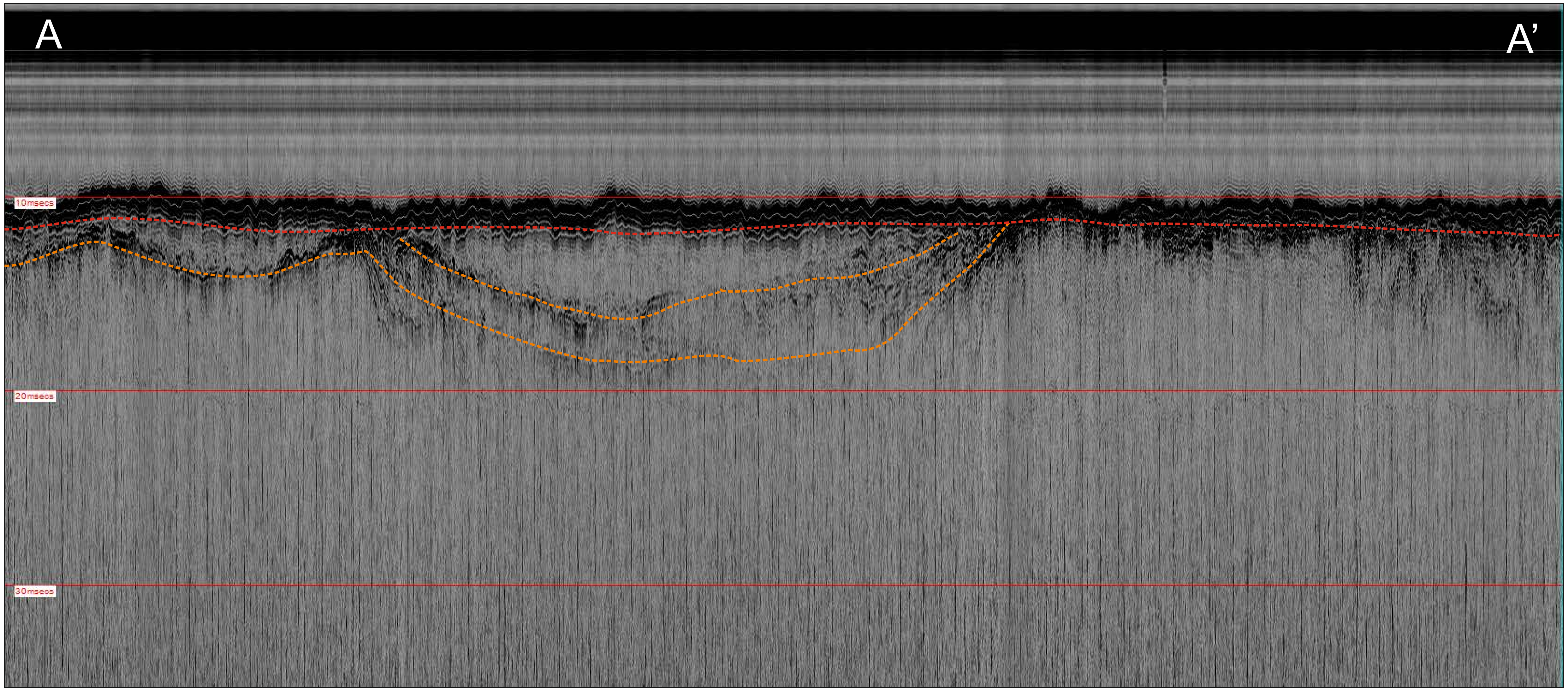
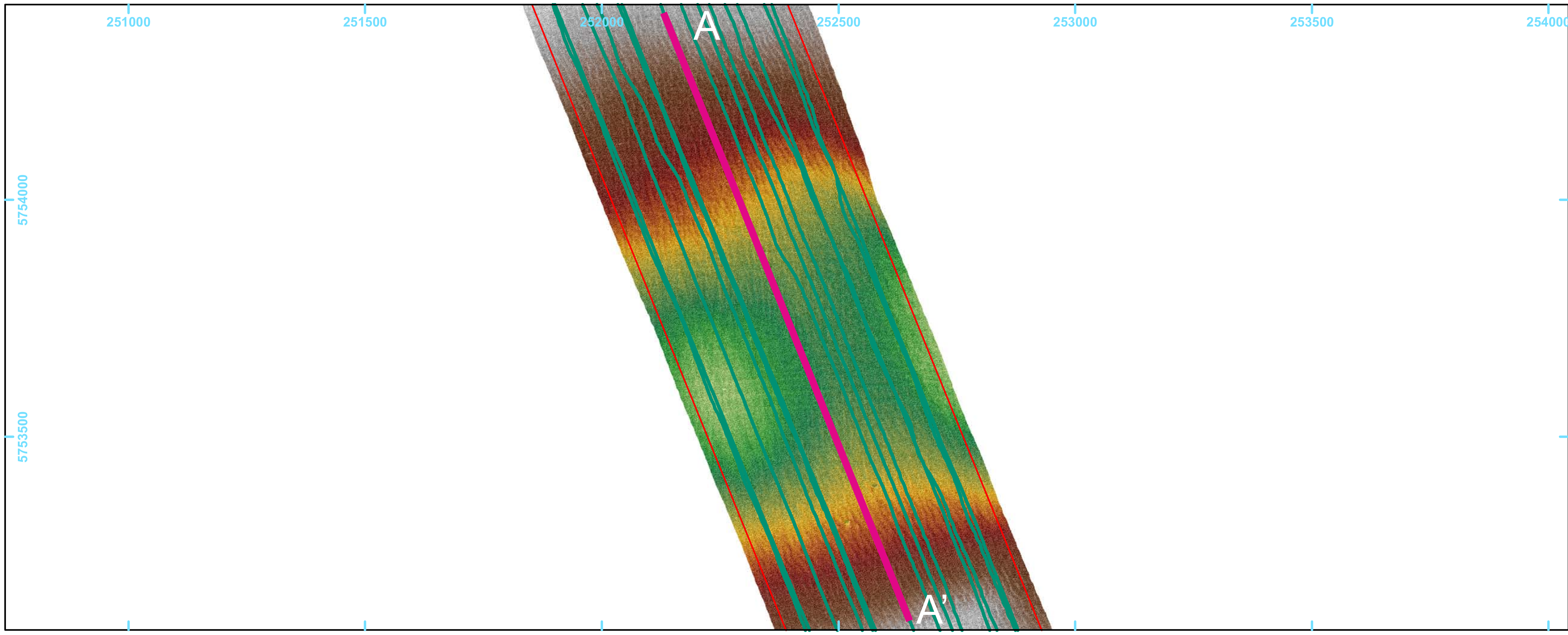
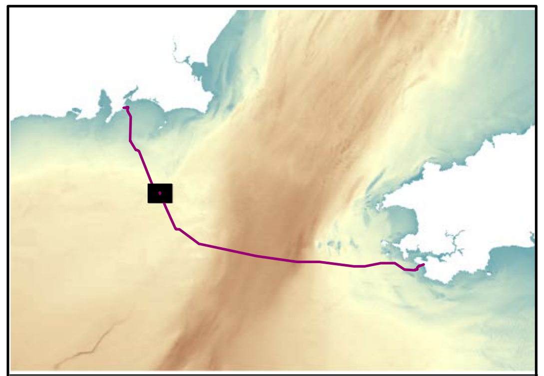
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom feature CA_3001

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.1
APPROVED BY	MW	SCALE@A3	1:10,000	







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -69.79
Low : -73.482

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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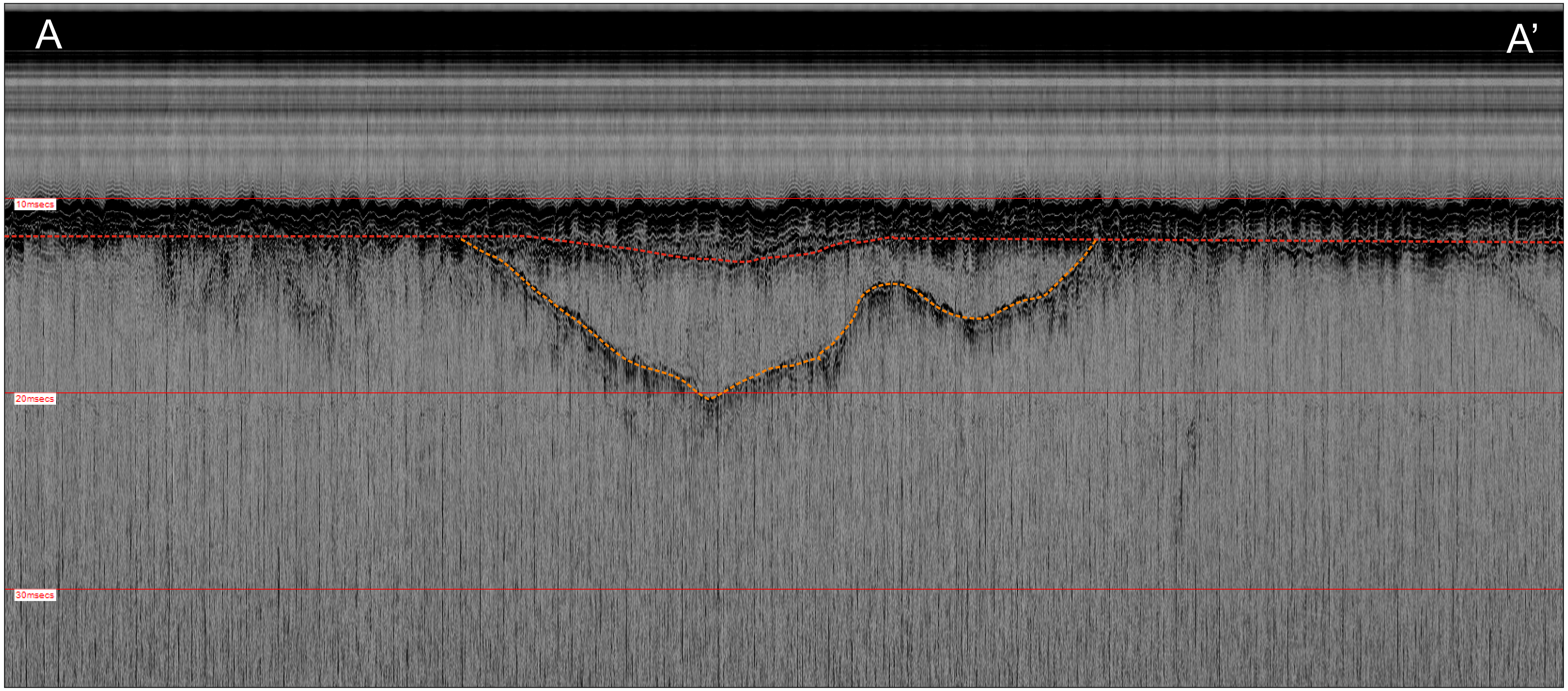
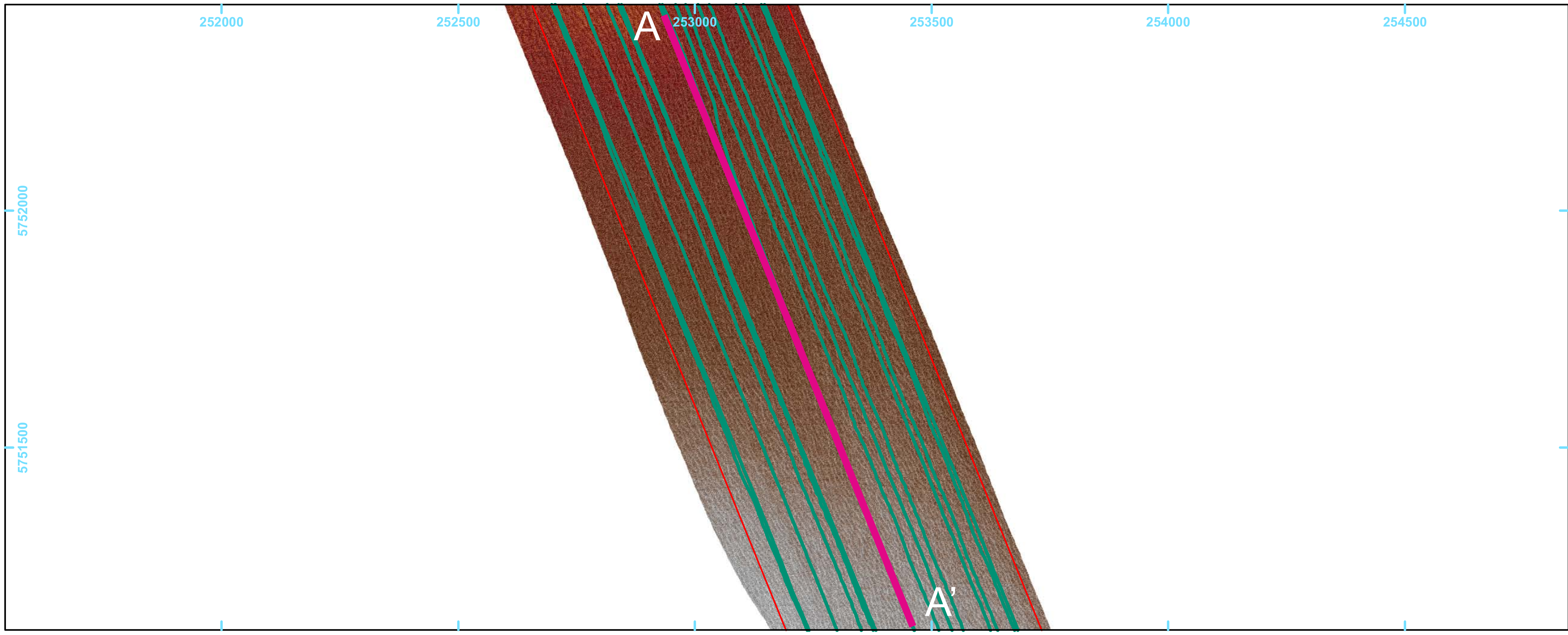
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom feature CA_3002

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.2
APPROVED BY	MW	SCALE@A3	1:10,000	





Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -68.179
Low : -71.392

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom feature CA_3003

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
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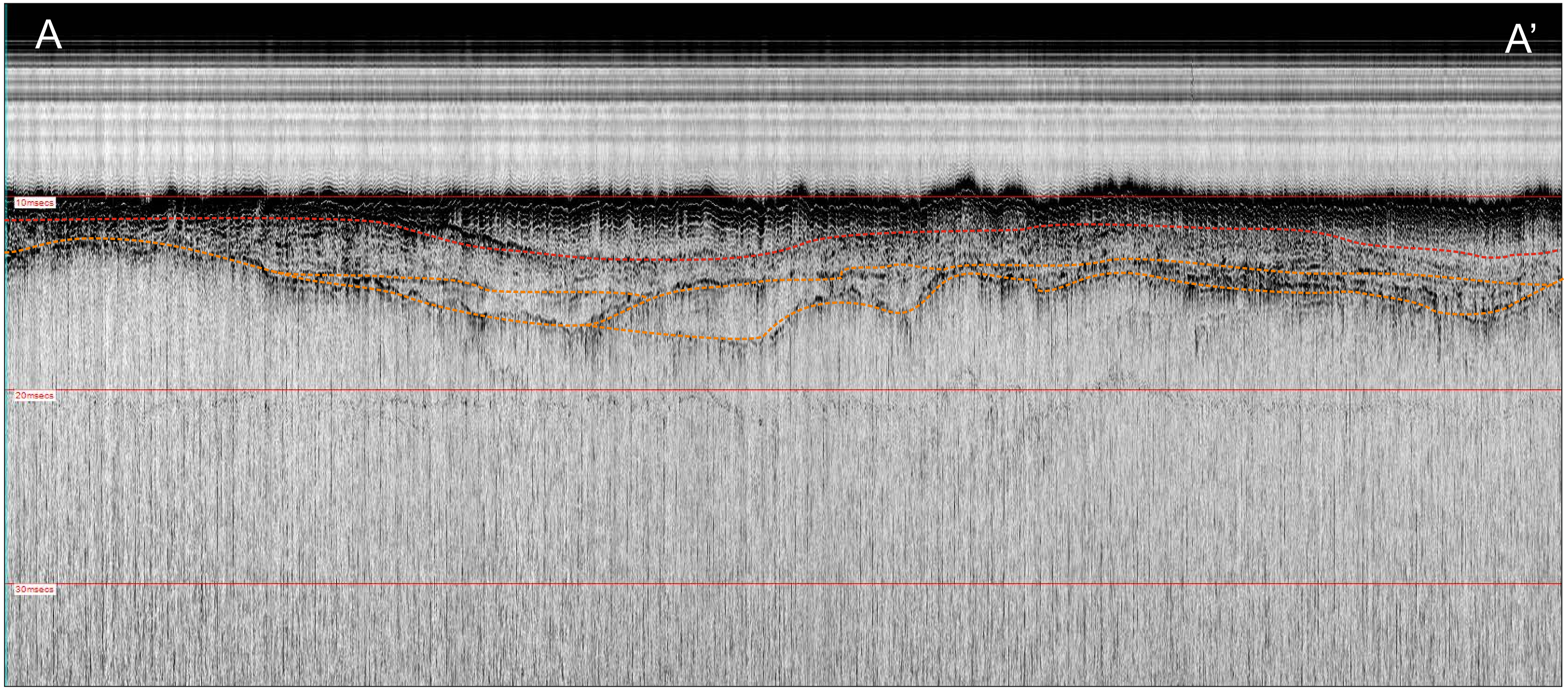
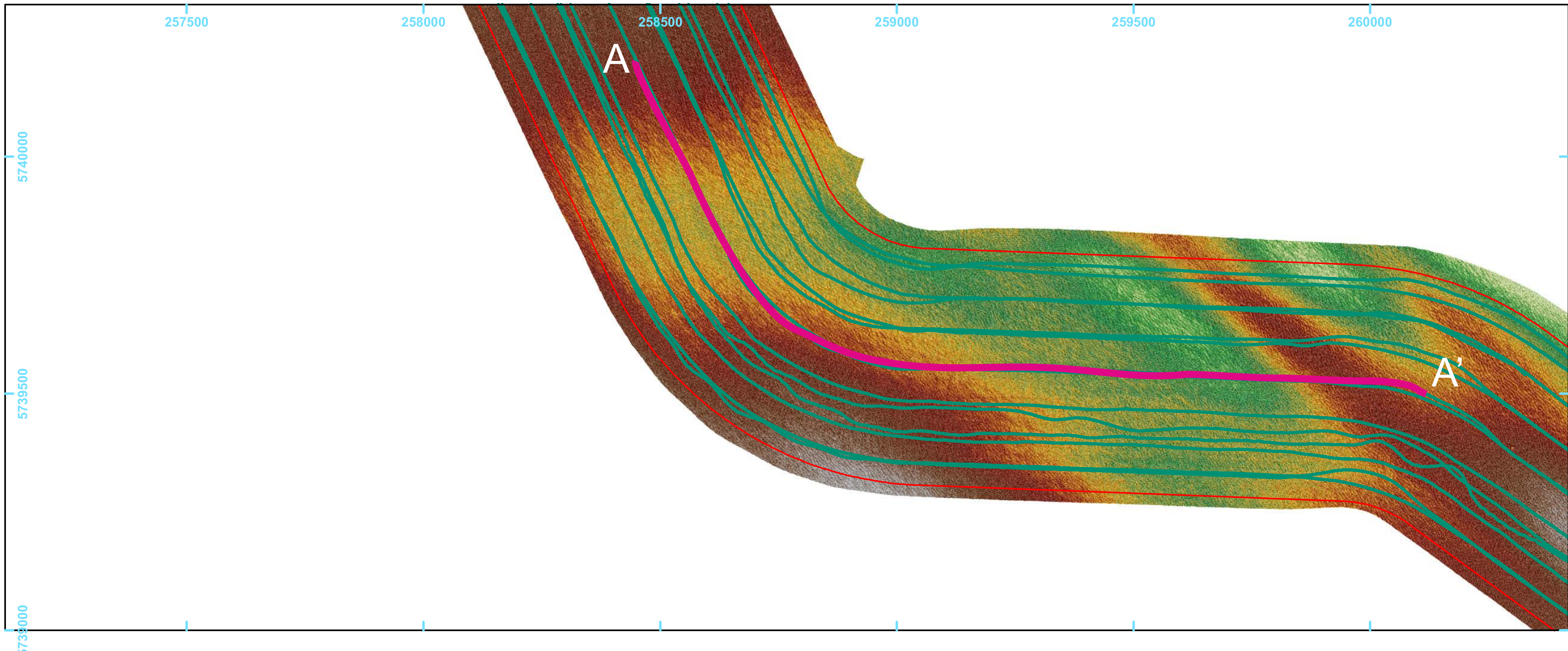
APPROVED BY	MW	SCALE@A3	1:10,000	





Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -67.124
Low : -69.004

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

Andover	01264 347630
Cirencester	01285 771022
Exeter	01392 826185
Milton Keynes	01908 564660

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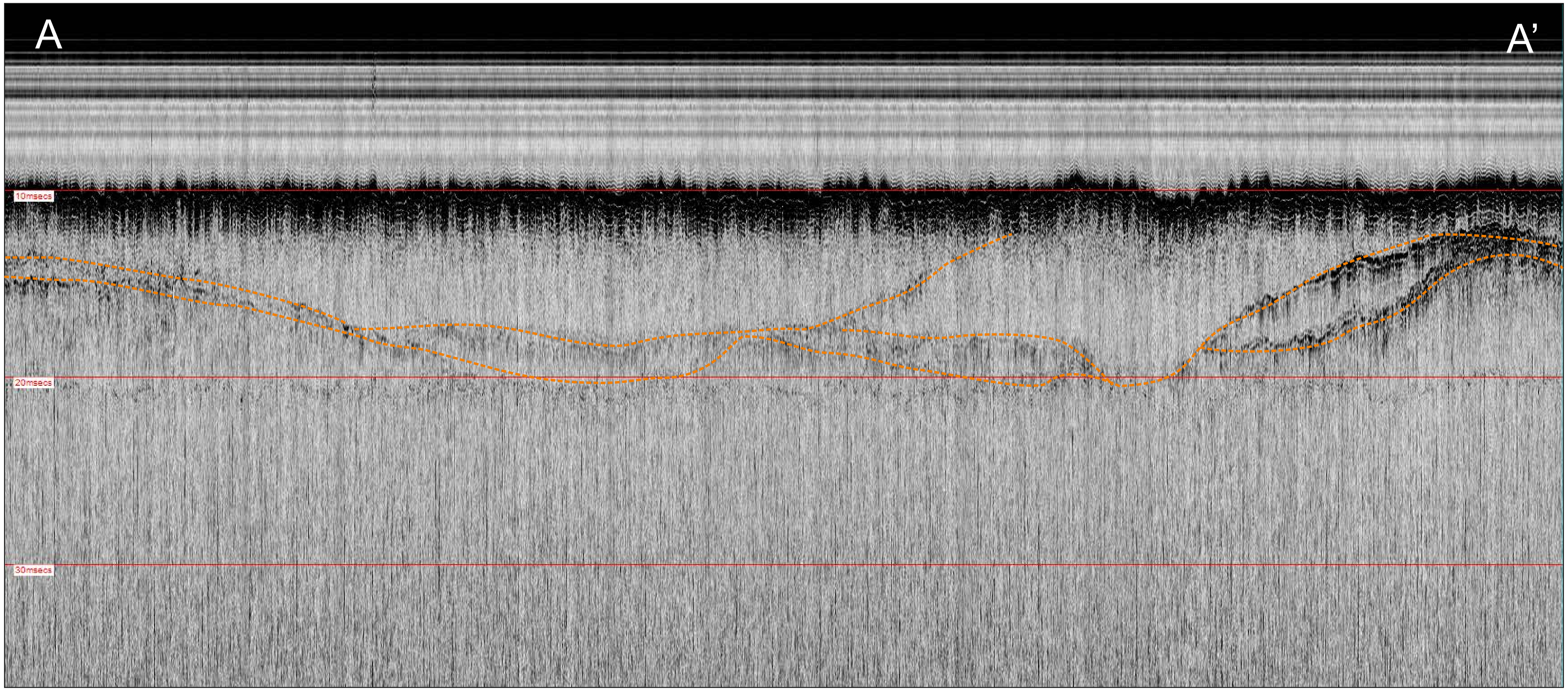
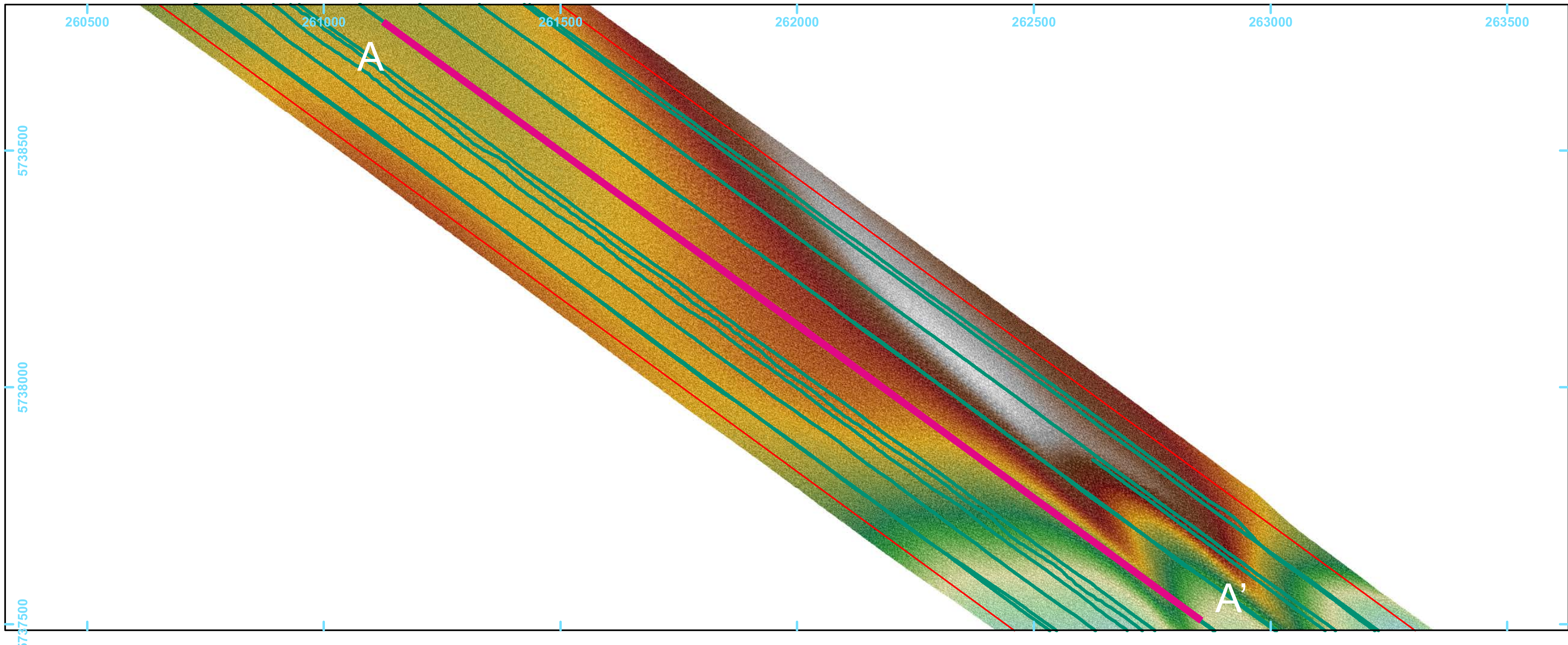
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom feature CA_3004

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.4
APPROVED BY	MW	SCALE@A3	1:10,000	





Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -61.241
Low : -70.532

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

Andover	01264 347630
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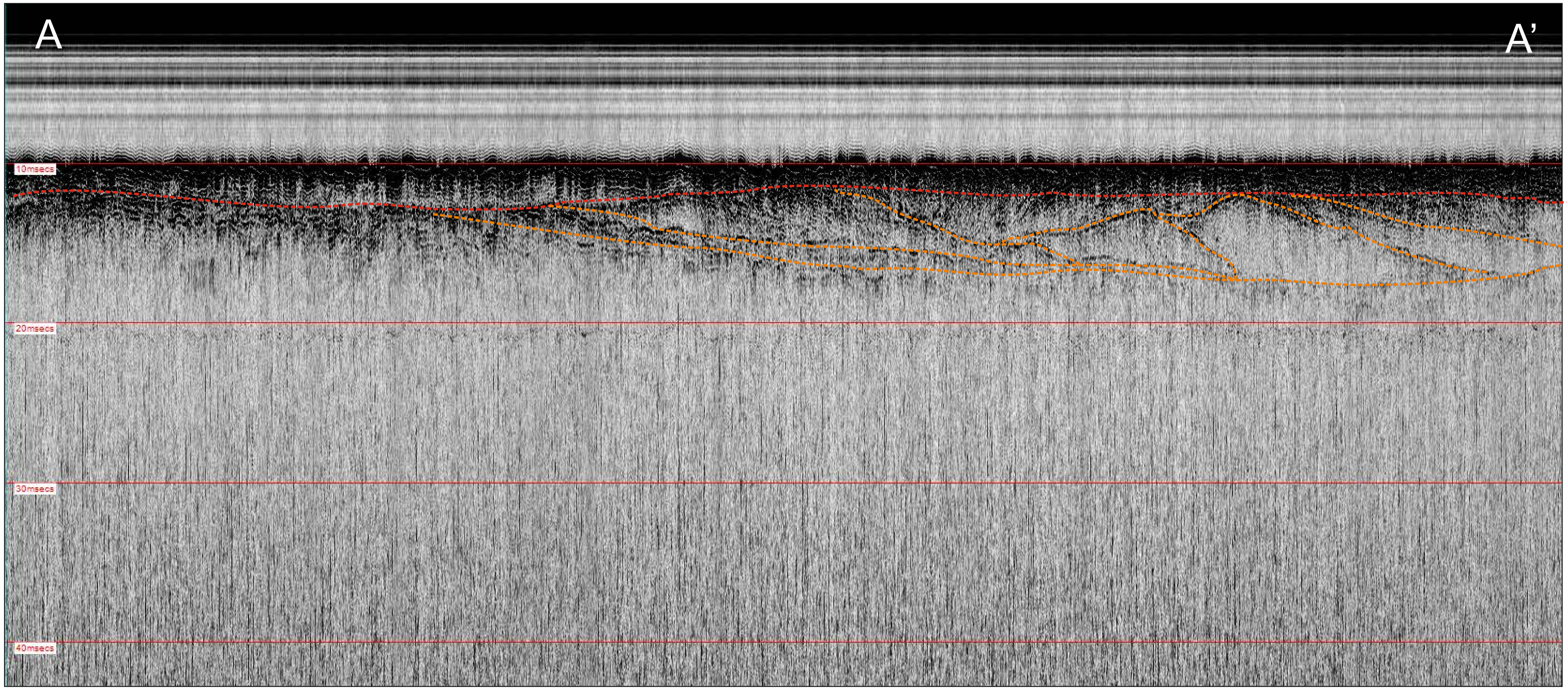
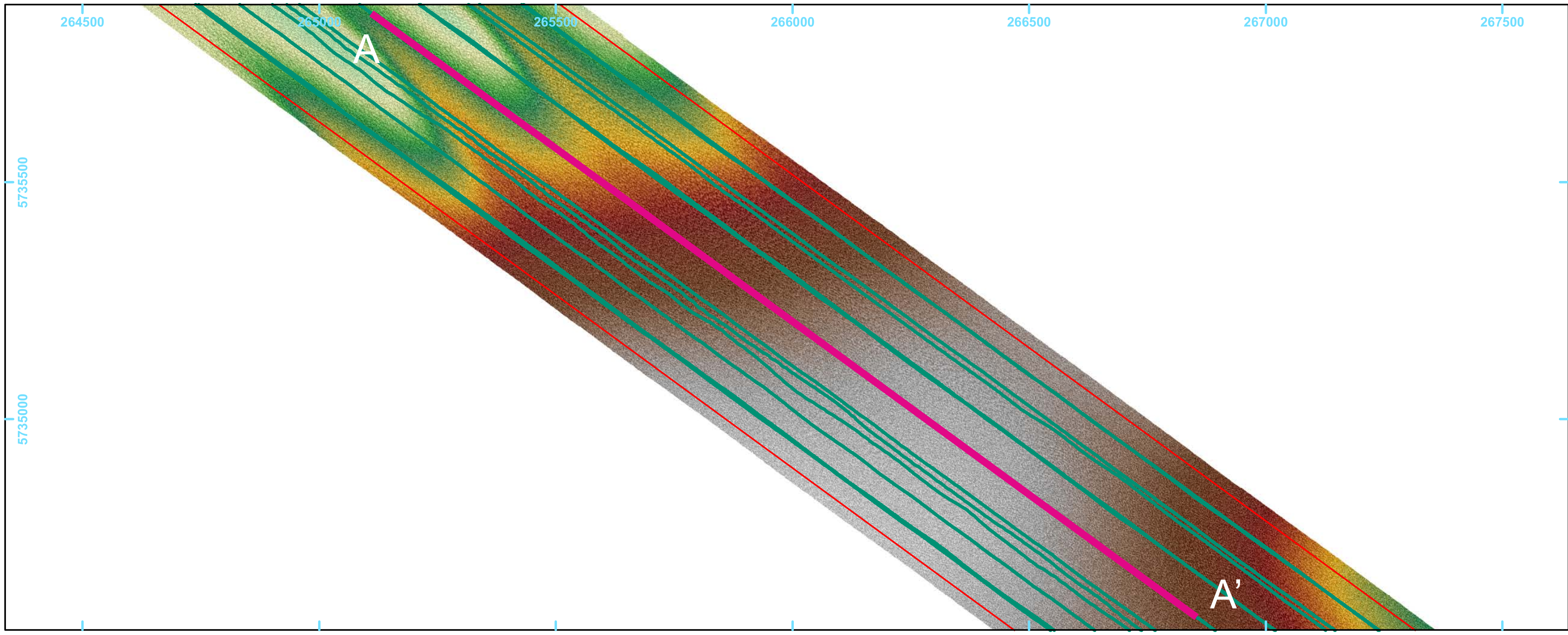
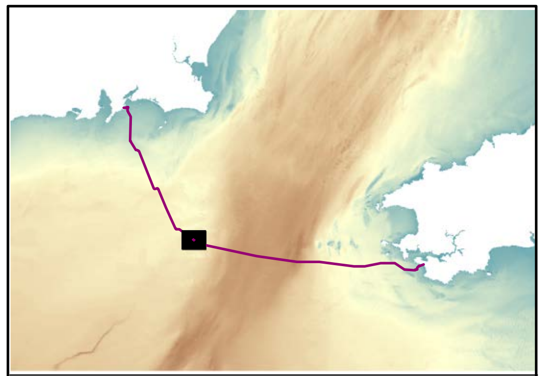
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom feature CA_3005

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.5
APPROVED BY	MW	SCALE@A3	1:10,000	







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -68.156
Low : -73.258

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

Andover 01264 347630
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PROJECT TITLE
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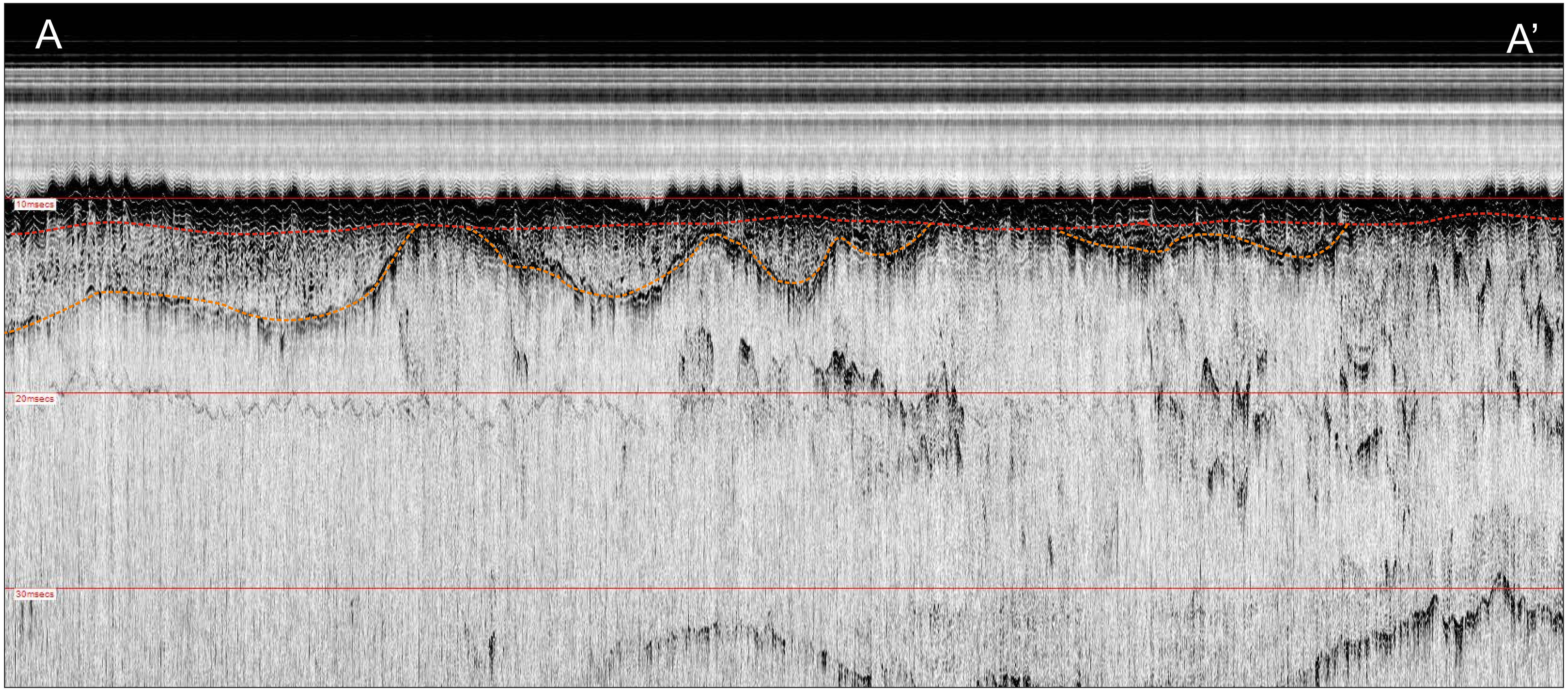
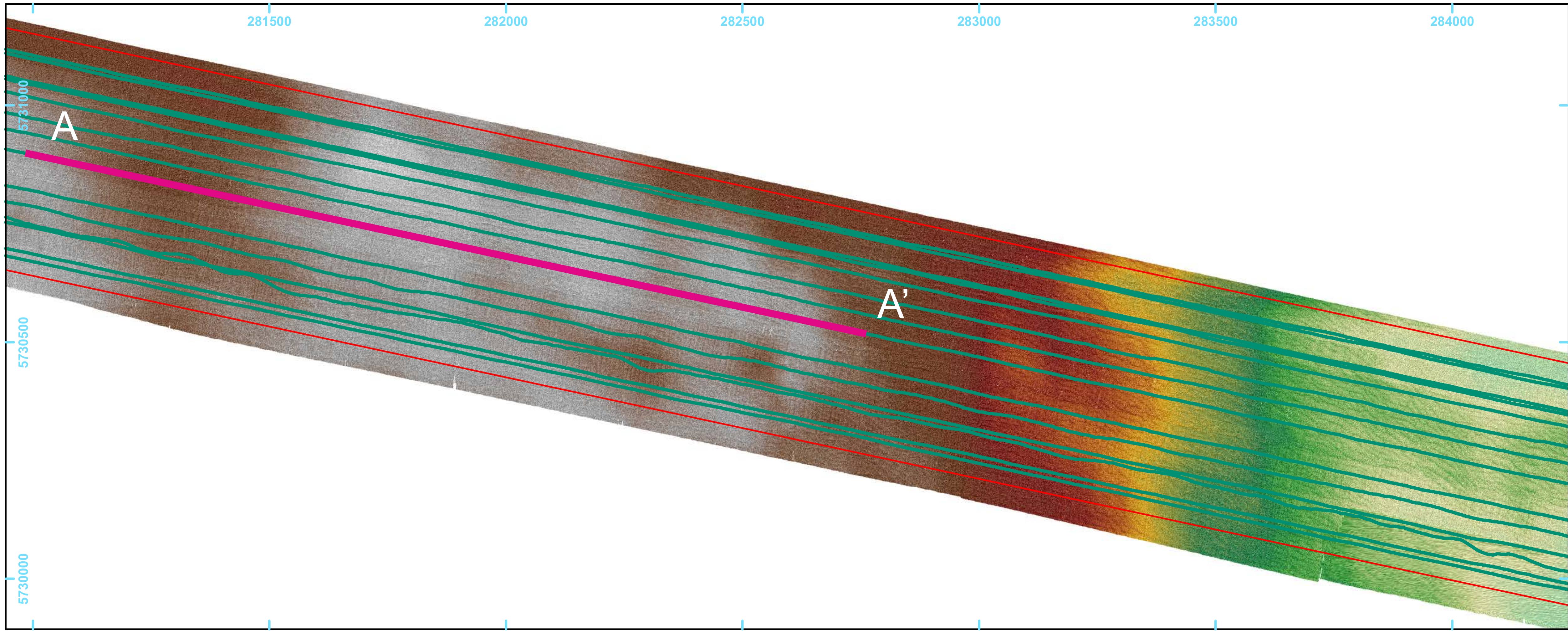
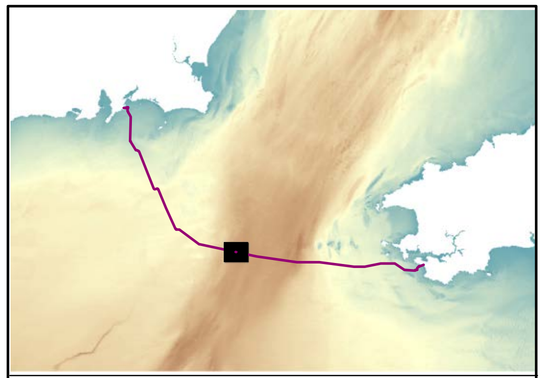
FIGURE TITLE
Sub-bottom feature CA_3006

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.6
APPROVED BY	MW	SCALE@A3	1:10,000	







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -110.419
Low : -116.183

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

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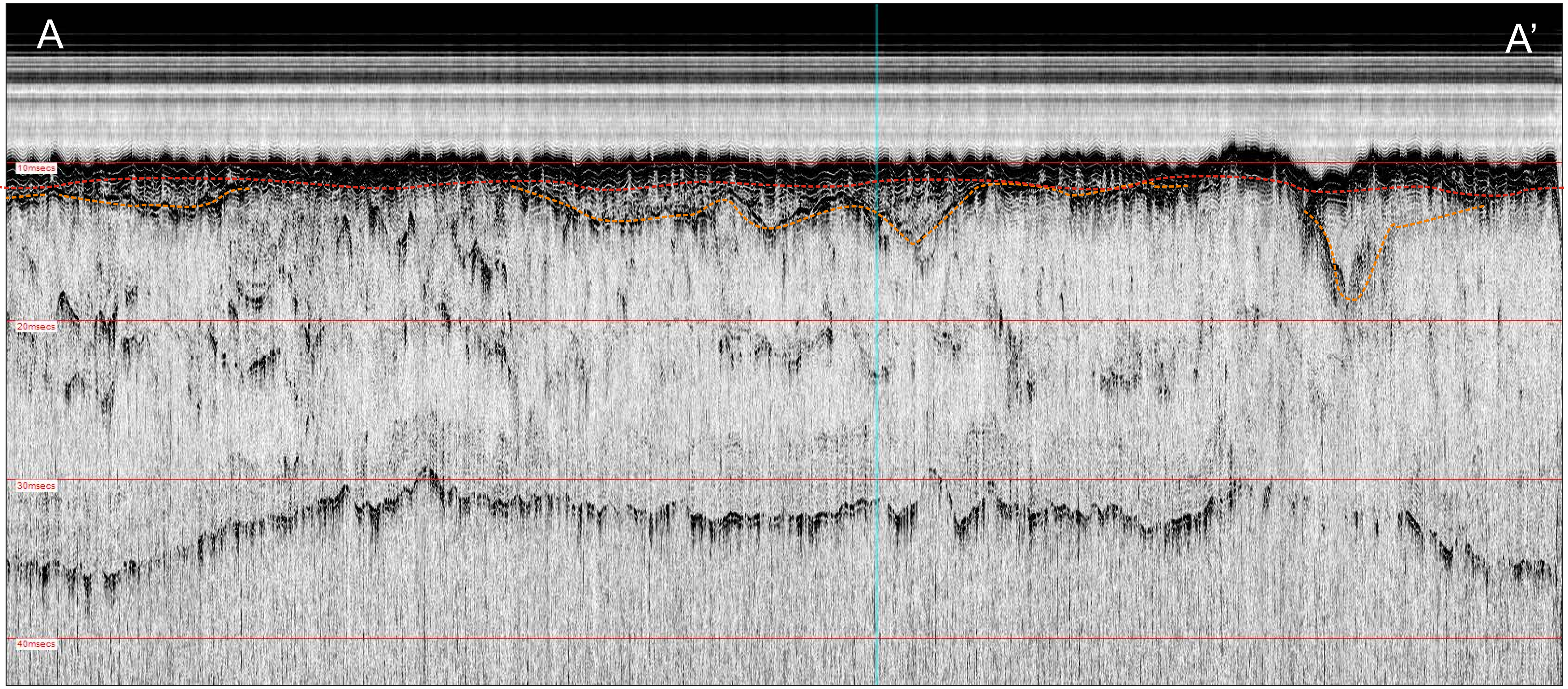
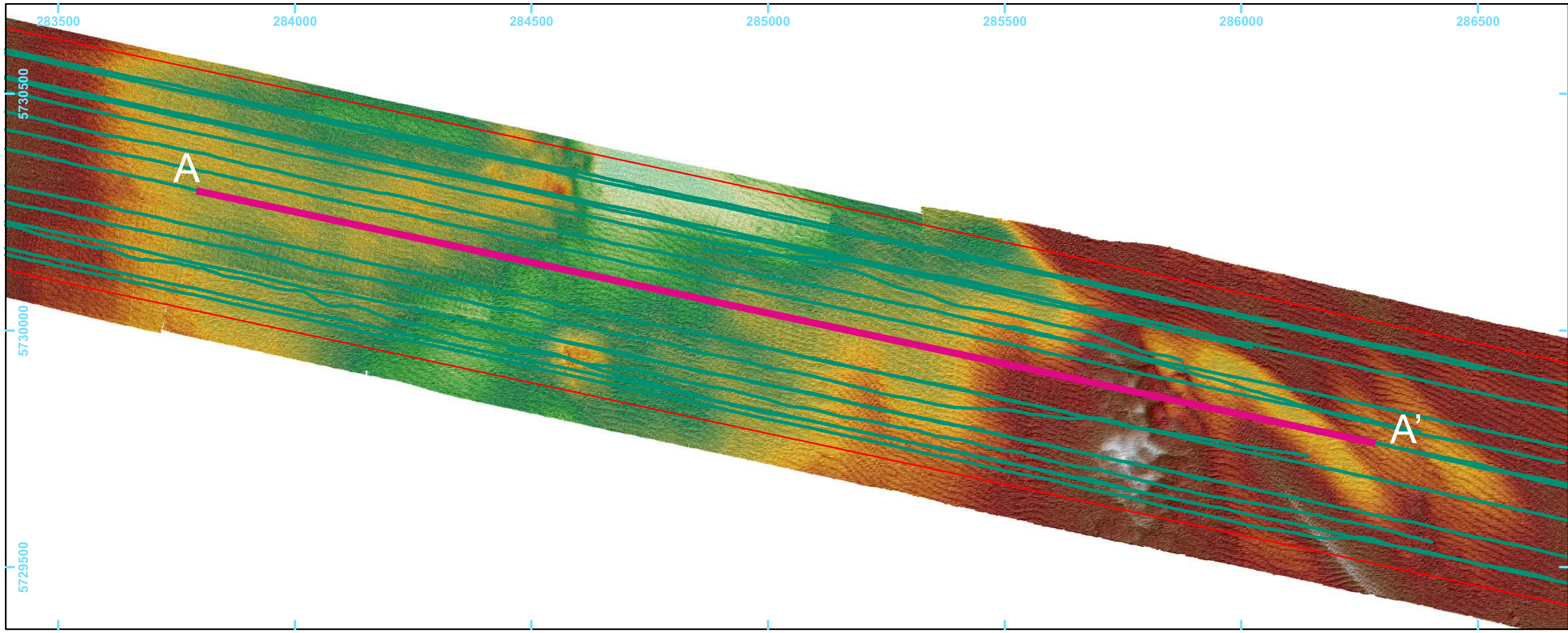
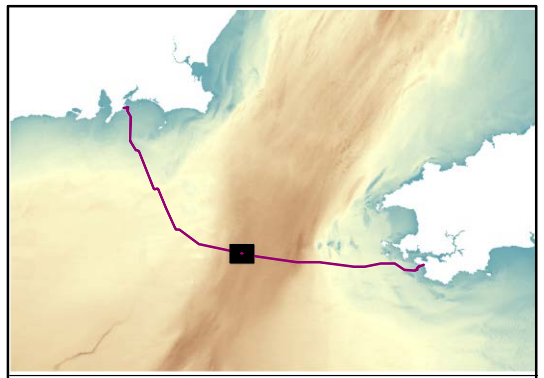
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom feature CA_3010

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.7
APPROVED BY	MW	SCALE@A3	1:10,000	







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -112.261
Low : -116.902

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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PROJECT TITLE
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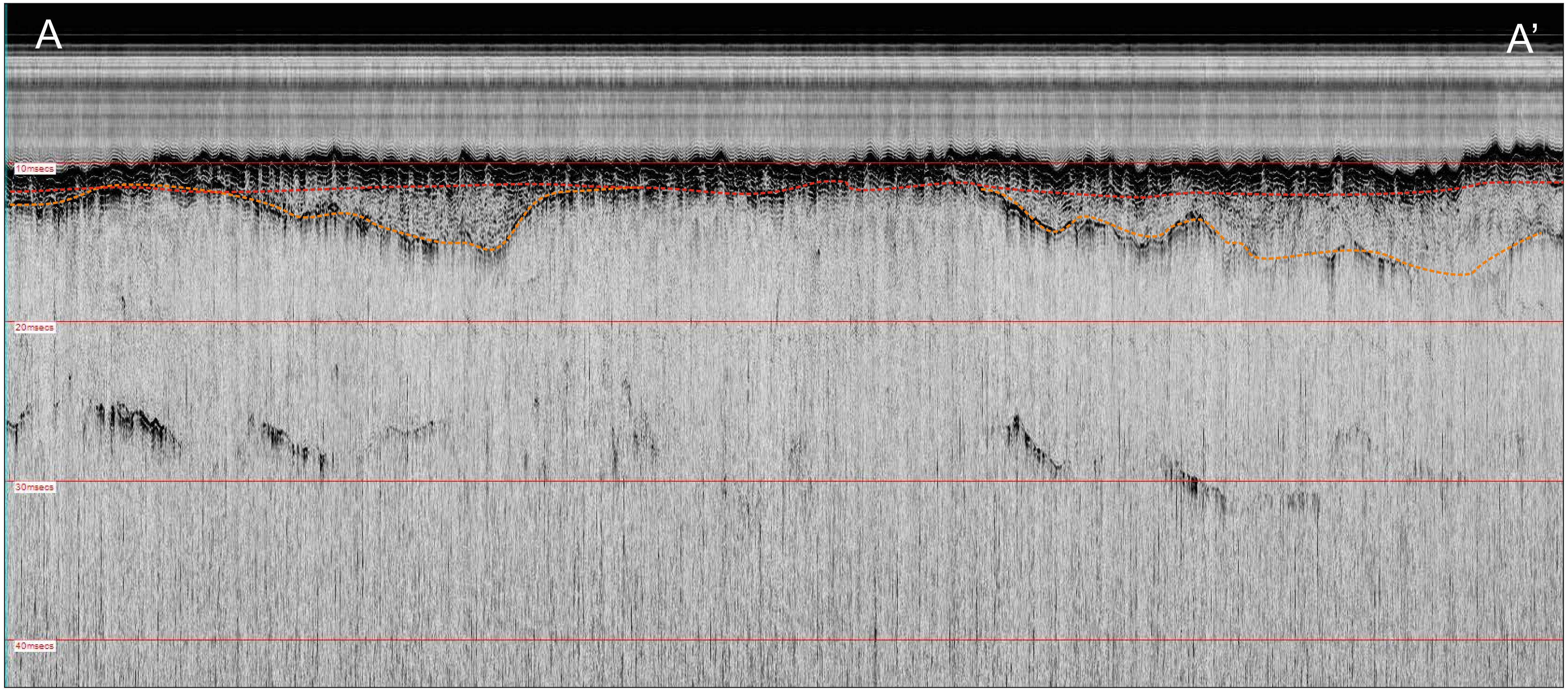
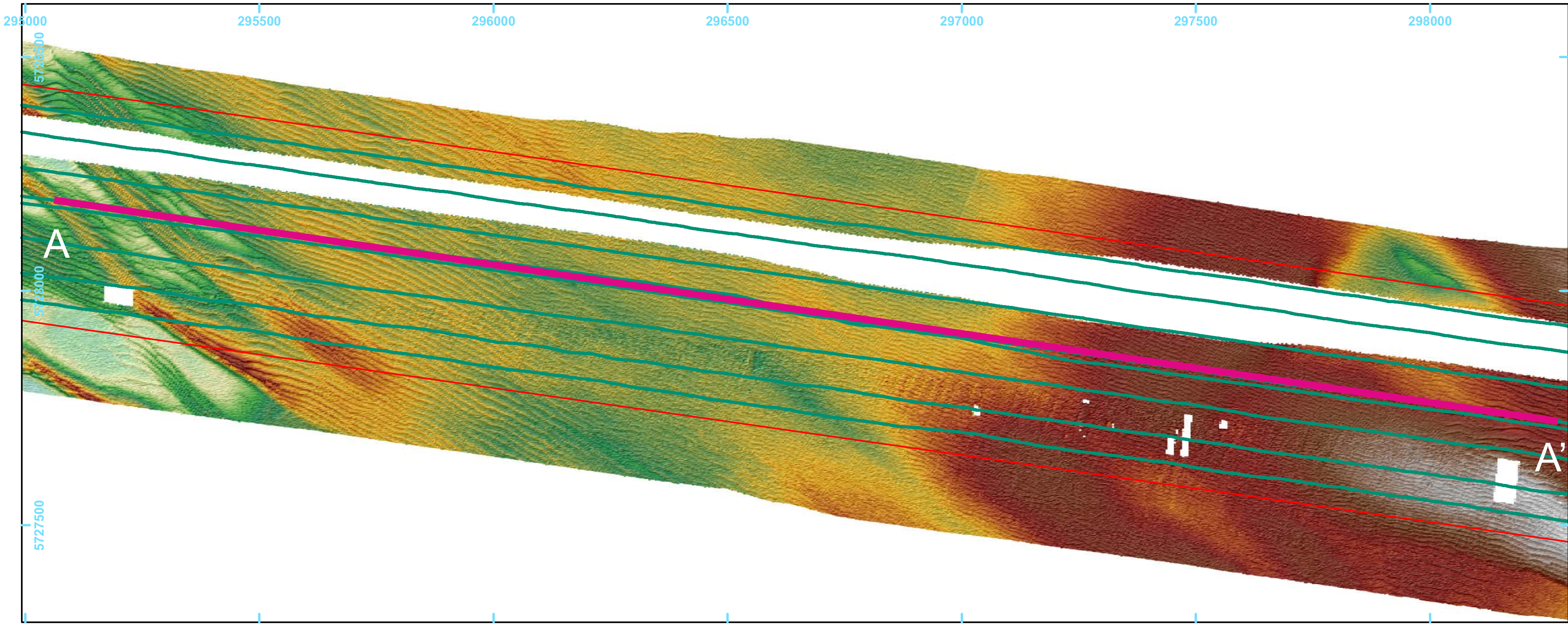
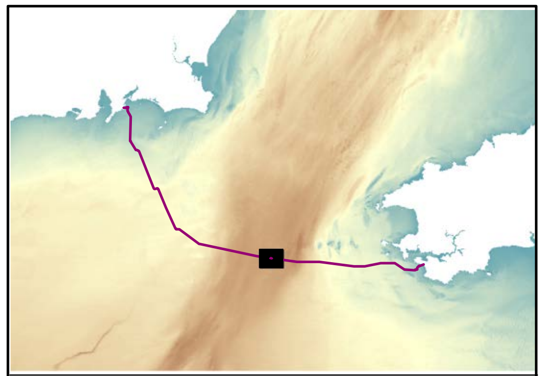
FIGURE TITLE
Sub-bottom feature CA_3011

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.8
APPROVED BY	MW	SCALE@A3	1:10,000	







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -108.969
Low : -113.973

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

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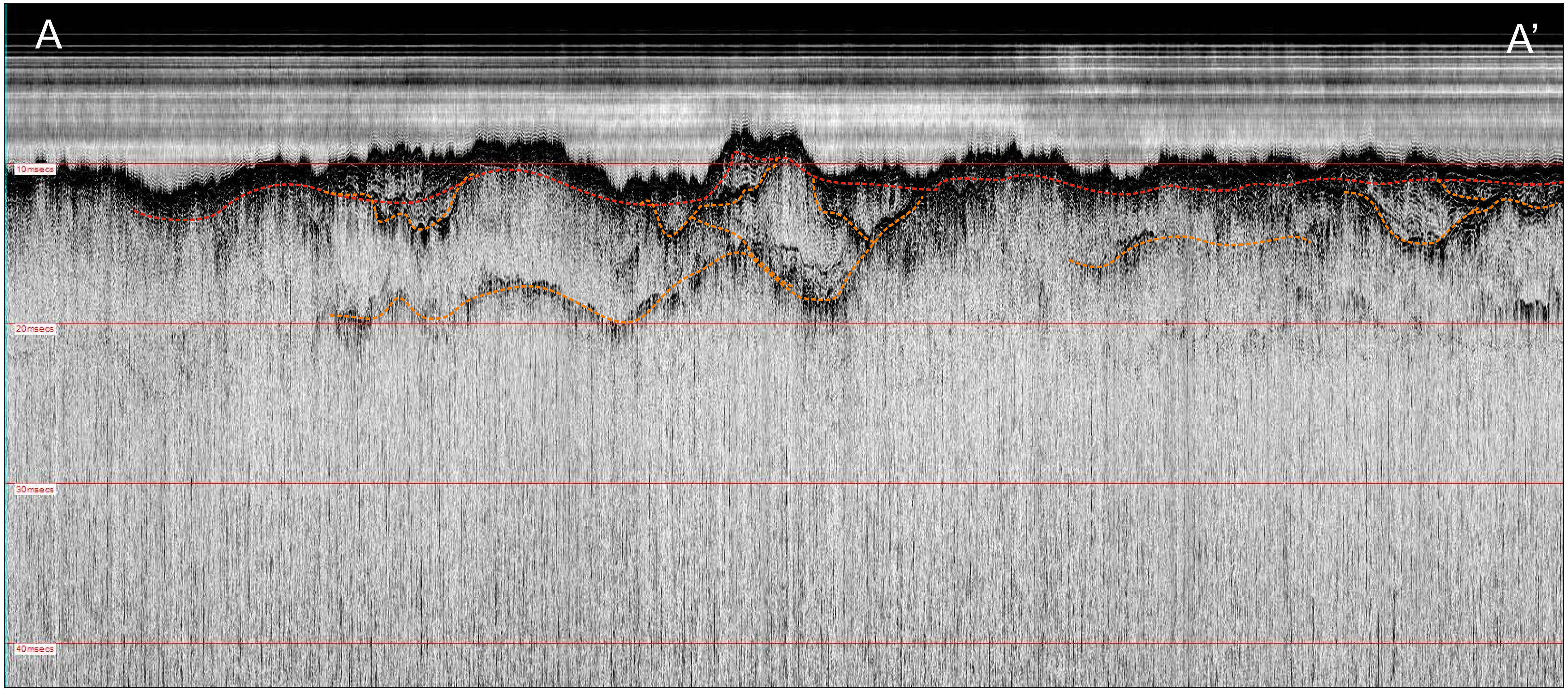
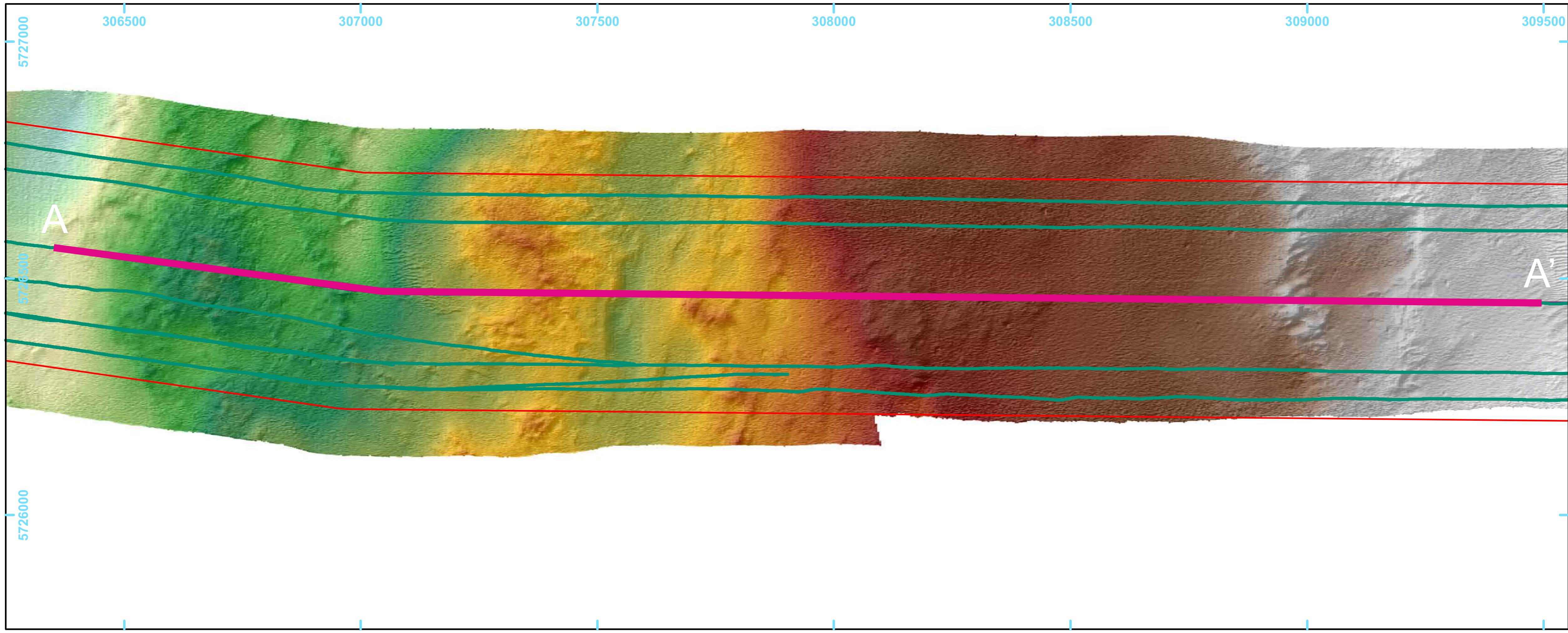
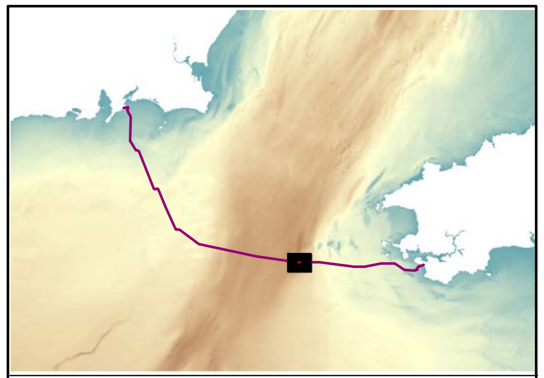
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom features CA_3012 and 3013

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.9
APPROVED BY	MW	SCALE@A3	1:10,000	







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -96.0475
Low : -126.992

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

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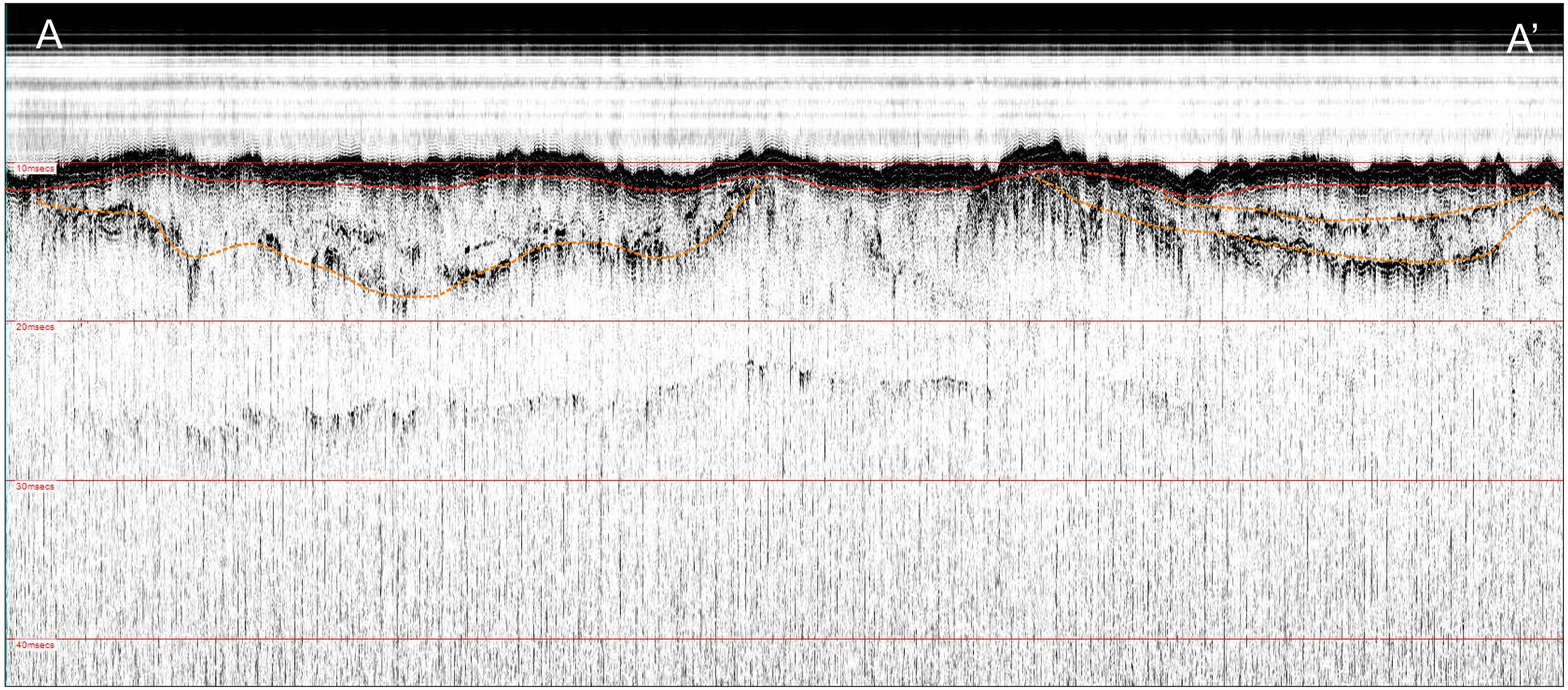
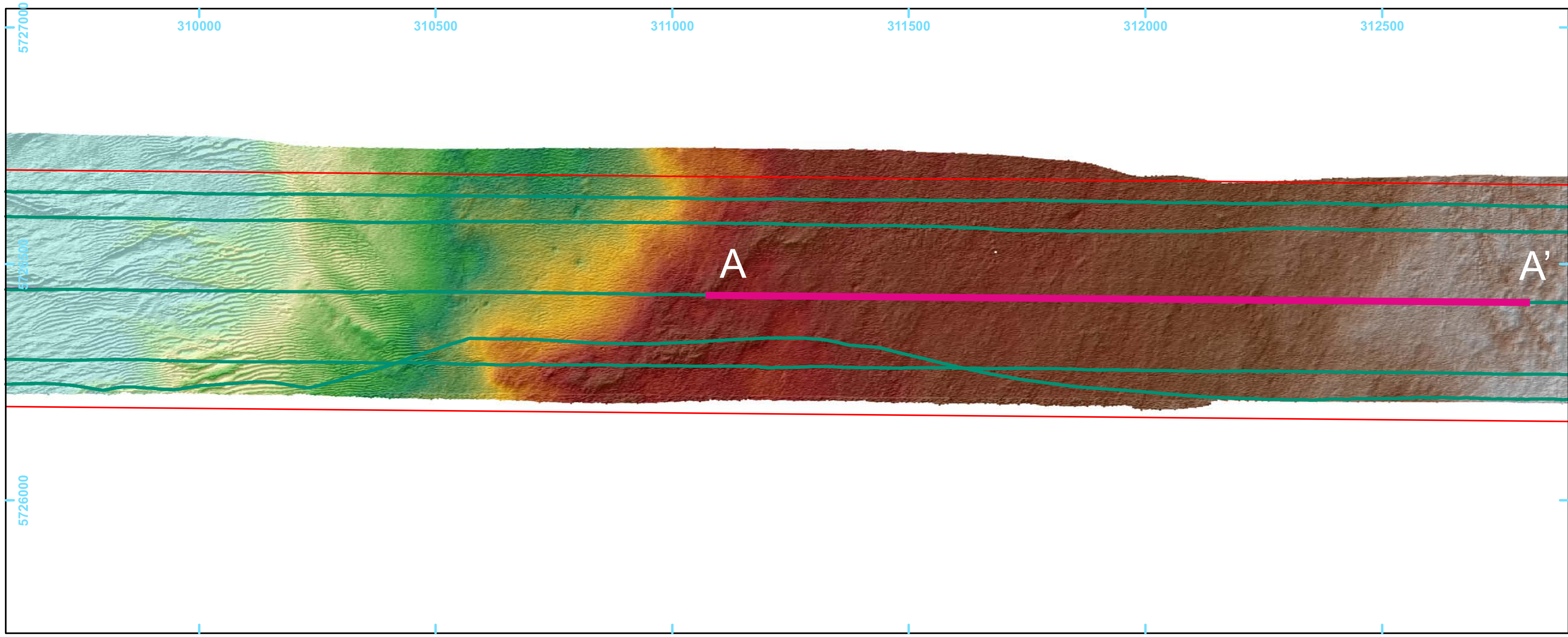
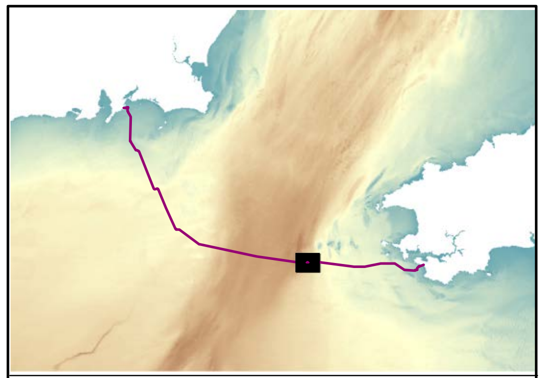
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom feature CA_3014

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.10
APPROVED BY	MW	SCALE@A3	1:10,000	







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -80.4829
Low : -93.9058

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine
Andover 01264 347630
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PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom features CA_3015 and 3016

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
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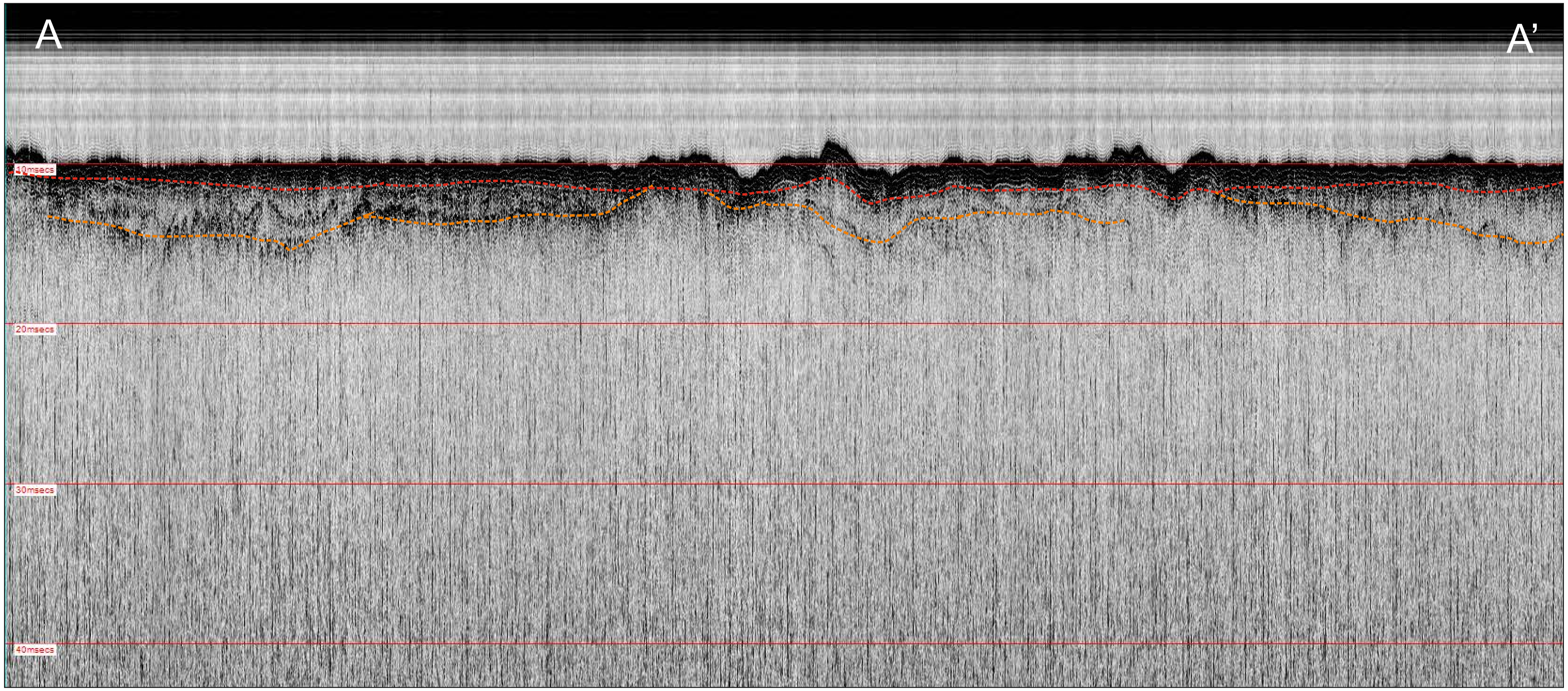
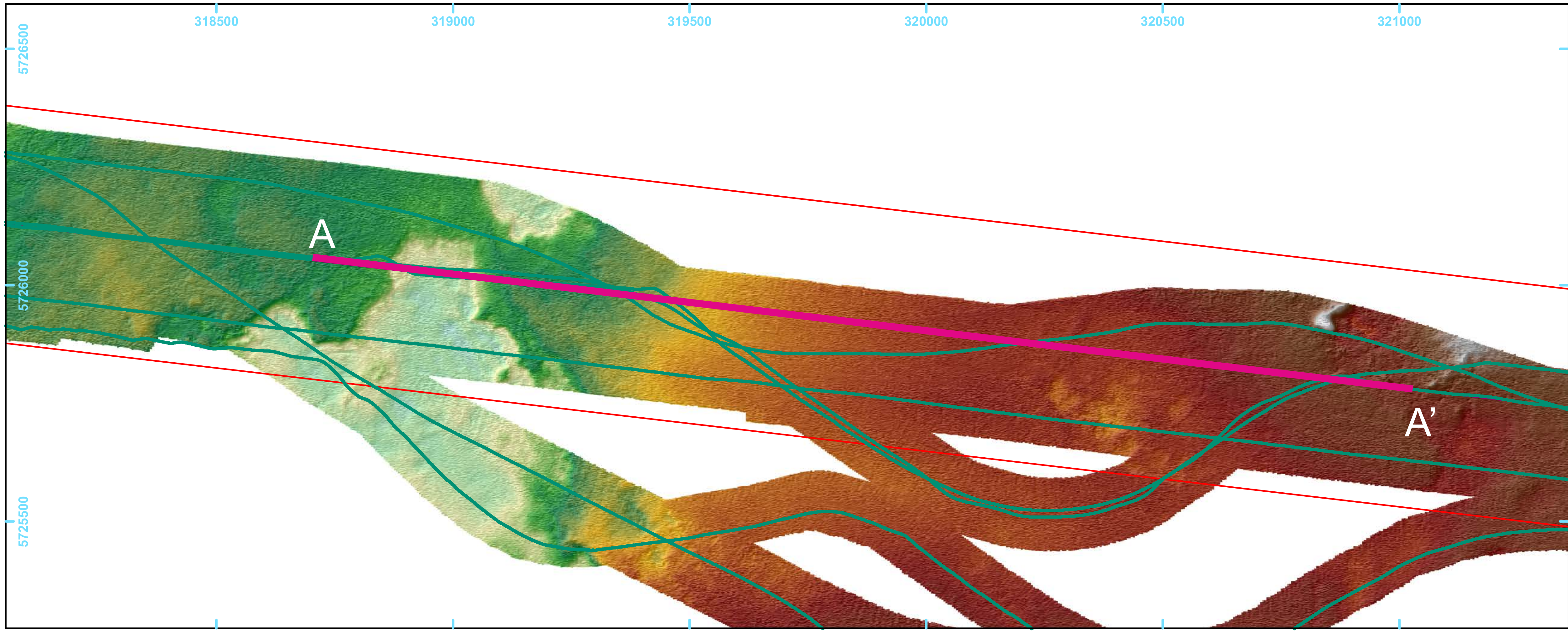
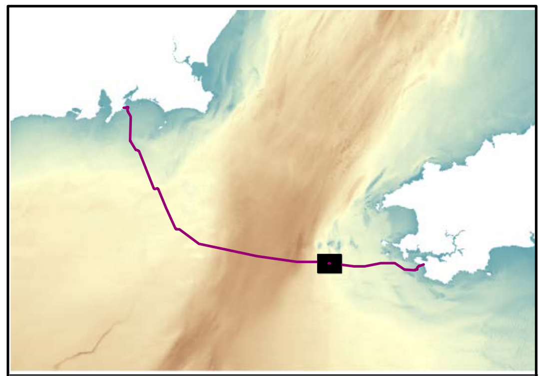
APPROVED BY	MW	SCALE@A3	1:10,000	







N

Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -62.4907

Low : -68.7137

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

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PROJECT TITLE
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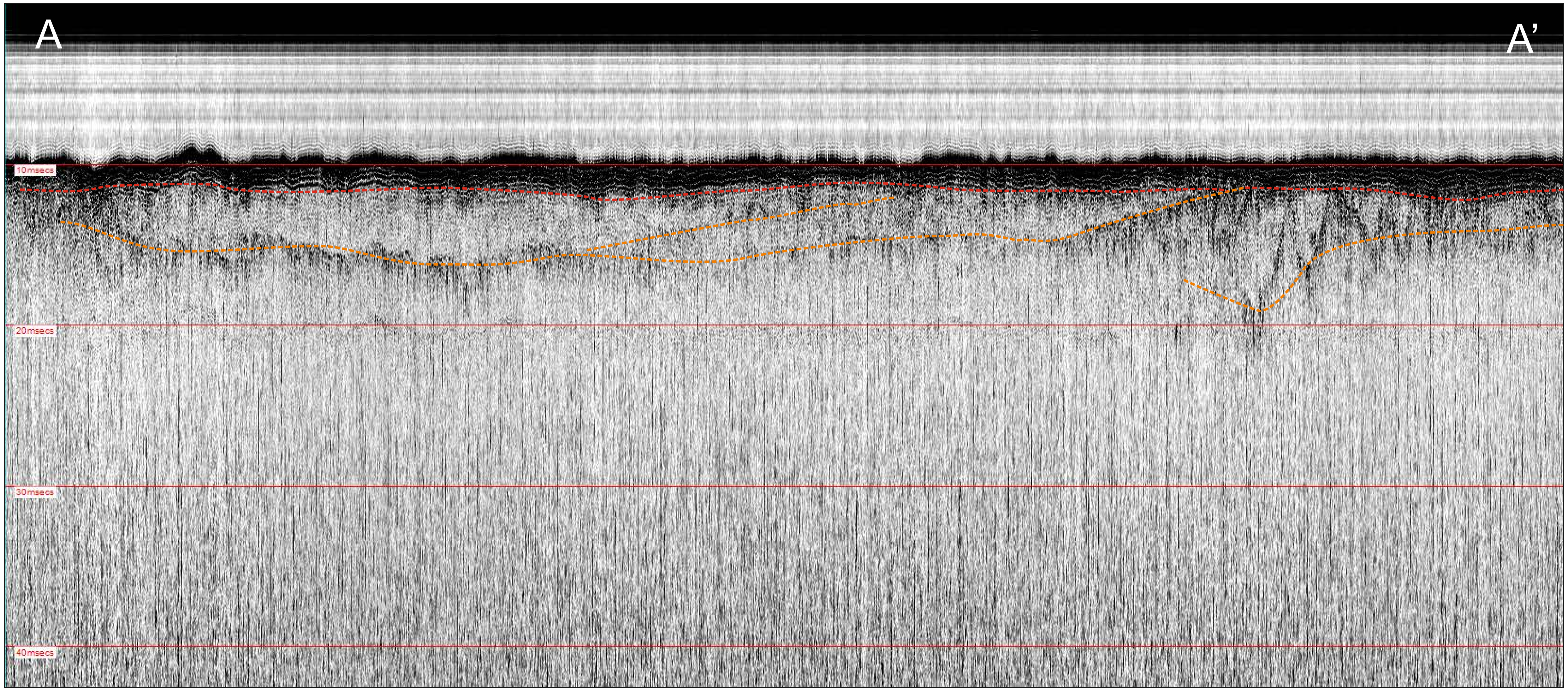
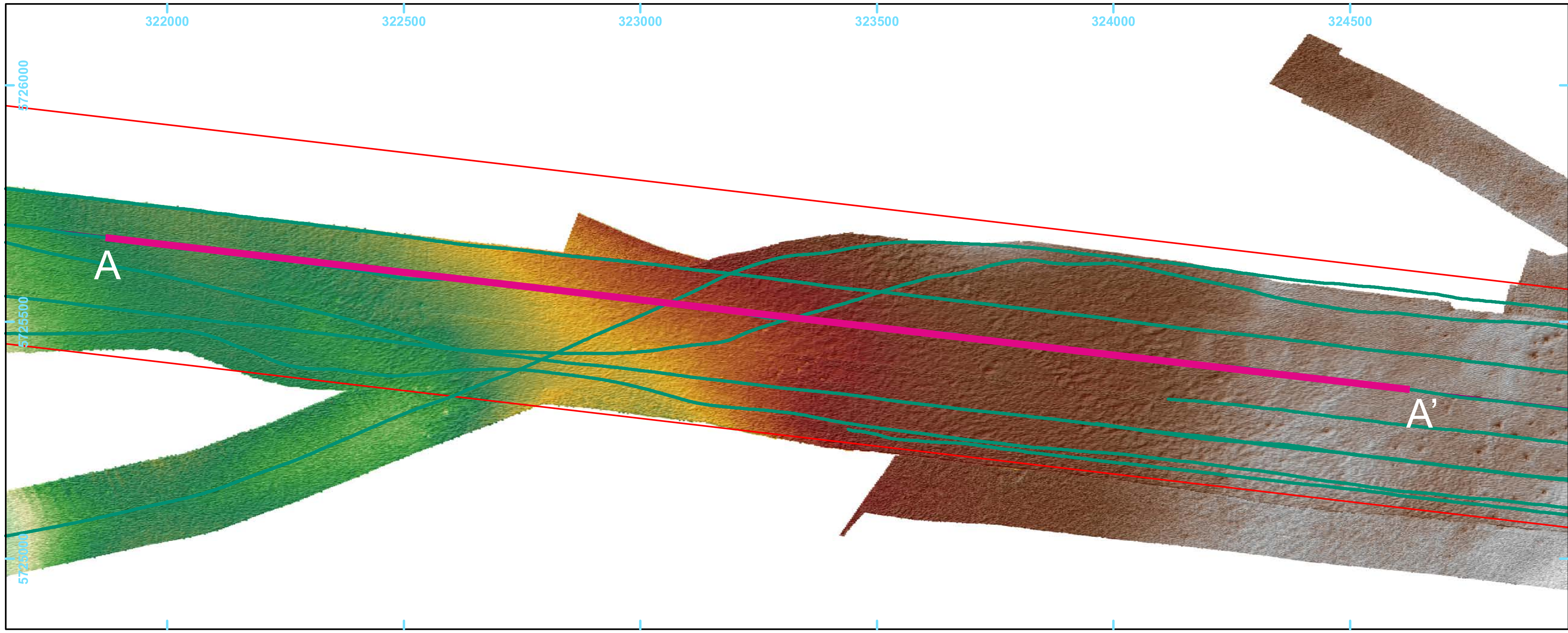
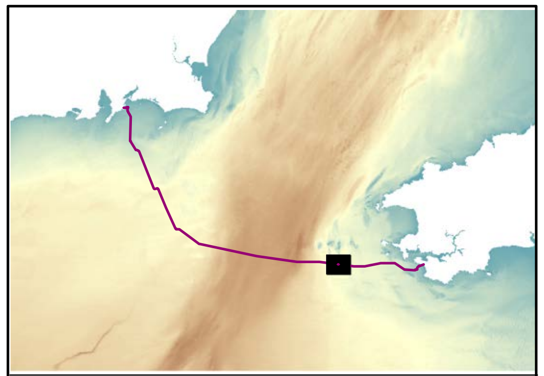
FIGURE TITLE
Sub-bottom feature CA_3017

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.	
CHECKED BY	RK	DATE	01/04/2019		4.12
APPROVED BY	MW	SCALE@A3	1:10,000		







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -61.251
Low : -64.6009

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine
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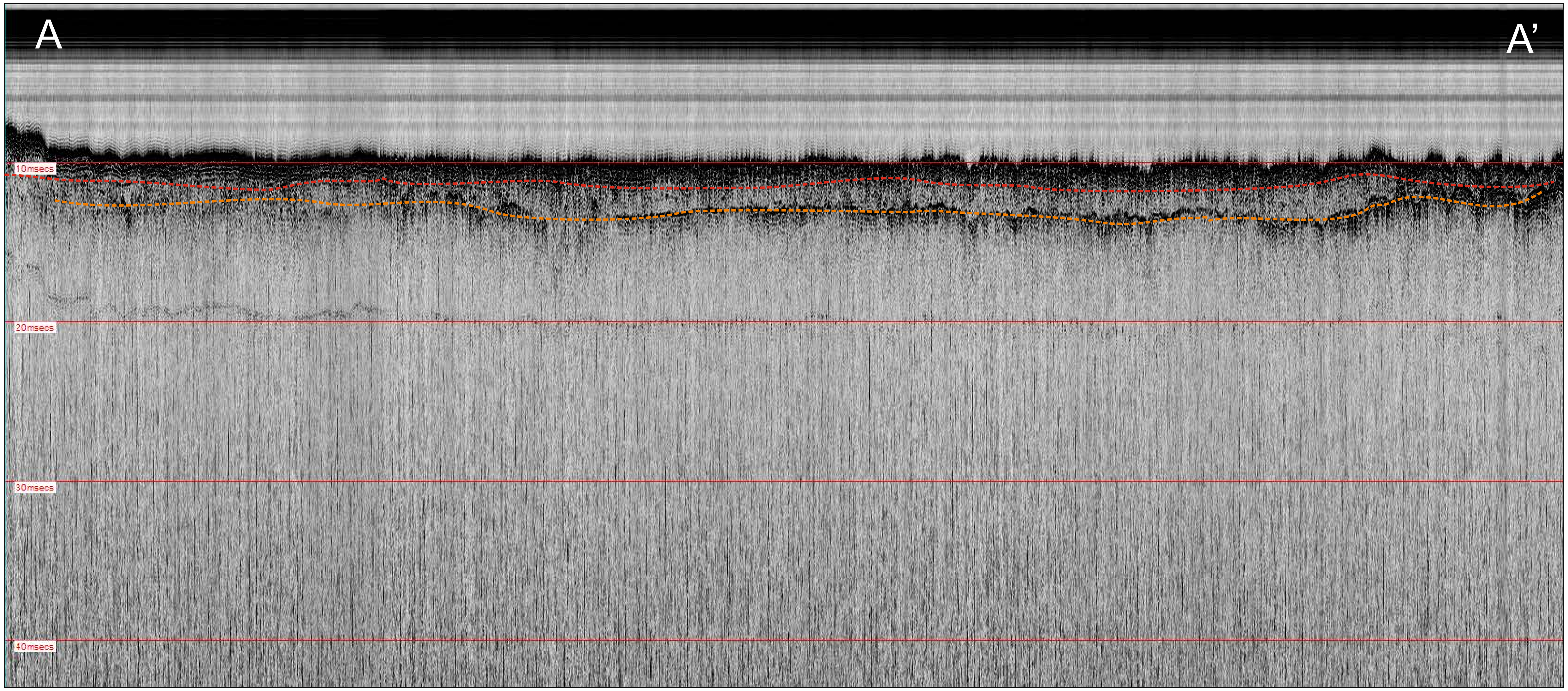
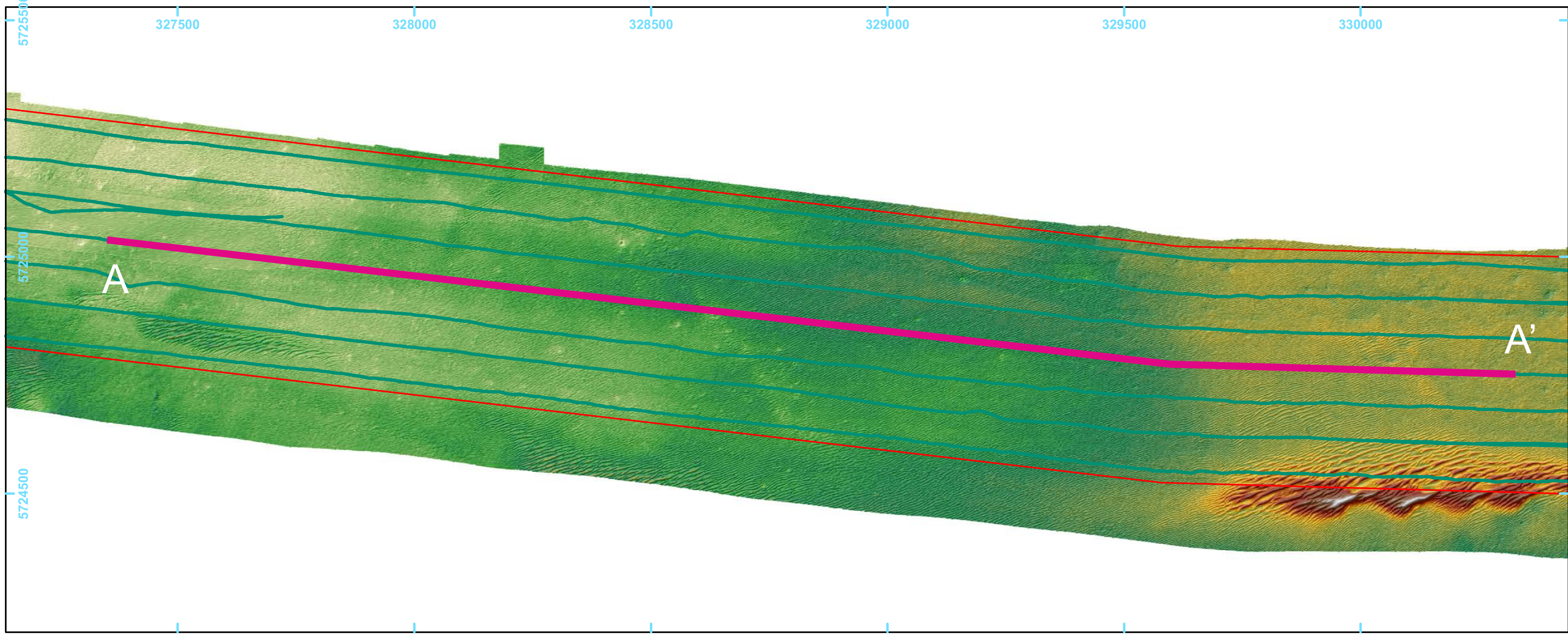
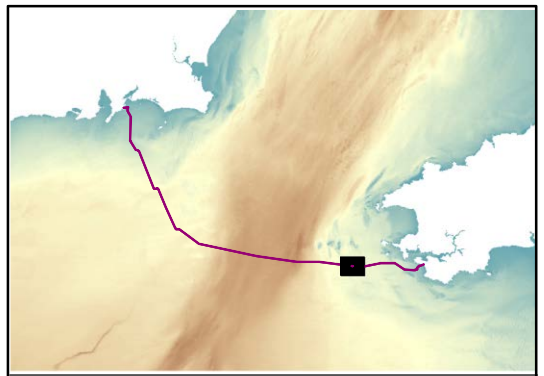
PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom feature CA_3018

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.13
APPROVED BY	MW	SCALE@A3	1:10,000	







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -55.7623
Low : -62.1894

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

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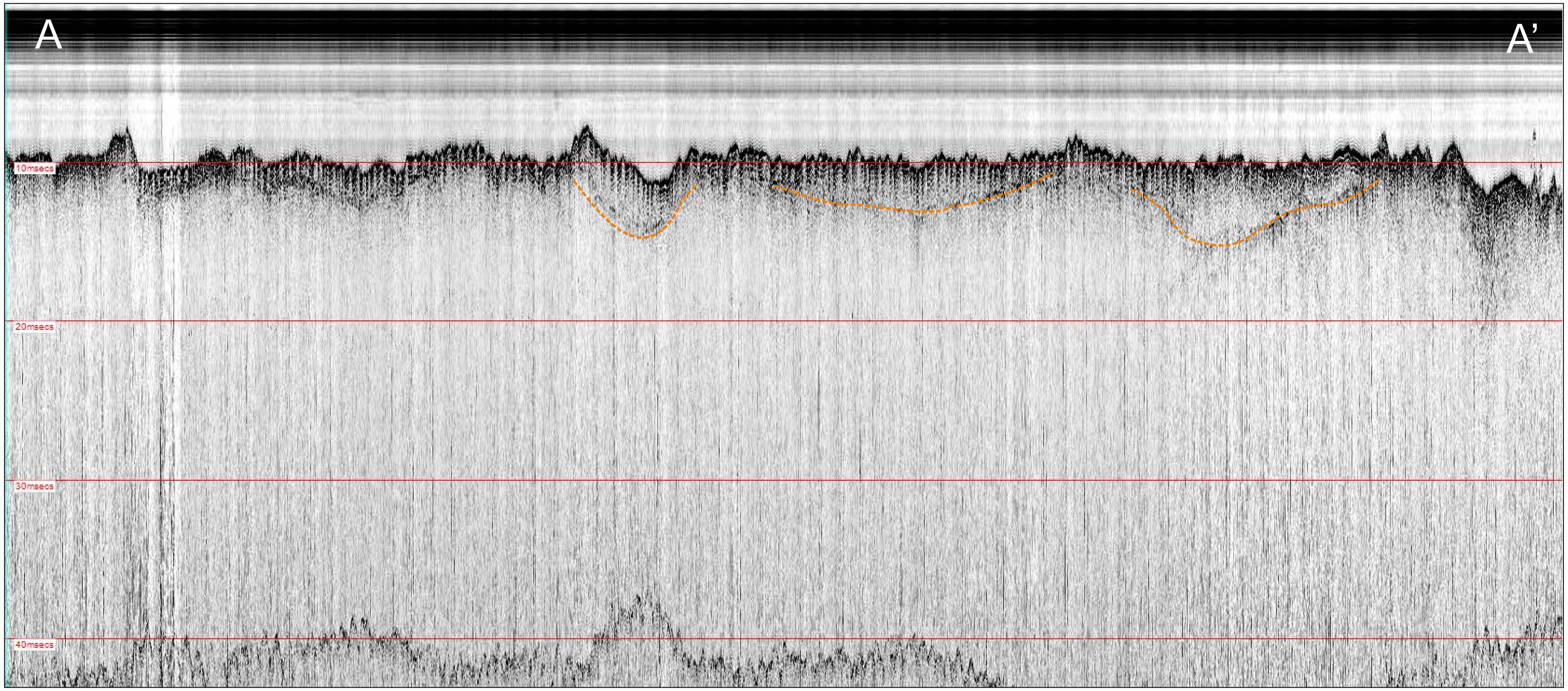
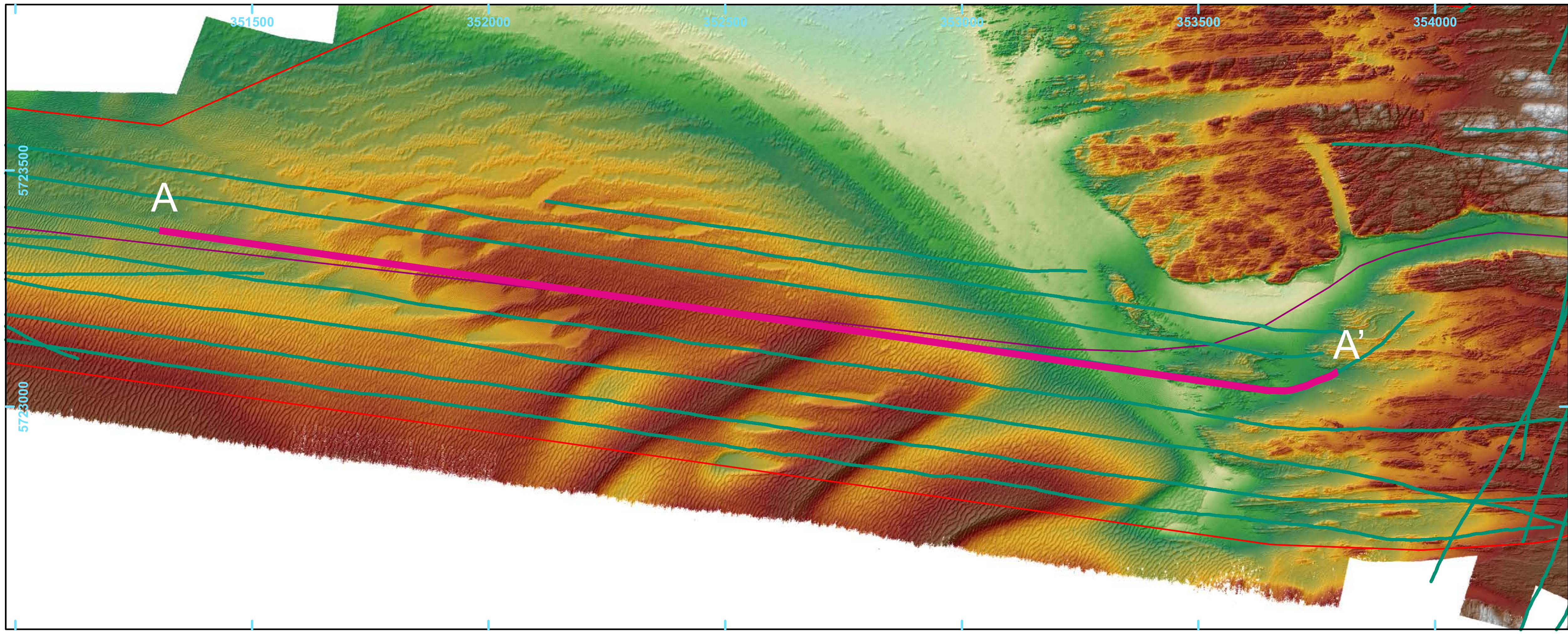
PROJECT TITLE
Greenlink Interconnector project

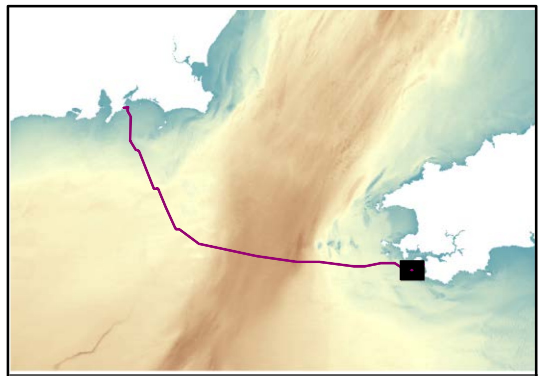
FIGURE TITLE
Sub-bottom feature CA_3019

DRAWN BY	MJG (UoS)	PROJECT NO	770349
CHECKED BY	RK	DATE	01/04/2019
APPROVED BY	MW	SCALE@A3	1:10,000

FIGURE NO.
4.14







Legend

- Route Centreline
- Route Corridor
- Sub-bottom Profile Survey Lines

Bathymetry (mLAT)
High : -24.4854
Low : -36.9327

N

0 375m

Coordinate System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator
Datum: WGS 1984
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -3.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

Cotswold Archaeology marine

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PROJECT TITLE
Greenlink Interconnector project

FIGURE TITLE
Sub-bottom feature CA_3020

DRAWN BY	MJG (UoS)	PROJECT NO	770349	FIGURE NO.
CHECKED BY	RK	DATE	01/04/2019	4.15
APPROVED BY	MW	SCALE@A3	1:10,000	

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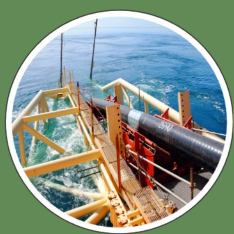
GREENLINK
MARINE ENVIRONMENTAL IMPACT ASSESSMENT REPORT- IRELAND

APPENDIX G

Cable Route Survey Report

P1975_R4500_RevF1
July 2019

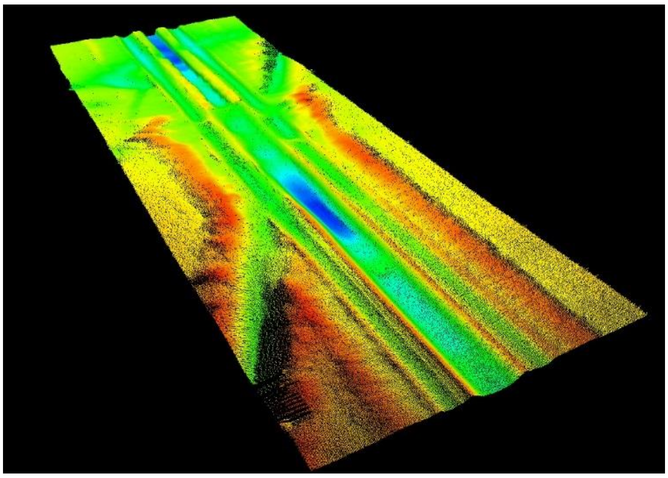
Greenlink Interconnector
- connecting the power markets
in Ireland and Great Britain



Greenlink
INTERCONNECTOR

GEOPHYSICAL SURVEY REPORT

102953-GRL-MMT-SUR-REP-GEOPHYRE
REVISION 03 | CLIENT REVIEW
APRIL 2019



Greenlink INTERCONNECTOR

GREENLINK INTERCONNECTOR IRELAND – UNITED KINGDOM

OFFSHORE, NEARSHORE, ONSHORE

IRISH SEA
SEPTEMBER 2018 - APRIL 2019

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MMT

EXECUTIVE SUMMARY

GREENLINK SURVEY ROUTE AND CORRIDOR OVERVIEW
MMT were contracted by Greenlink Interconnector Ltd. to conduct a geophysical, geotechnical and benthic survey for a proposed high voltage direct current (HVDC) submarine power interconnector between Pembrokeshire, Wales, UK and County Wexford, Ireland. This report presents the results of the geophysical survey, encompassing seabed and sub-seabed conditions, obstructions and installation constraints. The results are divided by country into two sections: UK and Ireland. Results are presented for the Final Route, as well as surveyed route options A and E whenever they deviate from the Final Route. The survey corridor was 500 m wide and divided into 6 blocks covering nearshore and offshore areas.

PRINCIPAL ROUTE POINTS RPL_30112018_Rev0					
Geodetic Datum & Projection: UTM Zone 30N (EPSG 16030)					
Point	**KP**	**Latitude (mm.mmm)**	**Longitude (mm.mmm)**	**Easting (m)**	**Northing (m)**
Start: Block 06	0.000	51° 39.771' N	5° 03.870' W	357214	5725559
End: Block 01	159.267	52° 10.663' N	6° 49.797' W	238162	5787723
BATHYMETRY AND SEABED MORPHOLOGY					
The route is generally characterised by flat or gradually changing seabed with very gentle to gentle slopes. The water depth is slowly increasing from the UK landfall towards a bathymetric trough, located approximately in the middle of the route. From there the water depth begins to decrease again, towards the Irish landfall. The maximum depth along the route is 127.8 m at KP 53.660 (UK offshore). Moderate gradients are generally associated with areas of mobile bedforms, comprising of megaripples and sandwaves, or over rocky outcrops. Mobile bedforms are frequently present throughout the corridor length. From the start of the route to KP 4.850 the route is leading through a valley between rocky outcrops. The maximum slope gradient encountered along the route is 12.26° over a rock located on the route at KP 2.400, in the UK offshore section.					
SEABED SEDIMENTS AND FEATURES					
The surficial sediments vary mainly between SAND and gravelly SAND/sandy GRAVEL with local areas of GRAVEL and SILT. BEDROCK is found outcropping and subcropping mainly in the UK and Ireland nearshore as well as the beginning of the route, for the first 43 km, approximately. Large areas of outcropping BEDROCK are present on route option A. Areas of occasional and numerous boulders are usually present in the vicinity of out- and subcropping BEDROCK. Large areas of BEDROCK and clayey TILL are covered by a veneer of mobile sediments, SAND to GRAVEL. Mobile bedforms of ripples, megaripples and occasionally sandwaves are present throughout the majority of the route. Some trawl marks were identified in the UK offshore section.					

SHALLOW GEOLOGICAL FEATURES
The shallow geology along the route is characterized by a sequence of SAND, channel infills, TILL and BEDROCK (from top to bottom). A surficial SAND unit is present over almost all of the route, with varying depth of some decimetres, as veneers over BEDROCK or TILL, to more than 10 m in some infills or sandwave areas. The lower boundary of the SAND unit is usually characterized by a GRAVEL layer. On the Welsh platform, BEDROCK and TILL are present at shallower sediment depth, more frequently out-and subcropping, compared to the Irish platform. A thicker sediment cover is present in the basin extent of the St. George's Channel. Deep incisions in BEDROCK and TILL, filled by channel infill sediment (clay to gravel), are found throughout the route, although appear more extensively on the Irish platform.
Potential Installation Constraints
• BEDROCK outcrops are present from KP 2 to KP 42 and KP 158 to the end of the route. • Boulder fields with occasional to numerous boulders are present mainly in UK offshore. • Mobile sediments ranging from ripples to megaripples and occasional sandwaves, with associated local gradients, are present throughout the majority of the route. • Six cables cross the route, one in UK and five in Irish waters. All are buried and were detected during the cable crossing campaign, see report 102953-GRL-MMT-SUR-REP-CABLECRE. • A linear magnetometer anomaly trend at KP 6.325 might indicate a possible unknown cable. • One known wreck, Saint Jacques, was confirmed at KP 4.717, 248.6 m south of the proposed route.

REVISION HISTORY

REVISION	DATE	STATUS	CHECK	APPROVAL
03	2019-04-24	Issue for Client Review	MB	MG
02	2019-01-30	Issue for Client Review	MB	MG
01	2019-01-25	Issue for Internal Review	MB	MG

REVISION LOG

DATE	SECTION	CHANGE
2019-04-24	Various	Updated according to Client comments and additional data from survey by Franklin 2019.

DOCUMENT CONTROL

RESPONSIBILITY	POSITION	NAME
Content	Sr. Geophysicist	Daniela Hanslik
Content	Data Processor	Emily Johnston
Content, Check	Project Geologist / Sr. Geophysicist	Hanna Milver
Content, Check	Project Report Coordinator	Maria Blom
Check	Reporting Quality Controller	Hampus Arvidsson
Approval	Project Manager	Martin Godfrey

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ABBREVIATIONS AND DEFINITIONS

BOB	Back of Beach
CHIRP	Compressed High Intensity Radar Pulse (SBP)
CPT	Cone Penetration Test
DDV	Drop Down Video Camera
DPR	Daily Progress Report
DTM	Digital Terrain Model
EPSG	European Petroleum Survey Group
GIS	Geographic Information System
GNSS	Global Navigation Satellite Systems
HDD	Horizontal Directional Drilling
HPVC	High Power Vibrocorer
HVDC	High Voltage Direct Current
ISO	International Organization for Standardization
kHz	kilohertz
KP	Kilometre Post
LAT	Lowest Astronomical Tide
MAC	Mobilisation and Calibration
MAG	Magnetometer
MASW	Multichannel Analyses of Surface Waves
MBES	Multibeam Echo Sounder
MDAC	Methane-Derived Authigenic Carbonates
MLW	Mean Low Water
MSL	Mean Sea Level
M/V	Motor Vessel
nT	nanotesla
OD	Ordnance Datum
ODMH	Ordnance Datum Malin Head
ODN	Ordnance Datum Newlyn
OSGM	Ordnance Survey Geoid Model
OSTN	Ordnance Survey Transformation Network
PCPT	Piezo Cone Penetration Testing
PPS	Pulse Per Second
ROV	Remotely Operated Vehicle
ROTV	Remotely Operated Towed Vehicle
RPL	Route Position List
SBET	Smoothed Best Estimated Trajectory
SBP	Sub-Bottom Profiler
SSS	Side Scan Sonar
Survey Corridor	The area specifically surveyed e.g. 500 m wide section

Survey Coverage	The area surveyed, this may be wider than 500 m in some instances
TVG	Transverse Gradiometer
UAV	Unmanned Aerial Vehicle
UK	United Kingdom
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
VC	Vibrocore
VORF	Vertical Offshore Reference Frame
WGS84	World Geodetic System 1984

1 | INTRODUCTION

1.1 | PROJECT INFORMATION

Greenlink Interconnector Limited, proposes to develop an interconnector, which will allow transfer of power between the high voltage grid systems of the UK and the Republic of Ireland. Greenlink will connect to the United Kingdom (UK) National Grid system at Pembroke substation in Pembrokeshire, United Kingdom and to the Irish network at Great Island substation in County Wexford, Ireland.

Figure 1 presents an overview of the survey area and final route.

Project details are presented in Table 1.

Table 1 Project details.

Client:	Greenlink Interconnector Limited
Project:	Greenlink Interconnector
MMT Sweden AB (MMT) Project Number:	102953
Survey Type:	Geophysical, Geotechnical, Environmental, Topographic, UXO, ROV infrastructure crossing, Land Seismic
Area:	Irish Sea
Survey period:	September 2018 – March 2019
Survey Vessels:	M/V Franklin, M/V Seabeam, M/V Olympic Challenger, M/V Sandpiper
MMT Project Manager:	Martin Godfrey
Client Project Manager:	Stephane Theurich

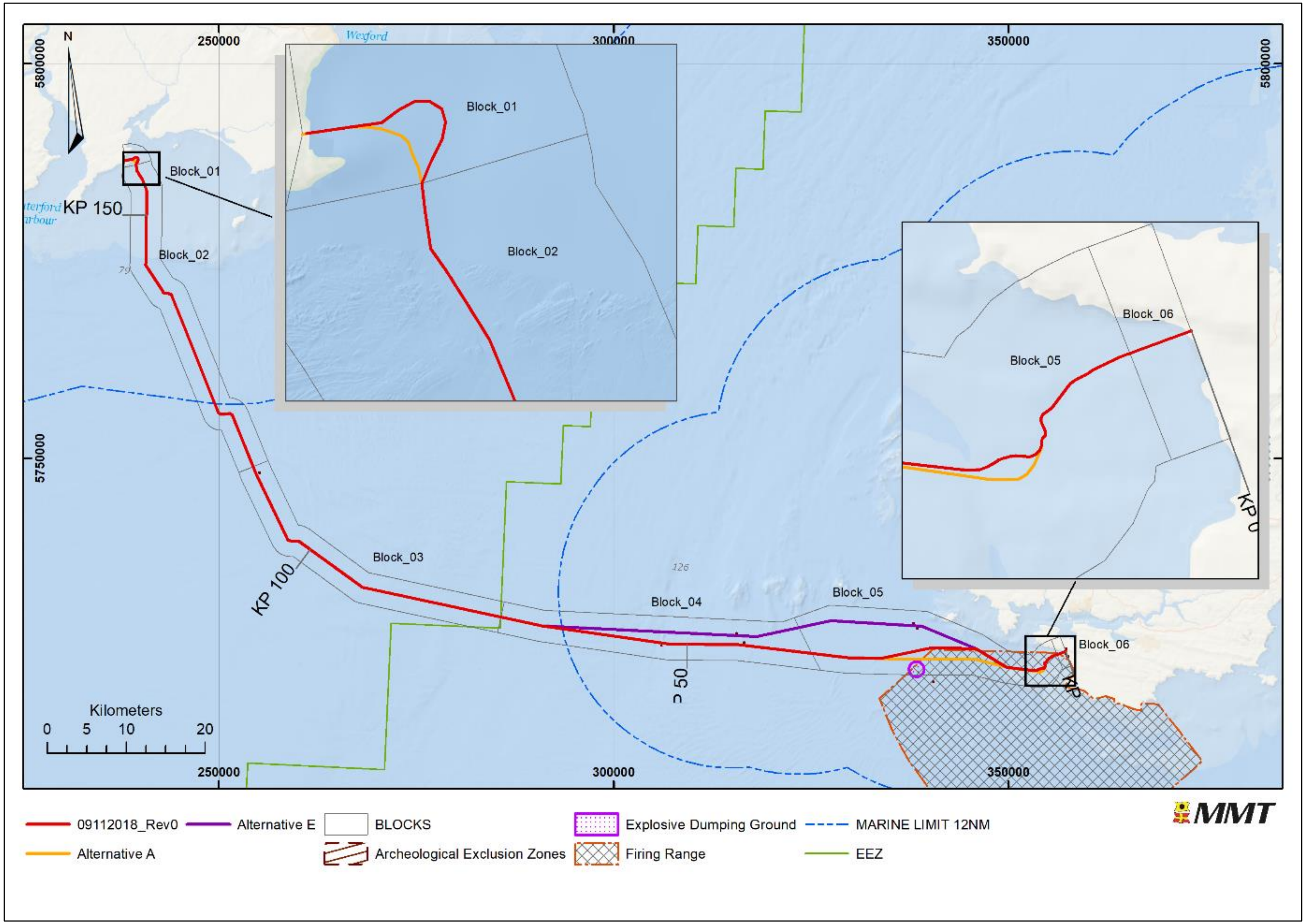


Figure 1 Overview of survey area.

1.2| SURVEY INFORMATION

The Greenlink marine survey scope of work comprises:

- Onshore/intertidal topographic survey
- Geophysical/hydrographic nearshore and offshore data acquisition
- Geotechnical investigations along the proposed route with vibrocoring (VC) and cone penetration testing (CPT)
- Environmental sampling and imagery
- Infrastructure crossing survey with remotely operated vehicle (ROV)
- Unexploded ordnance (UXO) survey
- Geotechnical boreholes to inform horizontal directional drilling
- Onshore reflection and refraction survey

These operations, in the nearshore and offshore, provide high resolution and accurate measurements of the bathymetry, seabed features and shallow geological conditions along the route(s). This was supplemented by localised UXO surveys, within the Castlemartin Firing Range area, environmental sampling and imagery as well as surveys of infrastructure crossings using an ROV.

1.3| SURVEY OBJECTIVES

1.3.1| DEVIATIONS TO SCOPE OF WORK

Due to fishing gear and extensive weather down time, in agreement with the client, the operations for M/V Franklin were suspended in December 2018, prior to completing the full geophysical scope of work. M/V Franklin returned to the project on 27th February 2019 for continuation of the agreed outstanding parts. Further information regarding this and other decisions made during the survey operations are further presented in the Operations Report (102953-GRL-MMT-SUR-REP-OPERATRE).

In addition to the above mentioned deviations the following changes were made:

- Due to strong currents and weather implications it was not possible to have both the vessel, Sparker and the Remotely Operated Towed Vehicle (ROTV) on the survey line at all times. In these instances, priority was given to the ROTV, which was accepted by the Client Representative on board.
- M/V Seabeam worked further offshore on the UK side than originally planned, covering parts of M/V Franklin's scope of work.
- The Nearshore survey on the Irish side was performed as a site survey due to the shape and location of the area, meaning the general route survey operation could not be surveyed as planned. Sub-bottom Profiler (SBP) and Magnetometer data was acquired over the centre lines.
- Boomer was not used during the nearshore survey on the UK landfall, it was only used during the landfall survey on the Irish side.
- Two additional survey lines were added perpendicular to Alternative A and Alternative E in order to get a broader knowledge about the surface conditions in-between the two alternative routes. The final survey route was routed between the original Alternative A and Alternative E.

1.3.2| GEOPHYSICAL SURVEY (OFFSHORE)

The offshore geophysical survey was performed with a hull mounted multibeam echo sounder (MBES) installed on M/V Franklin and a side scan sonar (SSS)/sub-bottom profiler (SBP) mounted on a remotely operated towed vehicle (ROTV) with a tethered single magnetometer or transverse gradiometer (TVG). In addition to the Chirp system, a surface towed GeoSparker was used to achieve an enhanced penetration for the required >10 m depth.

It should be noted that the survey was carried out in two parts, where the first part was done as a reconnaissance survey focusing on block 5. The reason for the reconnaissance survey was to enable an environmental survey including video and still photos transects in order to send the data to Natural Resources Wales (NRW) for approval prior to deciding on a final route.

1.3.3| GEOPHYSICAL SURVEY (NEARSHORE)

The nearshore geophysical survey was performed by M/V Seabeam using a hull mounted MBES and a pole mounted SSS and SBP with a towed magnetometer. A boomer system was available on board, should the required penetration of 10 m not be fulfilled by the pole mounted SBP system. The boomer was only utilised on the Irish side.

Nearshore operations were carried out as a 12-hour operation including transport of survey personnel to the vessel, start-up of equipment and transport back to living quarters.

1.3.4| GEOPHYSICAL SURVEY (ONSHORE) - TOPOGRAPHIC

Topographical surveys were conducted by land based topography for UK and Ireland using drone-based photogrammetry techniques, i.e. unmanned aerial vehicle (UAV). The digital terrain model (DTM) has a resolution such that 0.25 m contours can be mapped. Infrastructure, obstacles and surficial sediments were mapped.

1.3.5| GEOPHYSICAL SURVEY (ONSHORE) – SEISMIC REFRACTION & REFLECTION

The scope was for a seismic refraction and reflection survey along a 350 m corridor in Freshwater West, UK, and a 300 m corridor in Baginbun, Ireland. The survey carried out P- and S-wave seismic refraction and multichannel analysis of surface waves (MASW) techniques

1.3.6| UXO SURVEY (NEARSHORE & OFFSHORE)

Since part of the route in UK waters is located within the Castlemartin firing range area, a focussed UXO survey, covering a 100 m wide corridor within the firing range, from KP 0.000 to KP 12.650, commenced on 27th February 2019. The UXO survey was performed using an ROTV with a tethered single magnetometer or transverse gradiometer (TVG)

Due to Castlemartin being an active defence training area with permission to fire live rounds into the sea, the performed UXO survey can only be considered valid for the time of the survey as future changes are highly likely.

1.4| PURPOSE OF DOCUMENT

This report presents the geophysical results from the onshore, nearshore and offshore geophysical surveys.

The document provides an overview of the bathymetry, topography, biotope, seabed features and shallow geology along the surveyed corridor, based on the interpretation of the geophysical data. Furthermore, the report summarises the conditions along the survey corridor with regards to other seabed features, e.g. infrastructure crossings, obstacles, potential sensitive habitat types, wrecks, and man-made objects, detected during the survey. Factors that may impose constraints on the cable laying operations have also been identified and considered.

Separate reports are issued for the geotechnical scope, UXO scope, environmental scope as well as infrastructure crossing scope. A full list of reports is given in Table 2. For a wider understanding of the conditions along the cable route, it is recommended to read this report in conjunction with the UXO report, Environmental report, Geotechnical Report, Cable Crossing Report as well as the Operations Report.

1.4.1| GEOPHYSICAL ALIGNMENT CHARTS

The geophysical alignment charts in this report illustrate and describe the results from the survey and are intended to assist in further planning and evaluation purposes of the cable route. The charts are presented at a horizontal scale of 1:10 000. A list of all produced charts are presented in Appendix C|.

The geophysical alignment charts contain the following data fields:

BATHYMETRY

The bathymetry is presented with labelled 0.5 m contour lines and colour-shaded relief, with the depth range set across the whole route.

The route with KP annotations, background cables/pipelines, a grid with north arrow and chart matchlines, which show the neighbouring chart limits with ID, is also present.

SURFICIAL GEOLOGY AND SEABED FEATURES

This panel presents the interpretation of the SSS results. The surficial geology is colour coded and the seabed features are presented as a hatch with patterns laid over the surficial geology interpretation. The surficial geology has a transparency applied as the SSS mosaic is also displayed behind the interpretation. SSS contacts, magnetometer anomalies and possible UXO’s are also shown with symbols and ID along with both geotechnical and environmental sample locations.

The route with KP annotations, background cables/pipelines, a grid with north arrow and chart matchlines, which show the neighbouring chart limits with ID, is also present.

ISOPACH

The depth to base of sand is presented contoured at 1 m intervals, with labels.

The route with KP annotations, background cables/pipelines, a grid with north arrow and chart matchlines, which show the neighbouring chart limits with ID, is also present.

LONGITUDINAL PROFILE

This section illustrates the seabed profile along the surveyed route. Horizons have been mapped and annotated and geotechnical sample locations are also plotted.

The profile panel also contains a grid with depth and KP axis.

1.4.2| GEOPHYSICAL NORTH UP NEARSHORE CHARTS

The geophysical north up nearshore charts issued with this report illustrate and describe the results from the survey and are intended to assist in further planning and evaluation purposes of the cable route. The charts are presented at a horizontal scale of 1:5 000. A list of all produced charts are presented in Appendix C|.

The geophysical north up nearshore charts contain the information detailed below. In addition to this the route with KP annotations, background cables/pipelines and a grid with north arrow are also present.

BATHYMETRY

The bathymetry is presented with 0.5 m contour lines, with labels.

SURFICIAL GEOLOGY AND SEABED FEATURES

This panel presents the interpretation of the SSS results. The surficial geology is colour coded and the seabed features are presented as a hatch with patterns laid over the surficial geology interpretation. SSS contacts, magnetometer anomalies and possible UXO’s are also shown with symbols and ID along with both geotechnical and environmental sample locations.

ISOPACH

The depth to base of sand is presented contoured at 1 m intervals, with labels.

1.5| REFERENCE DOCUMENTS

The documents used as references to this survey report are presented in Table 2.

Table 2 Reference documents.

DOCUMENT NUMBER	TITLE	AUTHOR
102953-GRL-MMT-QAC-PRO-PMQAPLAN	Project Manual and Quality Assurance Plan	MMT
102953-GRL-MMT-HSE-PRO-HIRA	Hazard Identification & Risk Assessment: Geophysical	MMT
102953-GRL-MMT-HSE-PRO-HSEFRANK	HSE Plan Franklin	MMT
102953-GRL-MMT-HSE-PRO-HSESEAON	HSE Plan Seabeam and Onshore	MMT
102953-GRL-MMT-QAC-PRO-CADGIS	CAD and GIS Specification	MMT
102953-GRL-MMT-SCH-PRO-SCHEDULE	Time schedule	MMT
102953-GRL-MMT-MAC-REP-FRANKLIN	Mobilisation and Calibration Report - Franklin	MMT
102953-GRL-MMT-MAC-REP-SEABEAM	Mobilisation and Calibration Report – Seabeam	MMT
102953-GRL-MMT-SUR-REP-OPERATRE	Operations Report	MMT
102953-GRL-MMT-SUR-REP-GEOPHYRE	**Geophysical Report**	**MMT**
102953-GRL-MMT-SUR-REP-UXOREP	UXO Report	MMT
102953-GRL-MMT-SUR-REP-GEOTECRE	Geotechnical Report	MMT
102953-GRL-MMT-SUR-REP-CABLECRE	Cable Crossing Report	MMT
102953-GRL-MMT-SUR-REP-ENVIRORE	Environmental Report	MMT
102953-GRL-MMT-SUR-REP-INTEGRRE	Integrated Report	MMT
P1975_ExhibitB_ScopeofWork	Scope of work	GRL
P1975_ExhibitC_TechnicalSpecifications	Technical Specifications	GRL
P1975_ExhibitG_Greenlink UXO DBS	UXO Desktop Study	GRL
P1975 Greenlink Clarification	Clarifications	GRL
P1975 Greenlink Addendum_Rev0	Clarifications	GRL

2| SURVEY PARAMETERS

2.1| GEODETIC DATUM AND GRID COORDINATE SYSTEM

Table 3 Geodetic parameters.

Geodetic Parameters	
Datum	World Geodetic System 1984 (6326)
Ellipsoid	World Geodetic System 1984 (7030)
Spheroid	WGS84
Semi Major Axis	6378137.000 m
Semi Minor Axis	6356752.31414035610 m
Inverse Flattening (1/f)	298.25722210100002
Unit	International metre

Table 4 Projection parameters.

Projection Parameters	
Projection	UTM Zone 30N (EPSG 16030)
Longitude at Central Meridian	003°00'00.0" W
Latitude of Origin	00°00'00.0" N
False Northing	0m
Scale Factor (Central Meridian)	0.9996
Units	Metres
Time Datum	UTC

The vertical reference parameters are presented in Table 5.

Table 5 Vertical reference parameters.

Vertical Reference Parameters	
Vertical reference (offshore)	DTU10 Lowest Astronomical Tide (LAT)
Height model (offshore)	Vertical Offshore Reference Frame (VORF)
Height model (nearshore)	Ordnance Survey Geoid Model 15 (OSGM15)
Vertical reference (nearshore UK)	Ordnance Datum Newlyn (ODN) Mean Sea Level (MSL)
Vertical reference (nearshore IRL)	Ordnance Datum Malin Head (ODMH) Mean Sea Level (MSL)

2.2| VERTICAL DATUM

Global navigation satellite system (GNSS) tide was used to reduce the bathymetry data to Lowest Astronomical Tide (LAT), the defined vertical reference level (Figure 2).

As vertical control for all depth and/or height measurements LAT via VORF LAT reduction from WGS84-based ellipsoid heights were used.

The nearshore geophysical data has also been provided to Ordnance Datum (OD), which is a local version of the Mean Sea Level (MSL). This was achieved using the OSTN15/OSGM15 model, which has been developed to incorporate UK and Irish OD in to one model.

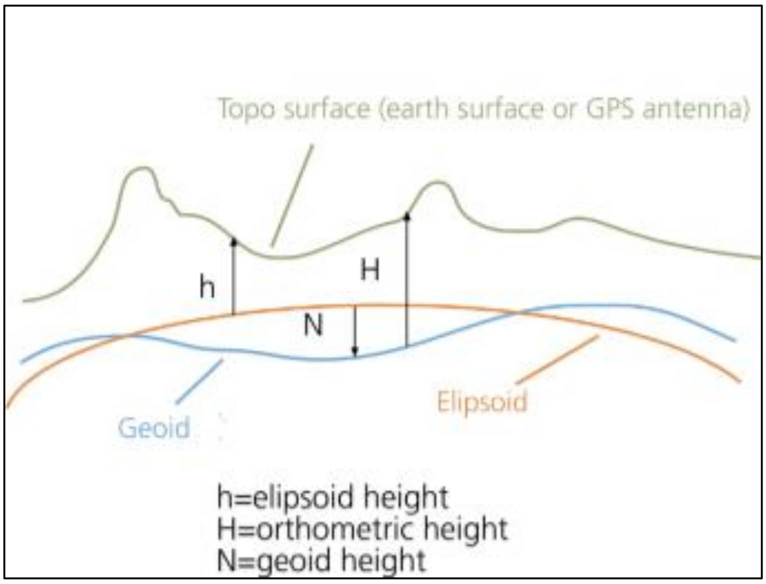


Figure 2 Overview of the relation between different vertical references.

This tidal reduction methodology encompasses all vertical movement of the vessel, including tidal effect and vessel movement due to waves and currents. The short variations in height are identified as heave and the long variations as tide.

This methodology is very robust since it is not limited by the filter settings defined online, and provides very good results in complicated mixed wave and swell patterns. The vessel navigation is exported into a post-processed format, SBET (Smoothed Best Estimated Trajectory) that is then applied onto the MBES data.

The methodology has proven to be very accurate as it accounts for any changes in height caused by changes in atmospheric pressure, storm surge, squat, loading or any other effect not accounted for in a tidal prediction.

2.3| TIME DATUM

Coordinated universal time (UTC) was used on all survey systems on board the vessel. The synchronisation of the vessel’s onboard system was governed by the pulse per second (PPS) issued by the primary positioning system. All displays, overlays, and logbooks were annotated in UTC. The Daily Progress Report (DPR) refers to UTC.

2.4| KP AND SURVEY BLOCK PROTOCOL

Four routes were considered during the preparation and survey phase of the project, see Figure 3, namely Route A which was the base route starting with KP 0 at the landfall in Freshwater West, UK and with an increasing KP towards the landfall in Baginbun, Ireland.

In addition to Route A, Alternative E also starts at the landfall in Freshwater West, UK and increases in KP towards the landfall in Baginbun, Ireland. The difference between Route A and Alternative E is visible in Figure 3 where Alternative E runs north of Route A in blocks 4 and 5.

Option C deviates from Route A (as well as Alternative E) in block 3 where it turns south to an alternative landing point in Boyce's Bay, Ireland. Option C was never surveyed and no results are therefore present in this report.

Option D deviates from Route A (as well as Alternative E) in block 1 and runs further north of Route A before it joins Route A towards the landing point at Baginbun, Ireland.

The final route, RPL_09112018_Rev0, is presented in Figure 4, starting at Freshwater West, UK with KP 0 and increasing towards the landfall in Baginbun, Ireland. The final route is a mixture of Route A, Alternative E and Option D as well as re-routing conducted during the survey.

The parts surveyed which do not coincide with the final route are the following:

Table 6 Route deviations from Final Route.

Deviation	Start/End Route	KP	Comments
Route A deviation 1	Start KP (final route)	3.653	
	Start KP (Route A)	3.647	
	End KP (final route)	25.389	The Final Route and Route A run parallel (max 0.12 m distance between the two routes) to each other from this point until KP 29.622 (Final route KP). For reporting purposes this deviation is not presented after KP 25.389
	End KP (Route A)	24.909	
Alternative E deviation 1	Start KP (final route)	13.173	
	Start KP (Alternative E)	13.373	
	End KP (final route)	68.600	
	End KP (Alternative E)	69.229	
Route A deviation 2	Start KP (final route)	156.667	
	Start KP (Route A)	156.187	
	End KP (final route)	158.759	
	End KP (Route A)	157.413	

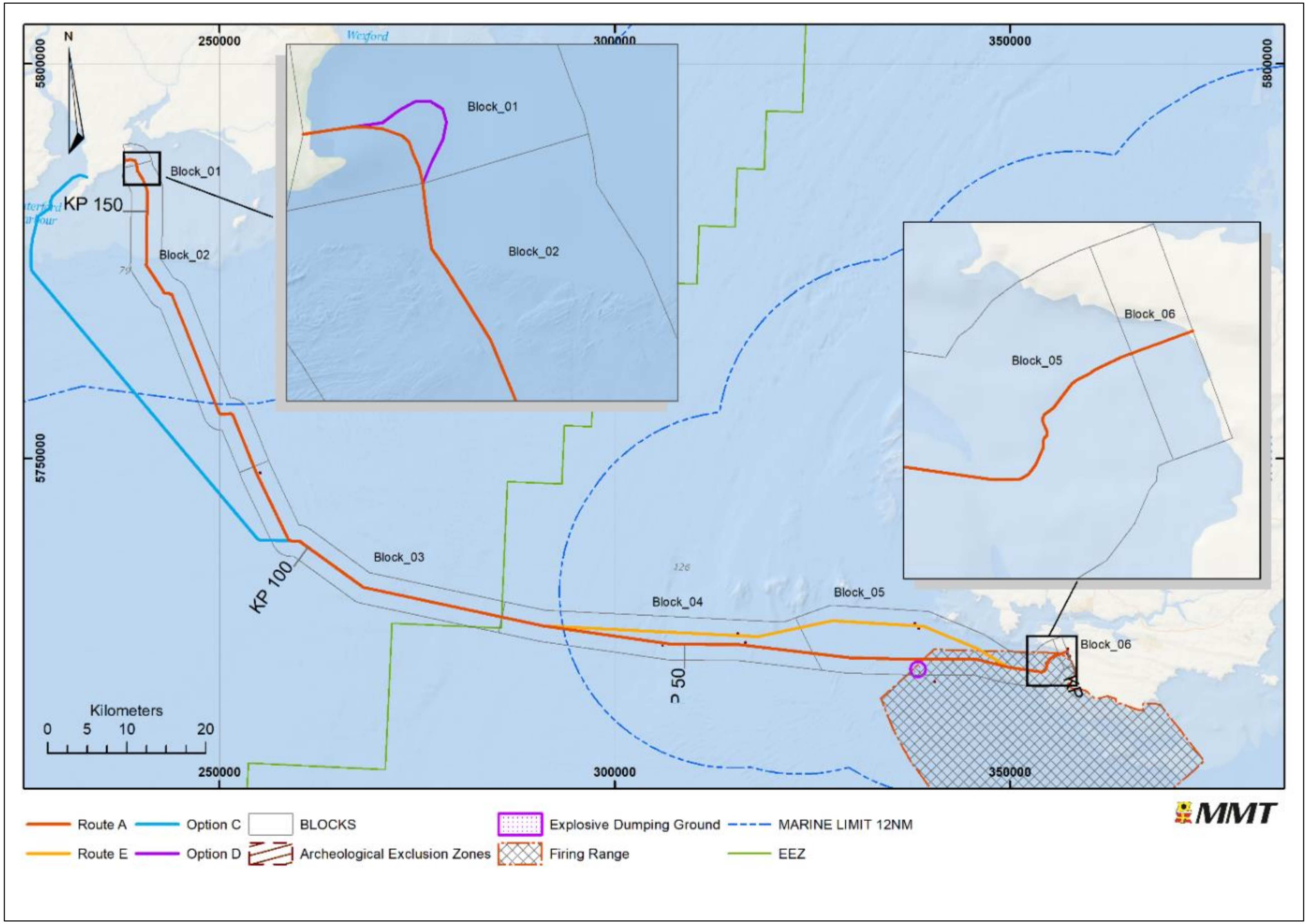


Figure 3 Initial route options.

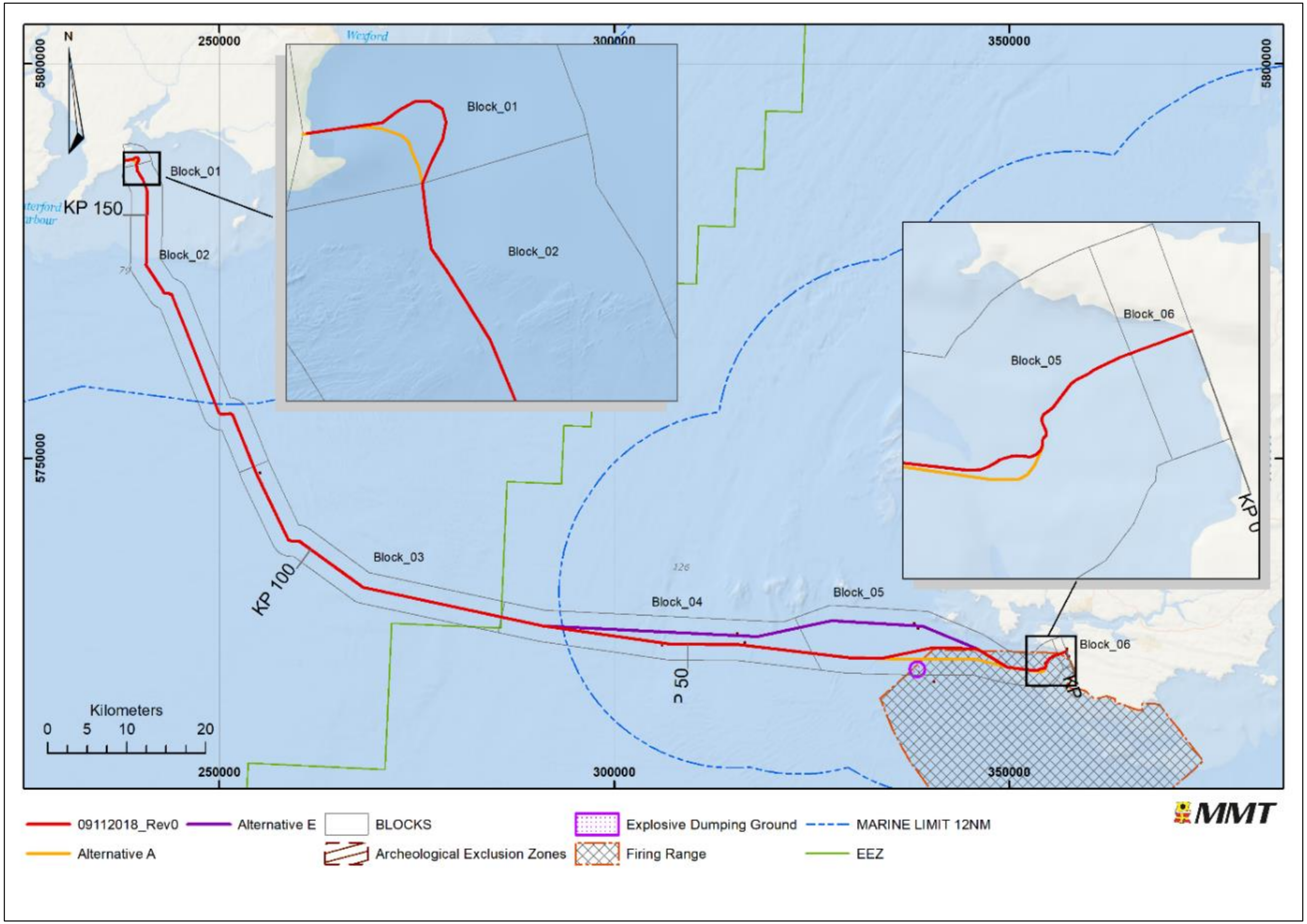


Figure 4 Final Route and reported route alternatives.

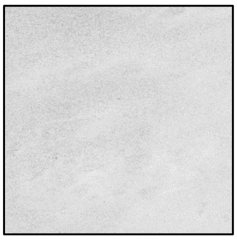
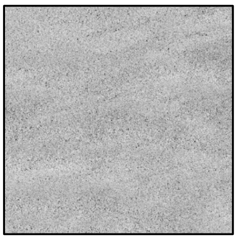
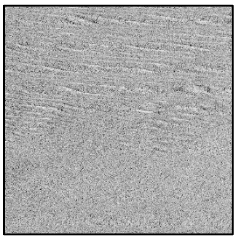
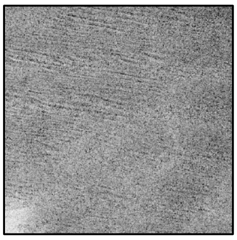
3| CLASSIFICATION AND TERMINOLOGY

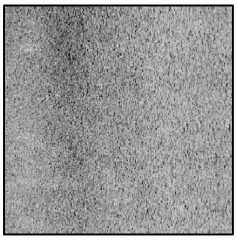
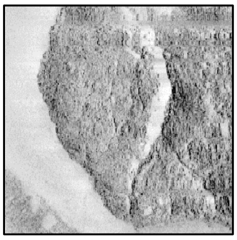
3.1| SEABED SEDIMENT CLASSIFICATION

The interpretation of surficial sediment types was derived from the acoustic character of the SSS data, and the interpretations were aided by MBES bathymetric 3D surfaces and SBP data. During the review of the SSS survey data, higher intensity sonar returns (darker grey to black colours) were interpreted as relatively coarser grained sediments, and lower intensity sonar returns (lighter grey colours) were interpreted as relatively finer grained sediments. Bathymetric data was used to correct the interpretation for the effects of seabed slope on sonar returns. The correlation with the geotechnical results was initially based on the field logs and further verified with the final geotechnical results.

The ID column in Table 7 defines the colour in the charts for the specific sediment type mapped along the survey corridor. All particle sizes refer to the soil classification in ISO 14688-1 (2002).

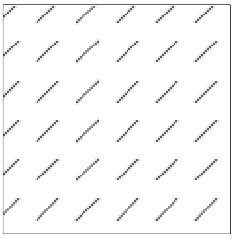
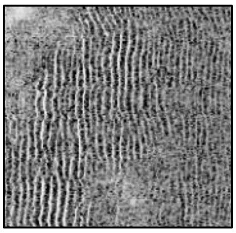
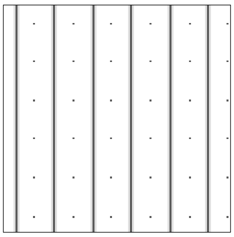
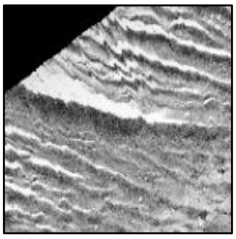
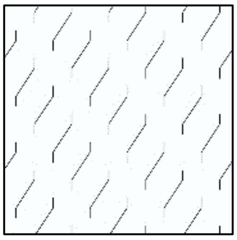
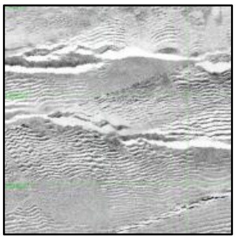
Table 7 Seabed sediment classification.

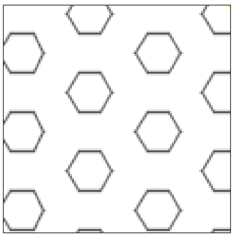
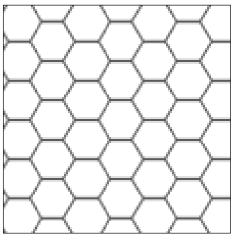
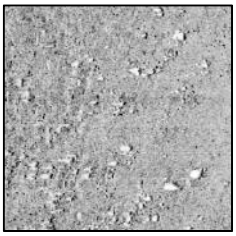
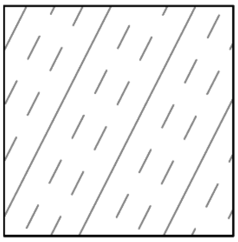
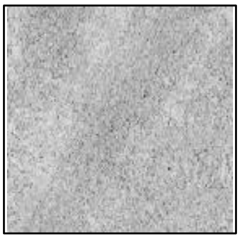
ID	SSS IMAGE	ACOUSTIC DESCRIPTION	LITHOLOGICAL INTERPRETATION
		Low to medium acoustic reflectivity. Slightly grainy to grainy texture.	**SILT** Predominantly silt, may have minor fractions of clay, sand and/or gravel.
		Low to medium acoustic reflectivity. Slightly grainy texture.	**SILT and SAND** The ratio between sand and silt can vary within this sediment type. The sediment often has a patchy appearance due to variation of the dominating sediment fraction.
		Medium acoustic reflectivity, slightly grainy texture. Often associated with ripples or sandwaves.	**SAND** Predominantly sand, may have minor fractions of clay, silt and/or gravel.
		Medium to high acoustic reflectivity. Slightly grainy to grainy texture, coarse texture in places. Often associated with ripples or megaripples.	**Gravelly SAND to sandy GRAVEL** The ratio between SAND and GRAVEL can vary within this sediment type but commonly it contains slightly gravelly sand to very gravelly sand.

ID	SSS IMAGE	ACOUSTIC DESCRIPTION	LITHOLOGICAL INTERPRETATION
		High acoustic reflectivity. Grainy to coarse texture. Often associated with ripples or megaripples.	**GRAVEL** Predominantly gravel. May contain minor fractions of sand, silt or clay. May also contain gravel sized shell fragments.
		Medium to high acoustic reflectivity. Exhibits relief and texture.	**BEDROCK** Comprises outcrops of crystalline bedrock

The ID column in Table 8 defines the pattern in the charts for the specific seabed feature type.

Table 8 Seabed features classification.

ID	SSS IMAGE	SEABED FEATURE	CRITERIA
		Ripples	Wave length < 5 m
		Megaripples	Wave length 5-25 m
		Sandwaves	Wave length > 25 m

ID	SSS IMAGE	SEABED FEATURE	CRITERIA
		Boulder Field Occasional boulders All > 0.5 m	Concentration of 10 to 20 boulders within a maximum area of 50 x 50 m
		Boulder Field Numerous boulders All > 0.5 m	Concentration of > 20 boulders within a maximum area of 50 x 50 m
		Current Lineation	Current lineation

3.2| CLASSIFICATION OF CONTACTS AND ANOMALIES

The SSS contacts were selected according to the following criteria:

- Wreck
- Boulder
- Debris
- Other

During seabed interpretation, boulder occurrence at surface has been grouped based on the frequency and content of boulders >0.5 m per 50 x 50 m. Contacts less than 0.5 m were not picked.

Magnetic anomalies have been identified during both the geophysical survey and the UXO survey, details regarding the UXO survey and the associated UXO listings are presented in the UXO report (102953-GRL-MMT-SUR-REP-UXOREP).

Magnetic anomalies, if identified, are classified according to the following criteria:

- Dipole, monopole or complex shape
- Single anomaly or anomalies creating a linear trend relating to possible or identified cable/pipeline crossings.

3.3| SHALLOW GEOLOGY CLASSIFICATION

The classifications of the shallow geology have been derived through a combination of analysis and interpretation of the acoustic character of the SBP data and was modified according to the geotechnical results. A comparison with available background information was made and broken down into major sediment types along the route (Table 9).

Table 9 Shallow geology soil types and lithology summary.

SEDIMENT TYPE	ACOUSTIC CHARACTERISTICS	LITHOLOGICAL VARIATION
Veneer	-	Veneer of mobile sediments not resolved in seismic data (generally <0.5 m). Gravelly SAND to GRAVEL. Occasionally SILT on Irish side. Veneer of reworked sediment by winnowing of fines often present of top of TILL and BEDROCK.
SAND	Acoustically homogeneous to layered, low to medium amplitude recent sediments present at seabed. Base often medium to high amplitude indicating presence of coarser sediment.	Fine to coarse SAND. May locally contain shells, pebbles, cobbles and pockets of SILT, CLAY and GRAVEL. Commonly forming mobile sediment.
Channel Infills	Acoustically homogeneous to layered, low to medium amplitude recent sediments lying underneath surface sand layer and filling palaeo-channels.	Sandy to clayey sediments with layers of coarser sediment. May locally contain pebbles, cobbles.
TILL	Either heterogeneous with acoustic character indicating the presence clay with sand layers and possible coarser sediments, and boulders or Limited or no acoustic penetration.	Possible glacial deposit / till or diamicton. Unsorted sediment, soft to stiff clay with interbeds of sand, and layers/lenses of coarse sand and gravel. May contain pebbles, cobbles, and boulders.
BEDROCK	High amplitude top with no acoustic penetration.	Devonian Shale and Sandstone, Cretaceous Chalk

3.4| SEABED GRADIENT CLASSIFICATION

The seabed gradient is classified according to Table 10.

Table 10 Seabed gradient classification.

CLASSIFICATION	GRADIENT
Very Gentle	<1°
Gentle	1° - 4.9°
Moderate	5° - 9.9°
Steep	10° - 14.9°
Very Steep	>15°

4| DATA QUALITY AND INTERPRETATION

4.1| DATA QUALITY

4.1.1| ONSHORE TOPOGRAPHY

The onshore topographic survey data met all project requirements.

4.1.2| NEARSHORE SURVEY

The MBES data were of a good quality throughout. In Block 6 at Freshwater West between KP 0.290 and KP 0.44 there was evidence of mobile sediments, see Figure 6 in section 5.1.2|. A section was surveyed a few weeks after M/V Seabeam had initially surveyed in this area and there was up to 70 cm difference between the data. Due to the location of the survey being in the surf zone and considering the large tidal range in the area, it is expected to find seabed movement here. At both nearshore intertidal zones there are some data gaps in the UAV data. These could be explained by the presence of a very flat and featureless seabed, where an image is unable to be resolved. Other explanations for these gaps include bad light or visibility during the survey, or movement in the water, such as seaweed.

The SSS data were of good quality throughout, achieving all requirements. A slight increase in noise was noted towards the shore.

SBP data proved to be fit for purpose. Penetration of up to 13.4 m with the Innomar system was achieved, meeting the project requirements.

The magnetometer data quality was good in general with noise increasing slightly towards the shore. There is a 40 m gap in the magnetometer data in Block 1. Infill was attempted but unsuccessful. The data gap was accepted by the client representative.

4.1.3| OFFSHORE SURVEY (BLOCKS 5 TO 2)

The MBES data are generally very good. In Block 4 there are occasional areas where the data quality was affected by the weather, so density is reduced due to cleaning out noisy data, meaning some parts of the corridor are unsurveyed. Throughout the offshore section, where the seabed is very flat, the overlap between survey lines is sometimes visible. This is to be expected in flat areas and the difference between overlapping lines is between 10 cm to 20 cm so is well within specification at these depths.

SSS data proved to be fit for purpose. The low frequency (300 kHz) SSS data was mainly interpreted. The high frequency data was used to aid in the interpretation.

The overall quality of the Sparker and Chirp data were good. Average penetration with the Sparker was 50 m. The penetration of the Chirp was usually between 1 m and 15 m. Greater signal attenuation was observed when thick layers of surficial sand were present.

The magnetometer data quality was generally of good quality.

4.2| DESCRIPTION OF DATA INTERPRETATION

SSS data has been used for interpretation of surficial geology, identification of seabed features, and to select contacts. Sediment classes distinguished from topographical features identified from SSS records have been correlated with MBES data, grab samples and geotechnical information. Shallow geology interpretations are based on SBP data and have been correlated with the final geotechnical laboratory results from the VC and PCPT. SSS and MBES data were also used to corroborate the SBP interpretation in the uppermost layers.

Magnetometer records collected during the survey were used to identify cables/pipelines and ferrous objects on the seafloor within the survey corridor. Note that due to line spacing this does not constitute an UXO survey.

4.2.1| ISOPACH

For the isopach the base of SAND unit was chosen. The base is either on the top of stiff or hard sediments, e.g. TILL or BEDROCK, or is characterized by a layer of coarse sediment, e.g. GRAVEL. Isopachs are presented in the charts.

The isopachs are based on the data from all SBP systems and are gridded using flex gridding with 5 m cell size. The contours were subsequently created in GIS. The gridding was made using 17-60 m limit distance from data depending on survey line distance. Since the gridding process occasionally creates false surfaces over known bedrock outcrops, the data was subsequently cropped to the bedrock polygons from the interpreted surface geology.

5| RESULTS UNITED KINGDOM

5.1| UNITED KINGDOM NEARSHORE

5.1.1| OVERVIEW ROUTE OPTION RPL_09112018_REV0

Reported KP for the UK nearshore section are KP 0.000 to KP 1.152. The bathymetry description includes intertidal zone and surf zone data acquired by UAV from KP 0.000. Surficial geology descriptions start from the limit of the nearshore vessel at KP 0.334 and for the shallow geology at KP 0.498.

BATHYMETRY

The bathymetry in this area begins at the top of the intertidal zone and gently slopes away down to the surf zone where there is an area of mobile sediments and small ripples. The seabed continues to gently slope offshore to a depth of 10.02 m and the beginning of a rocky outcrop appears at the south side of the corridor (Figure 5). Depths are increasing with KP.

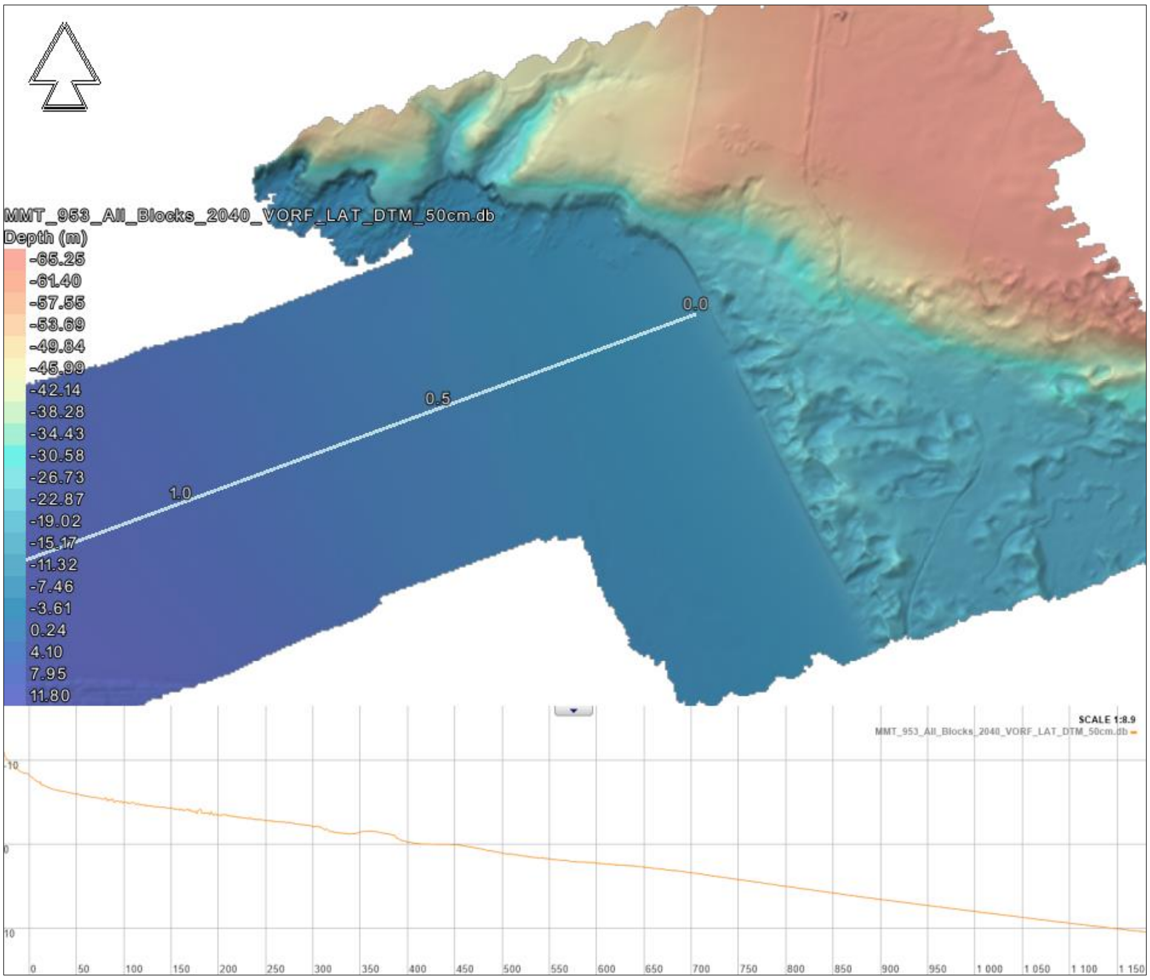


Figure 5 Shaded bathymetric relief and cross profile showing the shoreline at Freshwater West gently sloping out to KP 1.152.
Longitudinal profile (orange) depicts seabed along the route from KP 0.000 to KP 1.152. Negative values are above LAT (Profile vertical exaggeration: 1:8.9).

SURFICIAL GEOLOGY

The surficial geology in UK nearshore comprises of SAND. An area of megaripples is seen around KP 0.500.

SHALLOW GEOLOGY

The shallow geology in the UK nearshore area is typically characterised by a silty SAND unit over coarser SAND with some GRAVEL. These sediments overlie undulating BEDROCK, which can reach up to 2 m below the seabed surface.

5.1.2| DETAILED DESCRIPTION ROUTE OPTION RPL_09112018_REV0

A detailed presentation of the conditions and features in the UK nearshore corridor along the route are shown in Table 11.

Table 11 Seabed details route option RPL_09112018_REV0 KP 0.000 to KP 1.152.

KP	Associated Chart	Description	Remark
0.000- 1.152	102953-GRL-MMT-SUR-DWG-AL10KF01	**Bathymetry:** From KP 0.000 the seabed slopes gradually down through the intertidal zone to KP 0.340 where there is visible seabed movement at the surf zone of up to 0.7 m difference in depth. A sandbank has formed and migrated towards the beach over the course of three weeks between surveys, possibly due to a storm or the spring tide, see Figure 6. There are small ripples visible that run parallel to the shore in this area due to the oscillating movement of the waves. The ripples are no longer present from KP 0.620, where the seabed becomes smooth and flat and continues to gently slope deeper offshore down to 10 m. At KP 1.100 on the south side of the route there is the beginning of a rocky outcrop, see Figure 5.	Gentle gradient with a maximum value on the route of 5.5 degrees at KP 0.000. Depths range up to 10.02 m LAT on the route (Figure 7).
		Surficial geology: The surficial geology interpretation starts at KP 0.334 and consists of SAND. Megaripples are also present.	(Figure 8)
		Shallow Geology: The shallow geology interpretation starts at KP 0.498. A surface SAND unit of 1-2 m thickness is present over SAND with some GRAVEL. The underlying BEDROCK is generally >2 m below seabed.	(Figure 9)

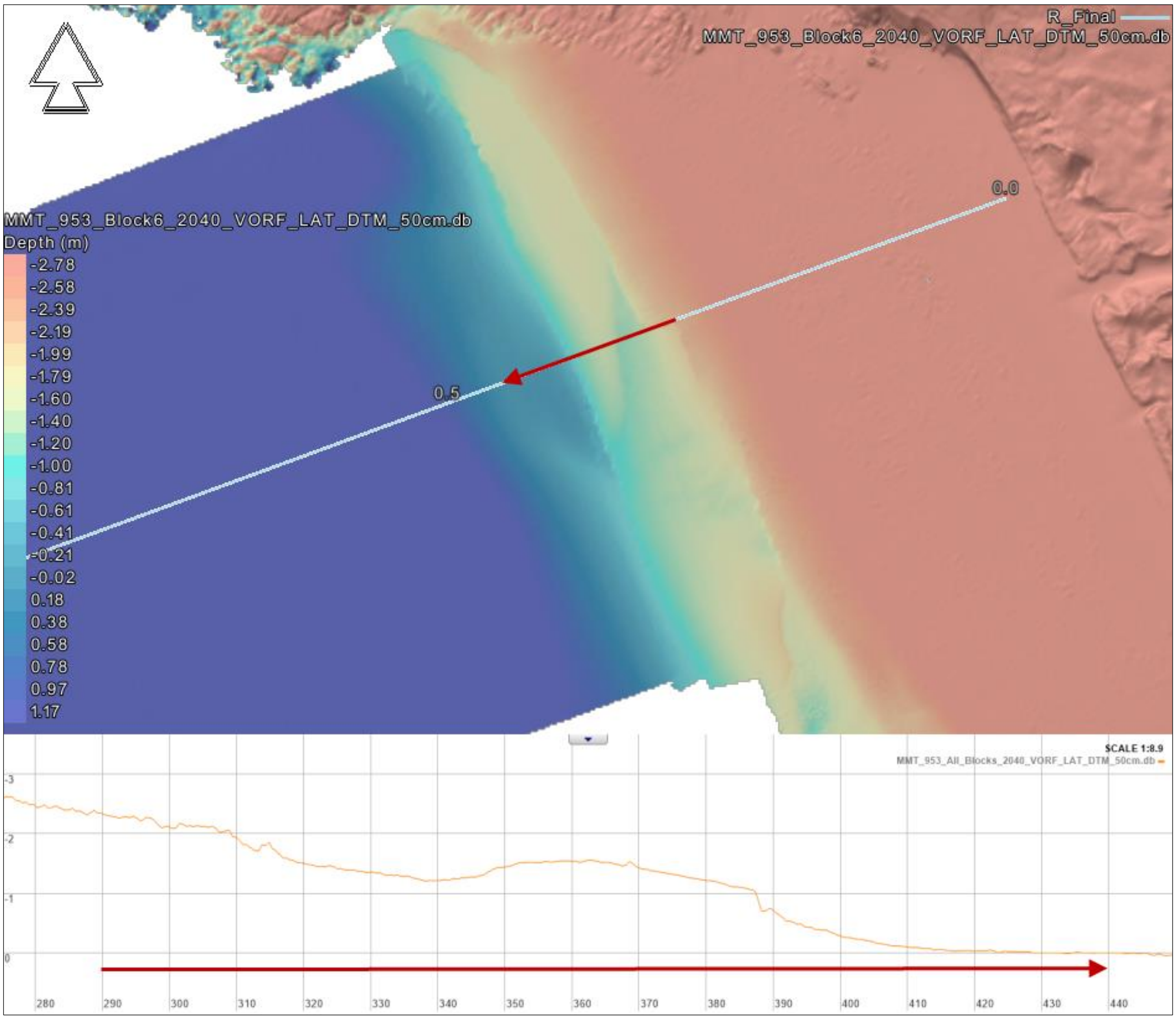


Figure 6 Shaded bathymetric relief showing mobile sediment in the surf zone.
The palette has been adjusted to highlight the area. Longitudinal profile (orange) depicts seabed along the route and the red arrows demonstrate the direction. Negative values are above LAT (Profile vertical exaggeration: 1:8.9).

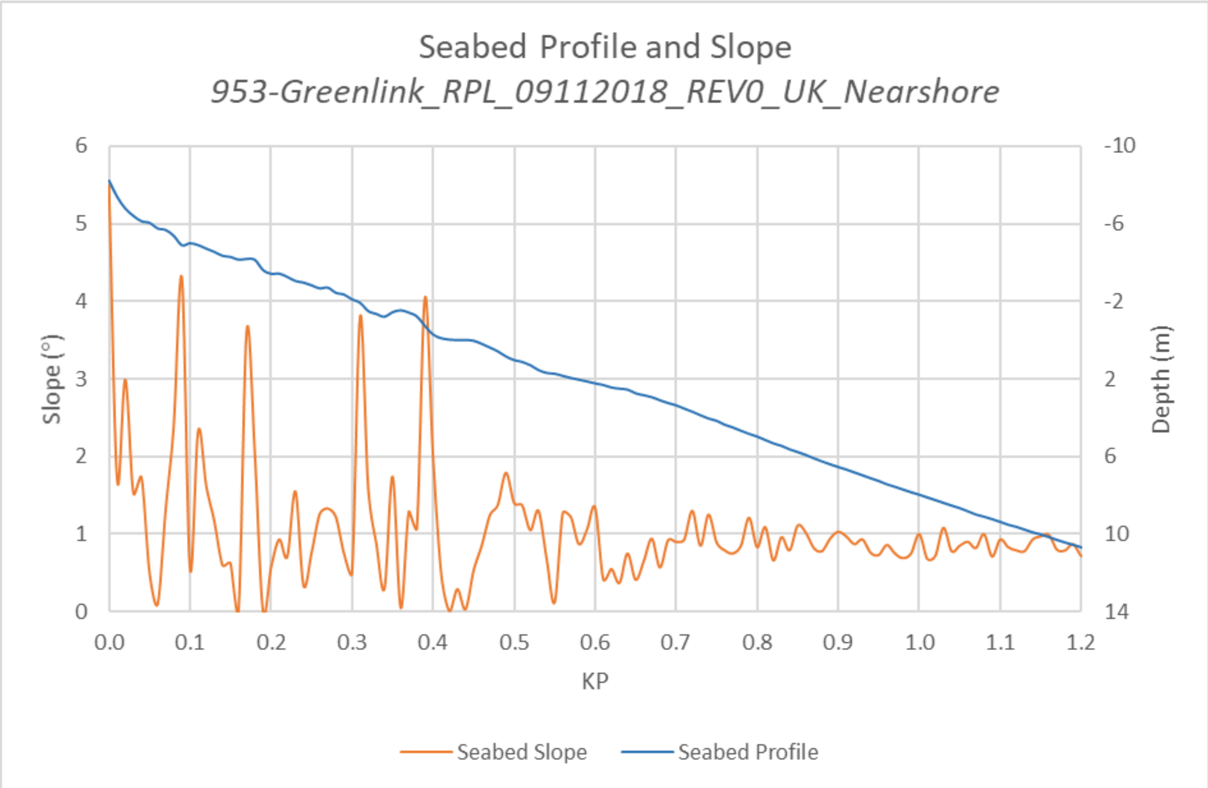


Figure 7 Seabed gradient and depth on the Final route between KP 0.000 – KP 1.152. Negative values are above LAT.

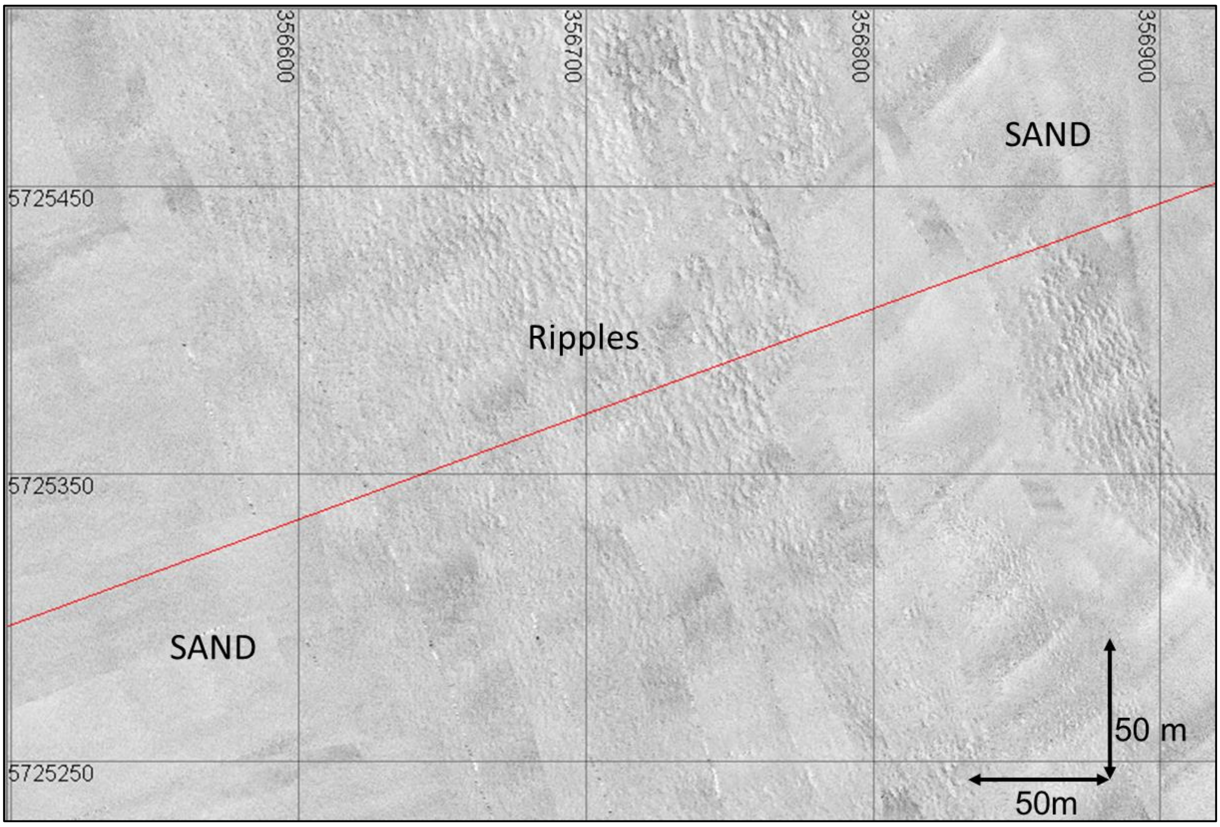


Figure 8 SSS plan view example from KP 0.315 to KP 0.762 showing SAND with Ripples. Image is north up.

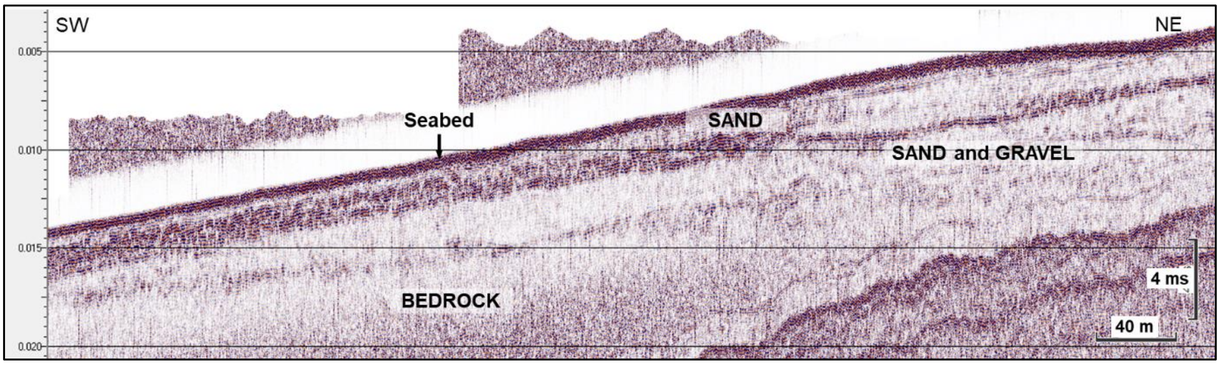


Figure 9 Innomar SBP data example from KP 0.537 to KP 1.063. Showing surface SAND layer overlying SAND and GRAVEL and BEDROCK.

5.1.3| CONTACTS AND ANOMALIES ROUTE OPTION RPL_09112018_REV0

No SSS contacts were identified from the data within the survey corridor in UK nearshore.

A total of 15 magnetic anomalies were detected in the UK nearshore corridor. Of these, 15 were unclassified (

Table 12)

A total of 0 SSS contact positions correlated with detected magnetic anomalies.

Table 12 Summary of UK nearshore magnetic anomalies.

CLASSIFICATION	NUMBER
Unclassified, possible objects	15
Cable	0
Total	**15**

5.2| UNITED KINGDOM OFFSHORE

5.2.1| OVERVIEW ROUTE OPTION RPL_09112018_REV0

Results are present for KP 1.152 to KP 73.906.

BATHYMETRY

Depths range from 10.02 m at KP 1.152, to 127.83 m on the route at KP 53.660. The depth reaches 130 m in the corridor to the north of the route at KP 53.693. Very gentle to gentle gradients in general with some moderate slopes in sandwave and ripple areas. Overall the depth is increasing with KP. The seabed has ripples, sandwaves, numerous boulder areas and occasional rocky outcrops.

SURFICIAL GEOLOGY

The surficial geology along the UK parts of the route is dominated by SAND or gravelly SAND/sandy GRAVEL, interrupted by areas of outcropping BEDROCK, the largest of which is seen between KP 2.000 and KP 5.000. In this area, the route is routed in a narrow channel like formation between areas of outcropping BEDROCK.

Mobile sediments are common along this part of the route. Most common are the megaripples, ranging in wavelength between 5 m and 25 m, however ripples <5 m wavelength are also seen. An area with sandwaves is present between KP 25.685 and KP 26.408.

Boulder fields are seen in several instances in this section. The density of boulders in the fields vary, from occasional to numerous. The largest boulder field area is present between KP 20.198 and KP 22.532. The boulders in the survey area range in height from very small up to 2.3 m.

SHALLOW GEOLOGY

The shallow geology is characterised by a gravelly to silty surface SAND unit overlying BEDROCK or/and TILL over large parts of the Welsh platform. The layer of SAND and TILL thickens as the southern extent of the St. George's Channel trough is reached.

The surface SAND unit is almost continuous and varies in thickness between 1 and 4 m. It reaches a thickness of >10 m in a sand accumulation between KP 5.120 and KP 9.520. The base of the SAND unit is not resolved in the seismic data from KP 42.853 to KP 45.746. The SAND unit can reach thicknesses of up to 6 m in the bathymetric trough beyond KP 44.620. The geotechnical sampling shows that the surface layer commonly comprises SAND, but local variations are seen where the amount of GRAVEL and CLAY might be significant.

BEDROCK is close to the seabed, often within 3 m, between KP 1.890 and KP 3.765 where the route leads through the trough of a channel, closely surrounded by BEDROCK to either side. The bedrock is also close to seabed surface between KP 9.520 to KP 24.900.

A distinction between BEDROCK and TILL based on the available seismic data is difficult between KP 25.700 and KP 44.500 as a lower boundary of TILL is not resolved. The geotechnical samples in this area terminate close to the upper boundary of the interpreted TILL and does not provide much more information regarding the boundary between the TILL and the BEDROCK below. TILL is present as a thick sediment unit within the trough beyond KP 44.620. Geotechnical results show that the TILL in the area typically comprises mainly high strength, stiff CLAY with varying fractions of sand, gravel and silt.

Incisions in the TILL or BEDROCK with channel infill sediments are present from KP 22.640.

5.2.2| DETAILED DESCRIPTION ROUTE OPTION RPL_09112018_REV0

A detailed presentation of the conditions and features in the UK offshore corridor along the route are presented in Table 13.

Table 13 Seabed details route option RPL_09112018_REV0 KP 1.152 to KP 73.906.

KP	Associated Chart	Description	Remark
1.152 - 4.997	102953-GRL-MMT-SUR-DWG-AL10KF01	**Bathymetry:** The seabed continues to slope gently and smoothly towards KP 2.260 where there is a drop of approximately 1 m, see Figure 10. From here the seabed has ripples until KP 2.850 where it becomes smooth again amongst the rocky outcrops that flank the route. Ripples can also be observed between KP 3.600 and KP 3.750, and between KP 4.500 and KP 4.660.	Gentle to moderate gradients with a maximum of 12.26 degrees on a large rock in the centre of the route at KP 2.400, otherwise slopes ranging up to 8.91 degrees. Depths range up to 35.05 m on the route (Figure 13).
		Surficial geology: The surficial geology consists of mainly SAND and gravelly SAND to sandy GRAVEL. Small areas of BEDROCK outcrops are seen on the route between KP 2.214 and KP 4.873 and KP 4.997. Large areas of BEDROCK are outcropping <50 m to either side of the route. Occasional ripples and megaripples are present throughout.	Backscatter data was used for interpretation between KP 4.028 and KP 4.583. Bedrock outcrop on the route between: • KP 2.214 and KP 2.788 • KP 4.873 and KP 4.997 (Figure 14)
		Shallow Geology: From KP 1.152 to KP 2.213 the surface silty SAND unit of 1-2 m is underlain by gravelly SAND or sandy GRAVEL and BEDROCK. BEDROCK is subcropping with a thin SAND cover between KP 2.213 and KP 2.862 and outcropping at KP 2.388. From KP 2.862 to 4.997 BEDROCK is overlain by a surface SAND unit of 2-4 m	Geotechnical results shows absence of cohesive material, apart from KP 1.374, where SILT is recovered below 1.33 m (VC -094).
4.997 - 9.520	102953-GRL-MMT-SUR-DWG-AL10KF01 102953-GRL-MMT-SUR-DWG-AL10KF02	**Bathymetry:** The rocky outcrop stops flanking the route at KP 5.000 giving way to ripples and sandwaves across the corridor. The depth decreases gently until KP 5.680 where it levels out until KP 8.500. From here the depth begins to increase again.	Very gently to occasional moderate gradients, with a maximum value of 5.26 degrees. Depths range up to 44.27 m on the route (Figure 13).

KP	Associated Chart	Description	Remark
		Surficial geology: The surficial geology consists mainly of SAND with occasional areas of gravelly SAND to sandy GRAVEL. Megaripples covers this entire route section.	(Figure 15) Possible unknown cable identified during the UXO survey at KP 6.325 (Figure 64)
		Shallow Geology: A thick SAND unit up to 10 m thick is overlying BEDROCK. The unit thins towards KP 9.520 where the depth to BEDROCK becomes ~1.5 m .	
9.520 - 22.662	102953-GRL-MMT-SUR-DWG-AL10KF02 102953-GRL-MMT-SUR-DWG-AL10KF03	**Bathymetry:** Depth increases gently throughout. At KP 10.099 the ripples grow smaller and boulders appear between KP 11.318 and KP 12.000. More boulders are present on the north side of the route corridor from KP 13.268. At KP 13.385 the seabed is smooth with fewer ripples and numerous boulders throughout.	Very gentle to gentle gradients, with a maximum value of 3.74 degrees. Depths range up to 58.83 m on the route (Figure 13).
		Surficial geology: The surficial geology comprises mainly gravelly SAND to sandy GRAVEL. One BEDROCK outcrop is present at route centre line between KP 11.041 and KP 11.136. Ripples and megaripples are present from the start of the section up until KP 13.420. Fields with occasional boulders are crossing the route at several locations in this section.	BEDROCK outcrop crossing the route between: • KP 11.040 and KP 11.136 Boulder fields crossing the route between: • KP 11.500 and KP 11.574 • KP 11.788 and KP 11.831 • KP 16.002 and KP 16.623 • KP 16.557 and KP 16.961 • KP 17.839 and KP 18.134 • KP 19.237 and KP 19.312 • KP 19.429 and KP 19.587 • KP 20.200 and KP 22.535 (Figure 16)

KP	Associated Chart	Description	Remark
		Shallow Geology: The surface SAND unit is generally 1.5 m thick. It overlies BEDROCK with some possible coarse sediment or TILL on its top. A distinct boundary between coarse sediment and BEDROCK is not resolved in the seismic data.	Geotechnical results show very weak to weak, thinly laminated carbonaceous MUDSTONE below 0.3 m at KP 11.758 (VC-004, CPT-004).
22.662 - 34.989	102953-GRL-MMT-SUR-DWG-AL10KF03 102953-GRL-MMT-SUR-DWG-AL10KF04 102953-GRL-MMT-SUR-DWG-AL10KF05	**Bathymetry:** A rocky outcrop is observed at KP 23.590. Large ripples and sandwaves are present between KP 25.685 and KP 26.390 (see Figure 11) and ripples and boulders continue to be present on the route up to KP 34.989.	Gentle to moderate gradients in general, with a maximum value of 11.72 degrees at the sandwave at KP 26.02. Depths range up to 61.97 m on the route (Figure 13).
		Surficial geology: The surficial geology consists of alternating gravelly SAND to sandy GRAVEL and SAND. Minor areas of BEDROCK outcropping are present. Large parts of this section are covered with seabed features such as ripples and megaripples. One area with sandwaves is also seen. Boulder fields of different densities are seen on several locations along the route.	BEDROCK crossing the route between: • KP 24.178 and KP 24.202 Boulder fields present at the route between: • KP 24.924 and KP 25.439 • KP 33.914 and KP 34.368 (Figure 17 and Figure 18)
		Shallow Geology: The surface SAND unit is generally 1-3 m thick, up to 10 m in sandwaves. It overlies BEDROCK up to KP 26.414 and TILL from thereon. No clear distinction between TILL and BEDROCK can be made from the available seismic data. Several Channel infill sediments, typically comprising CLAY are present from KP 22.662 to KP 24.769, KP 27.364 to KP 28.502, KP 31.331 to KP 31.931 and KP 33.694 to KP 34.142.	(Figure 21)
34.989 - 37.980	102953-GRL-MMT-SUR-DWG-AL10KF05	**Bathymetry:** Very gently deepening seafloor continuing from KP 34.989. Occasional boulders are observed on an otherwise smooth seabed.	Very gentle to gentle slopes overall with a maximum value of 1.23 degrees. Depths range up to 64.43 m on the route (Figure 13).

KP	Associated Chart	Description	Remark
		Surficial geology: The surficial geology consists of mainly gravelly SAND to sandy GRAVEL and of SAND.	
		Shallow Geology: The surface SAND unit is generally 2-4 m thick and overlies TILL. Two channel infills are present. A lower boundary for the TILL unit or BEDROCK is not resolved in the seismic data.	
37.980 - 40.914	102953-GRL-MMT-SUR-DWG-AL10KF05 102953-GRL-MMT-SUR-DWG-AL10KF06	**Bathymetry:** Gently deepening seafloor up to KP 40.174 where the depth increases more rapidly for a short time until KP 40.366 where the depth begins to decrease gently. From KP 40.504 the seabed depth changes little up to KP 40.914.	Very gentle to gentle gradient with a maximum value of 3.41 degrees. Depths range up to 68.29 m on the route (Figure 13).
		Surficial geology: The surficial geology consists of mainly gravelly SAND to sandy GRAVEL. One field with numerous boulders is present, crossing the route between KP 38.108 and KP 38.571.	
		Shallow Geology: A deep basin with surface SAND and channel infill sediments over TILL characterize this section. The channel infills reach up to 16 m below seabed. TILL is overlying BEDROCK which is generally >8 m below seabed, but reaches within 2 m of the surface at KP 38.144.	
40.914 - 45.756	102953-GRL-MMT-SUR-DWG-AL10KF06	**Bathymetry:** Depth changes little from KP 40.914 until KP 41.572 where it begins to increase gently until it decreases from KP 41.931. There is a rocky outcrop at KP 42.070 and the seabed has patches of ripples. The depth increases gently again from KP 42.366 and the seabed is smooth until KP 43.881 where the seabed becomes uneven. Occasional boulders are observed throughout and at KP 45.619 trawl marks are observed on the south side of the corridor.	Very gentle to gentle slopes overall with a maximum value of 5.18 degrees on a rocky outcrop at KP 42.07. Depths range up to 80.90 m on the route (Figure 13).

KP	Associated Chart	Description	Remark
		Surficial geology: The surficial geology consists of mainly gravelly SAND to sandy GRAVEL interrupted by minor areas of SAND and outcropping BEDROCK. Megaripples are present between KP 41.847 and KP 42.424.	BEDROCK outcropping on the route between: KP 42.065 and KP 42.104
		Shallow Geology: This section starts with a surface SAND unit basin of up to 5 m thickness until KP 42.065. From there the SAND is discontinuous and if present underlain by channel infill sediments. SAND and channel infills overlie TILL/BEDROCK. The boundary between TILL and BEDROCK is not resolved in the seismic data. BEDROCK is outcropping at the seabed at KP 42.065. Penetration is limited between KP 42.860 und KP 44.505 and the lower boundary of TILL is not resolved. TILL/BEDROCK are here overlain by a veneer of gravelly SAND and sandy GRAVEL. The top of BEDROCK becomes discernible again at KP 44.505 and is overlain by TILL with a veneer of mobile sediments.	
45.756 - 48.233	102953-GRL-MMT-SUR-DWG-AL10KF06	**Bathymetry:** The seabed continues to deepen gently. At KP 46.517 trawl marks are observed.	Very gentle to gentle gradients with a maximum value of 4.49 degrees. Depths range up to 86.41 m on the route (Figure 13).
		Surficial geology: The surficial geology consists of mainly gravelly SAND to sandy GRAVEL with no seabed features.	
		Shallow Geology: The surface SAND unit is varying between 0.5 and 5 m. The Underlying TILL/BEDROCK is dipping down and is generally 10 m below seabed surface.	(Figure 22) Organic material found in upper parts of geotechnical sample at KP 47.645 (VC-102)
48.233 - 59.641	102953-GRL-MMT-SUR-DWG-AL10KF06	**Bathymetry:** Gently to moderately deepening seafloor until KP 52.959 where the seabed undulates until KP 59.387. Occasional boulders and sporadic patches of ripples are present throughout.	Very gentle to moderate gradients with a maximum value of 8.22 degrees at KP 53.29. Depths range up to 127.83 m on the route (Figure 13).

KP	Associated Chart	Description	Remark
	102953-GRL-MMT-SUR-DWG-AL10KF07 102953-GRL-MMT-SUR-DWG-AL10KF08	**Surficial geology:** The surficial geology consists of alternating areas of SAND and gravelly SAND to sandy GRAVEL. Fields with occasional boulders are present at some locations. Ripples, megaripples and sandwaves are present throughout.	Boulder field crossing the route between: KP 53.137 and KP 53.467 (Figure 19)
		Shallow Geology: The surface SAND unit is generally around 1 m thick, up to 5 m between 46.412 and KP 48.754. TILL is present below the SAND with some channel infills between KP 57.609 and KP 58.616. BEDROCK is generally around 4-10 m below seabed. It reaches within 2-3 m of the seabed from KP 50.833 to KP 51.540.	
59.641 - 73.906	102953-GRL-MMT-SUR-DWG-AL10KF08 102953-GRL-MMT-SUR-DWG-AL10KF09	**Bathymetry:** Depths remain steady with some undulation. Occasional boulders and ripples are present throughout, with larger ripples and sandwaves between KP 63.275 and KP 73.906, see Figure 12	Very gentle to moderate gradients with a maximum value of 5.82 degrees. Depths range up to 116.18 m on the route (Figure 13).
		Surficial geology: The surficial geology consists mainly of SAND. Almost the entire section is covered by features indicating mobile sediment, such as ripples, megaripples and sandwaves. Trawl marks, indicating fishing activity are also present with different densities within the section.	Trawl marks are abundant. Cable crossing: Pan European Crossing 2 at KP 59.791 (Figure 20)
		Shallow Geology: The surface SAND unit it generally <2 m thick, slightly more in areas of sandwaves, up to 5 m from KP 59.641 to KP 61.706. The underlying TILL unit is thick and the boundary to BEDROCK is generally >10 m. Channel infill sediment is present between SAND and TILL from KP 66.947 to KP 70.198.	

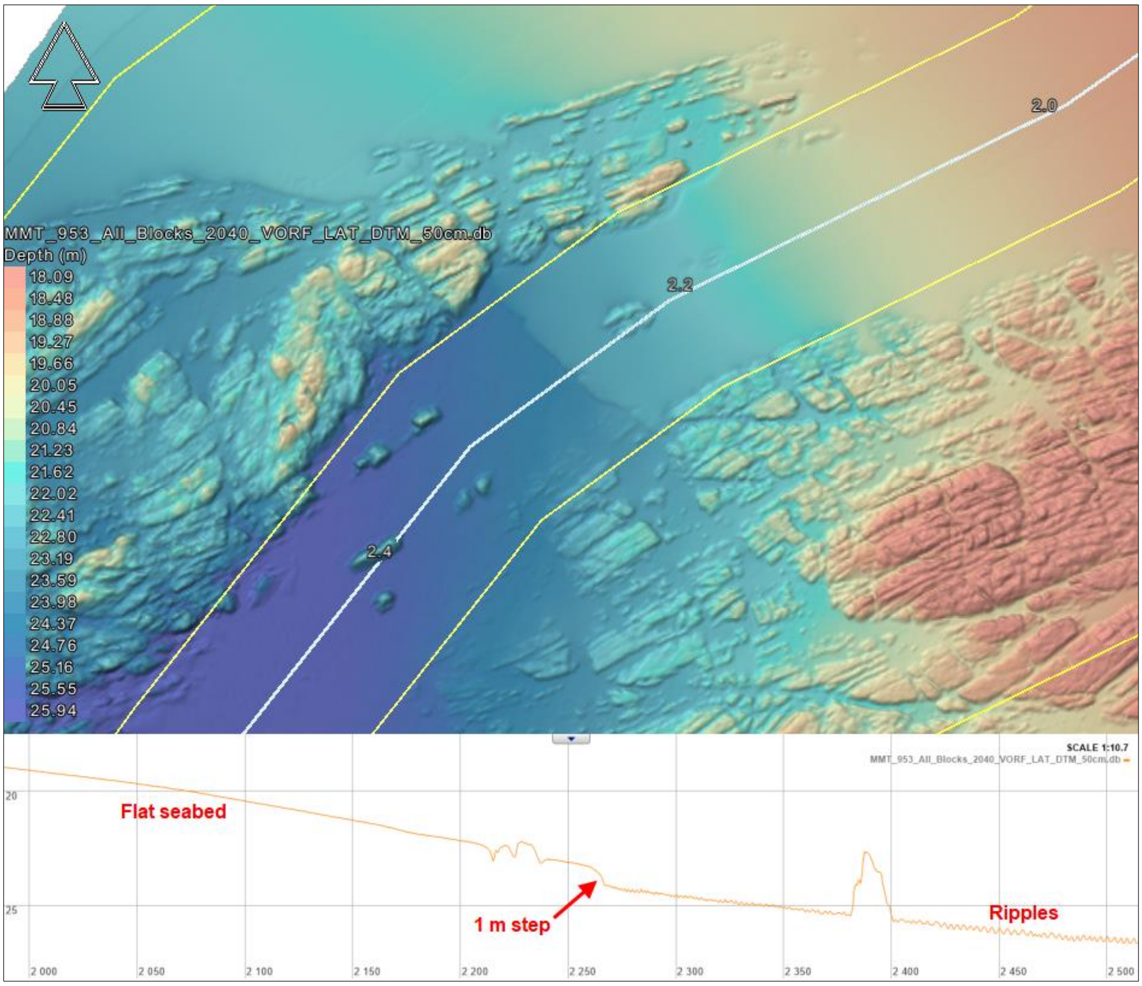


Figure 10 Shaded bathymetric relief showing the seabed gradually sloping deeper until a 1 m step at KP 2.26 where ripples begin to appear.
Longitudinal profile (orange) depicts seabed along the route from KP 2.000 to KP 2.500. (Profile exaggeration 1:10.7).

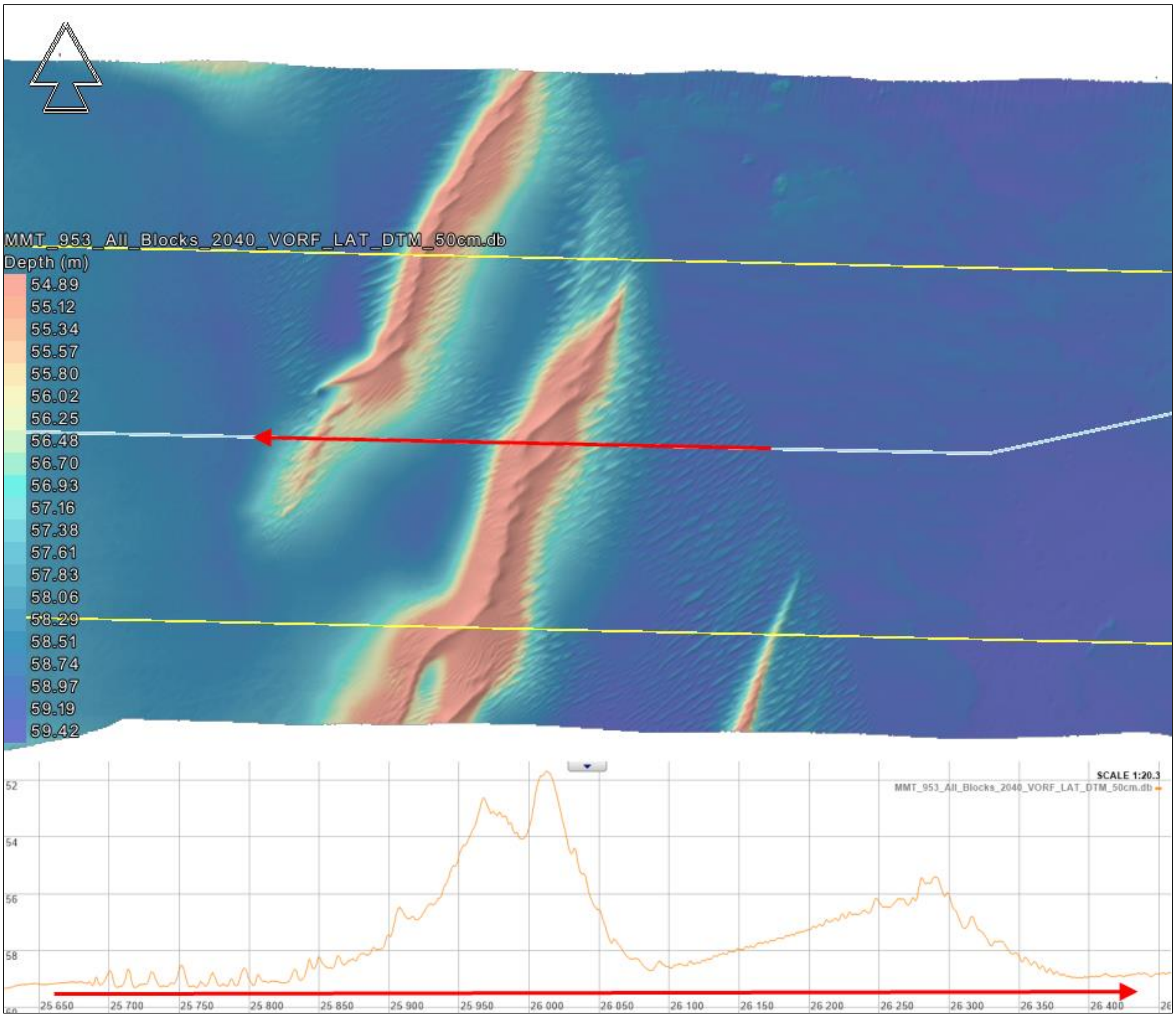


Figure 11 Shaded bathymetric relief showing ripples and sandwaves between KP 25.685 and KP 26.390.
Longitudinal profile (orange) depicts seabed along the route along the direction of the red arrow. (Profile exaggeration is 1:20.3). The palette has been adjusted to highlight the bathymetry.

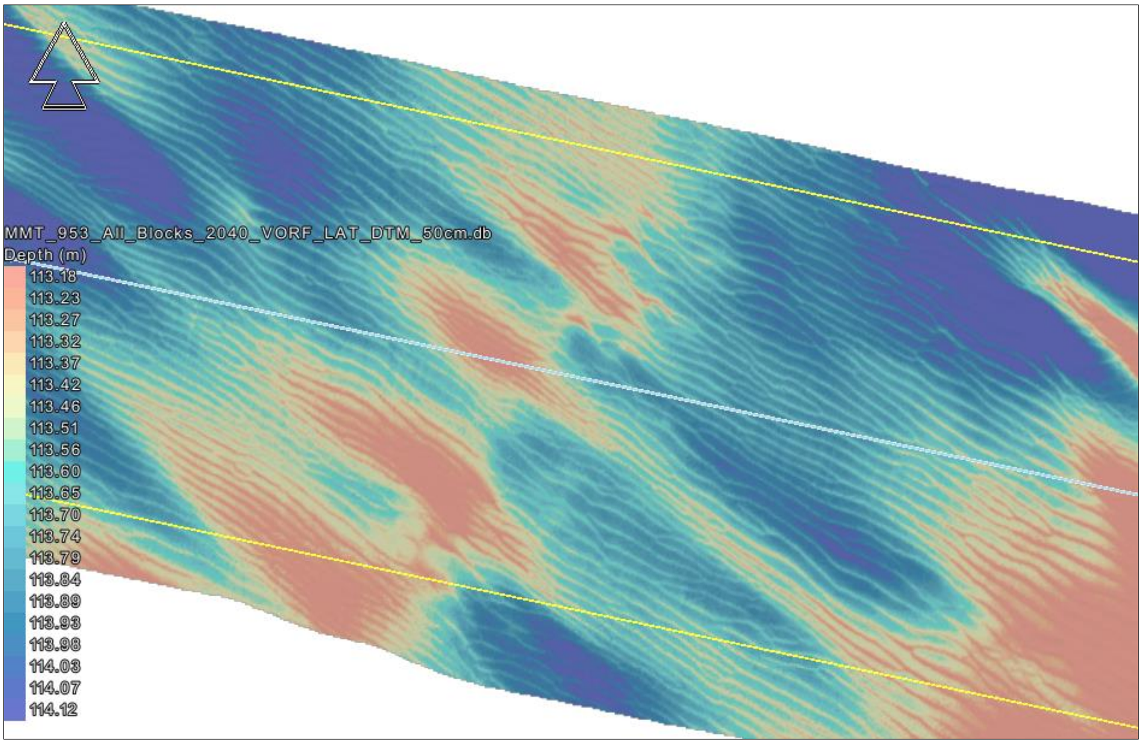


*Figure 12 Shaded bathymetric relief showing ripples at KP 71.917.
The palette has been adjusted to highlight the bathymetry.*

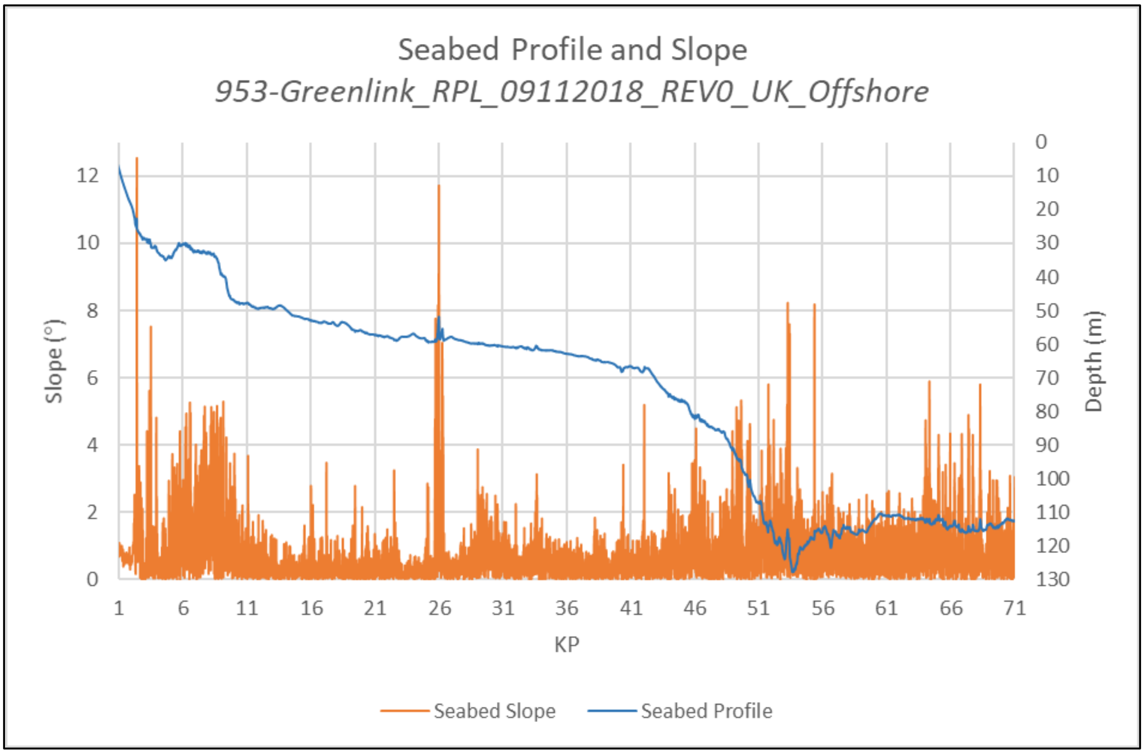


Figure 13 Graph presenting seabed gradient and depth on the Final route in the UK offshore section between KP 1.152 and KP 73.906.

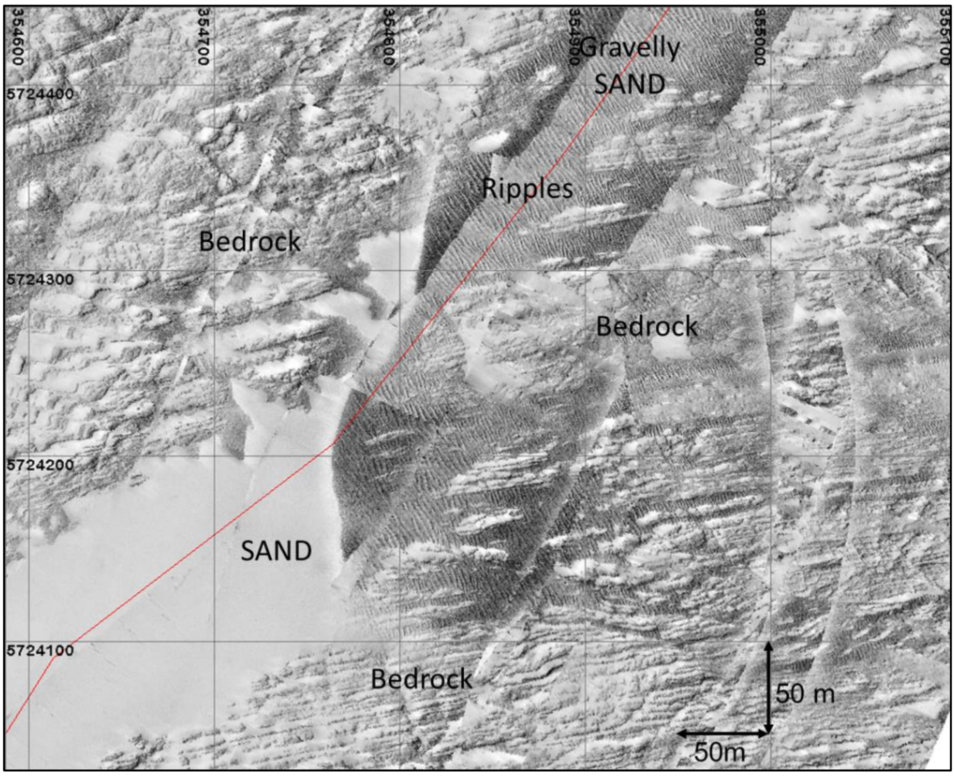


Figure 14 SSS plan view example from KP 2.565 to KP 3.099.
Showing a channel of rippled gravelly SAND and SAND between BEDROCK. Image is north up.

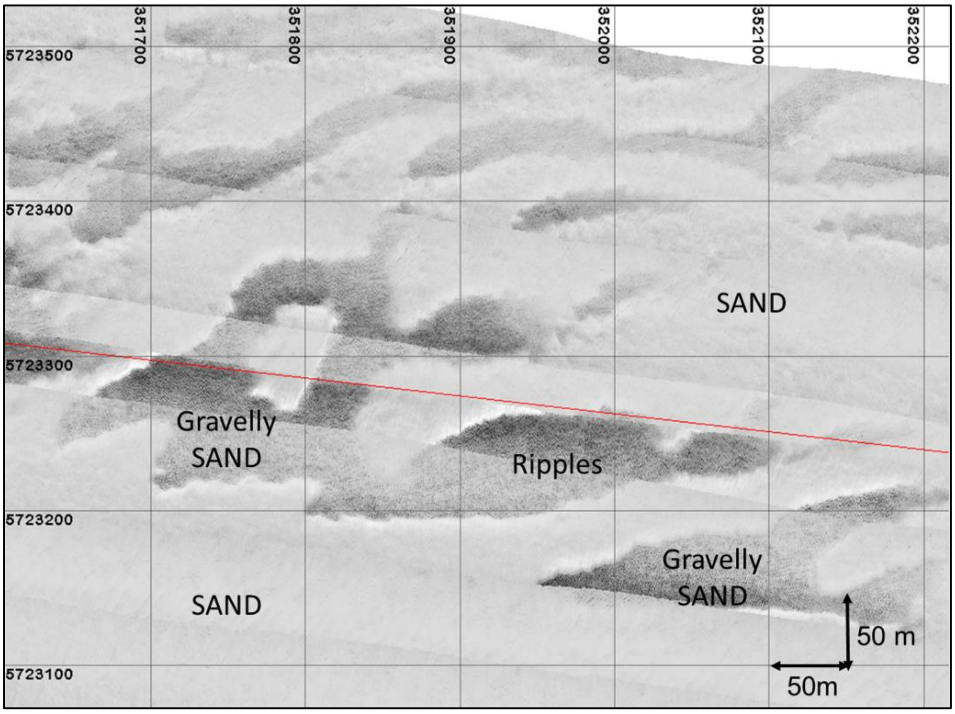


Figure 15 SSS plan view example from KP 6.174 to KP 6.787.
Showing patches of rippled gravelly SAND and SAND. Image is north up.

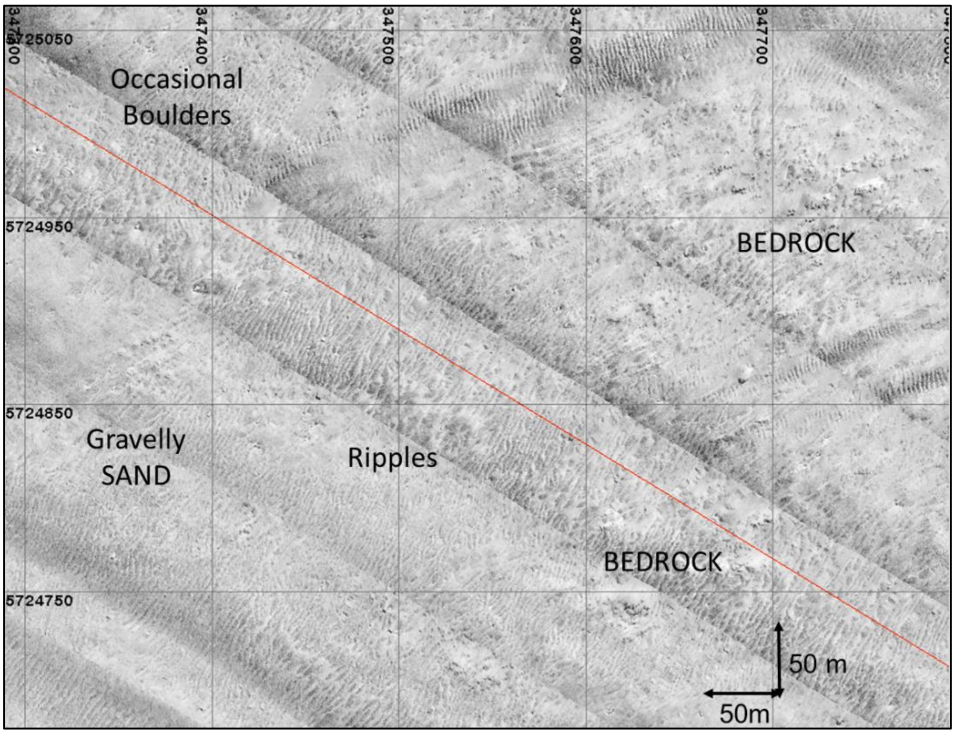


Figure 16 SSS plan view example from KP 10.951 to KP 11.476.
Showing rippled gravelly SAND with occasional boulders between outcropping BEDROCK. Image is north up.

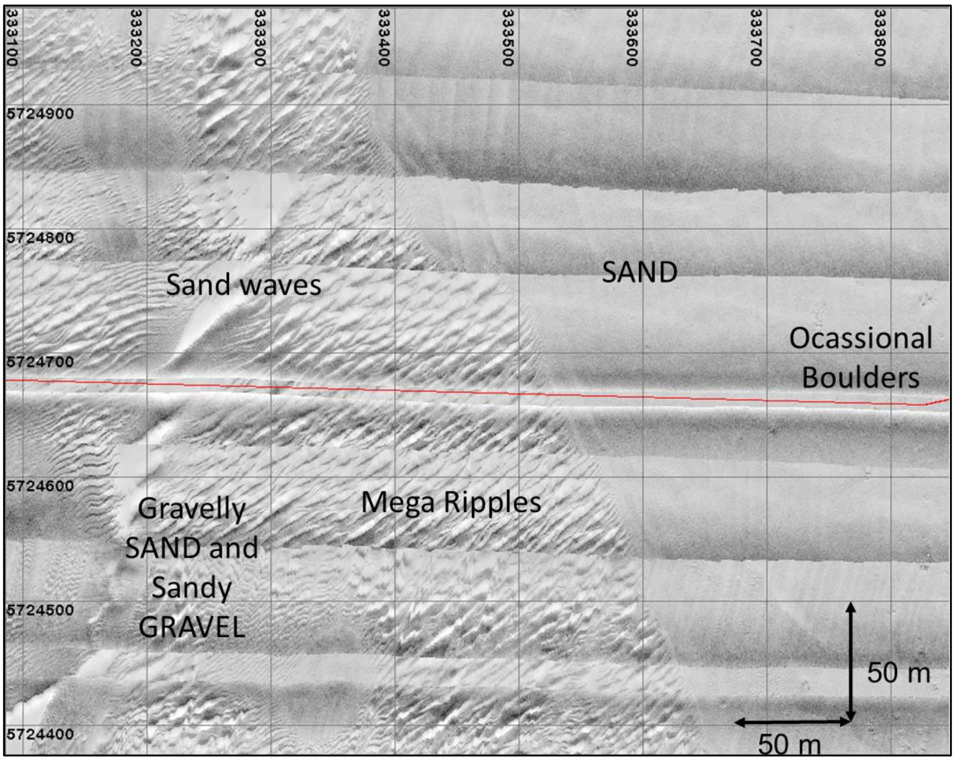


Figure 17 SSS plan view example from KP 25.369 to KP 26.129.
Showing SAND with occasional boulders and gravelly SAND and sandy GRAVEL with sandwaves and megaripples. Image is north up.

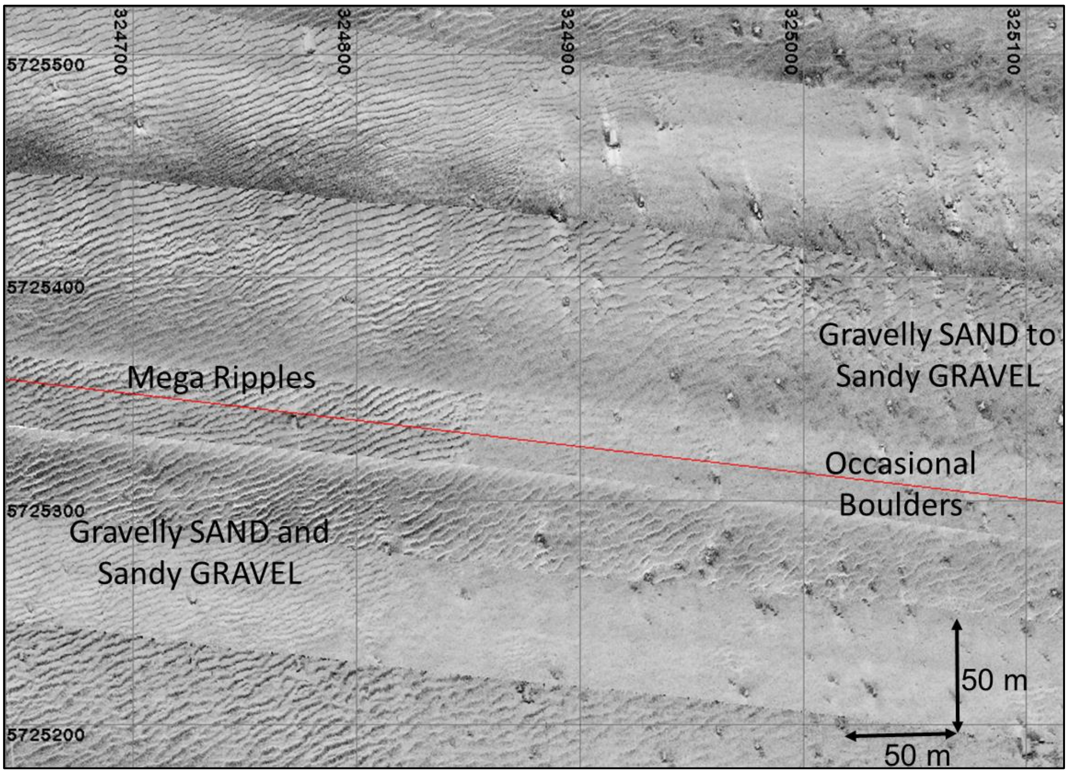


Figure 18 SSS plan view example from KP 34.118 to KP 34.609.
Showing gravelly SAND to sandy GRAVEL with occasional boulders. Image is north up.

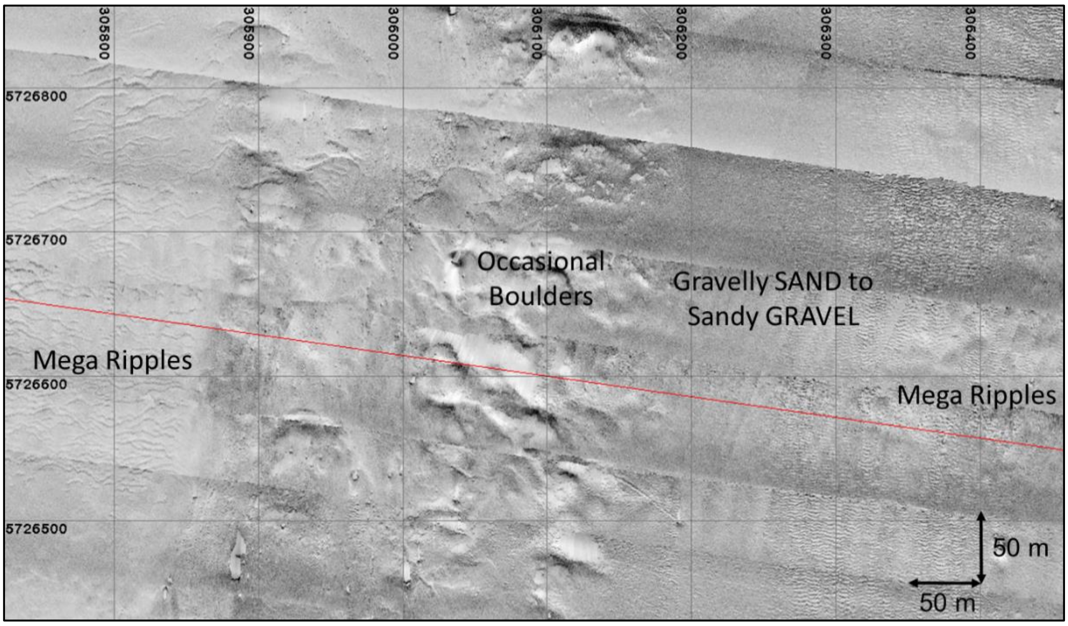


Figure 19 SSS plan view example from KP 52.858 to KP 53.602.
Showing gravelly SAND to sandy GRAVEL with areas of megaripples and occasional boulders. Image is north up.

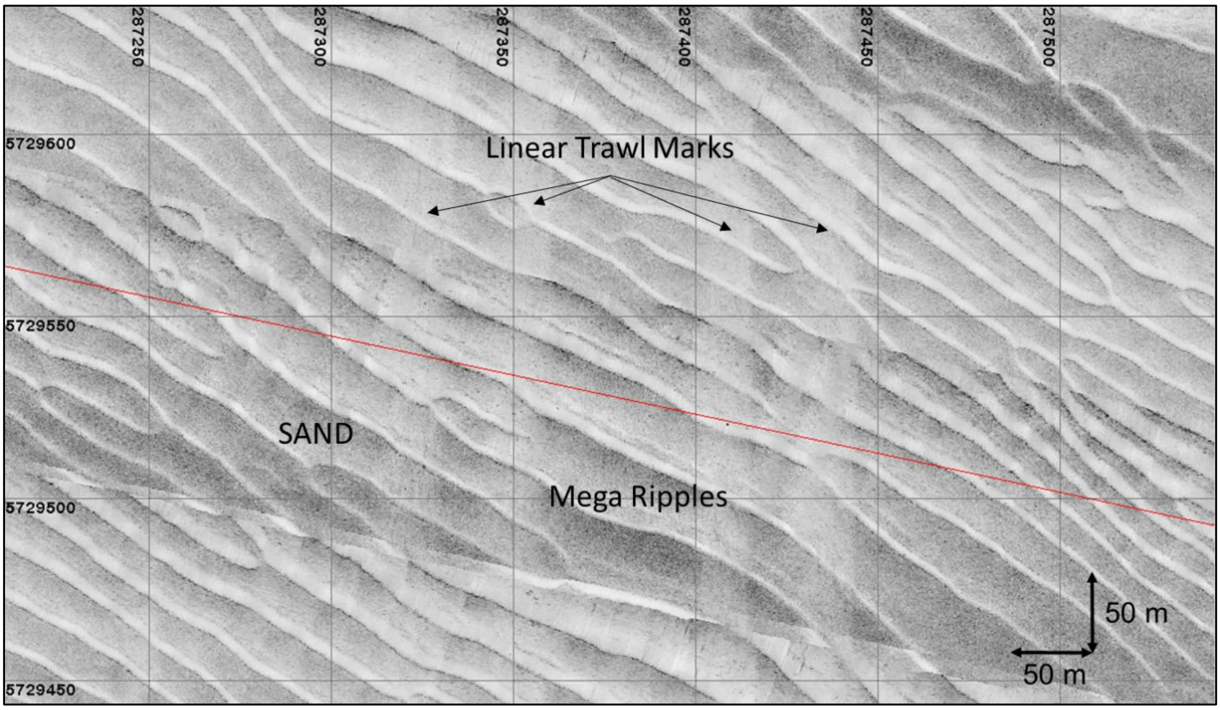


Figure 20 SSS plan view example from KP 72.011 to KP 72.349.
Showing SAND with megaripples and pairs of trawl marks. Image is north up.

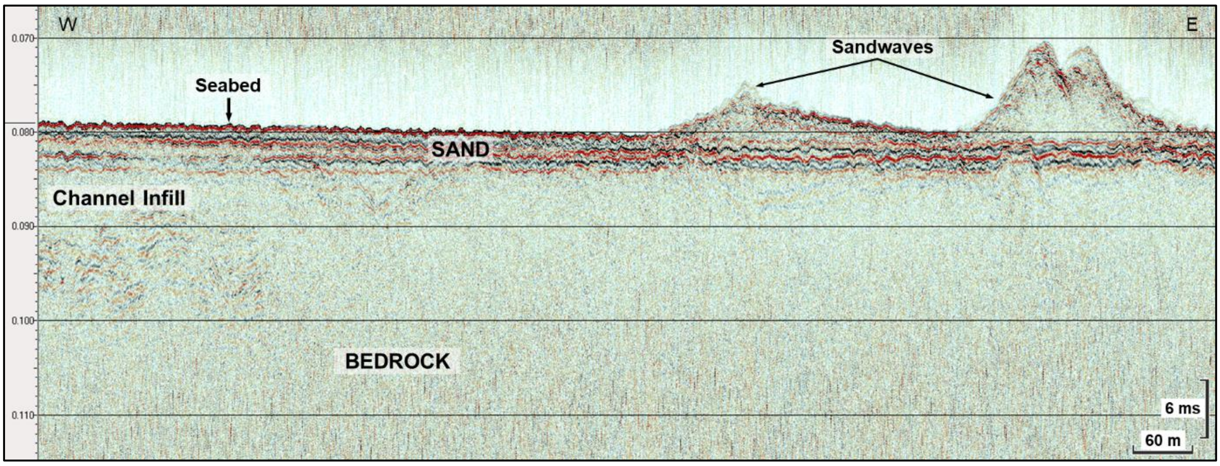


Figure 21 Sparker SBP data example from KP 25.835 to KP 26.950.
Showing surface SAND unit with sandwaves overlying a channel infill to the right and BEDROCK.

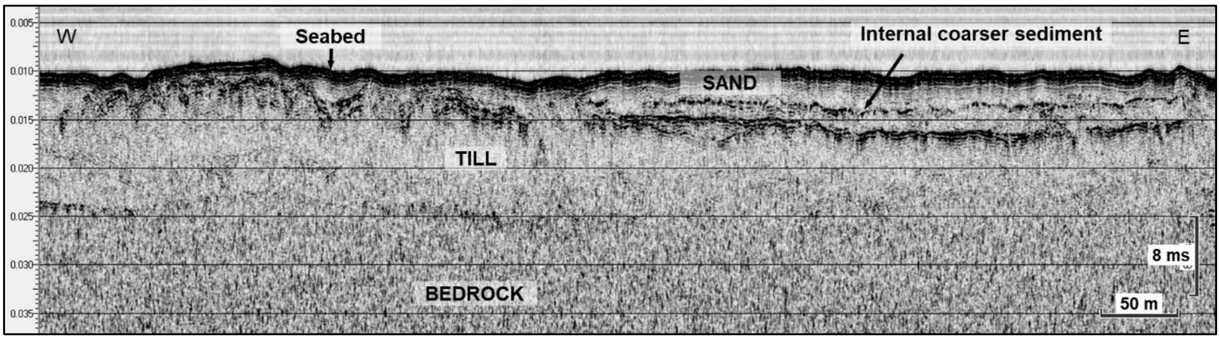


Figure 22 Chirp SBP data example from KP 46.540 to KP 47.320.
Showing surface SAND unit with coarse internal reflector overlying an erosional TILL surface and BEDROCK.

5.2.3| CONTACTS AND ANOMALIES ROUTE OPTION RPL_09112018_REV0

A total of 2690 SSS contacts were identified from the data within the survey corridor in UK offshore. The majority of the contacts were classified as either boulders or debris.

The SSS contacts are summarised in Table 14.

A total of 162 magnetic anomalies were detected in the UK offshore corridor. Of these, 161 were unclassified, 1 was a known wreck, a steel-hulled steamship, Saint Jacques (Table 15).

A total of 7 SSS contact positions correlated with detected magnetic anomalies from the geophysical survey and a total of 20 SSS contact positions correlated with detected magnetic anomalies from the UXO survey.

Table 14 Summary of UK offshore SSS contacts, route option RPL_09112018_REV0.

CLASSIFICATION	NUMBER
Boulder	2559
Other	5
Debris	125
Wreck	1
Total	**2690**

Table 15 Summary of UK offshore magnetic anomalies, route option RPL_09112018_REV0.

CLASSIFICATION	NUMBER
Unclassified, possible objects	161
Wreck	1
Cable	0
Total	**162**

5.2.4| OVERVIEW ROUTE OPTION A

Results are presented for KP 3.647 to KP 24.907 along route option A.

All KPs refer to route option A, RPL Route_A_WGS84_UTM30N_Rev1_20180521.

BATHYMETRY

Route A has a maximum depth of 59.66 m at KP 24.800 and is generally increasing in depth. The seabed is rocky to begin with, then ripples with sandwaves are observed before becoming rocky again. At the end of this section the seabed becomes smooth with occasional boulders. Gradients are very gentle to gentle with localised very steep slopes on the rocky areas.

SURFICIAL GEOLOGY

The surficial geology in Route Option A comprises outcropping BEDROCK in large parts. Between the BEDROCK outcrops, minor areas of gravelly SAND/sandy GRAVEL are seen. At the end of the section, the surficial geology comprises of mostly SAND.

Megaripples are common on the loose sediments in the section. Boulder fields are sparse, but some are seen in the survey corridor of Route Option A.

SHALLOW GEOLOGY

The shallow geology along route option A is characterised by outcropping BEDROCK and one large, thick SAND accumulation from KP 5.100 to KP 10.015. Deep incisions in the BEDROCK filled by channel infill sediments are present between KP 22.300 and KP 24.907.

5.2.5| DETAILED DESCRIPTION ROUTE OPTION A

A detailed presentation of the conditions and features in the UK offshore corridor along route option A are shown in Table 16.

Table 16 Seabed details route option A KP 3.647 to KP 24.909.

KP	Associated Chart	Description	Remark
3.647 - 5.094	102953-GRL-MMT-SUR-DWG-AL10KA01	**Bathymetry:** Rocky area with generally gentle depth changes and localised steeper slopes across the rocks, see Figure 23.	Very gentle to moderate gradient with locally very steep slopes of a maximum value of 20.37 degrees on the rocky areas. Depths range up to 34.56 m on the route (Figure 26).
		Surficial geology: The surficial geology consists of mainly BEDROCK and occasional areas consisting of gravelly SAND/ sandy GRAVEL. Megaripples are also present within the section.	Bedrock outcrops crossing the route between: • KP 3.803 and KP 3.829 • KP 3.846 and KP 3.920 • KP 4.008 and KP 5.094 (Figure 27)
		Shallow Geology: BEDROCK is outcropping.	(Figure 30)
5.094 - 8.879	102953-GRL-MMT-SUR-DWG-AL10KA01 102953-GRL-MMT-SUR-DWG-AL10KA02	**Bathymetry:** At KP 5.094 the rocky seabed becomes rippled and sandwaves are observed to KP 7.100, see Figure 24. Depth decreases gently to KP 5.970 where it begins to very gently increase again. Ripples are present throughout.	Very gentle to gentle gradients overall with localised moderate slopes of a maximum value of 5.41 degrees on the sandwaves. Depths range up to 34.68 m on the route (Figure 26).
		Surficial geology: The surficial geology consists of mainly SAND and occasional areas consisting of gravelly SAND/sandy GRAVEL. Minor areas with occasional boulders sparsely occurring. Megaripples are present throughout.	Boulder field crossing the route between: KP 7.799 and KP 7.870
		Shallow Geology: A thick SAND accumulation of up to 10 m thick is overlying BEDROCK.	(Figure 30)
8.879 - 10.865	102953-GRL-MMT-SUR-DWG-AL10KA02	**Bathymetry:** Between KP 8.879 and KP 10.400 the seabed depth increases gently by approximately 14 m then flattens until KP 10.865. Ripples are observed throughout.	Gently sloping seabed with a maximum value of 4.85 degrees on a ripple. Depths range up to 48.63 m on the route (Figure 26).

KP	Associated Chart	Description	Remark
		Surficial geology: The surficial geology consists of alternating areas of gravelly SAND/ sandy GRAVEL and SAND. Megaripples are present up to KP 10.337	
		Shallow Geology: The thick SAND layer continues to KP 10.015 where it pinches out to a thin layer of SAND over BEDROCK.	
10.865 - 22.310	102953-GRL-MMT-SUR-DWG-AL10KA02	**Bathymetry:** From KP 10.865 the seabed is rocky and gently becoming deeper throughout.	Very gentle to gentle gradient with localised very steep slopes on rocks, to a maximum value of 16.74 degrees. Depths range up to 59.1 m on the route (Figure 26).

KP	Associated Chart	Description	Remark
	102953-GRL-MMT-SUR-DWG-AL10KA03	**Surficial geology:** The surficial geology consists mainly of outcropping BEDROCK and occasional areas consisting of gravelly SAND to sandy GRAVEL. Occasional boulder fields are present within the interval, as well as megaripples and ripples.	Bedrock outcrops crossing the route between: KP 10.865 and KP 11.248 KP 11.478 and KP 14.657 KP 14.733 and KP 16.054 KP 16.536 and KP 16.609 KP 16.705 and KP 17.010 KP 17.157 and KP 17.756 KP 18.182 and KP 18.906 KP 18.929 and KP 19.995 KP 20.011 and KP 20.182 KP 20.284 and KP 20.504 KP 20.533 and KP 20.658 KP 20.763 and KP 20.827 KP 21.115 and KP 21.357 KP 21.395 and KP 21.798 KP 21.830 and KP 21.928 KP 21.986 and KP 22.311 Boulder fields crossing the route between: KP 16.147 and KP 16.345 KP 16.400 and KP 16.537 KP 16.610 and KP 16.706 (Figure 28)
		Shallow Geology: Mainly outcropping BEDROCK with some isolated small infills of SAND and GRAVEL.	
22.310 - 24.907	102953-GRL-MMT-SUR-DWG-AL10KA03	**Bathymetry:** The rocks give way to a smoother flatter seabed at KP 22.310 (see Figure 25) and depths gently become shallower until KP 23.200. From here the seabed gently deepens once more, remaining smooth with occasional boulders.	Very gentle to gentle slopes with a maximum value of 2.75 degrees at a boulder. Depths range up to 59.66 m on the route (Figure 26).

KP	Associated Chart	Description	Remark
		Surficial geology: The surficial geology consists of mainly SAND interrupted by a few areas comprising gravelly SAND/sandy GRAVEL. A field of occasional boulders is present at the end of the section. Ripple and megaripple areas are present at several locations in this section.	Boulder field area crossing the route from KP 24.527 to the end of the section. (Figure 29)
		Shallow Geology: The surface SAND unit is 1-3 m thick. Several deep incisions filled with mixed channel infill sediments are present in the underlying BEDROCK. The infills are up to 20 m deep.	(Figure 31)

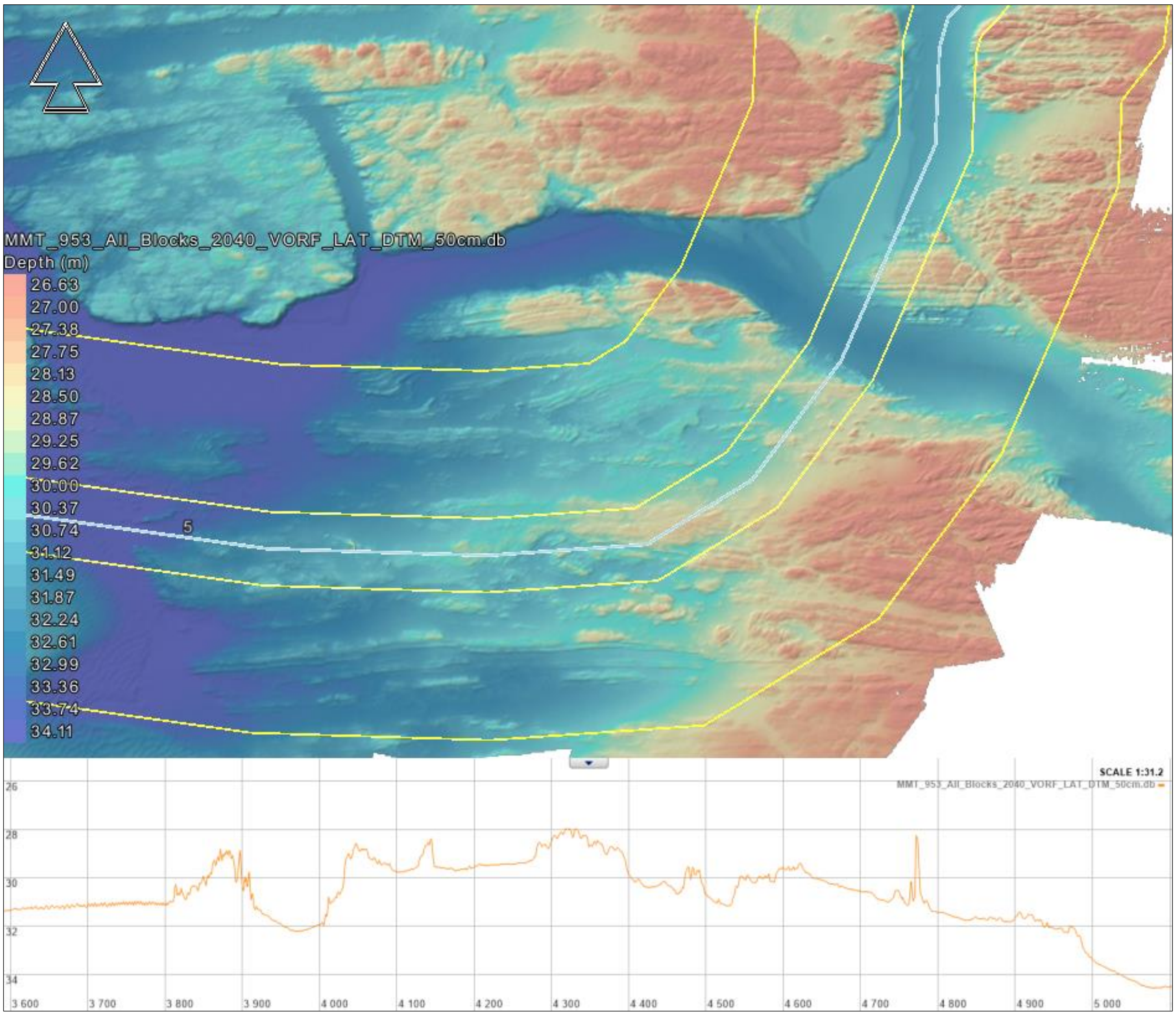


Figure 23 Shaded bathymetric relief showing rocky seabed on Route A.
Longitudinal profile (orange) depicts seabed along the route from KP 3.647 to KP 5.094. (Profile vertical exaggeration: 1:31.2).

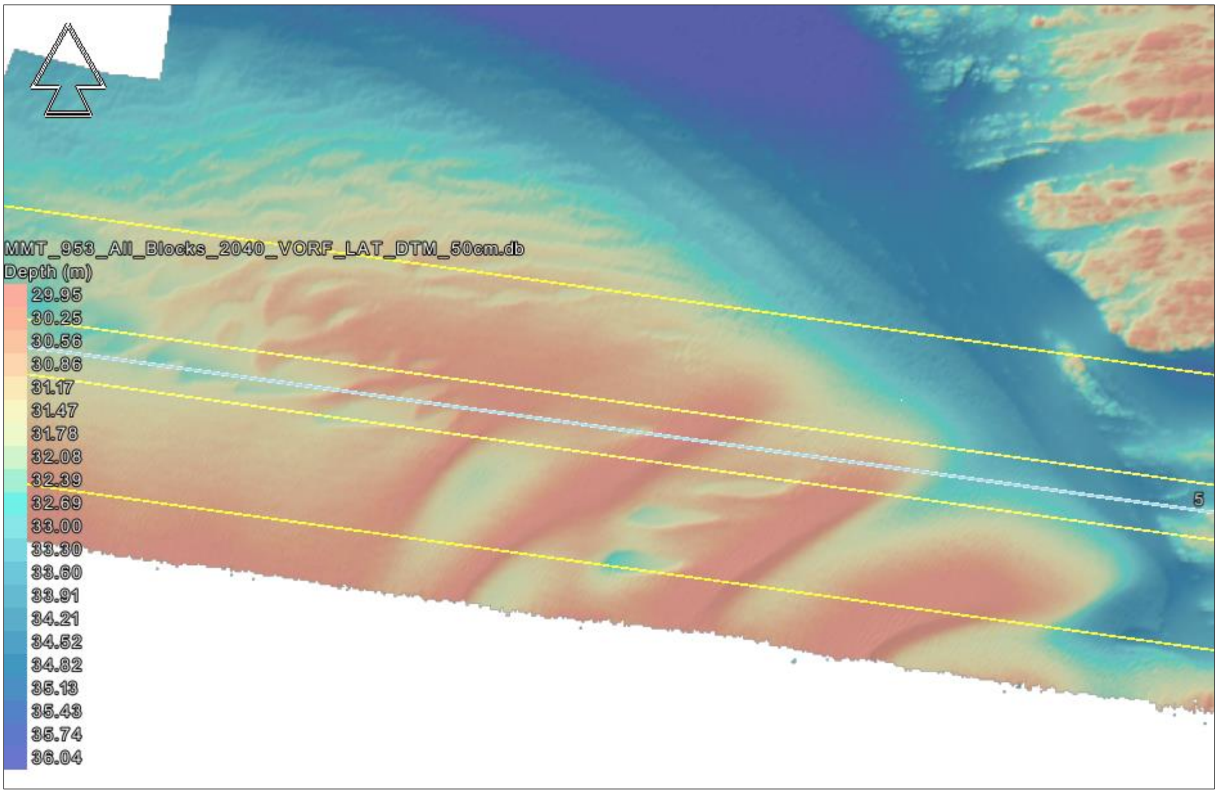


Figure 24 Shaded bathymetric relief showing the ripples and sandwaves on Route A between KP 5.094 and KP 7.100.

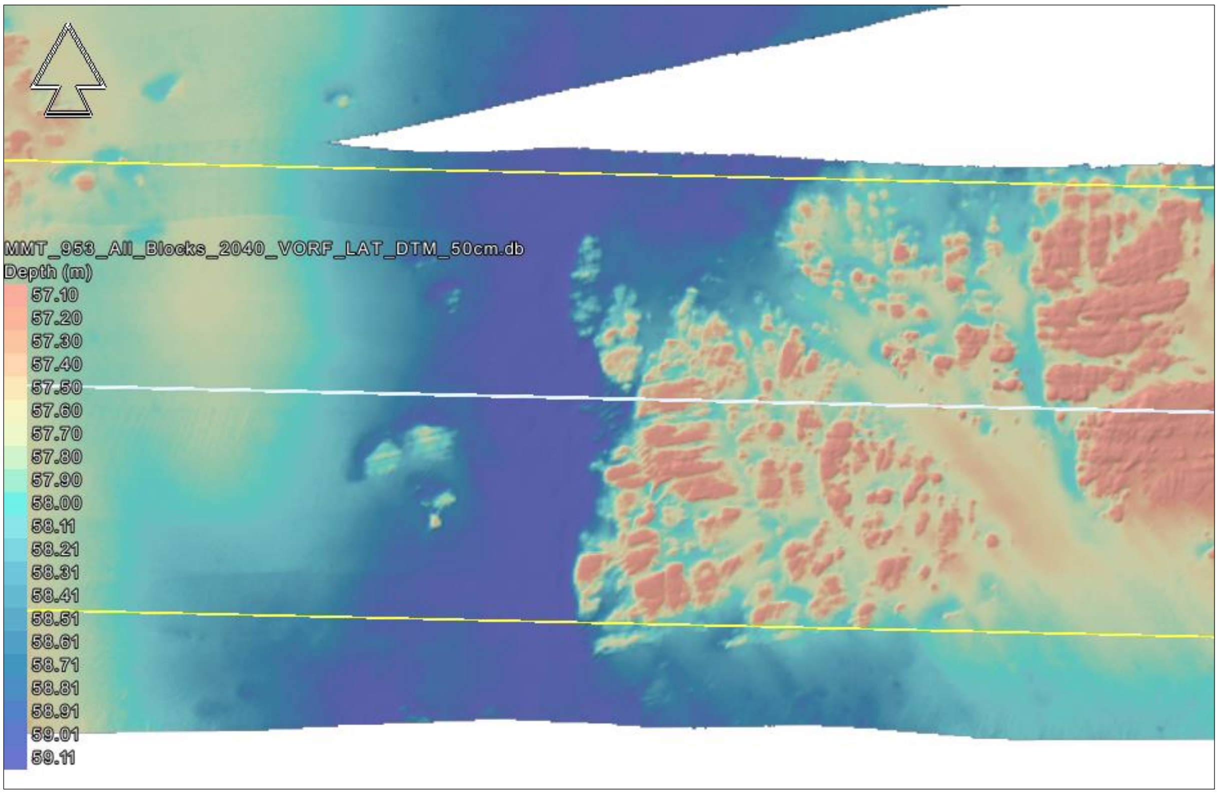


Figure 25 Shaded bathymetric relief showing the change in seabed from KP 22.310 on Route A.

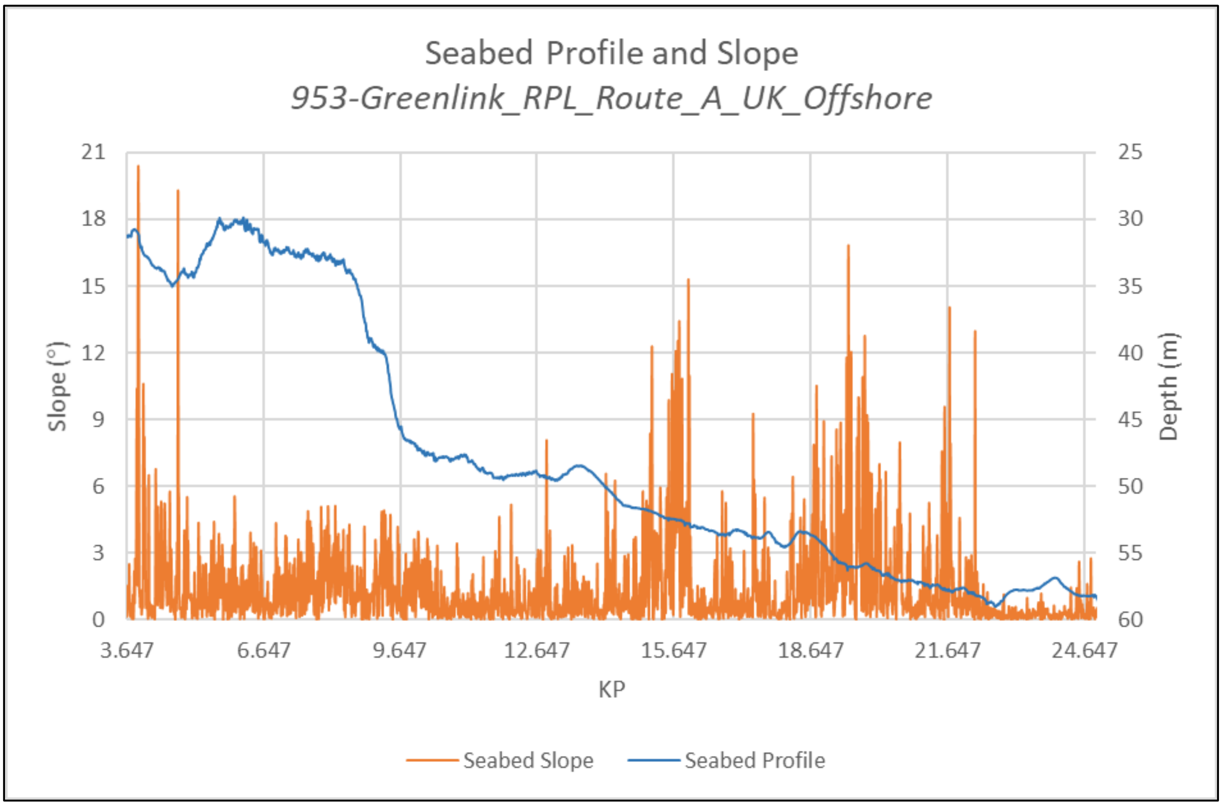


Figure 26 Seabed gradient and depth on route option A in the UK offshore section between KP 3.647 and KP 24.908.

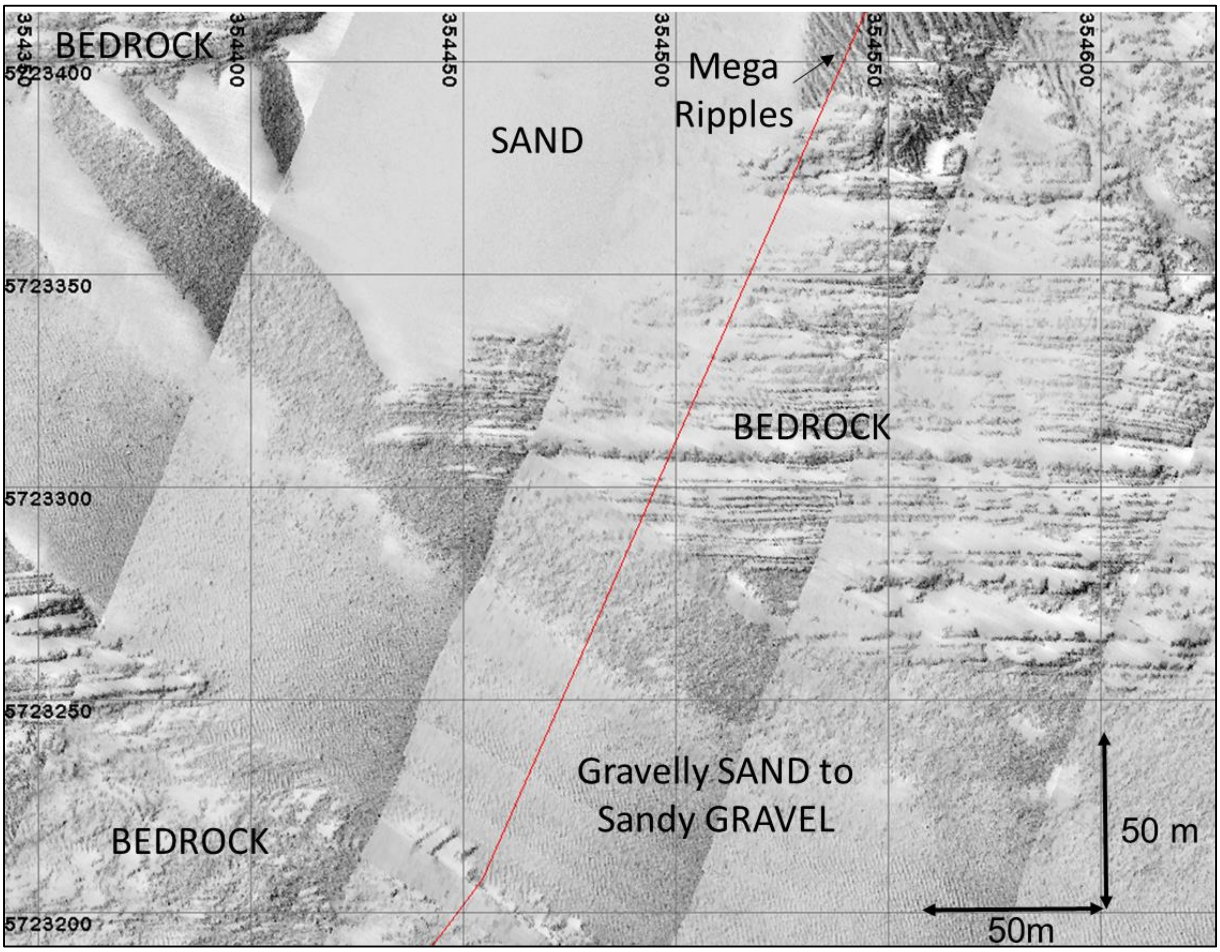


Figure 27 SSS plan view example from KP 3.785 to KP 4.053.
Showing gravelly SAND to sandy GRAVEL, SAND and megaripples with outcrops of BEDROCK. Image is north up.

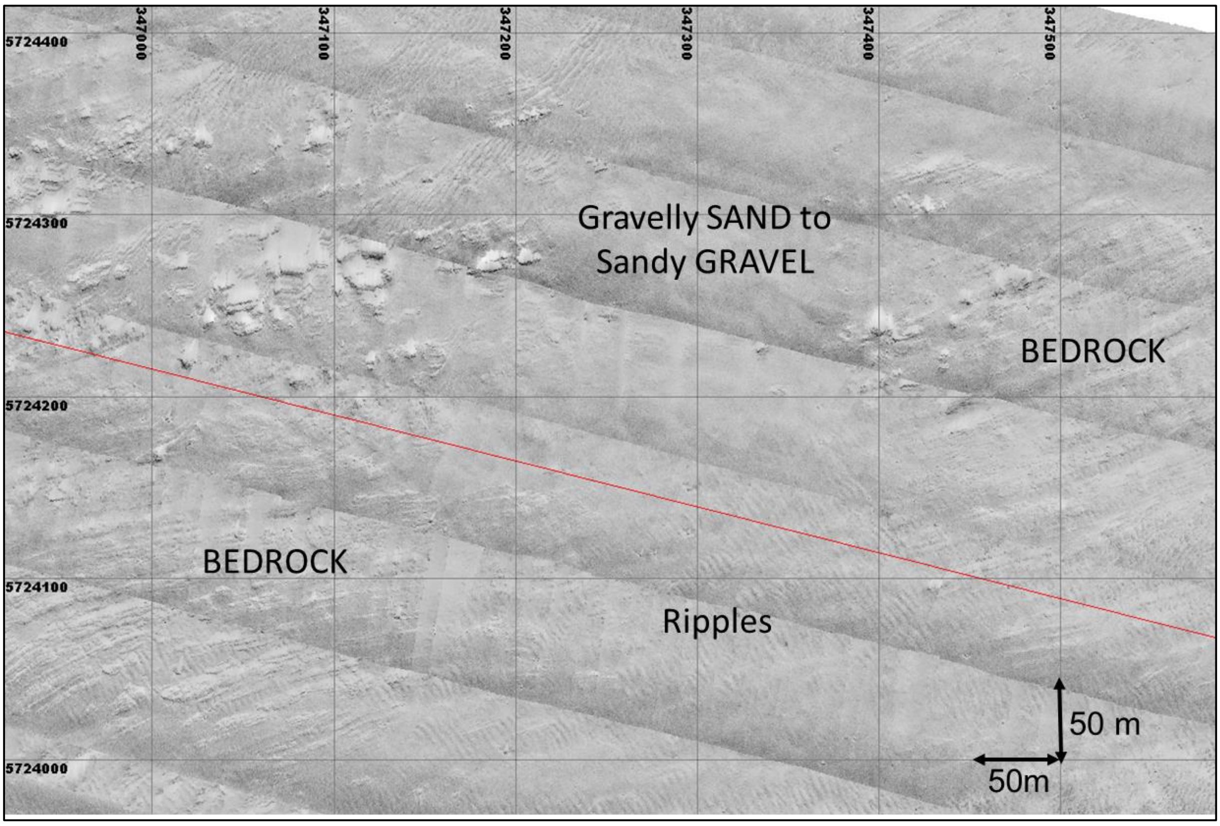


Figure 28 SSS plan view example from *KP 11.082 to KP 11.799.*
Showing gravelly SAND to sandy GRAVEL with ripples between outcropping BEDROCK. Image is north up.

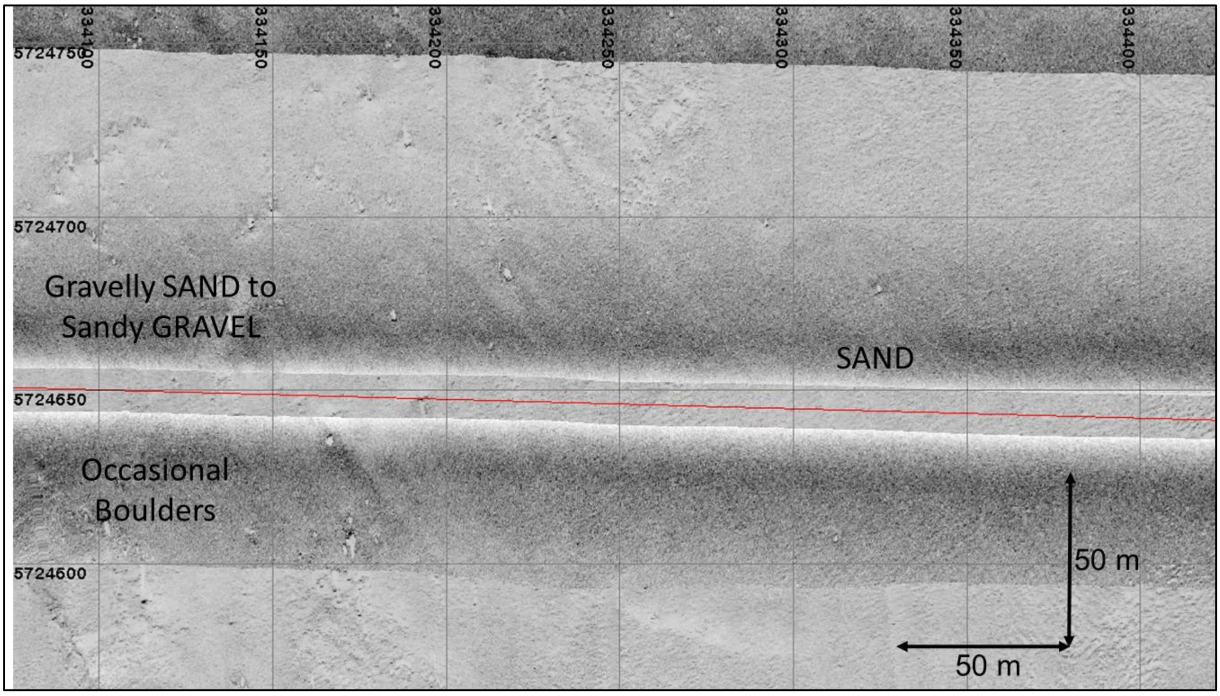


Figure 29 SSS plan view example from KP 24.356 to KP 24.656.
Showing SAND and gravelly SAND to sandy GRAVEL with occasional boulders. Image is north up.

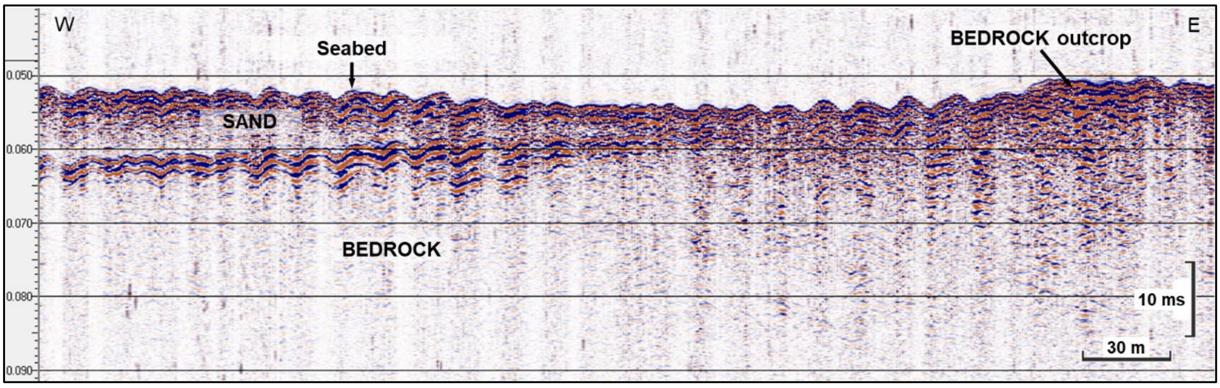


Figure 30 Sparker SBP data example from KP 4.926 to KP 5.350.
Showing BEDROCK (outcropping to the right) and the onset of a thick SAND accumulation.

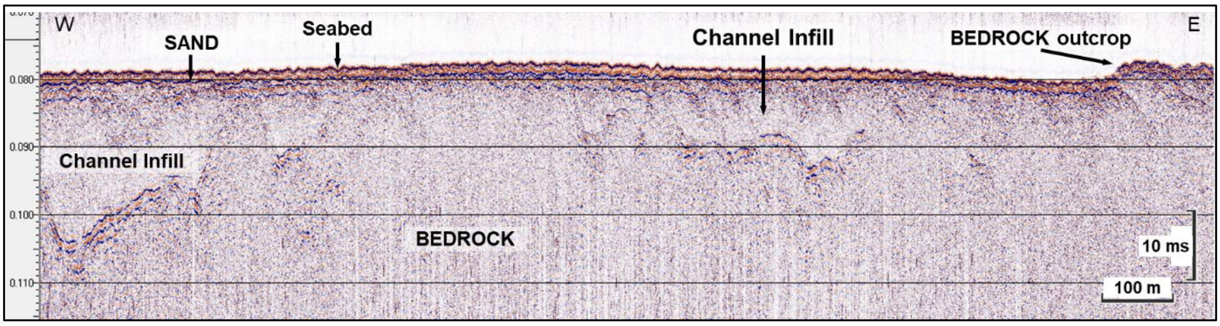


Figure 31 Sparker SBP data example from KP 22.107 to KP 23.965.
Showing undulating BEDROCK (outcropping to the right) covered by channel infills and surface SAND unit.

5.2.6| CONTACTS AND ANOMALIES ROUTE OPTION A

A total of 426 SSS contacts were identified from the data within the survey corridor in UK offshore. The majority of the contacts were classified as either boulders or debris.

The SSS contacts are summarised in Table 17.

A total of 72 magnetic anomalies were detected in the UK offshore corridor. Of these, 71 were unclassified, 1 was a known wreck, a steel-hulled steamship, Saint Jacques (Table 18).

One SSS contact position correlated with detected magnetic anomalies from the geophysical survey, the Saint Jacques wreck. No SSS contact positions correlated with detected magnetic anomalies from the UXO survey.

Table 17 Summary of UK offshore SSS contacts, Route A.

CLASSIFICATION	NUMBER
Boulder	419
Other	2
Debris	4
Wreck	1

CLASSIFICATION	NUMBER
Total	**426**

Table 18 Summary of UK offshore magnetic anomalies.

CLASSIFICATION	NUMBER
Unclassified, possible objects	71
Wreck	1
Cable	0
Total	**72**

5.2.7 | OVERVIEW ROUTE OPTION E

Results are presented for KP 13.373 to KP 37.608 along route option E.

All KPs refer to route option E, RPL Route_E_WGS84_UTM30N_Rev1_20180521.

BATHYMETRY

Route E has a rocky seabed with areas of ripples and large sandwaves throughout, with occasional boulder areas. Depths range up to 63.05 m at KP 33.330 with very gentle to moderate gradients and some localised very steep slopes over the rocky areas. Depth is generally increasing along the profile and some undulation of the seabed is observed.

SURFICIAL GEOLOGY

The surficial geology along Route Option E comprises mainly of SAND to gravelly SAND/sandy GRAVEL. Smaller areas of outcropping BEDROCK is present at several locations along the route.

Large parts of the survey corridor in Route Option E is covered with seabed features indicating mobile sediment, such as ripples, megaripples and sandwaves. Several areas of boulder fields, both with numerous and occasional boulders, are also present in the survey corridor of Route Option E.

SHALLOW GEOLOGY

The shallow geology of route option E is characterised by an almost continuous surface SAND layer overlying BEDROCK. The SAND layer is present as a veneer on the BEDROCK, up to 1 m thick throughout the route, but can reach up to 4 m in sandwave areas. BEDROCK is outcropping and subcropping in several places. Several deep incisions are present in the BEDROCK. These are filled with mixed channel infill sediments.

5.2.8 | DETAILED DESCRIPTION ROUTE OPTION E

A detailed presentation of the conditions and features in the UK offshore corridor along route option E are shown in Table 19.

Table 19 Seabed details route option E KP 13.373 to KP 37.608.

KP	Associated Chart	Description	Remark
13.373 - 37.608	102553-NEU-MMT-SUR-DWG-AL10KE01 102553-NEU-MMT-SUR-DWG-AL10KE02 102553-NEU-MMT-SUR-DWG-AL10KE03	**Bathymetry:** Boulders and ripples are present from KP 13.373, with larger ripples and sandwaves from KP 14.688 to KP 16.799. From here depth gently increases and numerous boulders are observed with occasional rocky outcrops. From KP 27 the seabed rises gently until KP 27.764 where it begins to slope gently down again. The seabed again rises at KP 29.732 to KP 29.912 where it gently increases in depth to KP 30.265. Here begins a rocky area until KP 33.432 where the seabed becomes smoother with further ripples and sandwaves.	Very gentle to moderate gradients to locally very steep slopes with a maximum value of 20.9 degrees on the sandwaves see Figure 33. Depths range up to 63.05 m.
		Surficial geology: The surficial geology consists of mainly gravelly SAND/sandy GRAVEL with occasional areas of SAND or GRAVEL. Small areas of BEDROCK outcrops are present. Boulder fields with occasional or numerous boulders occur throughout. Ripples, megaripples and sandwaves are common throughout.	BEDROCK outcrops crossing the route between: KP 24.330 and KP 24.351 KP 24.559 and KP 24.568 KP 26.475 and KP 26.646 KP 30.351 and KP 30.494 KP 30.893 and KP 30.939 KP 31.302 and KP 31.395 KP 31.496 and KP 31.571 KP 31.772 and KP 31.925 KP 33.216 and KP 33.231 KP 37.253 and KP 37.313 Boulder fields crossing the route between: KP 13.748 and KP 13.880 KP 17.803 and KP 17.138 KP 18.626 and KP 22.015 KP 24.669 and KP 24.909 KP 28.914 and KP 29.019 KP 29.258 and KP 29.277 KP 30.495 and KP 30.680 (Figure 34 to Figure 37)

KP	Associated Chart	Description	Remark
		Shallow Geology: A thin (~1 m) surface SAND unit is present over BEDROCK between KP 13.373 and KP 22.670. The SAND reaches up to 16 m in sandwave areas. Several deep channel incisions are present which are filled by sediment of SAND to GRAVEL. From KP 22.670 to KP 36.820 the surface SAND unit is mainly present as a veneer over BEDROCK. The SAND thickness increases in areas of sandwaves. The base of SAND is often poorly resolved. BEDROCK is outcropping or subcropping frequently (see Surficial Geology for KP intervals).	(Figure 38)

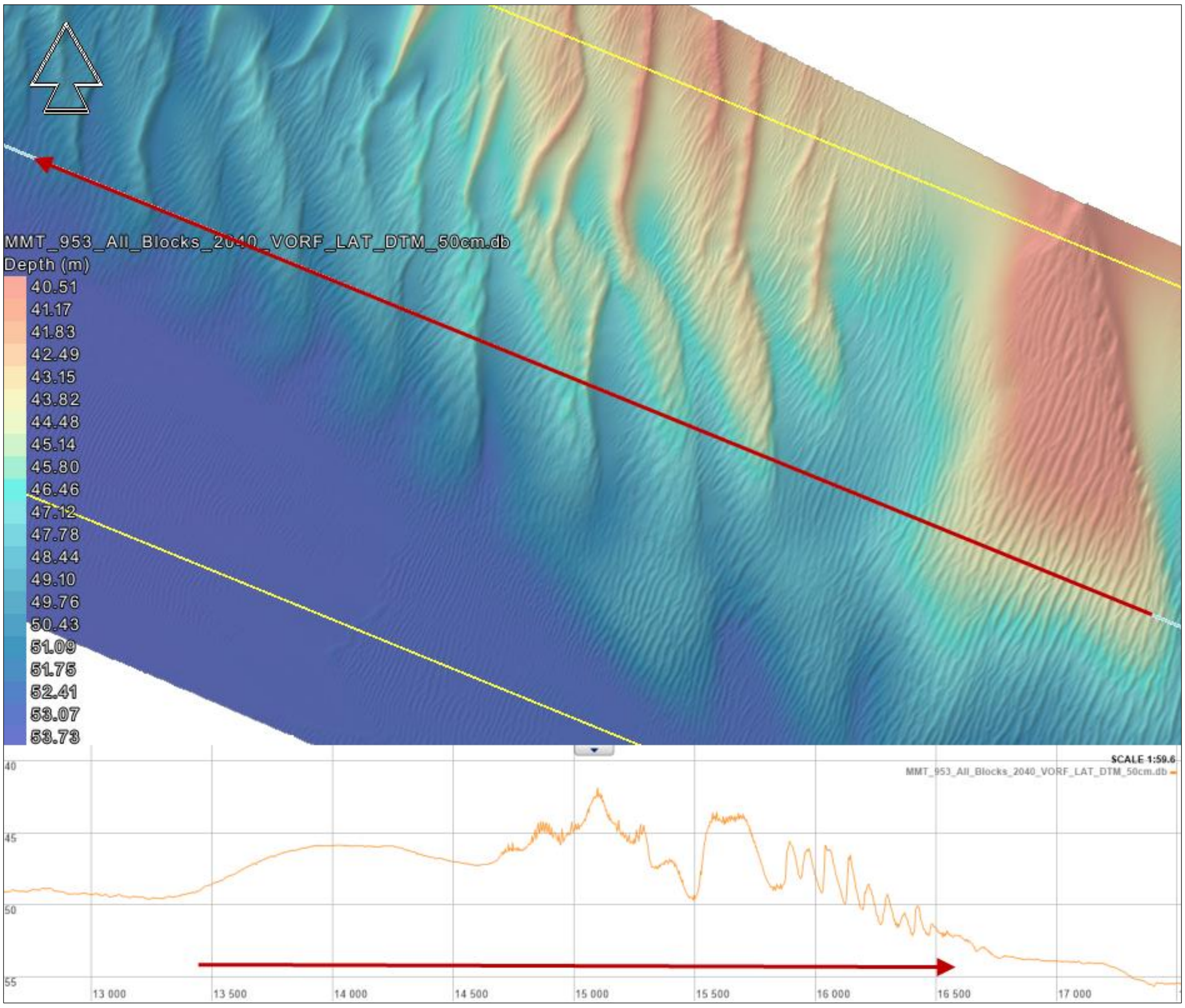


Figure 32 Shaded bathymetric relief showing the ripples and sandwaves on route option E centred on KP 16.040 where the steepest gradient is observed.
Longitudinal profile (orange) depicts seabed along the route along the direction of the red arrow (Profile vertical exaggeration: 1:59.6).

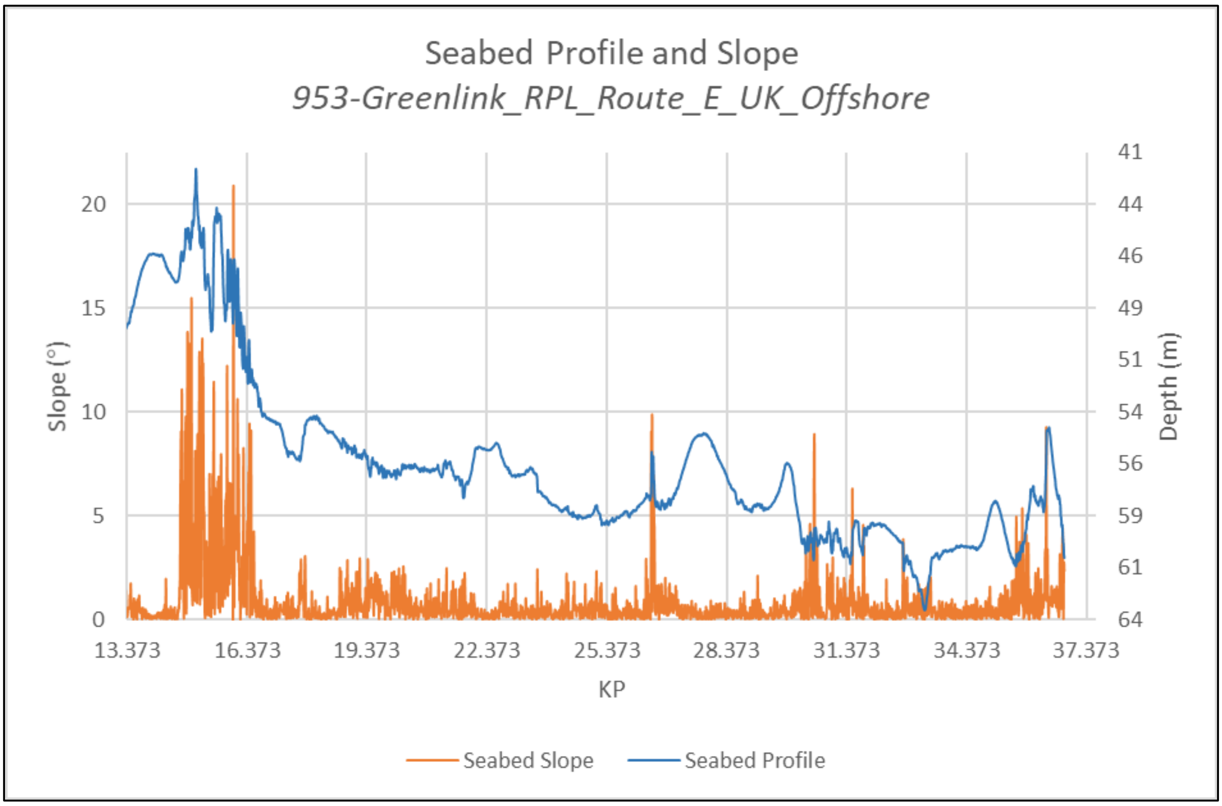


Figure 33 Seabed gradient and depth on route option E in the UK offshore section between KP 13.373 and KP 36.820.

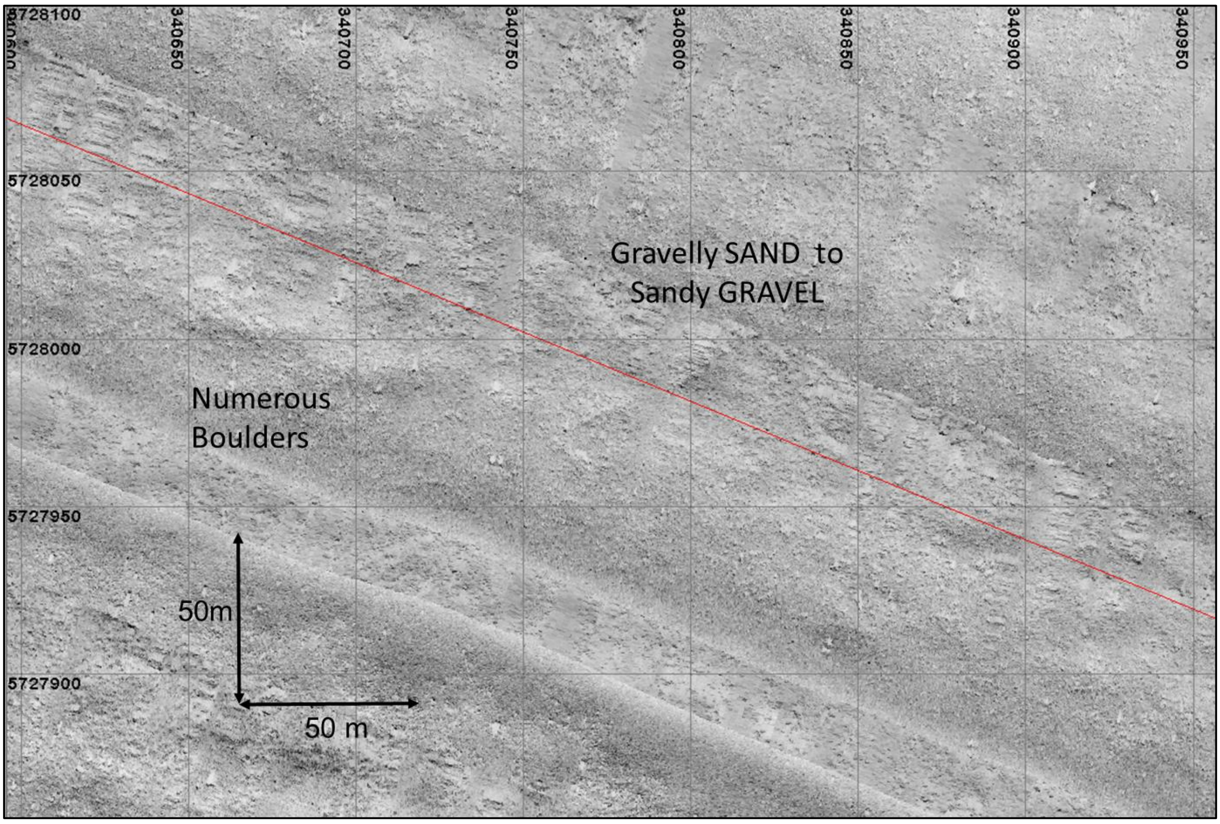


Figure 34 SSS plan view example from KP 18.725 to KP 19.105.
Showing gravelly SAND to sandy GRAVEL with numerous boulders. Image is north up.

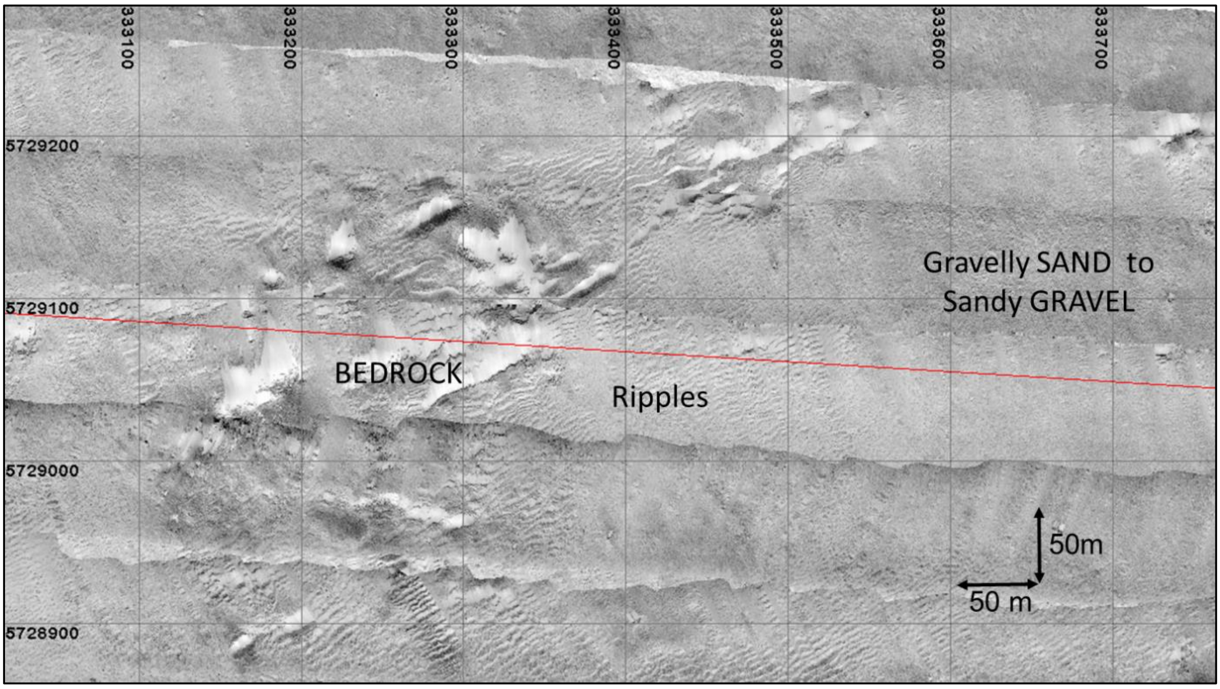


Figure 35 SSS plan view example from KP 26.081 to KP 26.826.
Showing gravelly SAND to sandy GRAVEL with ripples and outcrops of BEDROCK. Image is north up.

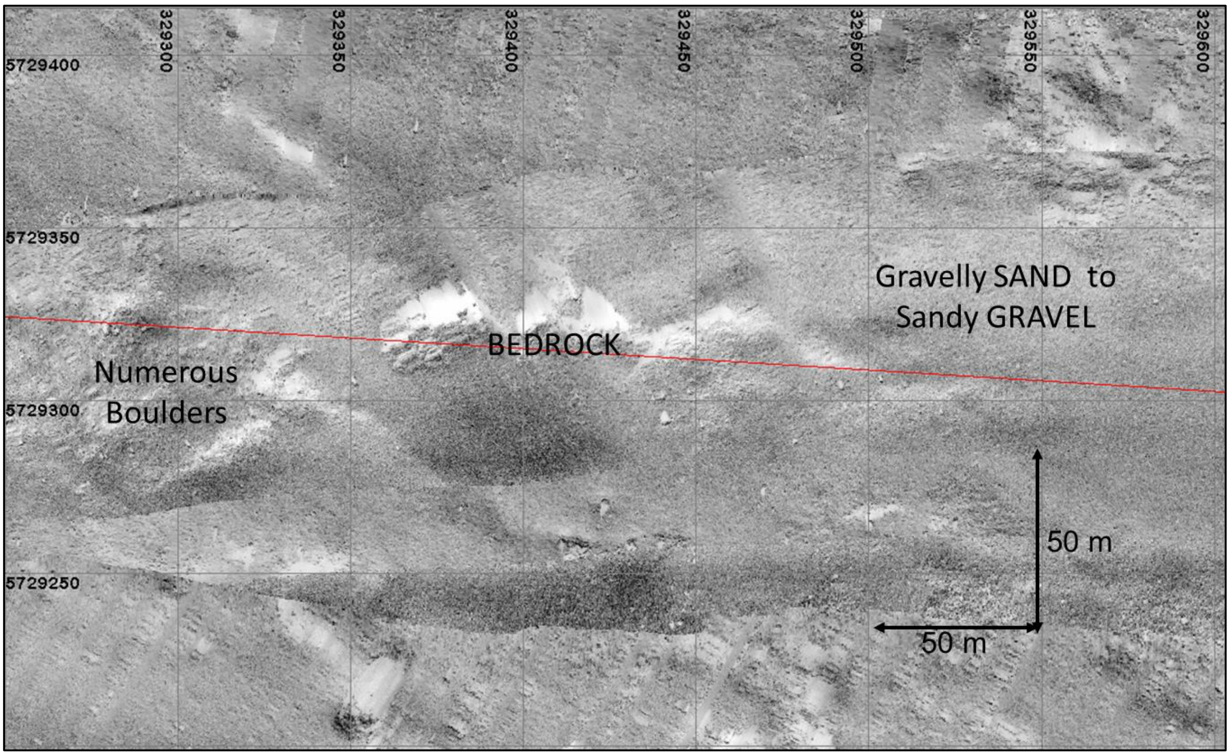


Figure 36 SSS plan view example from *KP 30.249 to KP 30.602*
Showing gravelly SAND to sandy GRAVEL with ripples and outcrops of BEDROCK. Image is north up.

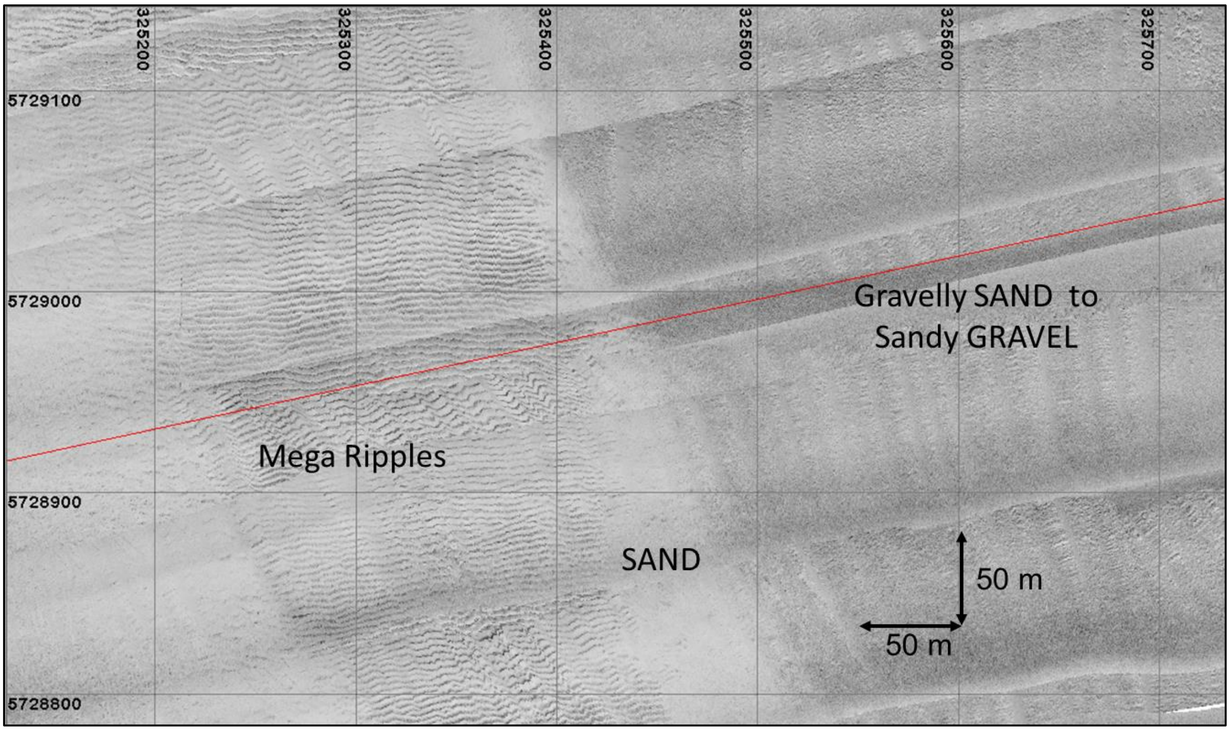


Figure 37 SSS plan view example from KP 34.167 to KP 34.784
Showing gravelly SAND to sandy GRAVEL and SAND with megaripples. Image is north up.

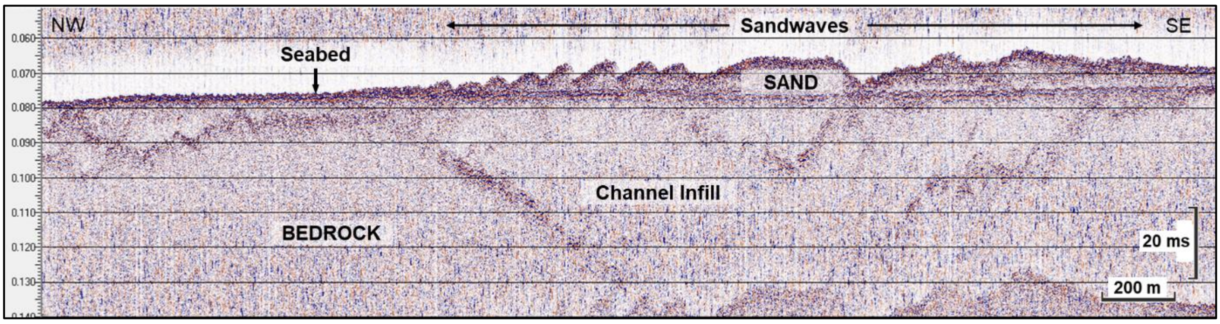


*Figure 38 Sparker SBP data example from KP 14.640 to KP 17.440.
Showing surface SAND with sandwaves underlain by a deep channel infill on BEDROCK.*

5.2.9| CONTACTS AND ANOMALIES ROUTE OPTION E

A total of 2139 SSS contacts were identified from the data within the survey corridor in UK offshore. The majority of the contacts were classified as either boulders or debris. Four contacts were classified as wrecks, two of which correlate with known wrecks from the background data.

The SSS contacts are summarised in Table 20.

A total of 88 magnetic anomalies were detected in the UK offshore corridor. Of these, 88 were unclassified (Table 21).

A total of 1 SSS contact position correlated with detected magnetic anomalies from the geophysical survey and no SSS contact positions correlated with detected magnetic anomalies from the UXO survey.

Table 20 Summary of UK offshore SSS contacts, Route E.

CLASSIFICATION	NUMBER
Boulder	2127
Other	0
Debris	9
Wreck	3
Total	**2139**

Table 21 Summary of UK offshore magnetic anomalies, Route E.

CLASSIFICATION	NUMBER
Unclassified, possible objects	88
Cable	0
Total	**88**

6| RESULTS IRELAND

6.1| IRELAND OFFSHORE

6.1.1| OVERVIEW ROUTE OPTION RPL_09112018_REV0

Results are present for KP 73.906 to KP 156.667.

BATHYMETRY

Depths in the corridor range from 13.50 m to 116.00 m and on the route the range is from 16.78 m to 115.95 m with depths generally decreasing with increasing KP. Very gentle to gentle gradients are predominant, with some moderate slopes in sandwave and ripple areas. The seabed has ripples, sandwaves, trawl marks, numerous boulder areas and rocky outcrops.

SURFICIAL GEOLOGY

The majority of the surficial geology in the Irish offshore section is characterised by SAND with megaripples and occasional sandwaves. The sand is occasionally interrupted by areas of gravelly SAND/sandy GRAVEL. The megaripples become less significant with increasing KP and are no longer present from KP 139.267.

From KP 148.300, the surficial geology becomes more varied, with areas of GRAVEL and abundant outcropping BEDROCK. In this area, boulder fields are also identified.

SHALLOW GEOLOGY

The shallow geology of the Ireland offshore section is characterised by a sequence of surface SAND unit, TILL and BEDROCK over large parts of the bathymetric trough, southern extent of St. George's Channel, and Nymphe Bank. The layer of SAND and TILL of the Nymphe Bank is thicker compared to the Welsh platform, up to KP 148.380 where these platform sediments pinch out.

The surface SAND unit is generally >2 m thick and is continuously present from KP 73.906 to KP 148.380. Within the trough it can reach thicknesses up to 15 m and more than 4 m in areas of aggregations of mobile seabed sediment.

The TILL comprise mainly low to high strength, soft to firm CLAY with varying sand, silt and gravel content. A thick sequence of TILL is present within the trough and from KP 102.510 to KP 130.520. The top of the TILL is highly undulating and the incisions are filled with mixes of channel infill sediments between KP 104.100 and KP 144.395.

For the majority of the Irish offshore section, BEDROCK is more than 5 m below the seabed surface. The top of BEDROCK is not resolved in the seismic data from KP 103.350 to KP 107.235 and KP 114.610 and KP 130.520. It reaches closer to the seabed between KP 148.380 and KP 155.480.

6.1.2| DETAILED DESCRIPTION ROUTE OPTION RPL_09112018_REV0

A detailed presentation of the conditions and features along the Ireland offshore route are shown in Table 22.

Table 22 Seabed details route option RPL_09112018_REV0 KP 73.906 to KP 156.667.

KP	Associated Chart	Description	Remark
73.906 – 77.134	102953-GRL-MMT-SUR-DWG-AL10KF09 102953-GRL-MMT-SUR-DWG-AL10KF10	**Bathymetry:** The seabed gently increases in depth until KP 75 where it begins to very gently decrease in depth. The seabed is rippled throughout.	Gentle to very gentle gradient with a maximum value of 3.45 degrees. Depths range up to 115.95 m on the route (Figure 41).
		Surficial geology: The surficial geology consists of mainly SAND. Megaripples are present throughout. Trawl marks indicating fishing activity are also seen.	Trawl scars abundant throughout the section.
		Shallow Geology: The surface SAND unit is generally <2 m and overlying TILL. The TILL shows a chaotic internal structure and overlies BEDROCK.	(Figure 47)
77.134 – 84.729	102953-GRL-MMT-SUR-DWG-AL10KF10 102953-GRL-MMT-SUR-DWG-AL10KF11	**Bathymetry:** Depth continues to decrease very gently. The seabed has ripples and occasional sandwaves.	Very gentle to gentle gradient and local moderate slopes with a maximum value of 6 degrees on the sandwave, see Figure 39. Depths range up to 112.14 m on the route (Figure 41).
		Surficial geology: The surficial geology consists mainly of SAND. Megaripples are present throughout as well as occasional sandwaves. Trawl marks indicating fishing activity are also common.	Trawl scars abundant throughout the section.
		Shallow Geology: The surface SAND unit reaches a thickness of 4 m or more (>10 m from KP 81.000 to KP 83.359 with a maximum of 15 m). An internal layer of possible coarser sediment is present approximately 1-2 m below the seabed. The SAND is overlying TILL and BEDROCK.	(Figure 48)
84.729 - 95.028	102953-GRL-MMT-SUR-DWG-AL10KF11	**Bathymetry:** The seabed continues to rise gently and is rippled with occasional sandwaves throughout.	Very gentle gradient with a maximum value of 2.9 degrees. Depths range up to 88.86 m on the route (Figure 41).

KP	Associated Chart	Description	Remark
	102953-GRL-MMT-SUR-DWG-AL10KF12	**Surficial geology:** The surficial geology consists of mainly SAND with occasional areas of GRAVEL. Megaripples are present throughout. Sandwaves are also seen in some locations along the route, often associated with areas of GRAVEL. Trawl scars indicating fishing activity are abundant in the initial parts of the section.	Trawl scars abundant up until approximately KP 88.000. Cable crossing- Hibernia Atlantic Seg D at KP 86.700. (Figure 42)
		Shallow Geology: The undulating seabed with several sandwaves results in varying SAND unit thickness from >0.5 m to 6 m. over TILL. The TILL overlies BEDROCK, which is generally >6 m below seabed but reaches ~4 m at KP 90.749.	
95.028 - 98.058	102953-GRL-MMT-SUR-DWG-AL10KF12	**Bathymetry:** The seabed continues to rise gently and has ripples and sandwaves throughout.	Gentle gradient with a maximum value of 2.91 degrees. Depths range up to 73.49 m on the route (Figure 41).
		Surficial geology: The surficial geology consists mainly of SAND. Megaripples are present throughout with occasional areas of sandwaves.	Cable crossing - Pan European Crossing 1 at KP 95.935.
		Shallow Geology: The surface SAND unit and underlying channel infill and TILL sediments are <4 m thick. The underlying BEDROCK reaches to within 1 m of seabed surface at KP 96.460.	
98.058 - 102.564	102953-GRL-MMT-SUR-DWG-AL10KF12 102953-GRL-MMT-SUR-DWG-AL10KF13	**Bathymetry:** The seabed rises shortly before gently deepening again from KP 99.439. There are ripples present throughout.	Gentle gradient with a maximum value of 3.25 degrees. Depths range up to 70.76 m on the route (Figure 41).
		Surficial geology: The surficial geology consists of SAND. Megaripples are present throughout.	Cable crossing - ESAT 1 at KP 102.513

KP	Associated Chart	Description	Remark
		Shallow Geology: The surface SAND unit together with underlying channel infill sediments reach a thickness of at least 4 m and up to 8 m over BEDROCK.	
102.564 - 108.662	102953-GRL-MMT-SUR-DWG-AL10KF13	**Bathymetry:** Seabed is rippled throughout with little variance in depth up to KP 106.922 where the seabed begins to rise once more and depths decrease gently. Trawl marks are also observed.	Very gentle to gentle gradient with a maximum value of 2.56 degrees. Depths range up to 68.61 m on the route (Figure 41).
		Surficial geology: The surficial geology consists of mainly SAND with only one instance of gravelly SAND/sandy GRAVEL. Megaripples are present throughout.	(Figure 43)
		Shallow Geology: The surface SAND unit of approximately 2-4 m thickness overlies deep channel infill sediments followed by a thick sequence of TILL. The channel infill reaches up to 16 m below seabed.	BEDROCK reflector is too deep and is not resolved in the seismic data.
108.662 - 114.625	102953-GRL-MMT-SUR-DWG-AL10KF13 102953-GRL-MMT-SUR-DWG-AL10KF14	**Bathymetry:** The seabed has ripples and sandwaves with occasional boulders and trawl marks.	Very gentle to gentle gradient with a maximum value of 3.41 degrees. Depths range up to 68.6 m on the route (Figure 41).
		Surficial geology: The surficial geology consists of SAND. Megaripples are present throughout. A few sandwave crests are present.	
		Shallow Geology: The SAND unit reflects sandwaves at the seabed and varies from 1 to 8 m in thickness. It is underlain by TILL and some channel infill sediments. The undulation BEDROCK reaches to 4 m below seabed surface at KP 110.893. It dips to beyond sparker resolution at KP 114.625	

KP	Associated Chart	Description	Remark
114.625 - 130.521	102953-GRL-MMT-SUR-DWG-AL10KF14 102953-GRL-MMT-SUR-DWG-AL10KF15 102953-GRL-MMT-SUR-DWG-AL10KF16	**Bathymetry:** Depths gently increase until KP 118.737 where they begin to gently decrease again. The seabed has ripples throughout and numerous trawl marks with occasional boulders see Figure 40.	Very gentle to gentle gradient with a maximum value of 3.8 degrees. Depths range up to 72.56 m on the route (Figure 41).
		Surficial geology: The surficial geology consists of mainly SAND with sparse areas consisting of gravelly SAND/ sandy GRAVEL. Megaripples are present throughout.	Cable crossing- SOLAS at KP 121.535
		Shallow Geology: This interval is characterised by frequent and sometimes deep channel infills on top of TILL. The surface SAND units varies from <1 to 6 m and channel infills in the deepest incision of up to 20 m. TILL is close to the seabed surface around KP 117.850.	BEDROCK reflector is too deep and is not resolved in the seismic data. (Figure 49)
130.521 - 138.639	102953-GRL-MMT-SUR-DWG-AL10KF16 102953-GRL-MMT-SUR-DWG-AL10KF17	**Bathymetry:** The seabed continues to rise with ripples and occasional boulders throughout.	Very gentle gradient with occasional gentle gradients up to a maximum value of 1.13 degrees. Depths range up to 57.32 m on the route (Figure 41).
		Surficial geology: The surficial geology consists of SAND. Megaripples are present throughout.	
		Shallow Geology: The surface SAND unit of 2-7 m is underlain by some channel infill sediments and TILL. BEDROCK is generally more than 6 m below seabed, but reaches to ~5 m at KP 137.223.	
138.639 - 148.402	102953-GRL-MMT-SUR-DWG-AL10KF17 102953-GRL-MMT-SUR-DWG-AL10KF18	**Bathymetry:** The seabed is mostly smooth with occasional boulders. Depths are gently decreasing.	Very gentle gradient with a maximum value of 0.91 degrees. Depths range up to 44.88 m on the route (Figure 41).
		Surficial geology: The surficial geology consists of SAND. Megaripples are present to approximately KP 139.	Cable crossing - CELTIC at KP 139.098

KP	Associated Chart	Description	Remark
		Shallow Geology: The thick surface SAND unit of 5-8 m pinches out towards KP 148.402. It is underlain by TILL with some channel infills. BEDROCK reaches close to the seabed from KP 148.290.	(Figure 50)
148.402 - 154.506	102953-GRL-MMT-SUR-DWG-AL10KF18 102953-GRL-MMT-SUR-DWG-AL10KF19	**Bathymetry:** Gently decreasing depths, with rocky outcrops, occasional boulders and ripples throughout.	Very gentle to gentle gradient with a maximum value of 3.61 degrees. Depths range up to 31.58 m on the route (Figure 41).
		Surficial geology: The surficial geology consists of alternating areas of GRAVEL, SAND and gravelly SAND/ sandy GRAVEL. Areas of outcropping BEDROCK are also present, none of which cross the route. Megaripple areas are present throughout, commonly associated with the more gravelly sediments.	(Figure 45)
		Shallow Geology: This section is characterised by TILL over BEDROCK with an unresolved veneer of mobile SAND and GRAVEL and some SAND infills between KP 149.045 and KP 151.961. BEDROCK reaches within 1-2 m from the seabed between KP 148.402 and KP 148.986 where the lower boundary of TILL is not resolved in the seismic data and around KP 151.240. The lower TILL boundary is also not resolved between KP 152.732 and KP 153.994.	
154.506 - 156.667	102953-GRL-MMT-SUR-DWG-AL10KF19	**Bathymetry:** The seabed continues to rise gently, small ripples are observed between rocky outcrops that flank the route.	Very gentle to gentle gradients with a maximum value of 2.25 degrees. Depths range up to 22.35 m on the route (Figure 41).

KP	Associated Chart	Description	Remark
		Surficial geology: The surficial geology alters between areas of gravelly SAND/ sandy GRAVEL, SAND, GRAVEL and BEDROCK outcrops. Ripples and megaripples are present throughout this section. A few boulder fields are also present. Neither the boulder fields, nor the BEDROCK outcrops cross the route. The BEDROCK outcropping is extensive both east and west of the route from KP 156.	(Figure 46)
		Shallow Geology: This section is characterised by TILL over BEDROCK with an unresolved veneer of mobile SAND and GRAVEL. BEDROCK reaches within 1-2 m from the seabed between KP 154.506 and KP 154.806 and again at KP 155.412.	

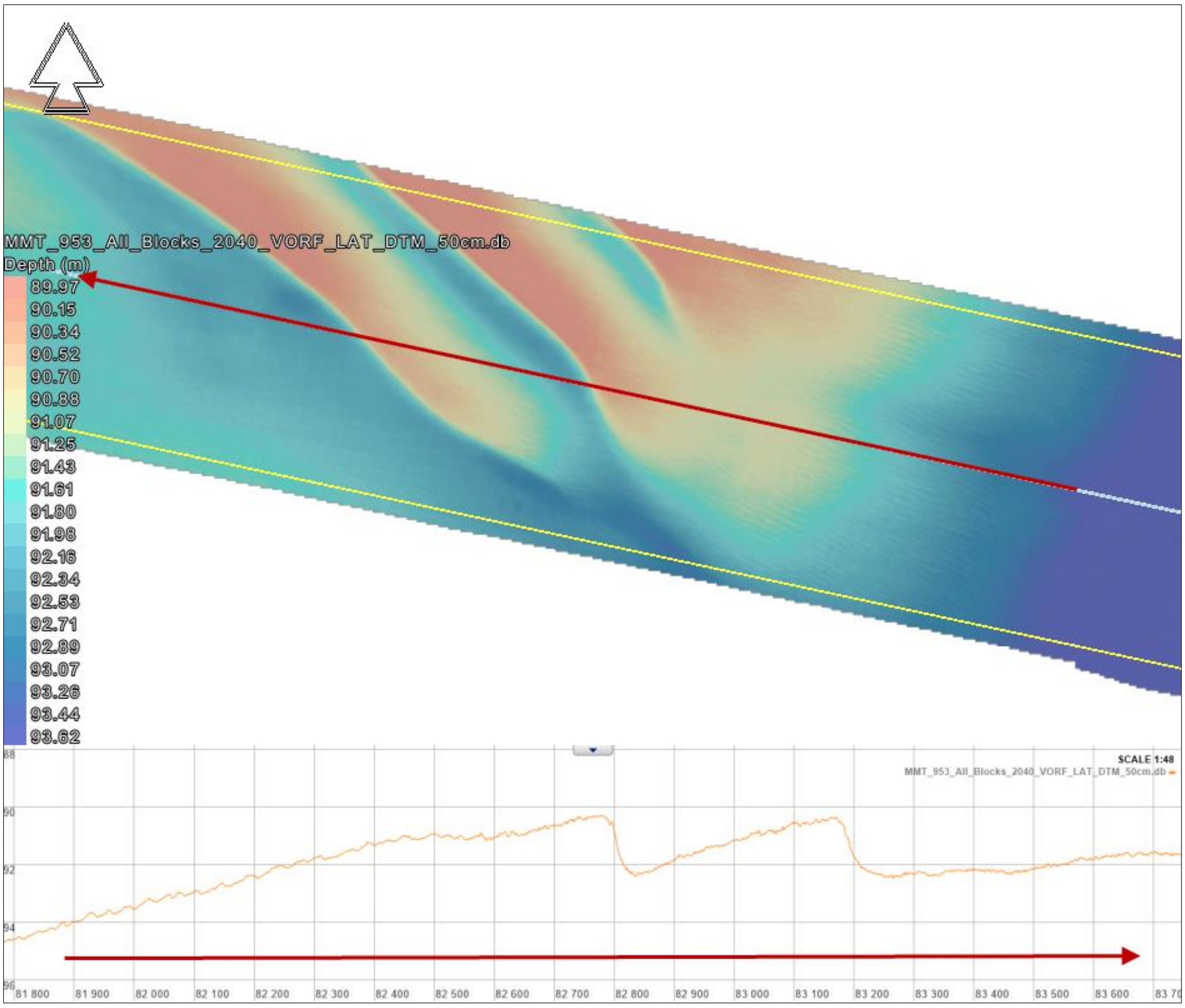


Figure 39 Shaded bathymetric relief showing the sandwaves centred on KP 82.800 where the steepest gradient is observed.
Longitudinal profile (orange) depicts seabed along the route in the direction of the red arrow (Profile vertical exaggeration: 1:48).

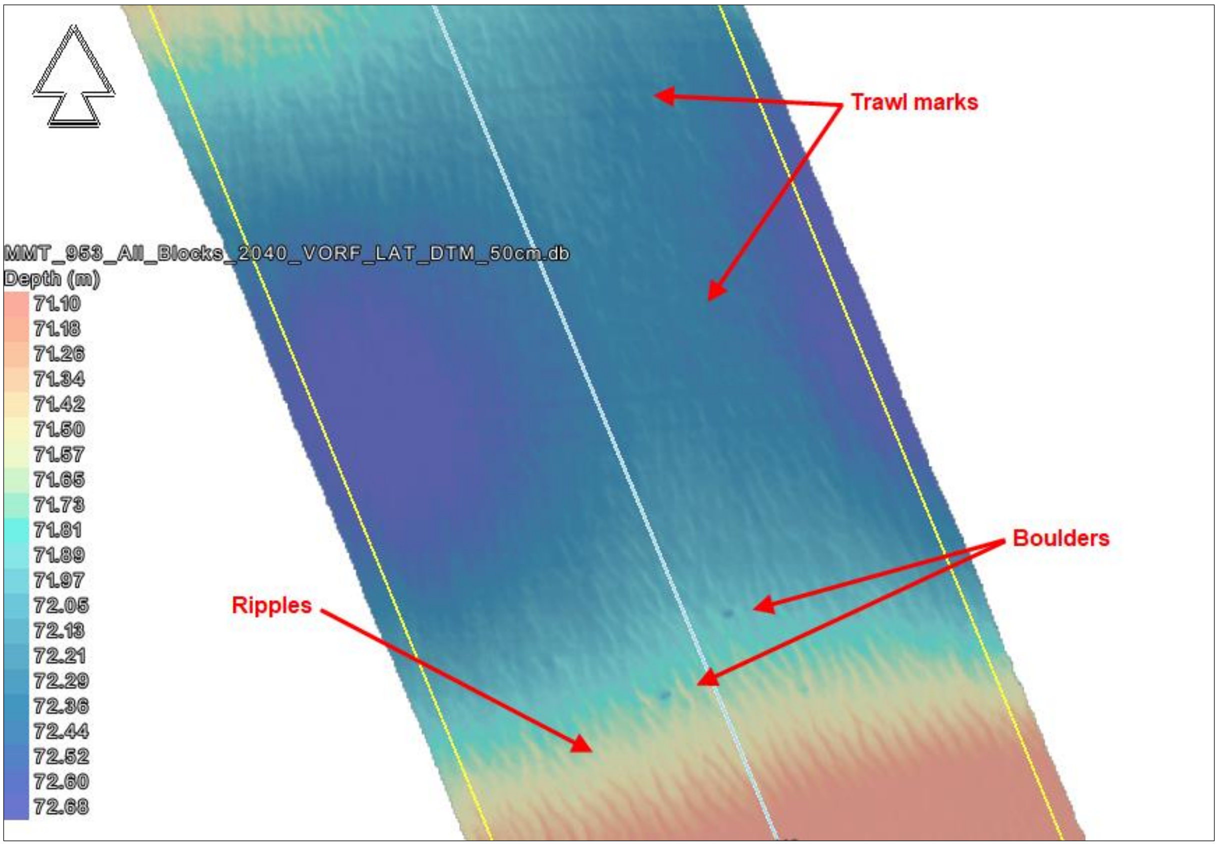


Figure 40 Shaded bathymetric relief showing the ripples, trawl marks and boulders around KP 118.400.
Palette has been adjusted to highlight features.

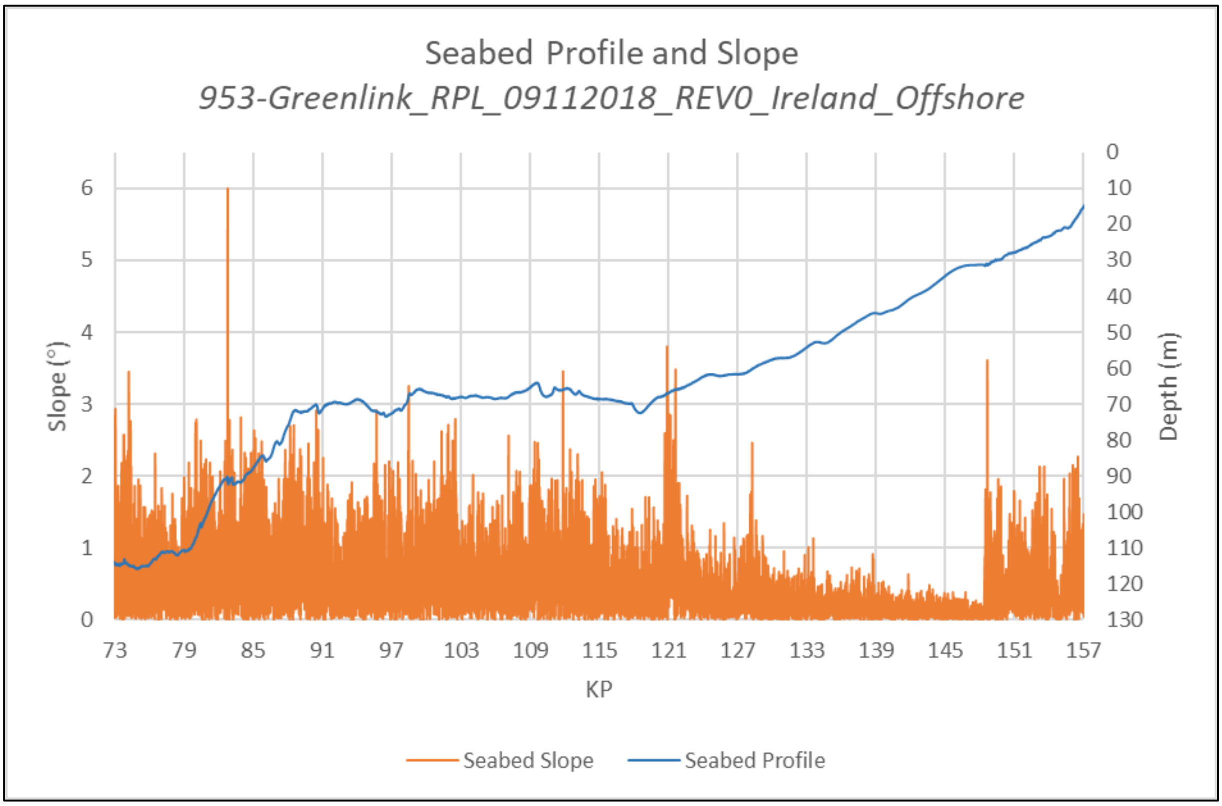


Figure 41 Seabed gradient and depth in the Irish offshore section from KP 73.906 to KP 156.667.

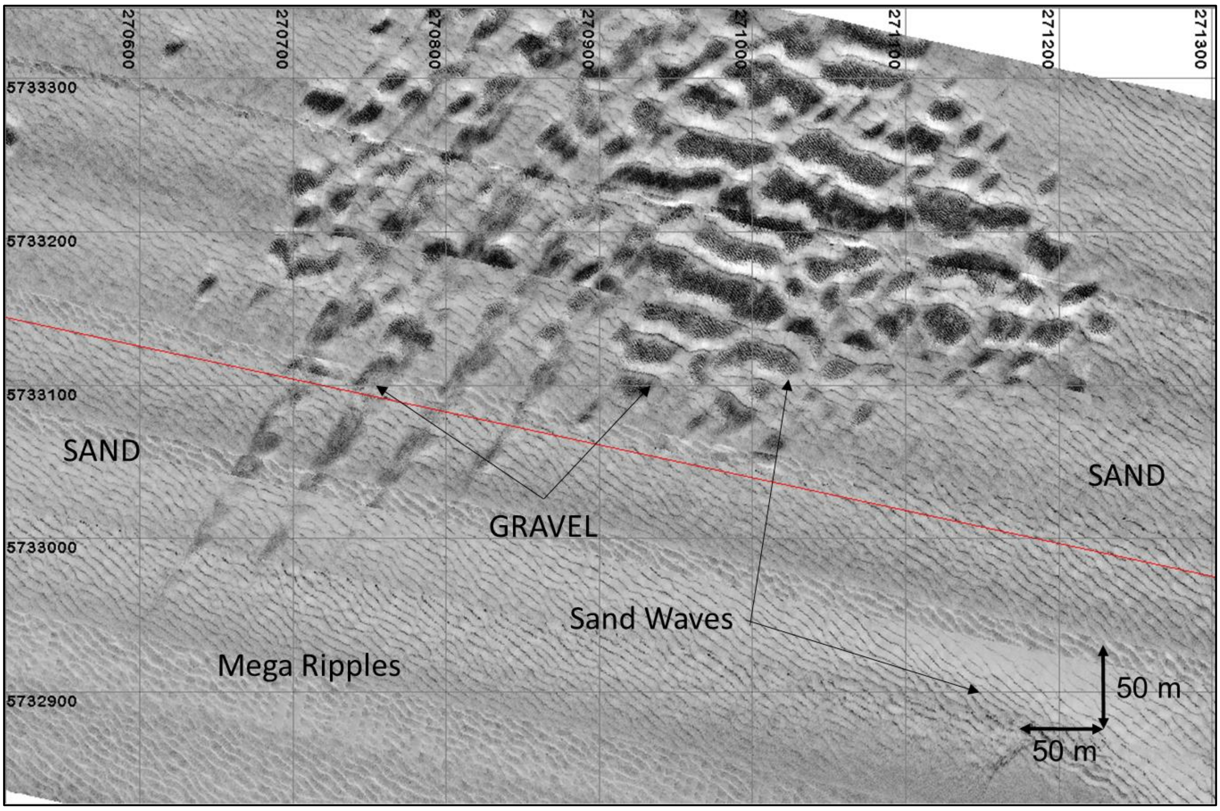


Figure 42 SSS plan view data example from KP 88.618 to KP 89.424.
Showing SAND and GRAVEL bed forms with megaripples and sandwaves. Image is north up.

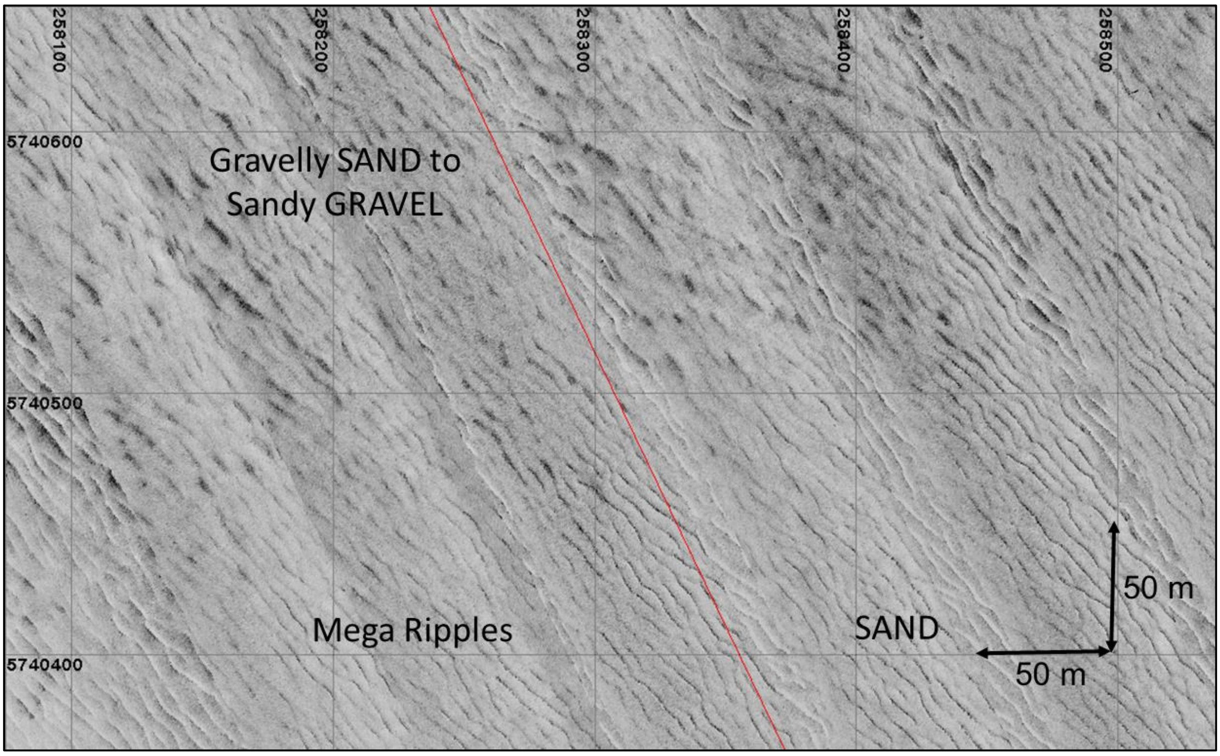


Figure 43 SSS plan view data example from KP 103.900 to KP 104.279.
showing SAND and gravelly SAND to sandy GRAVEL with megaripples. Image is north up.

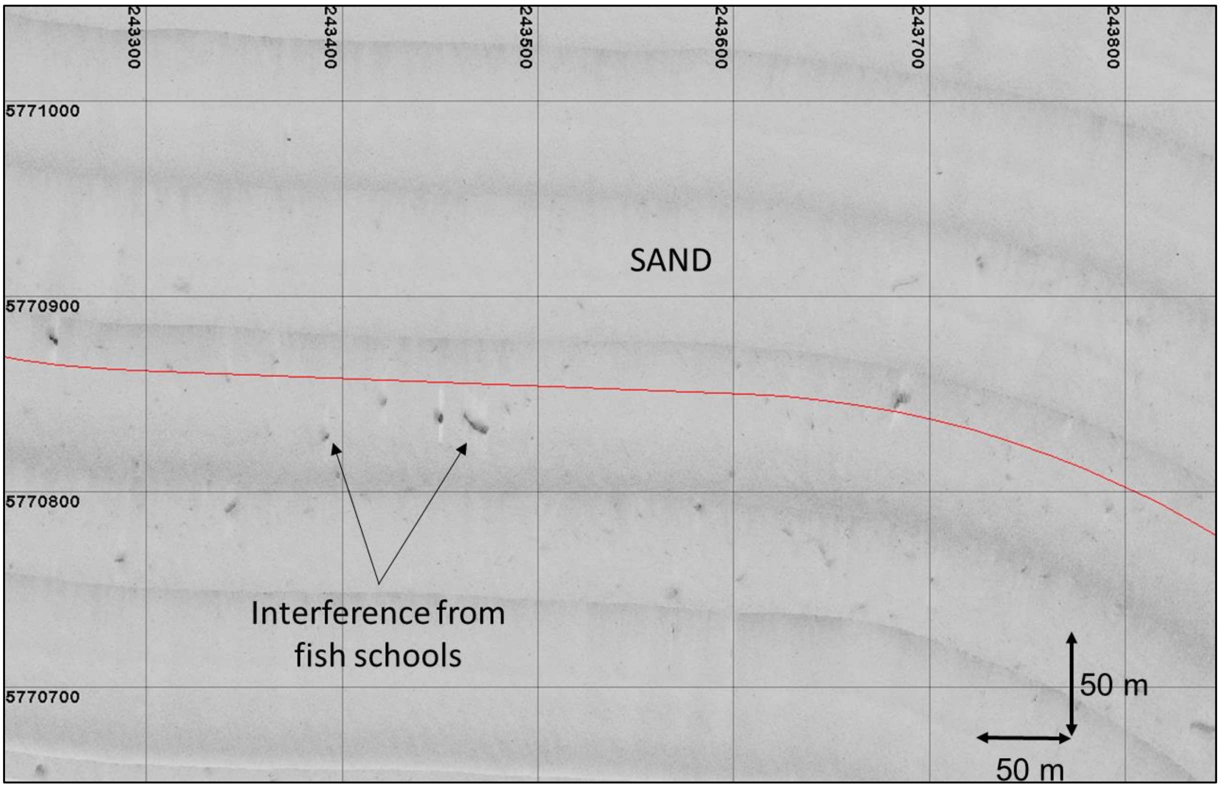


*Figure 44 SSS plan view data example from KP 138.603 to KP 139.238.
Showing SAND with minor acoustic interference from fish schools. Image is north up.*

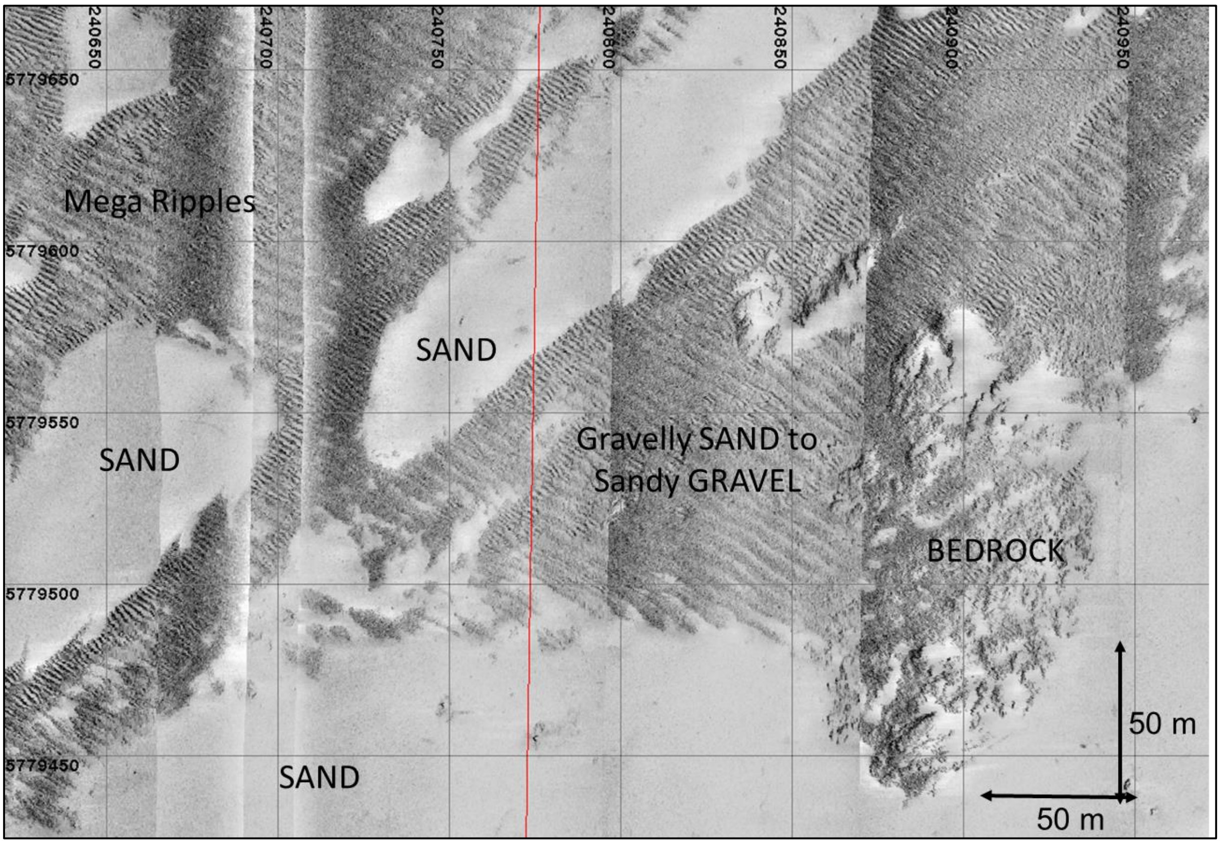


Figure 45 SSS plan view data example from KP 148.621 to KP 148.873.
Showing gravelly SAND to sandy GRAVEL with megaripples, SAND and an outcrop of BEDROCK. Image is north up.

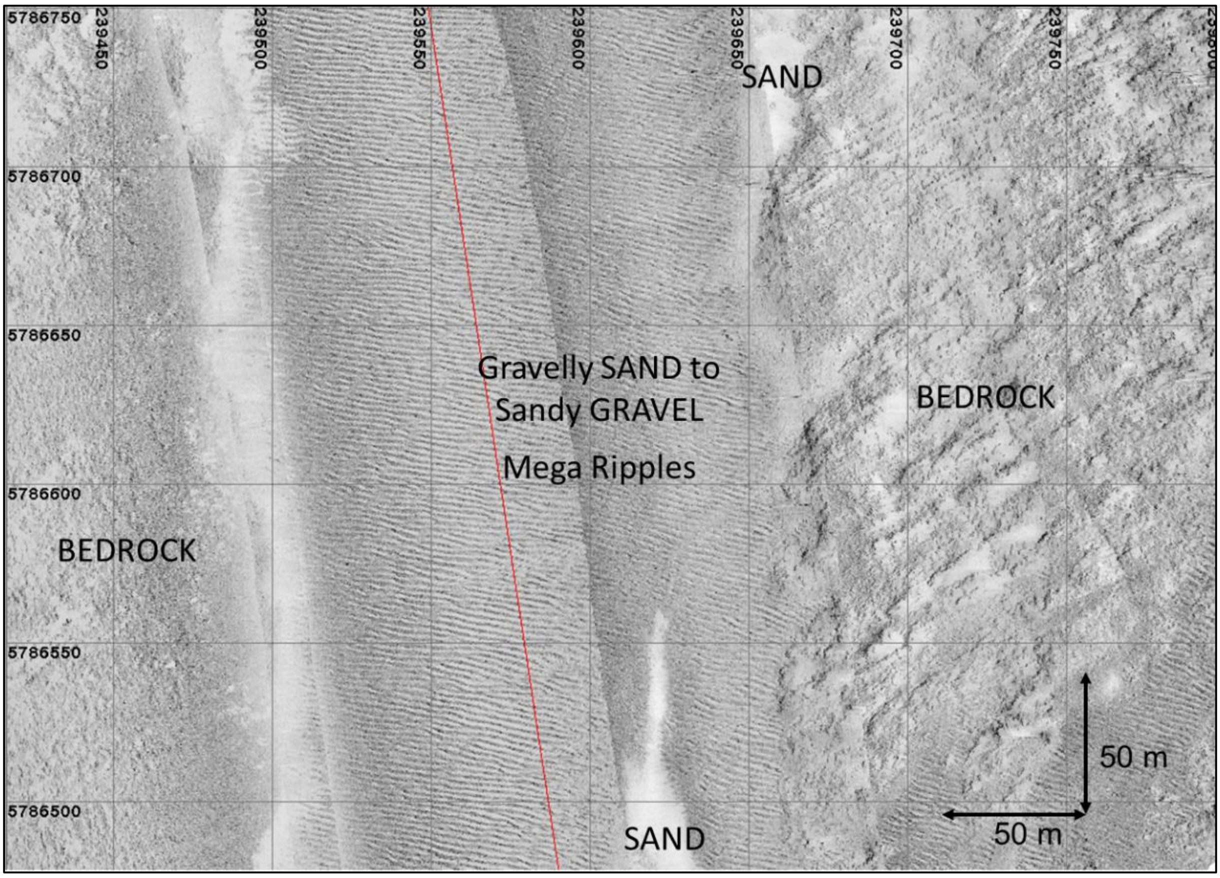


Figure 46 SSS plan view data example from KP 155.992 to KP 156.266.
Showing gravelly SAND to sandy GRAVEL with megaripples and outcrops of BEDROCK. Image is north up.

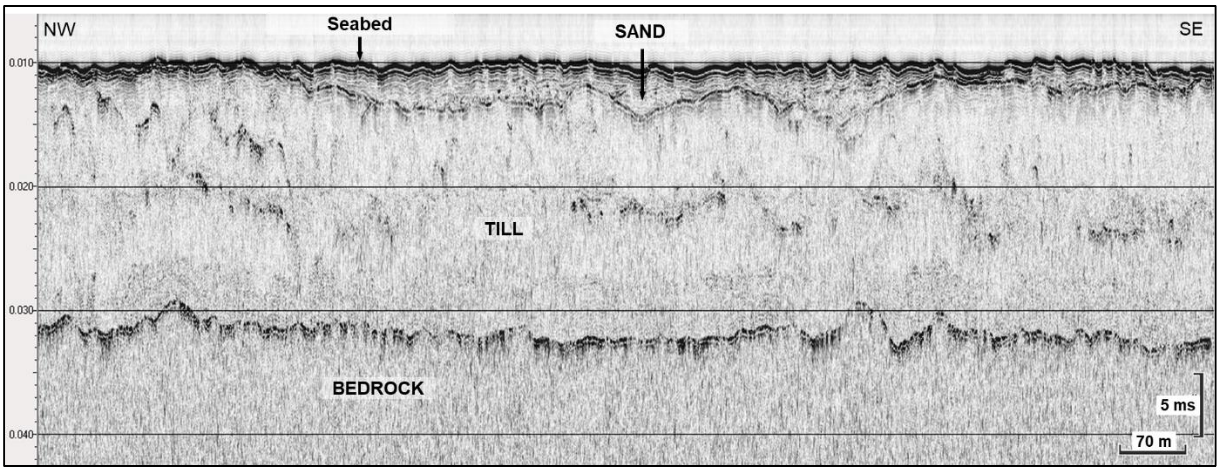


Figure 47 Chirp SBP data example from KP 73.950 to KP 75.250.
Showing surface SAND unit overlying a chaotic TILL sequence with multiple internal reflectors over BEDROCK.

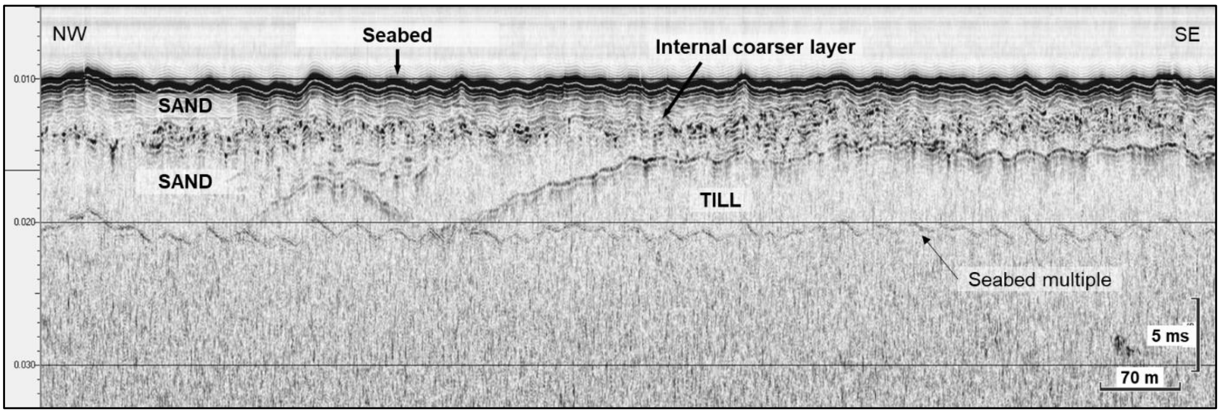


Figure 48 Chirp SBP data example from KP 78.990 to KP 80.040.
Showing surface SAND unit with an internal coarser sediment layer overlying TILL.

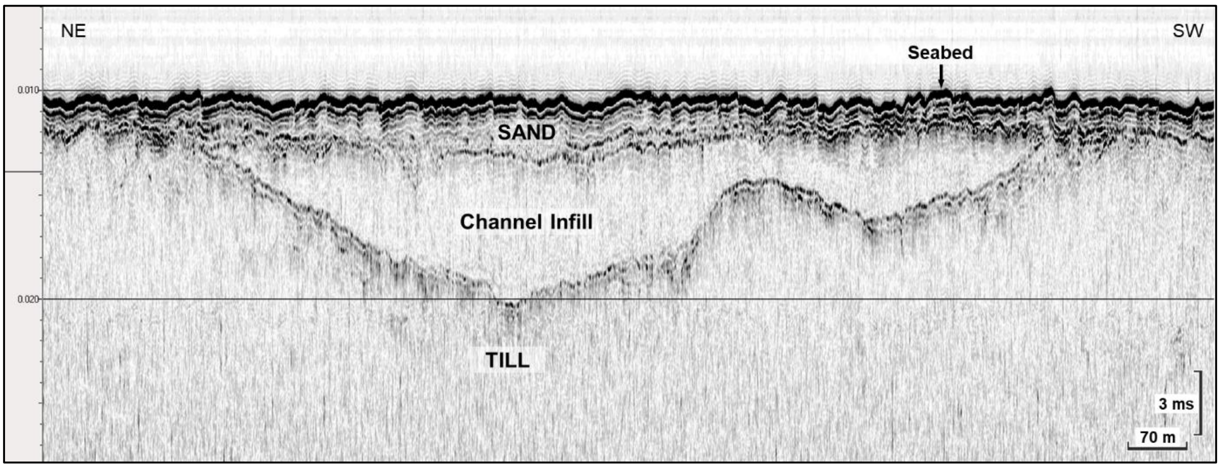


Figure 49 Chirp SBP data example from KP 115.500 to KP 116.500.
Showing an erosional TILL surface filled with channel infill sediments and covered by surface SAND unit.

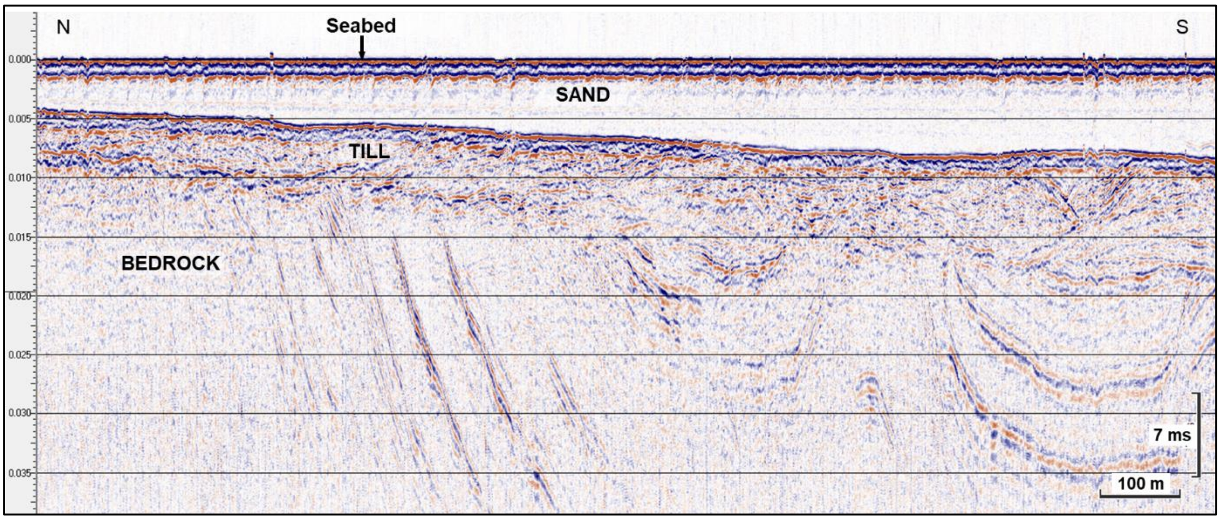


Figure 50 Sparker SBP data example from KP 145.350 to KP 146.860.
Showing the pinching out of a thick surface SAND layer over chaotic TILL and BEDROCK.

6.1.3| CONTACTS AND ANOMALIES ROUTE OPTION RPL_09112018_REV0

A total of 130 SSS contacts were identified from the data within the survey corridor in Ireland offshore. The majority of the contacts were classified as either boulders or debris.

The SSS contacts are summarised in Table 23.

A total of 42 magnetic anomalies were detected in the Ireland offshore corridor. Of these, 42 were unclassified (Table 24).

A total of 1 SSS contact positions correlated with detected magnetic anomalies.

Table 23 Summary of Ireland offshore SSS contacts route option RPL_09112018_REV0.

CLASSIFICATION	NUMBER
Boulder	102
Other	2
Debris	26
Wreck	0
Total	130

Table 24 Summary of Ireland offshore magnetic anomalies, route option RPL_09112018_REV0.

CLASSIFICATION	NUMBER
Unclassified, possible objects	42
Cable	0
Total	42

6.2| IRELAND NEARSHORE

6.2.1| OVERVIEW ROUTE OPTION RPL_09112018_REV0

Results are present for KP 156.667 to KP 159.172.

BATHYMETRY

The bathymetry in this area gently slopes up to the shore from a depth of 16.67 m. The seabed is rocky with occasional smooth flat areas that the route follows over, skirting around rocky outcrops. As the seabed gently rises up to the shore ripples are observed and from KP 159.071 the seabed is rocky until the end of the route, see Figure 51.

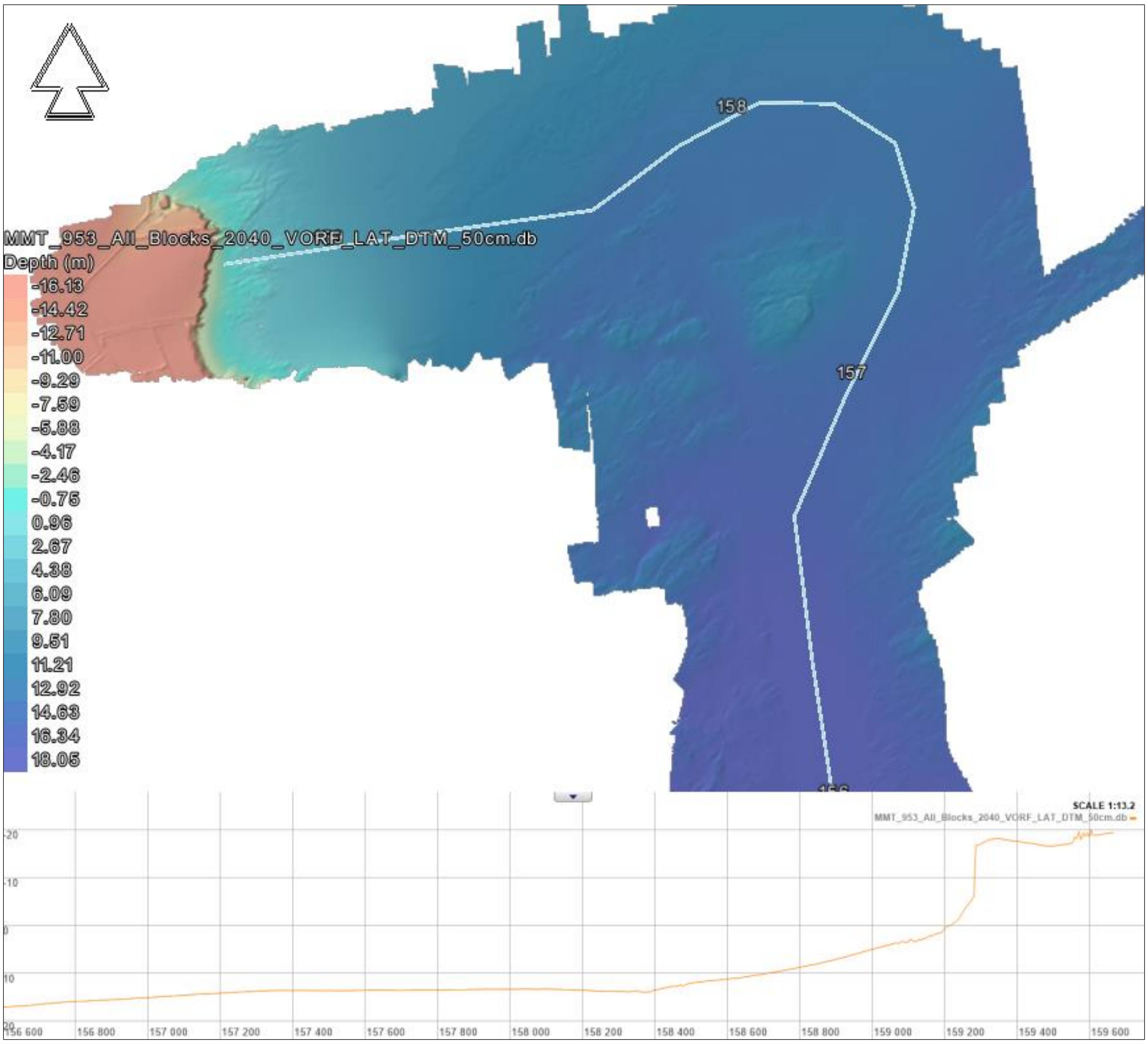


Figure 51 Shaded bathymetric relief and cross profile showing the shoreline at Baginbun gently sloping from KP 156.667.
Longitudinal profile (orange) depicts seabed along the route from KP 156.667 to the beach. Negative values are above LAT (Profile vertical exaggeration: 1:13.2).

SURFICIAL GEOLOGY

The surficial geology in the nearshore parts of the Irish route is varied. Large outcrops of BEDROCK are common, interrupted by areas of SAND, SILT or gravelly SAND/sandy GRAVEL. Large areas of megaripples and sandwaves are also present, most commonly in the eastern parts of the block.

SHALLOW GEOLOGY

The shallow geology in the Ireland Nearshore section is characterised by a basin infill and outcropping BEDROCK.

The TILL over BEDROCK present at the beginning of the nearshore section at KP 156.667 turns into a deep basin filled surface SAND layer and channel infills of mixed sediment up to 8 m thick. The basin is an incision in TILL or BEDROCK, a definite distinction with depth is not resolved. BEDROCK is outcropping from KP 158.365 to KP 158.847 and from KP 159.069 to the end of the available seismic data. In between the outcrops a thin layer of SAND is present.

6.2.2| DETAILED DESCRIPTION ROUTE OPTION RPL_09112018_REV0

A detailed presentation of the conditions and features along the Ireland nearshore route are shown in Table 25.

Table 25 Seabed details route option RPL_09112018_REV0 KP 156.667 to KP 159.172.

KP	Associated Chart	Description	Remark
156.667 - 157.710	102953-GRL-MMT-SUR-DWG-AL10KF19	**Bathymetry:** Depth decreases to KP 157.3 where it becomes generally flat. The seabed has ripples throughout the route with rocky areas in the outer corridor.	Very gentle to gentle gradients with a maximum value of 1.8 degrees. Depths range up to 16.67 m on the route (Figure 53).
		Surficial geology: The surficial geology consists of mainly gravelly SAND to sandy GRAVEL up to KP 157.721 where the dominating sediment becomes SILT. Megaripples are present along the route to KP 157.604.	(Figure 54)
		Shallow Geology: The start of this section to KP 157.060 is characterised by TILL over BEDROCK with an unresolved veneer of mobile SAND and GRAVEL. This is followed by a basin infill with the surface SAND unit of up to 4 m and some channel infill sediments over TILL and BEDROCK. The boundary between TILL and BEDROCK is not well resolved in the seismic data.	(Figure 56)
157.710 - 158.296	102953-GRL-MMT-SUR-DWG-AL10KF19	**Bathymetry:** There is little variation in depth until KP 158.106 where it increases very gently by 0.5 m. The seabed is rippled until the route turns at KP 157.611 on to smoother seafloor.	Very gentle gradient with a maximum value of 0.65 degrees. Depths range up to 13.77 m on the route (Figure 53).
		Surficial geology: The surficial geology consists of mainly SILT interrupted by areas comprising of SILT and SAND.	(Figure 55)
		Shallow Geology: Continued basin infill with the surface SAND unit of up to 4 m and some channel infill sediments, reaching a maximum of 8 m below seabed, over TILL and BEDROCK. The boundary between TILL and BEDROCK is not well resolved in the seismic data. TILL/BEDROCK reaches to within 1 m from the seabed from KP 158.230.	(Figure 56)

KP	Associated Chart	Description	Remark
158.296 - 159.172	102953-GRL-MMT-SUR-DWG-AL10KF19	**Bathymetry:** The route moves through a small rocky area at KP 158.365 (Figure 52), then at KP 158.5 continues to gently decrease in depth over smooth seabed until KP 159.070 where there is another rocky area leading on to the shore.	Very gentle to locally moderate gradients with a maximum value of 5.76 degrees over the rocks. Depths range up to 13.92 m on the route (Figure 53).
		Surficial geology: The surficial geology consists of mainly SAND interrupted by areas of SILT and SAND. In this section, the BEDROCK outcrops occasionally cross the route.	Bedrock outcrops crossing route between: • KP 158.426 and KP 158.490 • KP 159.073 to end of route
		Shallow Geology: BEDROCK or TILL/BEDROCK are close to seabed throughout this section. BEDROCK is outcropping (or with a veneer of SILT and SAND) between KP 158.365 and KP 158.847 and from KP 159.070 to the end of the route. SAND and some channel infill sediments of 1-2 m thickness are present between these BEDROCK outcrops, KP 158.847 to KP 159.069.	(Figure 57)

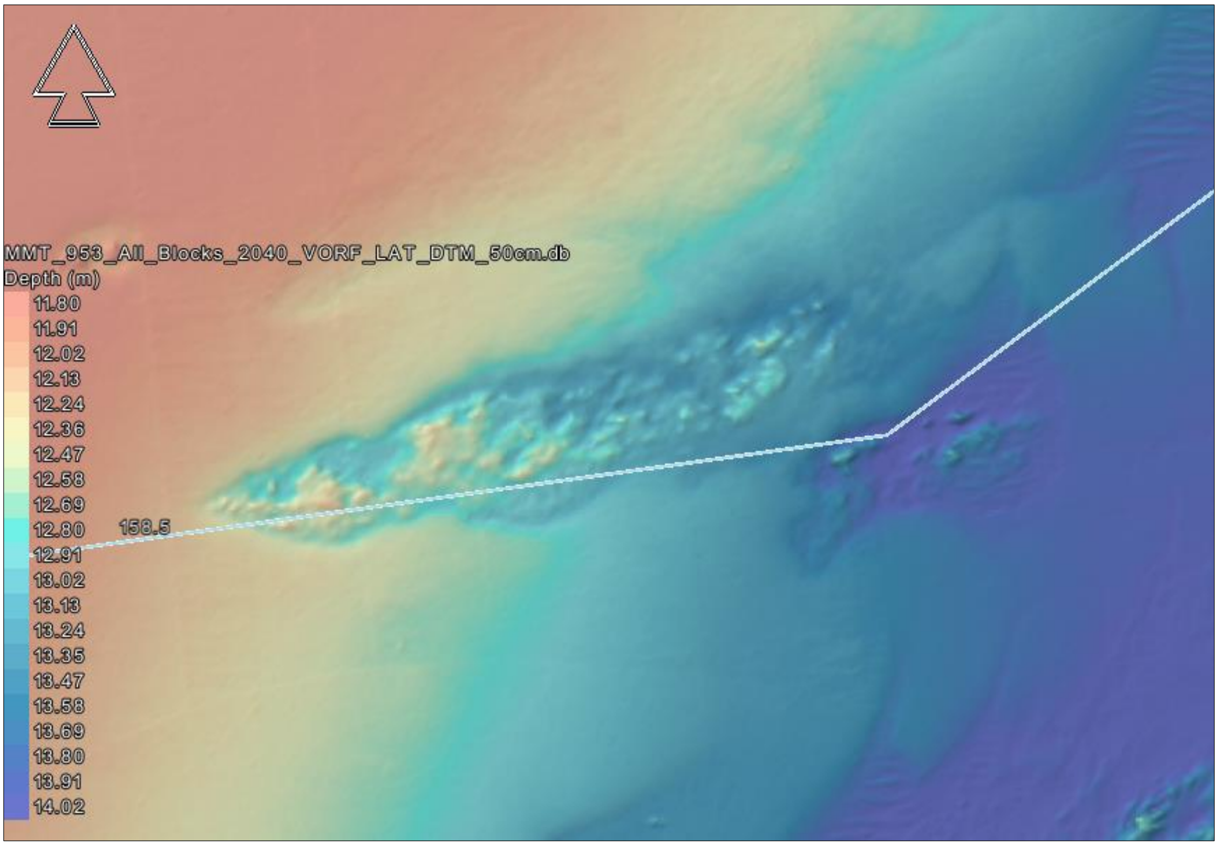


Figure 52 Shaded bathymetric relief showing the route passing over a rocky outcrop at KP 158.402. Palette is adjusted to highlight area.

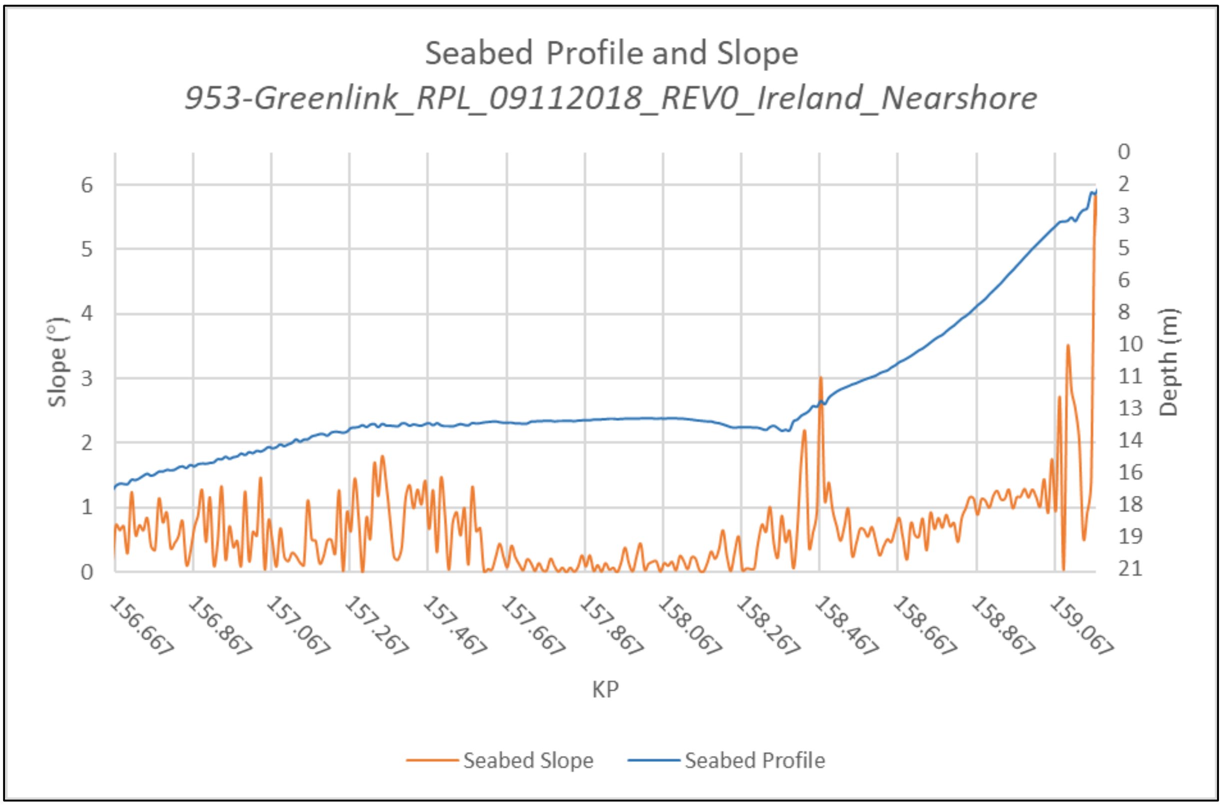


Figure 53 Seabed gradient and depth at the Irish nearshore section from KP 156.667 to KP 159.172.

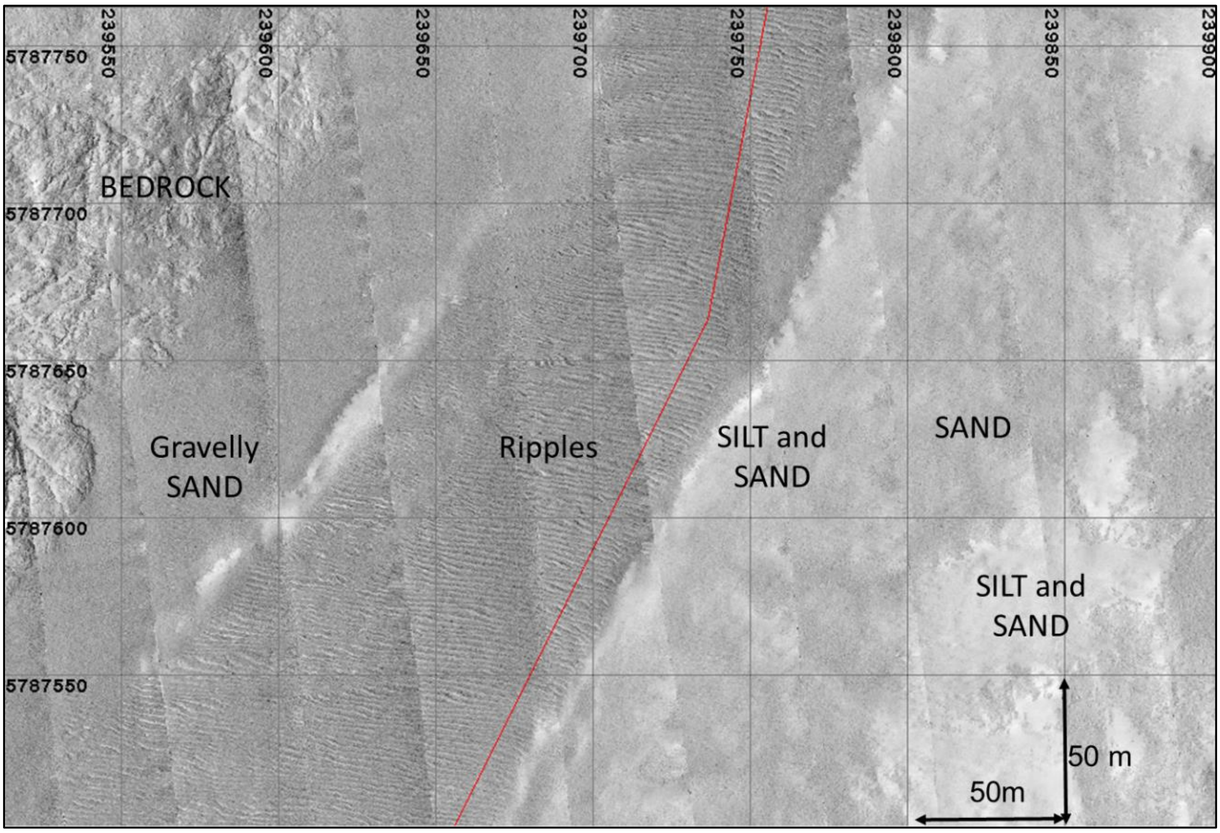


Figure 54 SSS plan view example from KP 157.145 to KP 157.335.
Showing gravelly SAND with ripples, patches of SILT and SAND between SAND and an outcrop of BEDROCK. Image is north up.

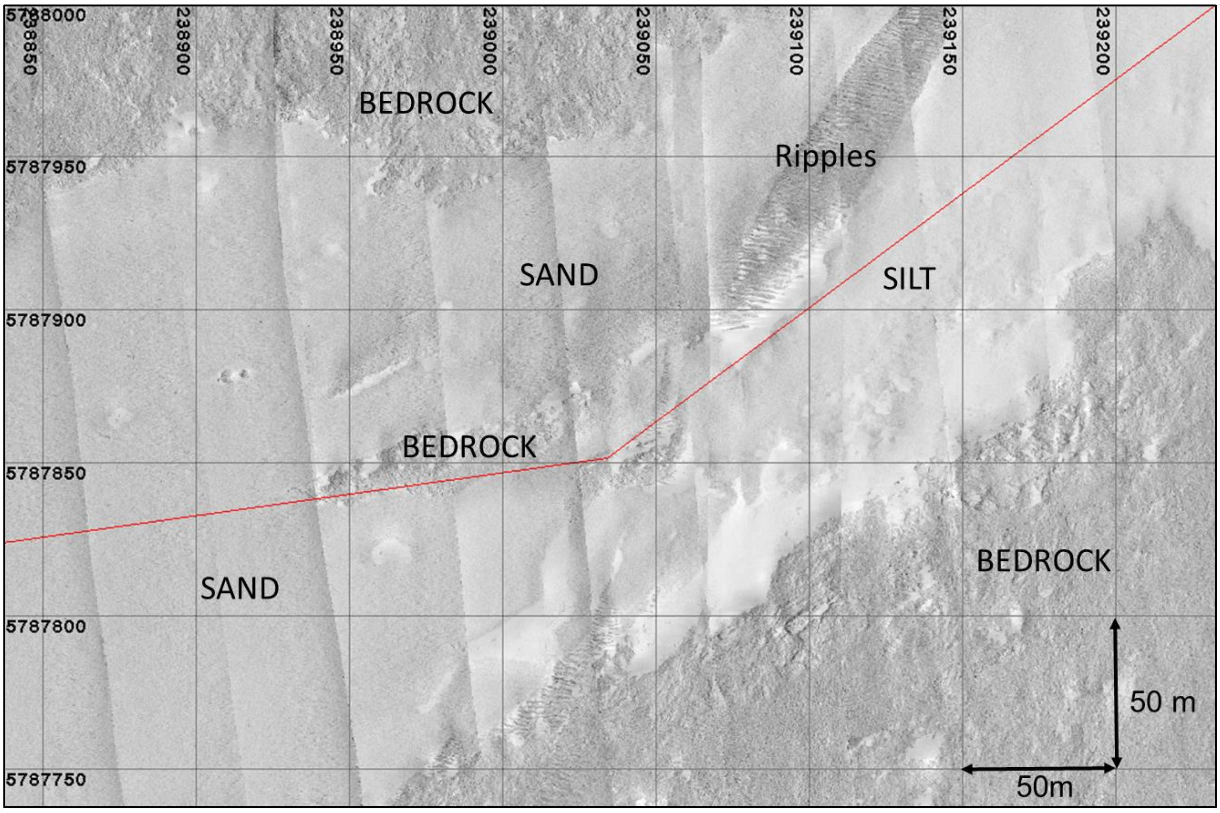


Figure 55 SSS plan view example from KP 157.925 to KP 158.584.
Showing SAND and SILT between BEDROCK. Image is north up.

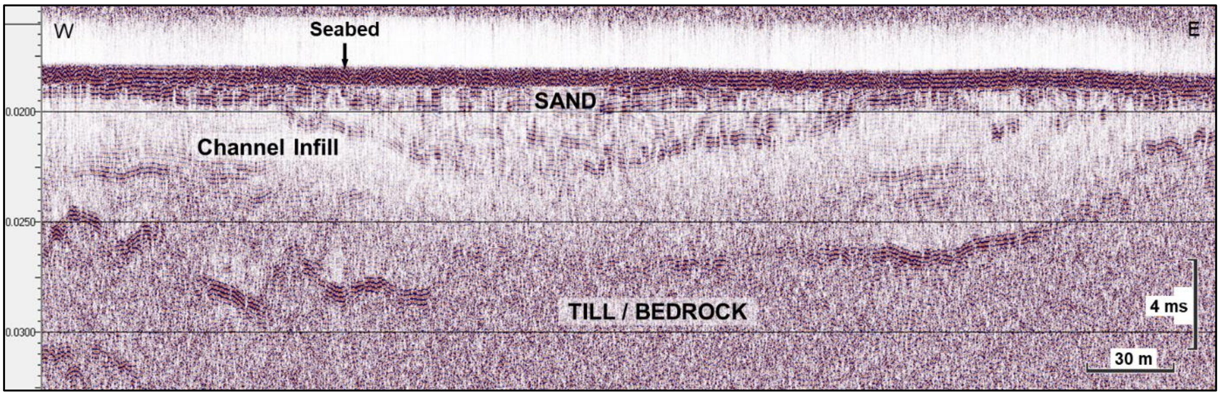


Figure 56 Innomar SBP data example from KP 157.570 to KP 158.020.
Showing a basin infilled by SAND and channel infill sediments over TILL/BEDROCK.

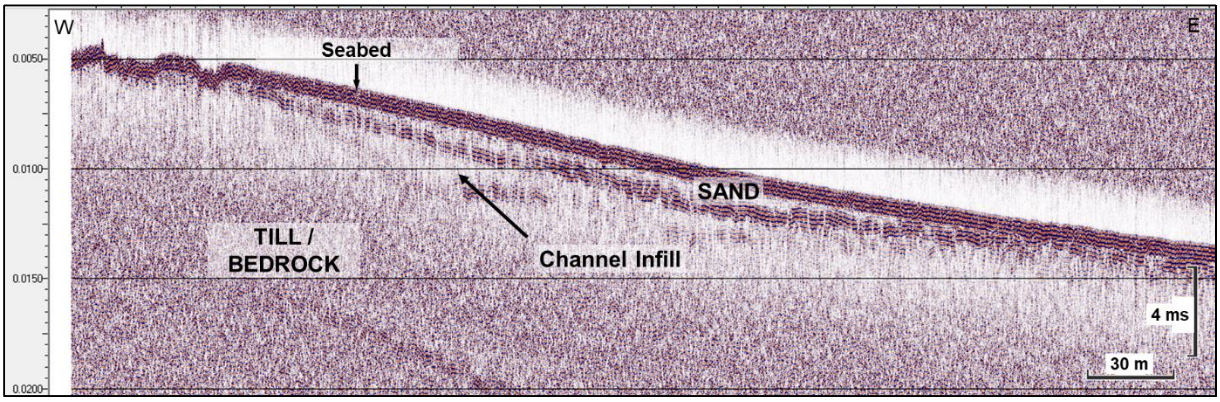


Figure 57 Innomar SBP data example from KP 158.420 to KP 159.110.
Showing a thin surface SAND layer and some channel infill sediments over TILL and BEDROCK towards the landfall on the left.

6.2.3| CONTACTS AND ANOMALIES ROUTE OPTION RPL_09112018_REV0

A total of 73 SSS contacts were identified from the data within the survey corridor in Ireland nearshore. The majority of the contacts were classified as either boulders or debris.

The SSS contacts are summarised in Table 26.

A total of 19 magnetic anomalies were detected in the Ireland nearshore corridor. Of these, 19 were unclassified (Table 27).

A total of 1 SSS contact positions correlated with detected magnetic anomalies.

Table 26 Summary of Ireland nearshore SSS contacts, route option RPL_09112018_REV0.

CLASSIFICATION	NUMBER
Boulder	57
Other	3
Debris	13
Wreck	0
Total	**73**

Table 27 Summary of Ireland nearshore magnetic anomalies, route option RPL_09112018_REV0.

CLASSIFICATION	NUMBER
Unclassified, possible objects	19
Cable	0
Total	**19**

6.2.4| OVERVIEW ROUTE OPTION A

Results are presented from KP 156.187 to KP 157.413.

All KPs refer to route option A, RPL Route_A_WGS84_UTM30N_Rev1_20180521.

BATHYMETRY

The seabed along the route is generally smooth with rocky areas on the outer corridor which eventually get closer, causing the entire corridor to become rocky. The depth generally decreases throughout with some undulation over the rocky area. Very gentle to gentle gradients throughout.

SURFICIAL GEOLOGY

The initial section of the Irish part of Route Option A is dominated by gravelly SAND/sandy GRAVEL, whereas the latter part is dominated by SAND. Large areas of BEDROCK outcrops are present throughout the alternative route.

Megaripples are present in areas along Route Option A.

SHALLOW GEOLOGY

An 8 m deep basin infilled by SAND and mixed channel infill sediments, outcropping BEDROCK or BEDROCK with a veneer of sediment are present along the route.

6.2.5| DETAILED DESCRIPTION ROUTE OPTION A

A detailed presentation of the conditions and features along the Ireland nearshore route option A are shown in Table 28.

Table 28 Seabed details route option A KP 156.187 to KP 157.413.

KP	Associated Chart	Description	Remark
156.187-157.413	102953-GRL-MMT-SUR-DWG-AL10KA04	**Bathymetry:** The route passes over smooth seabed in between rocky outcrops until KP 156.817. From here the seabed is rocky until KP 157.078 when it becomes smooth again, see Figure 58. Depth decreases gently along the route.	Very gentle to gentle gradient with a maximum value of 3.41 degrees. Depths range up to 16.79 m on the route (Figure 59).
		Surficial geology: The surficial geology consists of mainly gravelly SAND to sandy GRAVEL surrounded by some smaller sections of SILT and SAND. SAND becomes more common towards the end of the route and from KP 157.046 SAND is the main surficial sediment type. BEDROCK is outcropping in large areas of the route. Megaripples are present in several smaller areas.	Bedrock outcrops crossing the route between: KP 156.406 and KP 157.241. (Figure 60, Figure 61)
		Shallow Geology: The shallow geology in this section starts with a basin of SAND and channel infill that pinches out at KP 156.650. From there to KP 157.000 BEDROCK is outcropping at seabed or covered by a thin veneer of gravelly SAND to sandy GRAVEL. Between 157.000 and 157.413 a thin SAND layer of generally <2 m is present over TILL/BEDROCK.	(Figure 62)

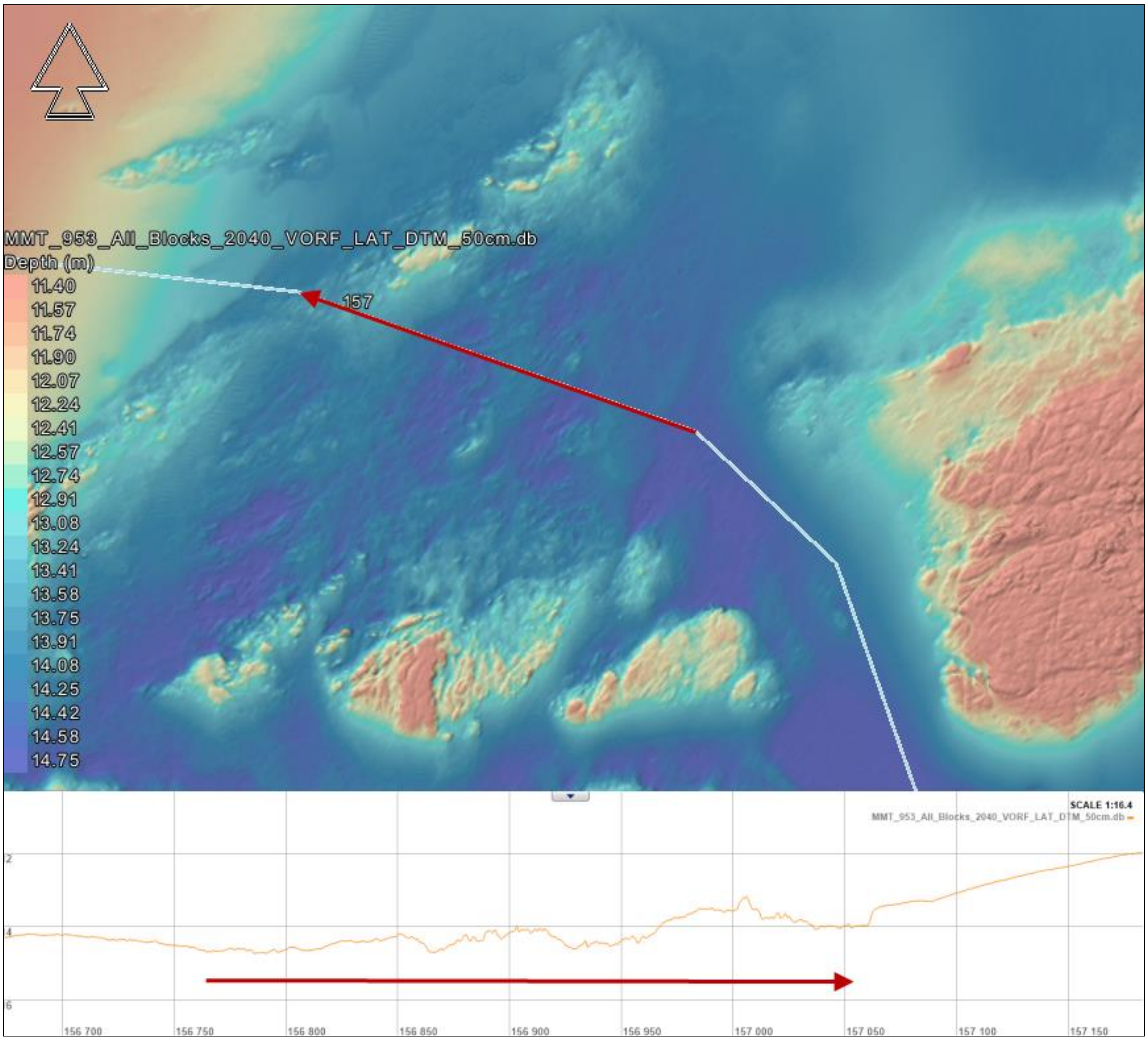


Figure 58 Shaded bathymetric relief showing the rocky seabed on Route A between KP 156.817 and KP 157.078.
Longitudinal profile (orange) depicts seabed along the route along the direction of the red arrow (Profile vertical exaggeration: 1:16.4).

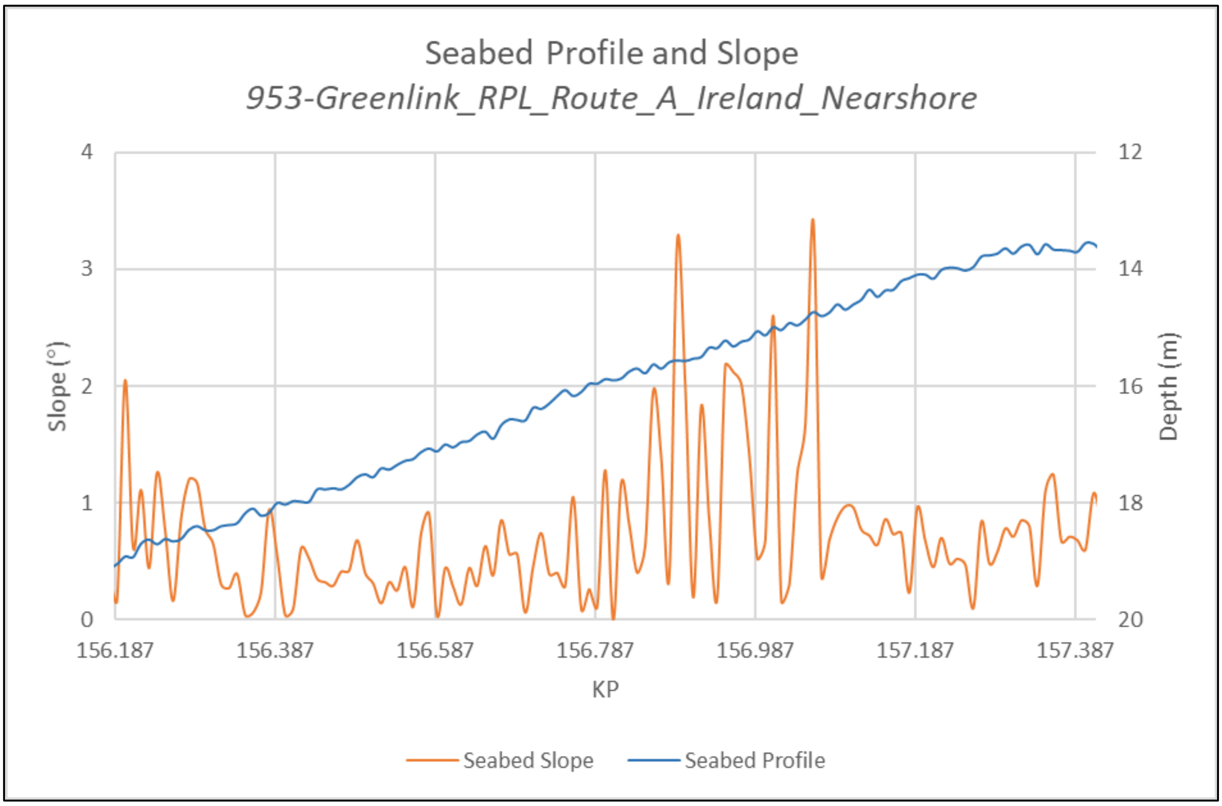


Figure 59 Seabed gradient and depth on route option A in the Irish nearshore section between KP 156.187 and KP 157.413.

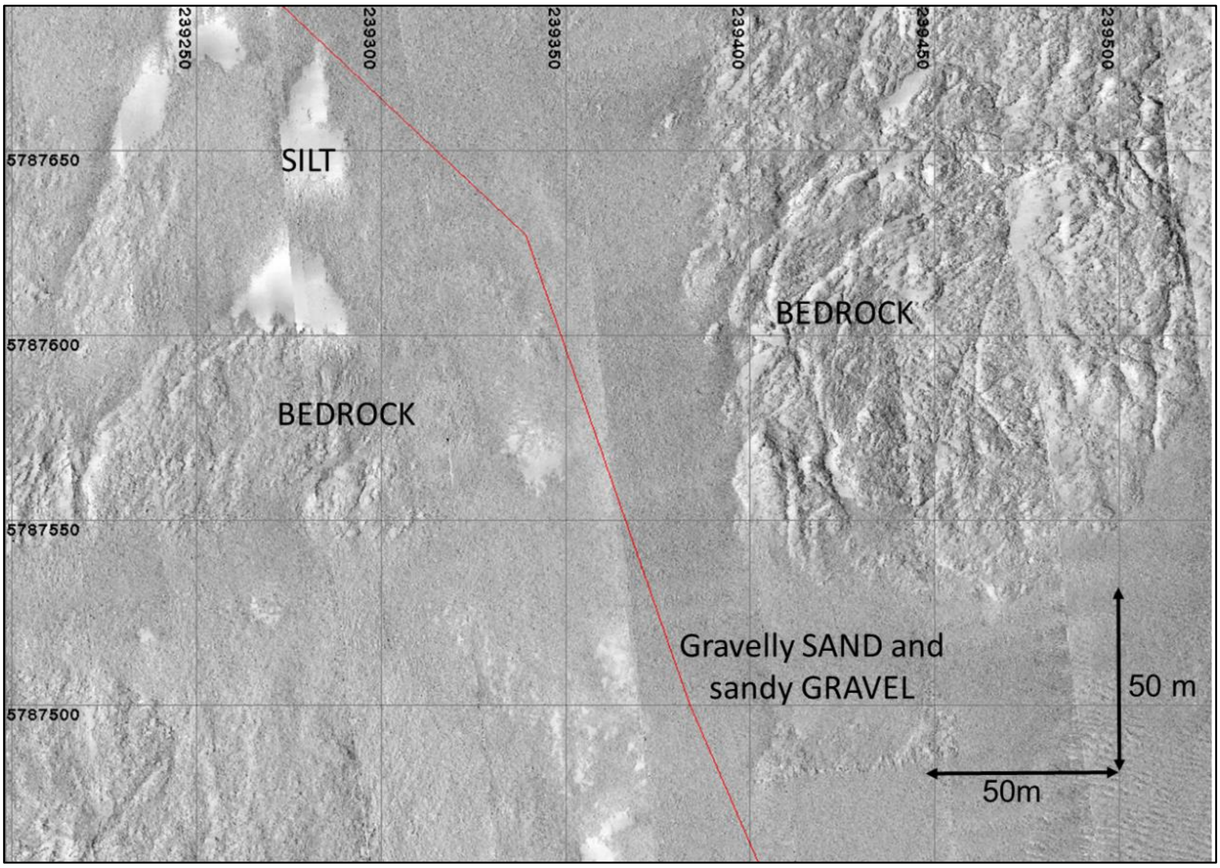


Figure 60 SSS plan view example from KP 156.782 to KP 157.241.
Showing a channel of gravelly SAND and sandy GRAVEL between BEDROCK. Image is north up.

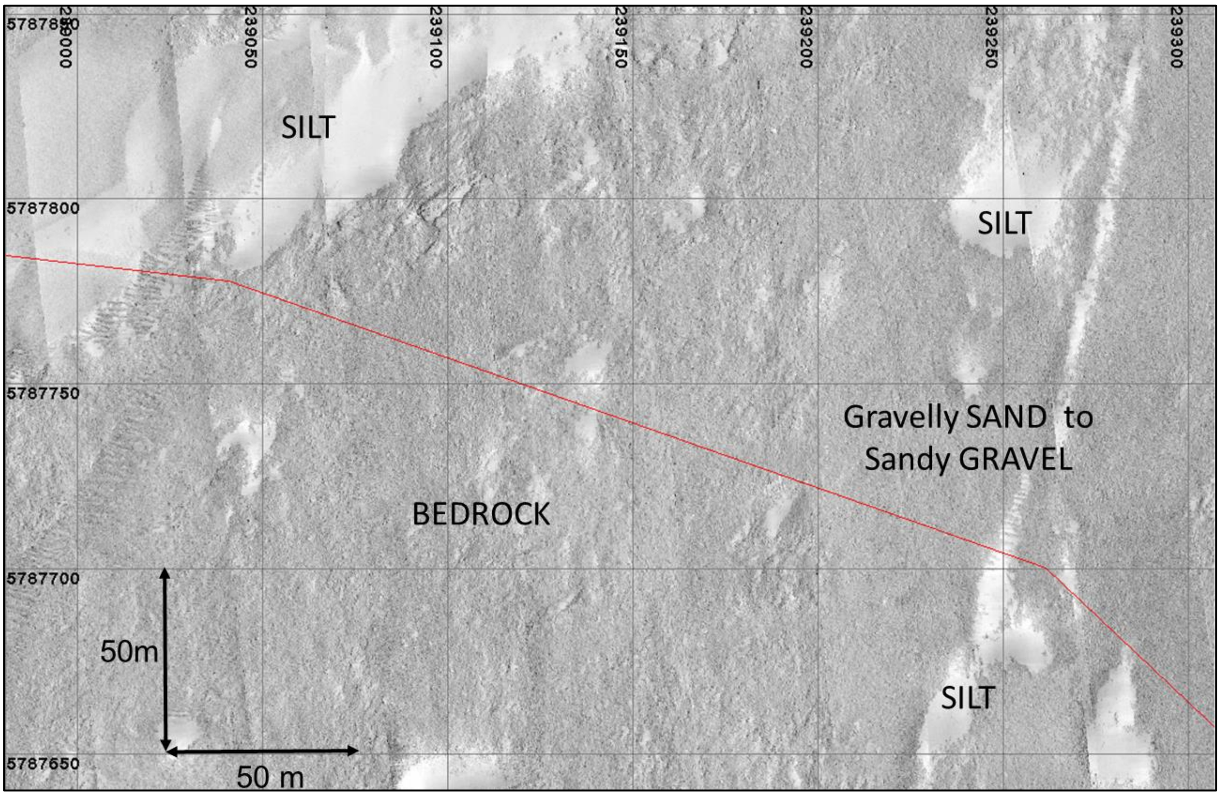


Figure 61 SSS plan view example from KP 157.095 to 156.739 095.
Showing BEDROCK with areas of gravelly SAND and sandy GRAVEL and patches of SILT. Image is north up.

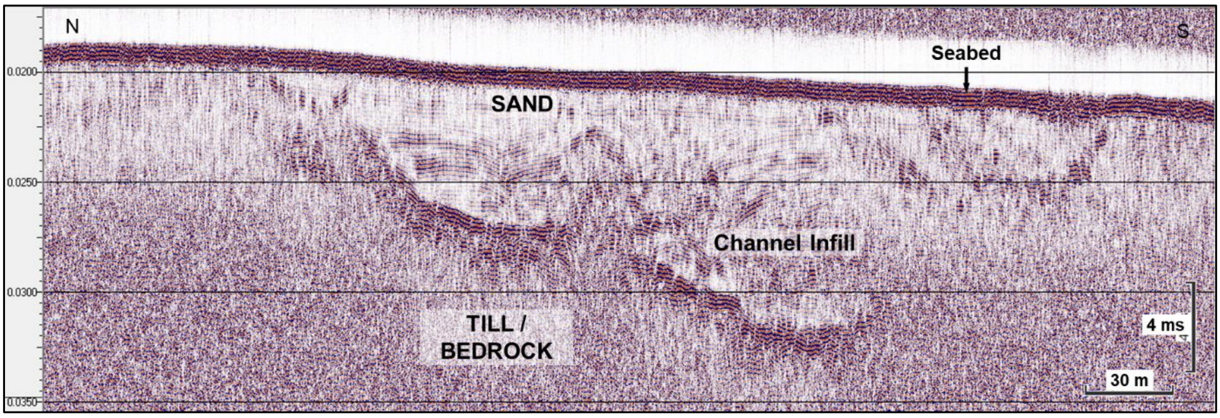


Figure 62 Innomar SBP data example from KP 156.330 to KP 156.720.
Showing a basin infilled by SAND and channel infill sediments over TILL/BEDROCK.

6.2.6| CONTACTS AND ANOMALIES ROUTE OPTION A

A total of 21 SSS contacts were identified from the data within the survey corridor in Ireland nearshore. The majority of the contacts were classified as either boulders or debris.

The SSS contacts are summarised in Table 29.

A total of 2 magnetic anomalies were detected in the Ireland nearshore corridor. Of these, 2 were unclassified (Table 30).

No SSS contact positions correlated with detected magnetic anomalies.

Table 29 Summary of Ireland nearshore SSS contacts, Route A.

CLASSIFICATION	NUMBER
Boulder	13
Other	2
Buoy	0
Debris	6
Wreck	0
Total	**21**

Table 30 Summary of Ireland nearshore magnetic anomalies, Route A.

CLASSIFICATION	NUMBER
Unclassified, possible objects	2
Cable	0
Total	**2**

7| INSTALLATION CONSTRAINTS

7.1| POSSIBLE CHALLENGES TO CABLE INSTALLATION AND PROTECTION

7.1.1| SEABED GRADIENTS

Steep ground is considered problematic when the seabed has a slope of a magnitude that affects the speed or effectiveness of the trenching operation. The critical slope angle depends on the trenching equipment. There may well be a difference in critical angle between along track slopes and across track slopes. Trenching and/or rock installation may also change slope stability and induce sediment slides.

Steep ground may affect cable installation. If the slope angle is great enough it can cause the cable to move out of position, which could also result in excess tension in the cable.

Steep slopes may cause problems for cable protection, e.g. rock and gravel berms, if the slope angle causes the protective material to slide downhill and eventually expose the cable.

7.1.2| BEDROCK AND HARD SEDIMENT

Bedrock and hard sediment are considered an issue when the seabed proves to have properties that affect and effectively inhibit the use of the trenching methods.

Bedrock and hard sediment may cause problems with reaching the required burial depth. In addition, topographical irregularities in bedrock or hard sediment may cause freespan, point load, and abrasion. Methods to avoid problems with bedrock or hard sediment include appropriate micro-routing, deployment of heavier trenching machines, or the installation of additional cable protection such as Pre lay rock installation/dredging to level the route to avoid free span.

7.1.3| BOULDER FIELDS

Fields with boulders may cause freespan and point load problems, and may also cause problems during the potential trenching of the cable. Methods of avoidance include, rerouting, boulder removal by using e.g. an ROV or a pulled plough pushing the boulders aside, and pre-lay rock placement.

Buried boulders can cause difficulties, especially if they are discovered during trenching of the cable. An effective method for pre-burial assessment of buried boulders is to perform a pre-lay trench.

7.1.4| MOBILE SEDIMENT

Mobile sediments may bury or expose the cable. Both scenarios are to be avoided, since excess burial depth may result in overheating, and exposure will leave cables vulnerable to damage.

Cable protection by trenching in sandwave areas is complicated, in particular where the trenching equipment will pass through a crest or trough, and the equipment is not properly supported on ground. In such situations, the burial depth is affected, complicating the procedure of reaching the designated depth and protection level.

In areas where there is evidence of mobile sediments, pre-dredging or pre-sweeping the cable route prior to laying and trenching is considered a good solution for mitigating future problems with cable exposure, or excessive burial depths.

Using rock placement on top of the laid cable is also a method to stabilise an area with mobile sediments. However, this solution may cause stones to sink and spread uncontrollably in sand if the erosional forces are strong, and may therefore require ongoing maintenance. Rock placements can also lead to scouring which may need post-lay control.

An often economically viable method of ensuring the safety of the cables is to perform frequent burial depth measurements and burial remediation, for example on a yearly basis in critical areas.

It is often necessary to perform a sandwave analysis, identifying any high risk areas in advance, and propose mitigation procedures based on pre-lay investigations. Post-lay activities may be very expensive, and are not always effective.

To be able to measure the mobility of the sediment, a reliable method is to compare at least two sets of data, which has been retrieved with some time elapsed in between the different surveys. Based on the result, the speed and volume of sediment movement can be calculated.

7.1.5| UNSTABLE SEDIMENT

Unstable sediment is a problem during cable installation, if sediment slumps, this may unbalance the equipment. Unstable sediments can cause problems for cable protection as a result of movement or collapse after installation. Unstable sediments can also cause problems for the operation integrity of the cable as slumping post installation can result in direct damage to the cable as well as freespan and exposure.

Trenching and/or rock installation may also change slope stability and induce sediment slides.

Mitigation includes cable re-routing.

7.1.6| ACOUSTIC BLANKING AND GAS SEEPAGE FEATURES

Shallow gas and gas seepage features, pockmarks, and Methane-Derived Authigenic Carbonates (MDAC) may cause problems to the cable installation. Sediment movements within pockmarks, uncontrollable movements of the cable may expose the cable to unnecessary strain. The thermal properties can be affected, causing problems with discharge of heat in the sediment around pockmarks. If a cable is laid in a pockmark or in a developing pockmark there is a risk for vortex induced vibrations in the cable, if it would go into freespan. Gas seeps may accelerate corrosion to the cable amour if seeps are corrosive.

The presence of MDAC and/or pockmarks can cause difficulties, especially if they are discovered during cable installation. During installation potential problems are reduced sediment stability, difficulties in choosing burial equipment, trencher instability, and potential problems to protect the cable in an acceptable way. It should also be considered that the presence of shallow gas may indicate larger amounts of gas at deeper levels.

Shallow gas may also be caused by organic matters, especially in the channel filled areas on the North Sea Plateau. Organic matters normally have a reduced thermal conductivity compared to minerogenic sediments and may cause overheating.

Mitigation includes cable rerouting and additional protection measures.

7.1.7| CABLES AND PIPELINES

Cable crossings and pipeline crossings should ideally be made as perpendicular as possible. Thus simplifying the design of the crossing arrangement, and minimising the risk of future maintenance and repair operations on neighbouring installations affecting the cable.

7.1.8 | WRECKS

A wreck presents an abrasive threat to a cable, and may hold the cable in suspension from the seabed. Wreck sites can often be extended, with debris scattered around the main object. Subsequent secondary entanglement with fishing gear is another risk to a cable laid over wreck sites. It is also possible that shipwrecks may be considered of archaeological importance.

7.1.9 | UXO

If UXO or UXO related objects are present, they may be possible to avoid by appropriate micro-routing. If rerouting is impractical, UXO clearance operations will be necessary. Magnetometer records collected during the survey were used to identify cables/pipelines and ferrous objects on the seafloor within the survey corridor.

A focused UXO survey was performed in the region surrounding the Castlemartin firing range which is further discussed in the UXO report (102953-GRL-MMT-SUR-REP-UXOREP). The UXO results can only be seen as valid at the time of the survey, as part of the route is located within the designated artillery range zone where future deposition of UXOs is possible.

7.2 | UNITED KINGDOM

7.2.1 | SEABED GRADIENTS

Gradients are generally very gentle to gentle with some localised moderate to very steep slopes which appear on rocks or sandwaves (Figure 63).

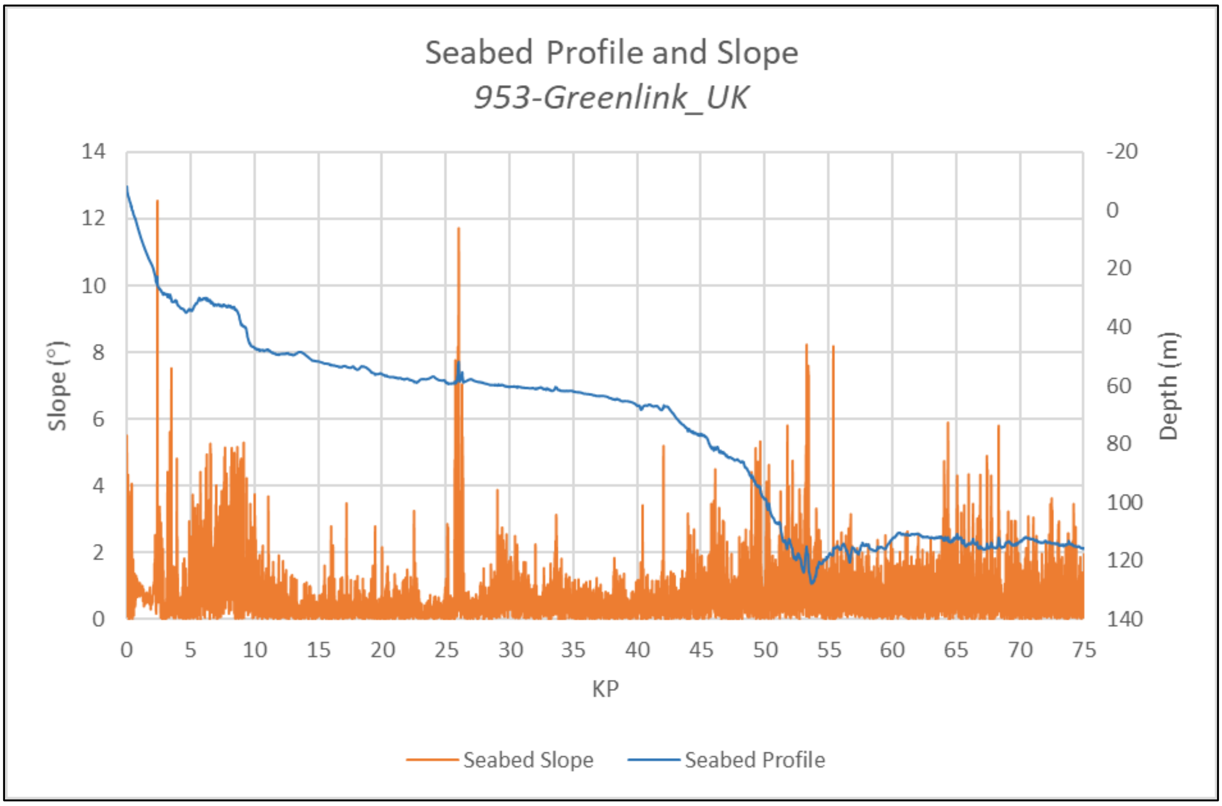


Figure 63 Seabed gradient and depth on the Final route in the UK, between KP 0.000 and KP 73.906.

7.2.2 | BEDROCK AND HARD SEDIMENT

The proposed route crosses bedrock outcrops at several locations in UK waters. These are listed in Table 31.

Table 31 Outcropping bedrock along the proposed route.

Feature	KP start	KP stop
BEDROCK	2.216	2.222
BEDROCK	2.222	2.236
BEDROCK	2.380	2.403
BEDROCK	2.778	2.788
BEDROCK	4.874	4.997
BEDROCK	11.041	11.137
BEDROCK	24.178	24.202
BEDROCK	42.066	42.104

7.2.3 | BOULDER FIELDS

The proposed route crosses boulder fields at several occasions in UK waters. These are listed in Table 32.

Table 32 Boulder fields along the proposed route.

Feature	KP start	KP stop
Occasional Boulders	11.497	11.574
Occasional Boulders	11.789	11.841
Occasional Boulders	16.003	16.123
Occasional Boulders	16.558	16.962
Occasional Boulders	17.839	18.135
Occasional Boulders	19.237	19.313
Occasional Boulders	19.430	19.588
Occasional Boulders	20.201	20.625
Numerous Boulders	20.625	20.949
Occasional Boulders	20.949	21.139
Numerous Boulders	21.139	21.309
Occasional Boulders	21.309	21.467
Numerous Boulders	21.467	21.512
Occasional Boulders	21.512	21.585

Feature	KP start	KP stop
Numerous Boulders	21.585	22.071
Occasional Boulders	22.071	22.532
Occasional Boulders	24.925	25.439
Occasional Boulders	33.915	34.368
Numerous Boulders	38.109	38.571
Occasional Boulders	53.137	53.468

7.2.4| MOBILE SEDIMENT

Mobile sediments are very common throughout the proposed corridor in UK waters. The mobile sediments are listed in Table 33.

Table 33 Mobile sediments along the proposed route, UK waters.

Feature	KP start	KP stop
Ripples	0.464	0.636
Ripples	2.267	2.380
Ripples	2.403	2.778
Ripples	2.788	2.863
Mega Ripples	3.188	3.195
Mega Ripples	3.330	3.367
Mega Ripples	3.596	3.747
Mega Ripples	4.502	4.660
Mega Ripples	4.997	8.841
Mega Ripples	8.841	9.404
Mega Ripples	9.404	11.041
Ripples	11.137	11.529
Ripples	11.841	11.937
Ripples	11.961	11.988
Ripples	12.103	13.421
Mega Ripples	22.373	22.402
Mega Ripples	22.532	22.900
Mega Ripples	23.533	23.821

Feature	KP start	KP stop
Mega Ripples	25.683	26.408
Sand waves	25.683	26.408
Ripples	26.482	26.802
Ripples	27.183	27.201
Ripples	27.213	27.260
Ripples	27.537	27.783
Ripples	27.855	29.061
Mega Ripples	29.061	29.136
Ripples	29.136	31.494
Ripples	32.684	33.429
Mega Ripples	33.429	33.915
Mega Ripples	34.368	34.988
Mega Ripples	35.060	35.094
Mega Ripples	41.848	41.900
Mega Ripples	41.933	42.066
Mega Ripples	42.299	42.424
Mega Ripples	48.233	48.722
Mega Ripples	48.873	49.068
Mega Ripples	49.136	49.822
Mega Ripples	49.822	50.022
Sand waves	50.051	50.212
Sand waves	50.279	50.390
Mega Ripples	50.390	53.070
Mega Ripples	53.468	53.634
Mega Ripples	53.734	54.254
Mega Ripples	55.248	55.301
Mega Ripples	55.471	55.906
Mega Ripples	56.461	57.985
Mega Ripples	58.113	58.395

Feature	KP start	KP stop
Mega Ripples	58.579	59.527
Mega Ripples	59.606	69.361
Sand waves	63.363	69.422
Mega Ripples	69.422	69.614
Sand waves	69.614	70.332
Mega Ripples	70.332	73.674
Sand waves	73.674	73.924

7.2.5| UNSTABLE SEDIMENT

No signs of unstable sediment were seen in the UK section of the proposed route.

7.2.6| ACOUSTIC BLANKING AND GAS SEEPAGE FEATURES

No acoustic blanking or signs of gas seepage was seen in the sediments along the UK parts of the proposed route.

7.2.7| CABLES AND PIPELINES

One cable crosses the proposed route in UK waters, the Pan European Crossing 2. It is buried at the crossing location. Details of the cable is given in Table 34. For detailed information, see the Cable Crossing Report (102953-GRL-MMT-SUR-REP-CABLECRE).

Table 34 Cables crossing the proposed route, UK waters.

Cable	Type of Cable	Owner	Depth of Burial BSB at Crossing Location	KP at Crossing Location
Pan European Crossing 2	In use cable	Century Link	0.2 m	59.791

Apart from this cable, a possible linear feature was detected during the UXO survey. It is seen at KP 6.325 (Figure 64). No correlation was seen, with either SSS or MBES contacts.

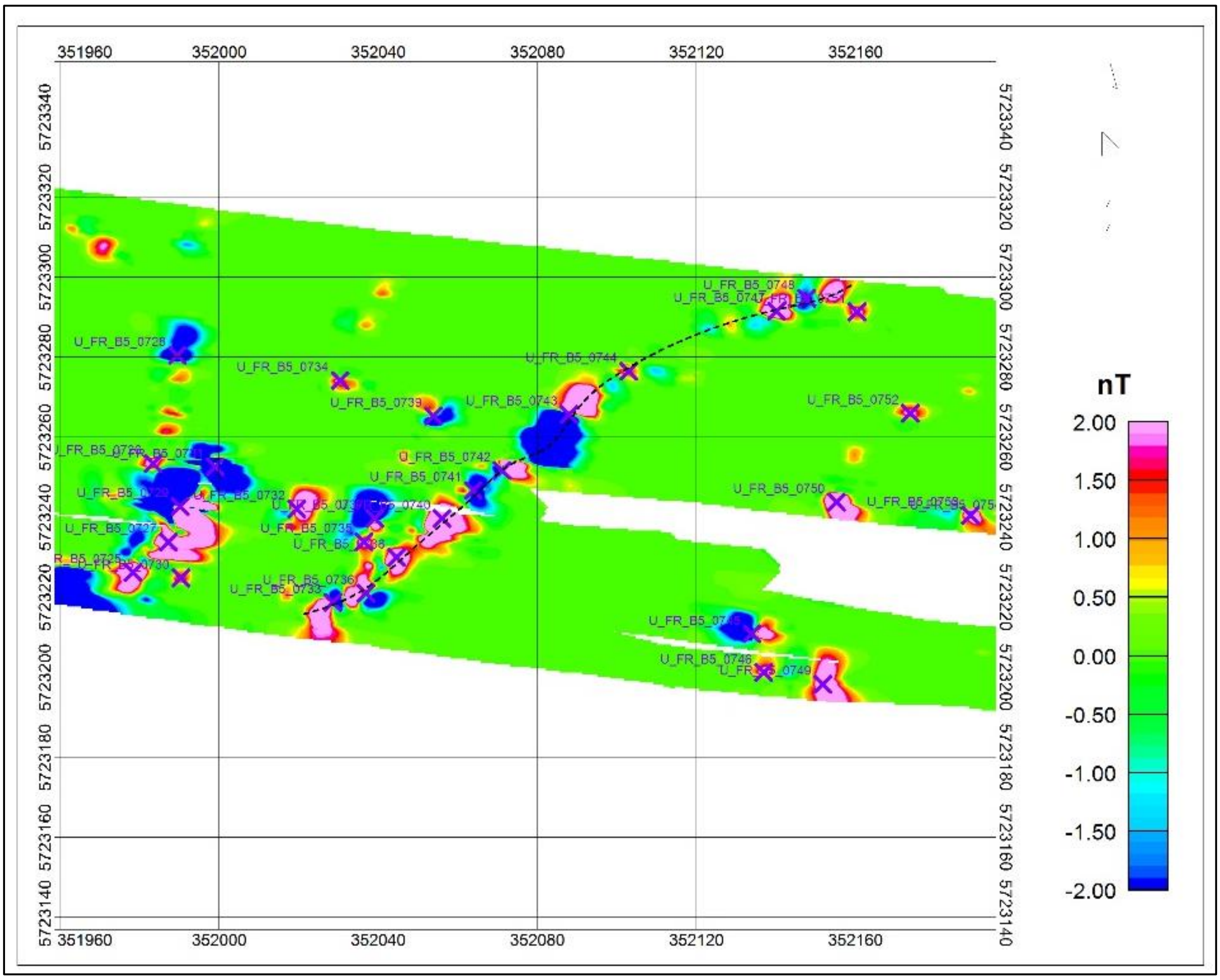


Figure 64 Linear magnetometer anomaly trend. Possible cable.

7.2.8 | WRECKS

One SSS contact was confirmed as the previously known Saint Jacques wreck during the survey. This was located at KP 4.717, 248.6 m away from the proposed route, (Figure 65).

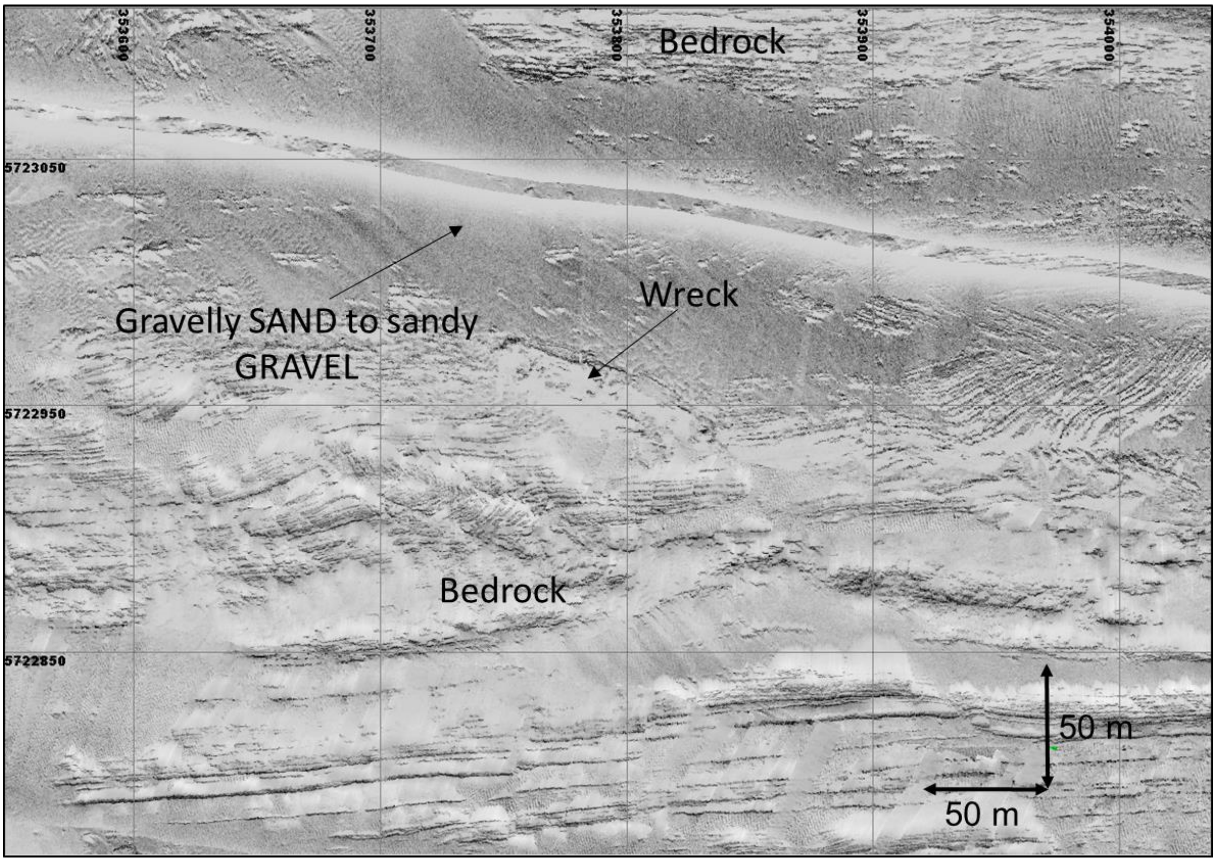


Figure 65 SSS plan view example from KP 4.717, south of proposed route.
Showing Saint Jacques wreck sitting on BEDROCK, near to areas of gravelly SAND and sandy GRAVEL. Image is north up

7.2.9 | UXO

A total of 58 magnetic anomalies were detected in the UK nearshore UXO corridor. Of these, 17 were unclassified, 41 correlated with possible cables (Table 35).

No SSS contact positions correlated with detected magnetic anomalies.

Table 35 Summary of UK nearshore magnetic anomalies, route option RPL_09112018_Rev0..

CLASSIFICATION	NUMBER
Unclassified, possible objects	17
Possible cable correlation	41
Total	**58**

In the offshore UXO corridor, a total of 1051 magnetic anomalies were detected. Of these, 1041 were unclassified, 10 correlated with a possible cable (

Table 36).

A total of 23 SSS contact positions correlated with detected magnetic anomalies.

Table 36 Summary of UK offshore magnetic anomalies, route option RPL_09112018_Rev0.

CLASSIFICATION	NUMBER
Unclassified, possible objects	1041
Possible cable correlation	10
Total	**1051**

7.3 | IRELAND

7.3.1 | SEABED GRADIENTS

Gradients are generally very gentle or gentle but occasionally there are localised moderate slopes over rocky seabed (Figure 66).

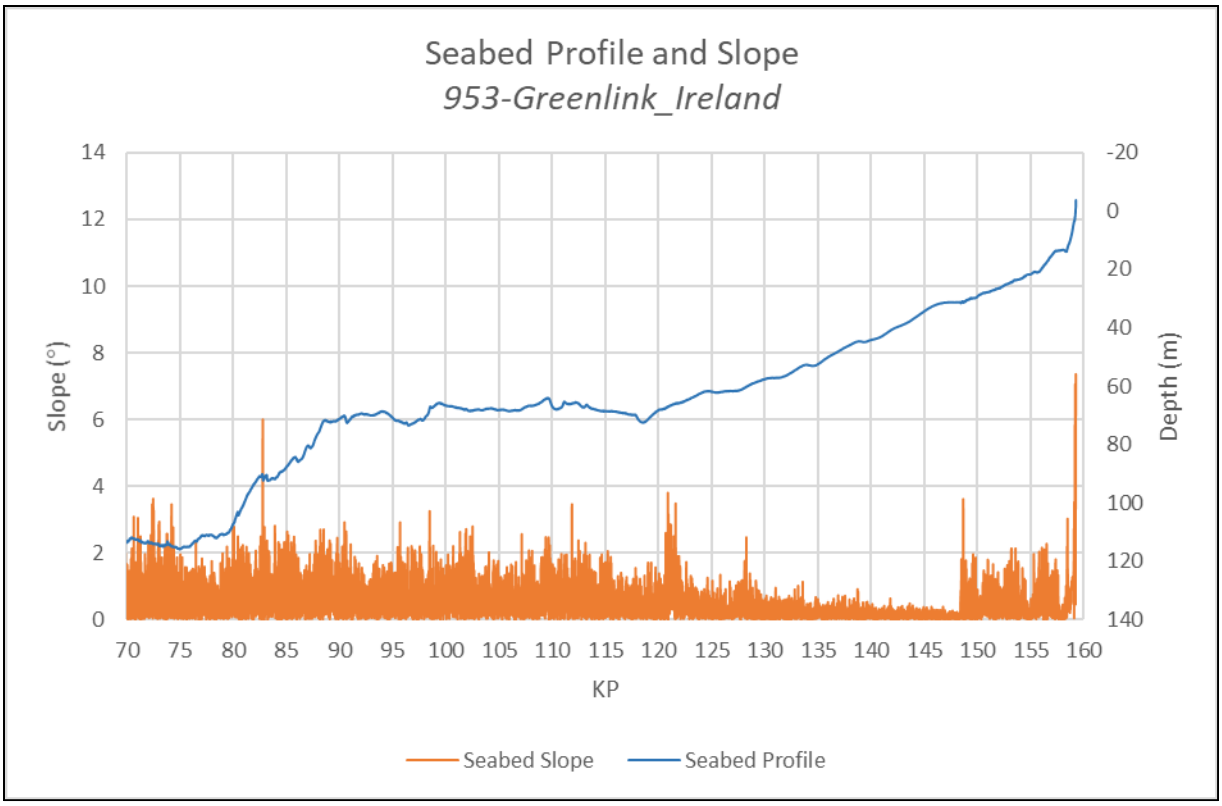


Figure 66 Seabed gradient and depth on the Final route in the UK, between KP 73.906 and KP 159.172.

7.3.2 | BEDROCK AND HARD SEDIMENT

The proposed route crosses bedrock outcrops at several locations in Irish waters. These are listed in

Table 37.

Table 37 Outcropping bedrock along the proposed route.

Feature	KP start	KP stop
BEDROCK	158.387	158.395
BEDROCK	158.425	158.490
BEDROCK	159.071	159.078
BEDROCK	159.089	159.172

7.3.3| BOULDER FIELDS

No boulder fields are crossing the centre line in the Irish part of the proposed route.

7.3.4| MOBILE SEDIMENT

Mobile sediments are very common throughout the proposed corridor in Irish waters. The mobile sediments are listed in Table 38.

Table 38 Mobile sediments along the proposed route, Irish waters.

Feature	KP Start	KP Stop
Mega Ripples	73.924	79.241
Sand waves	79.241	79.305
Sand waves	79.392	80.158
Mega Ripples	80.310	80.485
Mega Ripples	80.582	89.082
Sand waves	82.607	83.267
Sand waves	89.082	89.098
Mega Ripples	89.098	89.125
Sand waves	89.125	89.146
Mega Ripples	89.146	89.167
Sand waves	89.167	89.200
Mega Ripples	89.200	89.213
Sand waves	89.213	89.245
Mega Ripples	89.245	91.171
Sand waves	90.484	90.592
Sand waves	91.171	91.483
Mega Ripples	91.483	92.289
Sand waves	92.289	92.342

Feature	KP Start	KP Stop
Mega Ripples	92.342	138.639
Sand waves	95.452	96.459
Sand waves	97.365	97.835
Sand waves	98.424	98.766
Sand waves	109.396	109.762
Mega Ripples	148.421	148.465
Mega Ripples	148.480	148.562
Mega Ripples	148.708	148.773
Mega Ripples	148.825	148.854
Mega Ripples	148.865	148.948
Mega Ripples	149.005	149.037
Mega Ripples	149.097	149.309
Mega Ripples	149.329	149.364
Mega Ripples	149.423	149.712
Mega Ripples	149.807	149.831
Mega Ripples	149.847	149.936
Mega Ripples	149.944	150.015
Mega Ripples	150.059	150.079
Mega Ripples	150.086	150.090
Mega Ripples	150.095	150.158
Mega Ripples	150.170	150.173
Mega Ripples	150.186	150.226
Mega Ripples	150.261	150.314
Mega Ripples	150.352	150.485
Mega Ripples	150.489	150.491
Mega Ripples	150.496	150.500
Mega Ripples	150.539	151.194
Mega Ripples	151.229	151.317
Mega Ripples	151.565	151.696

Feature	KP Start	KP Stop
Mega Ripples	151.721	151.734
Mega Ripples	151.739	151.749
Mega Ripples	151.763	151.769
Mega Ripples	151.786	152.126
Mega Ripples	152.333	153.287
Mega Ripples	153.333	153.796
Mega Ripples	154.003	154.037
Mega Ripples	154.066	154.352
Mega Ripples	154.360	154.364
Mega Ripples	154.380	155.166
Ripples	155.196	155.271
Mega Ripples	155.271	155.378
Mega Ripples	155.530	155.653
Mega Ripples	155.736	155.816
Mega Ripples	155.963	157.604

7.3.5| UNSTABLE SEDIMENT

No signs of unstable sediment were seen in the Irish parts of the proposed route.

7.3.6| ACOUSTIC BLANKING AND GAS SEEPAGE FEATURES

No acoustic blanking or signs of gas seepage was seen in the sediments along the Irish parts of the proposed route.

7.3.7| CABLES AND PIPELINES

Five cables cross the proposed route in Irish waters. All of them are buried at the crossing location. Details of the cables are given in Table 39. For detailed information, see the Cable Crossing Report (102953-GRL-MMT-SUR-REP-CABLECRE).

Table 39 Cables crossing the proposed route, Irish waters

Cable	Type of Cable	Owner	Depth of Burial BSB at Crossing Location	KP at Crossing Location
Hibernia Atlantic Seg D	In use cable	GTT Communications	0.3 m	86.700
Pan European Crossing 1	In use cable	Century Link	0.1 m	95.935

Cable	Type of Cable	Owner	Depth of Burial BSB at Crossing Location	KP at Crossing Location
ESAT 1	In use cable	BT Ireland Communications Ltd	0.7 m	102.513
SOLAS	In use cable	Eircom and Vodafone	0.4 m	121.535
CELTIC	Inactive HVDC cable	BT	0.2 m	139.098

7.3.8 | WRECKS

No wrecks were found along the Irish part of the proposed route.

7.3.9 | UXO

No UXO survey was performed in the Irish part of the proposed route.

8 | CONCLUSIONS

Greenlink Interconnector Limited, proposes to develop an interconnector, which will allow transfer of power between the high voltage grid systems of the UK and the Republic of Ireland. Greenlink will connect to the United Kingdom (UK) National Grid system at Pembroke substation in Pembrokeshire, United Kingdom and to the Irish network at Great Island substation in County Wexford, Ireland.

MMT conducted a topographic, geophysical, geotechnical, benthic, land seismic and, within the Castlemartin Firing Range, an Unexploded Ordnance (UXO) survey for the proposed routes. The following datasets were collected from hull mounted, pole mounted and towed platforms on different vessels: multibeam echo sounder (MBES), side scan sonar (SSS), sub-bottom profiler (SBP) and magnetometer. An unmanned aerial vehicle (UAV) was used for the topographic survey. The data sets were analysed and correlated to draw conclusions regarding seabed and sub-seabed conditions, obstructions and installation constraints. The survey corridor was 500 m wide and divided into 6 blocks covering nearshore and offshore areas. Geotechnical sampling was completed using Vibrocorer (VC) and Piezo Cone Penetration Testing (PCPT). Geotechnical locations were placed every 1.5 km and co-located. Benthic sampling sites were selected based on preliminary geophysical interpretations, corresponding to areas of potential sensitive habitats and reef formations. A total of 38 locations were visited, the survey consisting of an initial photograph using a drop down video camera (DDV) followed by three grab samples at each site.

The survey was conducted in a safe manner and good quality data was acquired throughout. The survey was conducted in three sections; the onshore topographic and land seismic surveys, the nearshore survey and the offshore survey.

Seabed gradient and slopes are generally gentle with the exception of some areas of mobile sediment with sandwaves and some bedrock outcrops crossed by the currently proposed route. The maximum water depth Lowest Astronomical Tide (LAT) along the route was 127.8 m and 130.0 m within the corridor, where a bathymetric trough was encountered approximately in the middle of the route. The unexploded ordnance (UXO) survey covered a 100 m wide corridor within the Castlemartin firing range.

The seabed sediments along the proposed route and within the survey corridor are interpreted to mainly comprise granular sediments such as SAND and GRAVEL, and mixtures in between. The surficial sediments form mobile sediments, ripples to sandwaves, along the majority of the route. BEDROCK is found outcropping and subcropping mainly in the UK and Ireland nearshore as well as the first 43 km of the route, approximately. Areas of occasional and numerous boulders are usually present in the vicinity of out- and subcropping BEDROCK. From the shallow geology interpretation, it can be concluded that the surface SAND is commonly gravelly to silty and is present as a generally 0.5 – 3.0 m thick unit throughout large parts of the route.

The TILL comprise mainly gravelly, sandy silty CLAY which generally is of higher strength closer to the UK landfall and of low to medium strength closer to the Irish landfall. Where TILL is present close to seabed, it is generally covered by a veneer of mobile sediments consisting of SAND to GRAVEL, where the finer sediment fraction is winnowed by current activity. The boundary between TILL and BEDROCK is not always resolved in the seismic data due to limited penetration or the presence of coarser sediment.

There are a number of factors based on geophysical results for cable protection within the survey corridor that should be considered during planning of the final cable route.

- Presence of shallow dense to very dense material along the route.
- Presence of COBBLES and coarse GRAVEL along the route.
- Seabed gradients and mobile sediments.
- Cables and pipeline crossings should be made as perpendicular as possible.

- Fishing needs to be considered as it is associated with high risks to the cable if not buried sufficiently. Trawl scars were observed mainly in UK waters. Fishing gear was also present during the survey in both UK and Ireland.
- Since part of the route in UK waters is within an artillery range zone, the performed UXO survey can only be considered valid for the time of the survey and future changes are highly likely. This is due to Castlemartin being an active defence training area with permission to fire live rounds into the sea.
- Fields of occasional or numerous boulders increase the risk of cable suspension and damage to trenching equipment.

The possible presence of sub-surface boulders should be considered.

9| RESERVATIONS AND RECOMMENDATIONS

The information presented in this report is based on the interpretation of both geophysical and geotechnical data acquired during the course of the survey project. This interpretation and subsequent geophysical, geological and geotechnical findings described here are based on the requirements and scope of work contained within the Contract documentation. Whilst this report has been prepared with considerable due care and diligence, MMT AB of Sweden, or any other named party involved in the preparation of this report, cannot be held responsible, or be liable for any use of this report for purposes which do not form part of the specific Contract requirements.

The interpretation, discussion, and any geophysical or geological/geotechnical conclusions presented here are not exhaustive and reference should be made to the relevant survey records, together with the specific laboratory testing results provided. The selection of an installation methodology or construction technique, and the likely operational risks inherent in using a particular technique, are beyond the scope of this report. Any end-user of this report must satisfy themselves of the appropriateness of the results presented. This report considers the ground conditions along the proposed route at the time of survey. Inherent natural variation, or subsequent changes to the seabed or shallow sub-surface ground conditions can affect the reliability of data presented here. Decisions relating to future installation and construction methods must consider any changes in ground, site, regulatory, technological or economic conditions subsequent to the date of issue of this report. Distribution of this report, in whole or part, or the use of the data for a purpose not expressly stated within the contractual work scope or specified at the time of report issue is at the client's sole risk.

MMT's recommendations for further planning, within the survey corridor area of the Greenlink cable route, are:

- Route planning to avoid outcropping bedrock.
- The UXO results can only be seen as valid at the time of the survey, as part of the route are located with the Castlemartin designated artillery range zone where future deposition of UXOs is possible. This is further discussed in the UXO report (102953-GRL-MMT-SUR-REP-UXOREP).
- For future surveys and installation, the exposed location of the cable route to the North Atlantic with regard to wind and waves should be taken into consideration.

APPRENDICES

APPENDIX A | ROUTE POSITION LISTS

APPENDIX B | CONTACT AND ANOMALY LIST

APPENDIX C | LIST OF CHARTS

APPENDIX D | GEOTECH LOCATIONS

APPENDIX E | TERRADAT REPORTS

APPENDIX F | 4D OCEAN ORTHOPHOTOS