Ardersier Port Ltd.
Intertidal and Benthic Ecology

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Glasgow

Craighall Business Park
8 Eagle Street
Glasgow
G4 9XA
0141 341 5040
info@envirocentre.co.uk
www.envirocentre.co.uk

Aberdeen

Banchory Business Centre
Burn O'Bennie Road
Banchory
AB31 5ZU
01330 826 596

Inverness

Alder House
Cradlehall Business Park
Inverness
IV2 5GH
01463 794 212

Edinburgh

Suite 114
Gyleview House
3 Redheughs Rigg
Edinburgh
EH12 9DQ
0131 516 9530

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1 INTRODUCTION

1.1 Remit

EnviroCentre Limited was commissioned by CWC Group to conduct a walkover survey of the intertidal area of proposed development of the port of Ardersier, Moray Firth, Inverness-shire, to inform an Ecological Impact Assessment (EcIA). A desk study of historic intertidal benthic data for the site was also carried out.

The 'site' is defined as the area demarcated by the red line boundary as specified within the EIAR. The 'survey area' was limited to the developmental area of ecological influence within the intertidal zone and is detailed in Appendix A.

1.2 Background to the Studies

The development site is located on the former McDermott Fabrication Yard, which lies some 7.5km to the west of Nairn, 18km northeast of Inverness and 3km northeast of the village of Ardersier centred on grid reference NH812 576.

The site is bounded by the Moray Firth to the north; extensive undeveloped sand and mudflats, known as the Carse of Delnies to the east; Case Wood to the south; and a widespread area of sand dunes and tidal mudflats to the west. To the south west of the site lies the boundary of Fort George owned by the MOD.

The site extends to some 307 hectares, and includes a 1,000 metre long quay which is protected by naturally occurring long sand and shingle spit, salt marsh and dunes.

The spit known as Whiteness Head shelters the main part of the port. The majority of the site was reclaimed using dredged sand that was levelled behind a steel pile retaining wall at approximately 4.5m above ordnance datum (OD).

Following reclamation, the site was developed for industrial use as the McDermott Fabrication Yard, which specialised in the fabrication and construction of off-shore platforms used in the development of the North Sea oil and gas industry. Fabrication activities ceased at the site in 2001 and the site has subsequently been cleared. The Client proposes to dredge the port entrance and reinstate the site for this former use. The construction works relevant to this report are marine works involving a capital dredge and quay wall works.

1.3 Aim and Objectives

The aim of the survey was to confirm and update data supplied in the previous EcIA carried out in 2013 (Savills, 2013). The main objectives of the surveys were as follows:

- Record the intertidal biotopes present in and around the proposed dredging site, the piling site and the wider areas that may be affected by the works through coastal change;
- Record any marine non-native species (NNS) within the survey area;
- Compare survey results to those in the previous EcIA and highlight any changes in the distribution and composition of biotopes;
- Carry out a desk study to collate historic information on benthic ecology; and
- Outline appropriate mitigation measures for NNS.

1.4 Marine Non-native Species

A NNS which threatens native biodiversity, human health or economic activity it is often referred to as an invasive non-native species (INNS). Very little is known about NNS in the marine environment and their existing or potential impact, making it difficult to differentiate between non-native species which are clearly invasive and species which may become invasive (effectively all other non-native species). Both are referred to as NNS in this report.

More than 90 marine NNS have been identified in British and Irish waters (including Republic of Ireland and Northern Ireland), of which 17 are now established in Scotland. Their introduction is believed to be predominantly due to shipping, including ballast waters and sediments, fouling of hulls and other associated hard structures, and imported consignments of cultured species. Most marine NNS in Britain originate from parts of the world with a similar latitude to ourselves (e.g., North Pacific, North-west Atlantic). (Payne *et al.*, 2014). Movement of vessels and equipment can cause both the introduction of a new NNS or the spread of a NNS already established at a site to new locations.

Invasive non-native species can have a damaging impact on native plants, animals and ecosystems - by spreading disease, competing for habitat and food and direct predation. INNS also affect economic uses of our environment and can add significant management costs as plants that grow profusely can cause damage to buildings and infrastructure, block waterways while some animals can damage riverbanks.

1.5 Legislative Context

1.5.1 Habitats

European and national legislation and national and local policy relevant to habitats in this report includes:

- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended);
- The Wildlife and Countryside Act 1981 (as amended) (WCA);
- The Nature Conservation (Scotland) Act 2004;
- Environment Liability (Scotland) Regulations 2009;
- The Wildlife and Natural Environment (Scotland) Act 2011 (WANE);
- Scottish Planning Policy (2014);
- Highland-Wide Local Development Plan (LDP).

The Environmental Liability (Scotland) Regulations 2009 transposed the EU Environmental Liability Directive 2004/35/EC (ELD) of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage. Under the Regulations certain operators who cause a risk of 'significant' damage or cause 'significant' damage to land, water or biodiversity will have a duty to avert such damage occurring or, where damage does occur, a duty to reinstate the environment.

1.5.2 Non-native species

The principal legislation relevant to NNS is the Wildlife and Countryside Act 1981 (the 1981 Act) and Wildlife and Natural Environment (Scotland) Act 2011 (WANE). The 1981 Act contains provisions on:

- Release or planting of all non-native species;
- Keeping of invasive species;
- Sale of invasive species;

- Notification of invasive non-native species; and
- Species Control Agreements and Species Control Orders.

Under the Act it is an offence to :

- Cause an animal to be in a place outwith its native range; and
- Plant or cause any plant species to grown in the wild outwith its native range.

The 1981 Act includes a number of offences relating to the list above, some subject to a defence of having taken all reasonable steps and exercised all due diligence to avoid committing the offence.

European and national legislation and policy relevant to non-native species includes:

- The Wildlife and Countryside Act 1981 (as amended);
- Environment Liability (Scotland) Regulations 2009;
- The Wildlife and Natural Environment (Scotland) Act 2011 (WANE); and
- Code of Practice on Non-native Species

The WANE Act updates the Wildlife and Countryside Act by adopting the internationally recognised approach to dealing with invasive non-native species. New offences are based on a general 'no-release' approach.

1.6 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

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1.7 Assessment Limitations

Coastal systems are dynamic systems subject to change over time. The field survey provides a snapshot of intertidal biotopes present on the site during August 2018.

The field survey was limited by tidal level. The survey was carried out during a low spring tide to enable maximum exposure of the intertidal area, and clear water conditions allowed the subtidal zone up to 5m from low water level to be observed.

2 METHODS

All intertidal survey work was undertaken by experienced and competent ecologists, who are members of the Chartered Institute of Ecology and Environmental Management (CIEEM). The field work was conducted on the 9th August 2018 by Ecologist Lorna Wilkie MCIEEM and Technical Specialist Kathy Dale CEcol FCIEEM.

2.1 Desk study

A desk-based study was undertaken prior to field work and included a review of the following documents and sources:

- Ardersier Port Construction Environmental Management Document (Envirocentre Ltd., 2017).
- Littoral and Supralittoral Habitats in the Vicinity of the Former Ardersier Rig Yard, Phase 1 Survey, Whiteness Head, October 2005 (Physalia, 2005).
- Port of Ardersier Proposed Offshore Renewables Manufacturing and Port Facility Environmental Statement Volume 2, May 2013 (Savills, 2003).

Historic data on benthic ecology was also collated.

2.2 Field survey

Foreshore biotopes (flora and fauna) were previously identified and their locations recorded (Physalia, 2005; Savills, 2013) in accordance with the Marine Nature Conservation Review (MNCR) guidance, which is provided by the JNCC (Connor *et al.,* 2004).

The survey was carried out on 9th August 2018, the weather conditions were sunny with a light breeze, and an air temperature of 15°C. The survey area was walked and biotopes were identified *in situ*. and compared to those previously recorded. Flora and surface fauna present were recorded. The survey area comprised the intertidal zone within and immediately adjacent to the proposed licensed extent of the capital dredge, the spit restoration areas within the intertidal zone, the inner northeast shore of the port, the piling site and the land disposal area (Appendix B).

3 RESULTS

3.1 Desk study

3.1.1 Intertidal biotopes

One transect (CS2) within the current study area was previously surveyed in 2005 (Physalia, 2005) (Appendix D), which corresponds to centre of the area of spit restoration within the port. They recorded bare shingle on the upper to mid shore and bladder wrack (*Fucus vesiculosus*) on the lower shore to sub-tidal area.

Three intertidal habitats corresponding to the survey site were identified by Physalia (*Physalia, 2005)*, but these were not classified using the MNCR Biotope Classification (Connor et al., 2004).

- Intertidal sand with occasional patches of shingle. Cockles, lugworm and, at low tide levels on exposed shores, razor shells;
- Intertidal shingle (with occasional patches of exposed sand) supporting tailtrid amphipod shrimps and occasionally barnacles; and
- Intertidal boulder embankment with *Fucus vesiculosus, Mytilis edulis, Littorina littorea* and *Semibalanus balanoides.*

Four intertidal biotopes, classified using the MNCR Biotope Classification, were identified in the previous Environmental Statement (Savills 2013) for the development site/dredging channel (Table 3.1) (Appendix E).

- Fine sand LS.LSa.FiSa
- Mobile sand LS.LSa. MoSa
- Barren shingle LS.LSC.Sh. BarSh
- Muddy sand LS.LSa.MuSa

Technical Appendices which contain the relevant mapping were not provided, and biotope data were provided in tabular form only.

3.1.2 Benthic ecology

Physalia (2005) undertook sampling of benthic faunal and floral communities, but the number of samples and their locations within the port is not specified. The species found were:

- Algae
    - *Laminaria saccharina*
    - *Fucus vesiculosa*
    - *Fucus distichus* (ssp. *distichus* and *anceps*)
    - *Arthrocladia*

- Crustaceans
    - *Crangon crangon*
    - *Neomysis integer*
    - *Schistomysis ornate*
    - *Idotea neglecta*
    - Amphipod sp.

- Polychaete
    - *Kefersteinia cirrata*

- Fish
    - Long-spined Sea Scorpion *Tarulus bubalis*

Four benthic biotopes identified in the previous Environmental Statement (Savills 2013) for the development site/dredging channel (Table 3.2) (Appendix E).

- Sublittoral sand in low or reduced salinity (lagoons) SS.SSa.SSaLS
- Infralittoral mobile clean sand with sparse fauna SS.SSa.IFiSa.IMoSa
- *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand SS.SSa.IFiSa.NcirBat
- Muddy sand LS.LSa.MuSa

Benthic invertebrate fauna are listed in Appendix E (Savills, 2013) but it was not possible to ascertain from the report where samples were taken, or whether they were within the dredging zone, as the Technical Appendices which contain the relevant mapping were not provided.

Table 3.1: MNCR Biotope Classification for Intertidal Biotopes within the Development Site & Dredging Channel

Location	MNCR Classification	Littoral Mixed Sediments/Description	EU Habitats Directive Annex 1 Habitat[1]	Recorded 2013	Recorded 2018
Western/more exposed shoreline assessed within the port and adjacent to the development site.	LS.LSa.FiSa	Polychaete/amphipod dominated fine sand shores. Mudflats and sandflats not covered by seawater at low tide.	N/A	Yes	Yes
More exposed areas at the port entrance (both shores).	LS.LSa.MoSa	Barren or amphipod-dominated mobile sand shores. Mudflats and sandflats not covered by seawater at low tide.	Mudflats and sandflats not covered by seawater at low tide[1]	Yes	Yes
Northern/more sheltered shoreline assessed within the port and adjacent to the development site/spit	LS.LCS.Sh.BarSh	Littoral course sediment. Shingle pebble and gravel shores (barren).	N/A	Yes	Yes
Northern/more sheltered shoreline assessed within the port and adjacent to the development site/spit	LS.LSa.MuSa	Polychaete/bivalve dominated muddy sand shores. Mudflats and sandflats not covered by seawater at low tide. Typical of large shallow inlets and bays.	Mudflats and sandflats not covered by seawater at low tide[1]	Yes	No
Western/more exposed shoreline assessed within the port and adjacent to the development site.	LR.LLR.F	Dense blankets of fucoid seaweeds dominating sheltered, fully marine littoral rocky shores. Bedrock, boulders, cobbles and pebbles, mixed substrata on sand and mud. Sheltered to extremely sheltered rocky shores with very weak to weak tidal stream.		No	Yes

Table 3.2: MNCR Biotope Classification for Benthic Biotopes within the Development Site & Dredging Channel, recorded in 2013 (Savills, 2013)

Location	MNCR Classification	Littoral Mixed Sediments/Description	UK BAP Habitat	EU Habitats Directive Annex 1 Habitat1
All sample points within the port/dredging channel.	SS.SSa.SSaLs	Sublittoral sands and muddy sands. Sublittoral sand in low or reduced salinity (lagoons). Sandbanks which are slightly covered by sea water all the time.	Saline Lagoon	Large shallow inlets and bays. Sandbanks which are slightly covered by sea water all the time.
Sample points (1-2) within the port/ dredging channel.	SS.SSa.IFiSa.IMoSa	Infralittoral mobile clean sand with sparse fauna.	Subtidal sands and gravels	Large shallow inlets and bays. Sandbanks which are slightly covered by sea water all the time.
Sample point (5) within the port/ dredging channel.	SS.SSa.IFiSa.NcirBat	Nephtys cirrosa and Bathyporeia spp. in infralittoral sand.	Subtidal sands and gravels	Large shallow inlets and bays. Sandbanks which are slightly covered by sea water all the time.
Open water at the port entrance and beyond.	LS.LSa.MuSa	Circalittoral fine sand. Sandbanks which are slightly covered by sea water all the time.	Subtidal sands and gravels	Sandbanks which are slightly covered by sea water all the time

3.2 Field survey

3.2.1 Intertidal Biotopes

Three out of the four previously reported biotopes was present during the survey (Table 3.1); fine sand, mobile sand and barren shingle. Muddy sand was previously recorded, but was not found to be present during the survey. An additional biotope, littoral rock, was recorded (Appendix B). Site photographs are provided in Appendix C.

3.2.1.1 Fine sand

The port is dominated by fine sand (LS.LSa.FiSa) which is present on both the northern shoreline of the port and adjacent to the development site. Adjacent to the development site and towards the port entrance are areas of sandflat not covered at low tide. Fine sand is also present at the lower edge of the northern (outer) shoreline of the spit, on the Moray Firth. (Photographs 1, 4, 6, 11, 14, 17 & 20).

The sandflats adjacent to the development site on the southern shore are more productive than those towards the port entrance. Casts of the polychaete lugworm (*Arenicola marina*) and cockles (*Cerastoderma edule*) were present but not abundant, and foraging birds including Oystercatcher (*Haematopus ostralegus*), Bar-tailed Godwit (*Limosa lapponica*) and Red Shank (*Tringa totanus*) were present. Biofilms were visible on the surface of areas of sandflat adjacent to the development site. Mudflats and sandflats not covered by seawater at low tide are an Annex 1 habitat under EU Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (The Habitats Directive)[1]. (Photographs 10 & 15).

Fucoid algal species spiral wrack (*Fucus spiralis*) and bladder wrack (*Fucus vesiculous*) were recorded growing on dispersed cobbles and boulders on the northern shore at the east of the site, and adjacent to the development site. (Photographs 5 & 9).

3.2.1.2 Mobile sand

Mobile sand (LS.LSa. MoSa) is present at the more exposed areas of the port entrance, on both shores, and on the northern (outer) shore of the spit, on the Moray Firth. These areas are not covered by low tide and are largely amphipod dominated habitats. Areas of mobile sand are backed by dune habitat on both shores. A Sand Martin (*Riparia riparia*) colony was evident in dunes to the east of the development site (Photographs 1, 3, 4, 16, 18 & 19).

3.2.1.3 Barren shingle

Barren shingle (LS.LCS.Sh.BarSh) is present to the west of the development site on the southern shoreline of the port, and on the northern shoreline of the port towards the port entrance and within areas where land take has occurred to allow ships to turn. One of these areas corresponds to CS2 surveyed by Physalia (2005) and the biotope is similar to that recorded in 2005. Shingle also occurs on the upper northern (outer) shore of the spit, on the Moray Firth. (Photographs 7 & 8).

3.2.1.4 Littoral rock

A rip-rap embankment (LR.LLR) has been built to stablise reclaimed land on the southern shore of the port, to the western boundary of the development site. Boulders in the intertidal and splash zone have been colonised by fucoid algal species and barnacles. (Photograph 13).

[1] http://jncc.defra.gov.uk/Publications/JNCC312/UK_habitat_list.asp

3.2.1.5 Muddy sand

Muddy sand (LS.LSa.MuSa) was not found during the survey. It was previously recorded on the northern/more sheltered shoreline assessed within the port and adjacent to the development site/spit.

3.2.2 Invasive Non-Native Species

The INNS Japanese wireweed (*Sargassum muticum*) is present on the north shore of the spit exposed to the Moray Firth. The alga has been washed up on the shore and is not attached to the substrate. (Photograph 2).

3.3 Interpretation

Direct comparison between the survey results and those in the previous EcIA (Savills, 2013) was problematic as Appendices containing the relevant mapping or survey cross section locations were not provided, and biotope data were provided in tabular form only.

Physalia (2005) provided habitat mapping, but did not use MNCR nomenclature to describe biotopes. Only one cross section (CS2) surveyed in detail by Physalia corresponded to the current survey. It was possible to make a comparison between the 2005 and current surveys from the habitat descriptions and maps provided.

The fine sand, mobile sand and barren shingle biotopes recorded in 2005 and 2013 remain, and their current distribution appears to be relatively unchanged.

The absence of muddy sand, previously recorded in 2013, may be due to changes in sediment type as flow within the port has reduced and more stable sand has accumulated over time. It may also have been recorded in error, as some areas of fine sand gave the appearance of muddy sand due to the growth of surface biofilms (e.g. Photograph 14).

3.4 Mitigation

The Code of Practice in Non-Native Species[2] (Scottish Government, 2012) recommends:

- Monitoring to detect the spread of non-native species;
- Adopting a precautionary approach and not carrying out operations which might lead of the spread of NNS until there is a clear understanding of the situation;
- Carryout out risk assessments to understand the risk of spreading a NNS, setting out how to avoid it happening;
- Seeking advice and following good practice; and
- Reporting the presence of NNS.

To minimise the effects on the marine environment a Marine Biosecurity Plan should be put in place for the site and occurrence of INNS within the site, including Japanese wireweed is monitored every three years (Stebbing *et al.* 2014).

Under the Wildlife and Countryside Act 1981 offences can be committed when poor biosecurity allows non-native plants or animals to be introduced or spread within the marine environment through, for example, site operation or construction work. Knowledge of the offence, intention, recklessness or negligence do not have to be proved in these cases. If all reasonable steps were taken, by preparing and implementing a biosecurity plan,

[2] https://www.gov.scot/Publications/2012/08/7367/0

and all due diligence was exercised to avoid committing the offence then this can form the basis of a legal defence.

Assuming mitigation is applied, no introduction or spread of NNS is anticipated to occur that could significantly affect the ecological integrity of the site.

Due to the abundance and quality of alternative sandbank habitat in the surrounding area, and as recent dredging licences have previously been issued, it is therefore considered that the magnitude of the impact of dredging upon intertidal and subtidal habitats is negligible, and no mitigation is required.

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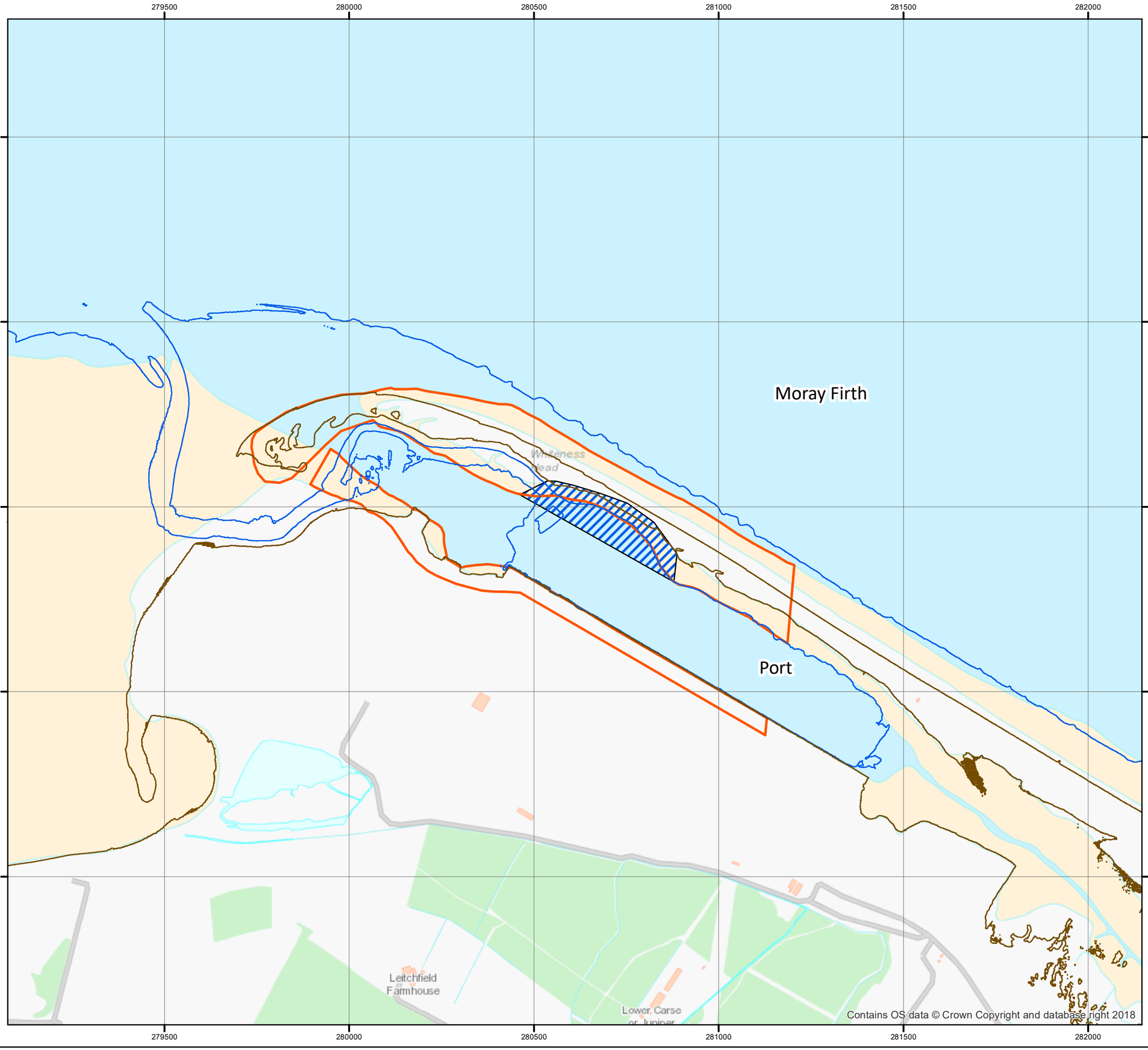
APPENDICES

A INTERTIDAL ECOLOGY SURVEY AREA



Legend

- Survey Boundary
- Spit Restoration
- Mean Low Water Spring (MLWS)
- Mean High Water Spring (MHWS)

Tidal contours from May 2018 Aspect Topographic and Bathymetric survey

Do not scale this map

Client
Ardersier Port Ltd

Project
Ardersier Port Redevelopment

Title
Ardersier Port Intertidal Ecology Survey Areas

Status
FINAL

Drawing No.
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Revision

Scale
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A3

Date
24 Sep 2018

Drawn	Checked	Approved
SMC	LW	LW

ENVIRO Centre
Craighall Business Park, Eagle Street, Glasgow, G4 9XA
Tel: 0141 341 5040
Fax: 0141 341 5045

B INTERTIDAL AND SUPRALITTORAL HABITATS

279500 280000 280500 281000 281500

859500 859000 858500 858000

Moray Firth

Port

20 18 17 19 16 15 14 6 13 5 3 4 1 2 7 8 9 10 11 12

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Legend

Photograph Locations
(Refer to Appendix D for Photographs)

Mean Low Water Spring (MLWS)

Mean High Water Spring (MHWS)

Habitats

- Intertidal sand with occassional patches of shingle
- Intertidal, boulder embankment
- Intertidal shingle (with occassional patches of exposed sand)
- Sand dune plant assemblages
- Sublittoral, littoral and supralittoral fouling communities present on the site's steel sheet piling frontage
- Supralittoral shingle banks

Tidal contours from May 2018 Aspect Topographic and Bathymetric survey

Do not scale this map

Client
Ardersier Port Ltd

Project
Arderseir Port Redevelopment

Title
Ardersier Port Intertidal and Supralittoral Habitats

Status
FINAL

Drawing No.
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ENVIRO Centre
Craighall Business Park, Eagle Street, Glasgow, G4 9XA
Tel: 0141 341 5040
Fax: 0141 341 5045

C SITE PHOTOGRAPHS

Photograph 1: Northern (outer) shore of the spit, on the Moray Firth.

Photograph 2: Japanese wireweed (Sargassum muticum) - northern (outer) shore of the spit.

Photograph 3: Mobile sand and shingle towards the port entrance – port northern shoreline.

Photograph 4: Shingle, and mobile sand grading to fine sand - port northern shoreline.

Photograph 5: Fucoid algae, fine sand and shingle - port northern shoreline.

Photograph 6: Sandflats exposed at low tide adjacent to development site - port southern shoreline.

Photograph 7: Shingle in area of land take for turning ships - port northern shoreline.

Photograph 8: Shingle in area of land take for turning ships - port northern shoreline.

Photograph 9: Fucoid algae, fine sand and shingle - port northern shoreline.

Photograph 10: Fucoid algae and fine sand with lugworm casts and cockles - port northern shoreline.

Photograph 11: Fucoid algae and sandflats exposed at low tide adjacent to development site - port southern shoreline.

Photograph 12: Saltmarsh west of, and out with the development area - port northern shoreline.

Photograph 13: Sandflats exposed at low tide and fucoid algae growing on boulders/shingle adjacent to development site - port southern shoreline.

Photograph 14: Sandflats exposed at low tide adjacent to development site - port southern shoreline.

Photograph 15: Sandflats exposed at low tide with lugworm casts, adjacent to development site - port southern shoreline.

Photograph 16: Mobile sand grading to fine sand and sandflats adjacent to development site - port southern shoreline.

Photograph 17: Fine sand and sandflats adjacent to development site- port southern shoreline.

Photograph 18: Mobile sand and dunes adjacent to development site and storage area - port southern shoreline.

Photograph 19: Sand martin colony site at dunes adjacent to development site and storage area - port southern shoreline.

Photograph 20: Fine sand and sandflats towards port entrance - port southern shoreline.

D INTERTIDAL BIOTOPE SURVEY DATA (PHYSALIA, 2005)

A. Lower shore shingle and cobble habitat on the landward side of the spit. Resident species shown in this photograph include Bladder Wrack (*Fuscus vesiculosus*), Edible Winkles (*Littorina littorea*), Edible Mussels (*Mytilus edulis*) and barnacles (*Semibalanus balanoides*).

B. The Edible Winkle, *Littorina littorea*, was abundant at mid and low shore habitats that had solid substrate, including shingle and cobbles, sheet piling harbour walls and boulder embankments.

C. A view East along the exposed (seaward) side of the spit (Area 1). The foreground shows the upper shore shingle bank while in the background the expanse of lower shore sand can be seen clearly. The location of a sand bar the runs parallel to the beach is indicated by the breaking waves.

D. The intertidal zone of the Western end of the landward side of the spit (Area 2). Stable shingle and cobbles were the predominant substrate here.

E. The cobbles and shingle of the mid shore at Areas 2 and 3 were colonised by barnacles, mainly *Semibalanus balanoides*. Beneath the stones, Sand-hoppers, Talitrus saltator, was abundant.

2005 *Whiteness Head*

Plate 1

A

B

C

D

E

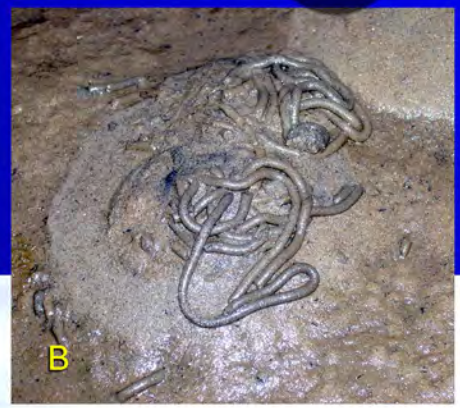
A. Area 3, the Eastern half of the landward side of the spit. The shore here was mainly sand with isolated patches of shingle. The mid and upper shore sand (foreground) was very soft with the consistency of fresh snow. The lower shore sand was saturated and contained cockles, *Cerastoderma edule*.

C. Common Cockles, *Cerastoderma edule*, found in the sheltered mid to lower shore sands. There was much evidence of this species being fed on by Oystercatchers, *Haematopus ostralegus*. Tell tale signs included trails of bill holes in the sand and piles of shell frass.

B. A single *Arenicola marina* cast. Some of the cast mounds were over 15 cm high.

D. Low level view across the intertidal sand to the East of the sheet piling harbour wall. The numerous worm cast mounds reflect the high density of Lugworm, Arenicola marina, that occurred in Area 4.

E. A view across Area 4 towards the sheet piling harbour wall (left) and the spit (right). The foreground shows the boulder embankment that was built to reinforce the reclaimed land. Beyond this is the basin of sand that contained *Cerastoderma edule* and substantial beds of *Arenicola marina*.



A. A view East over Area 4. The boundary of the development site is delineated by the sand embankment seen in the background at the top right of the photograph. The foreground shows the *Salicornia* saltmarsh floral community that covers large areas inland of the sand dunes to the east of the site.

A. The mural epigrowth, or fouling, community that was present on the steel sheet piling harbour wall in Area 5. At this level mussels (*Mytilus edulis*) encrusted with barnacles (*Semibalanus balanoides*) were abundant.

C. The floral community of the stabilised saltmarsh habitat was characterised by glasswort, a fleshy halophytic plant of the genus *Salicornia*.

D. Acorn Barnacles, *Semibalanus balanoides*, were abundant on most stable, solid surfaces at the mid and low tide mark. The barnacles shown here were growing on a mussel shell.

E. The sheet piling harbour wall of Area 5. At the lower littoral level dense growth of mussels and barnacles occurred (see Plate 3B, above). Above this was a distinct band with dense barnacles growth and no mussels. This reflects the ability of the former group to tolerate longer periods of immersion than the latter.

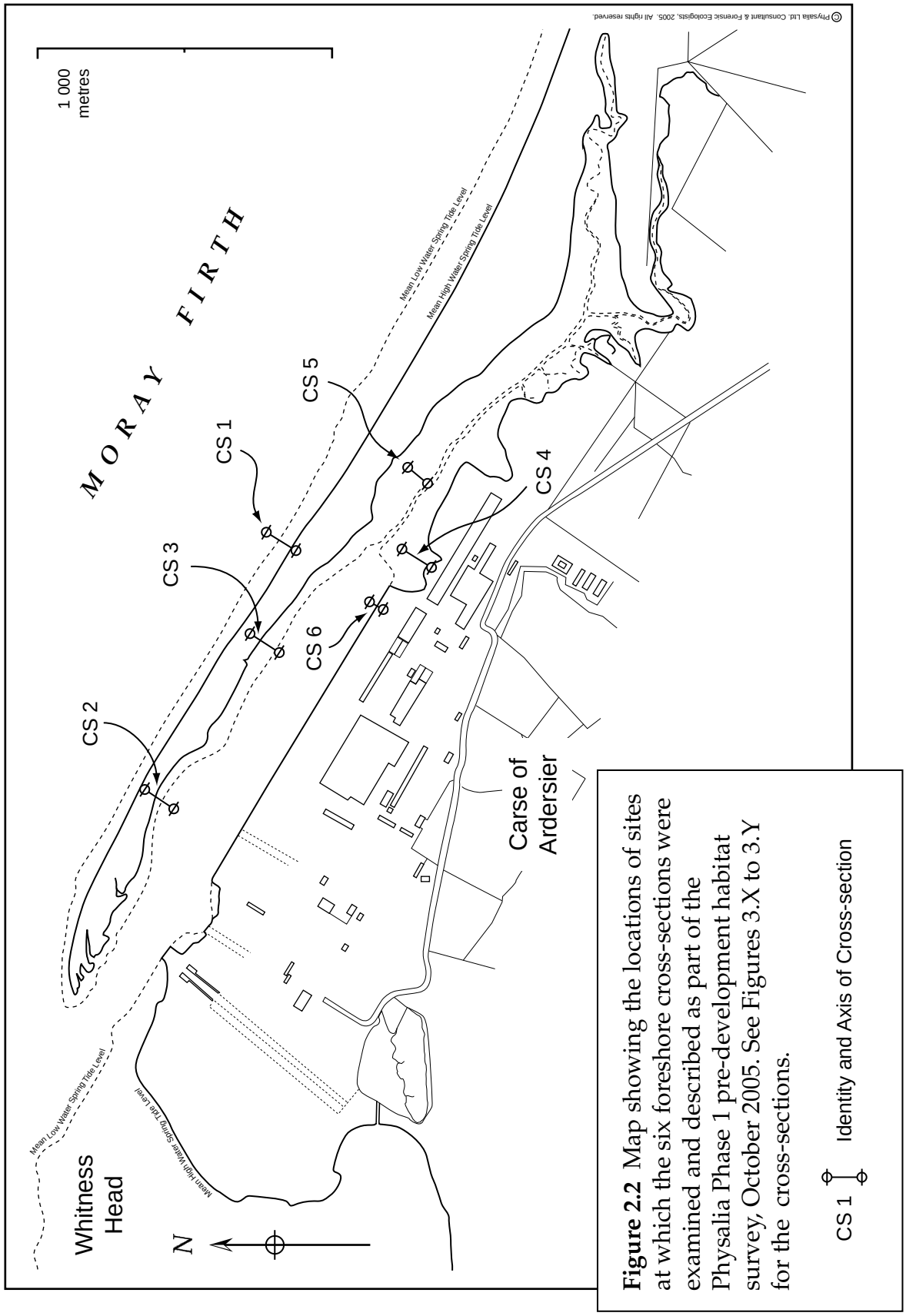


Figure 2.2 Map showing the locations of sites at which the six foreshore cross-sections were examined and described as part of the Physalia Phase 1 pre-development habitat survey, October 2005. See Figures 3.*X* to 3.*Y* for the cross-sections.

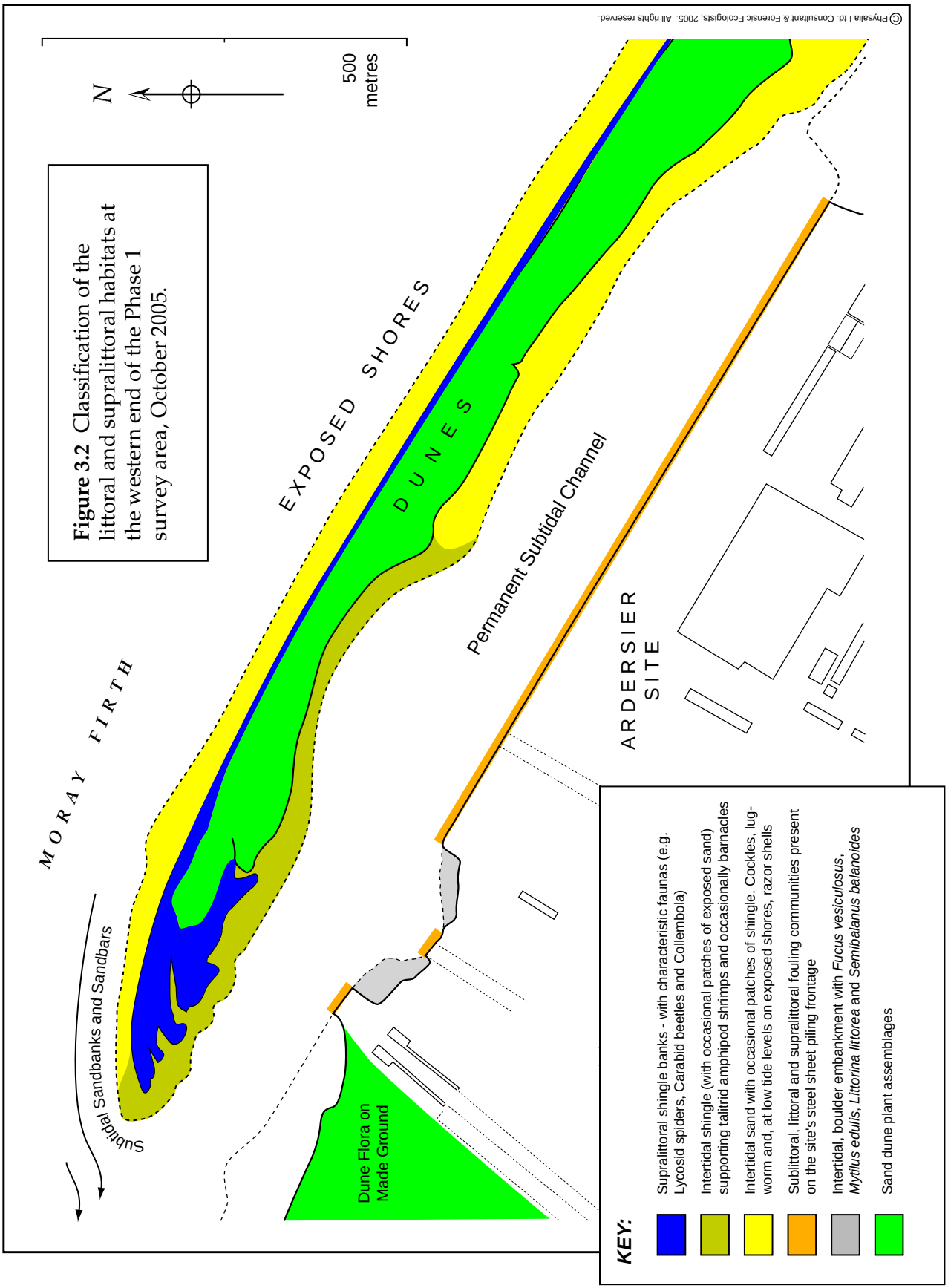


Figure 3.2 Classification of the littoral and supralittoral habitats at the western end of the Phase 1 survey area, October 2005.

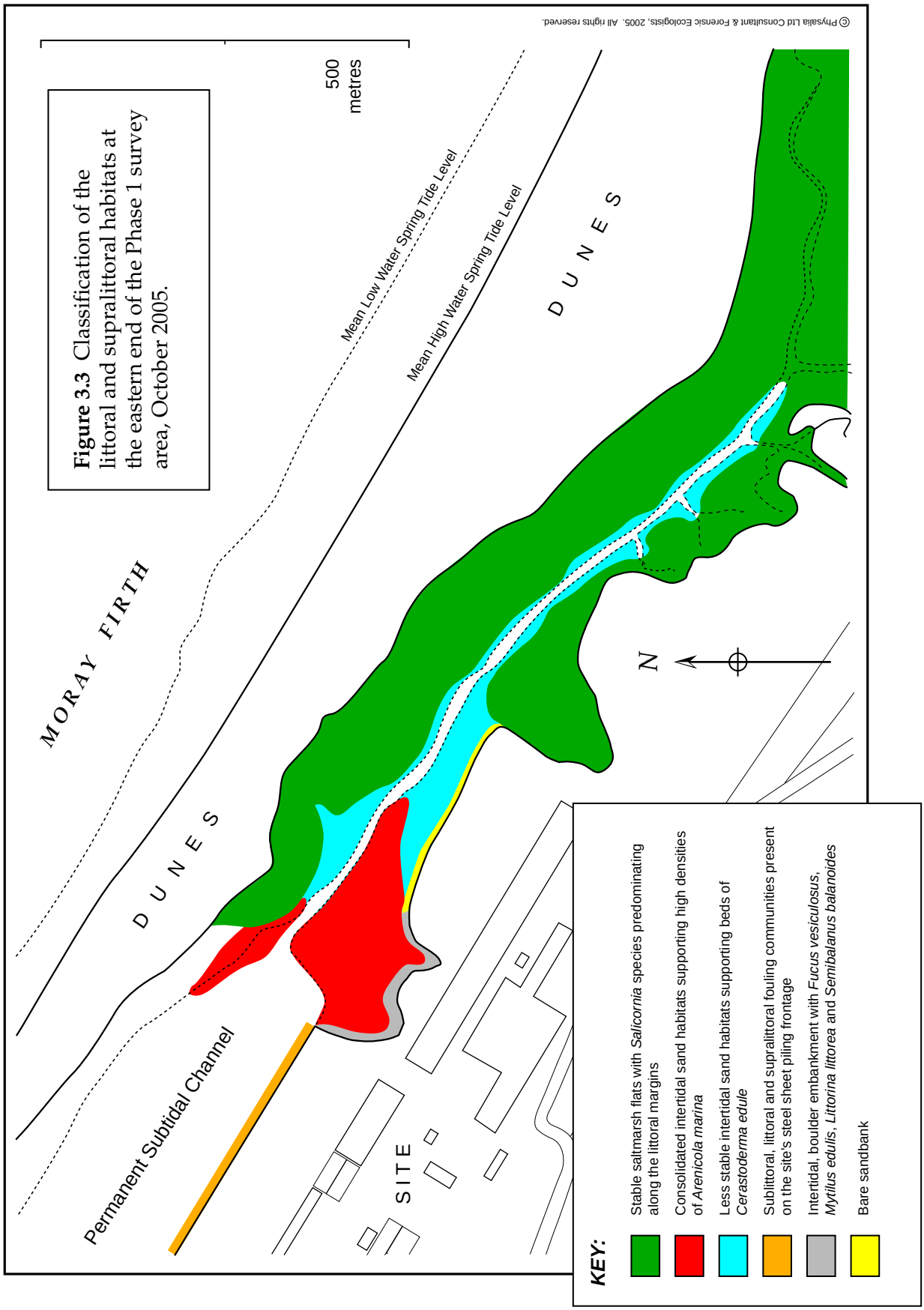


Figure 3.3 Classification of the littoral and supralittoral habitats at the eastern end of the Phase 1 survey area, October 2005.

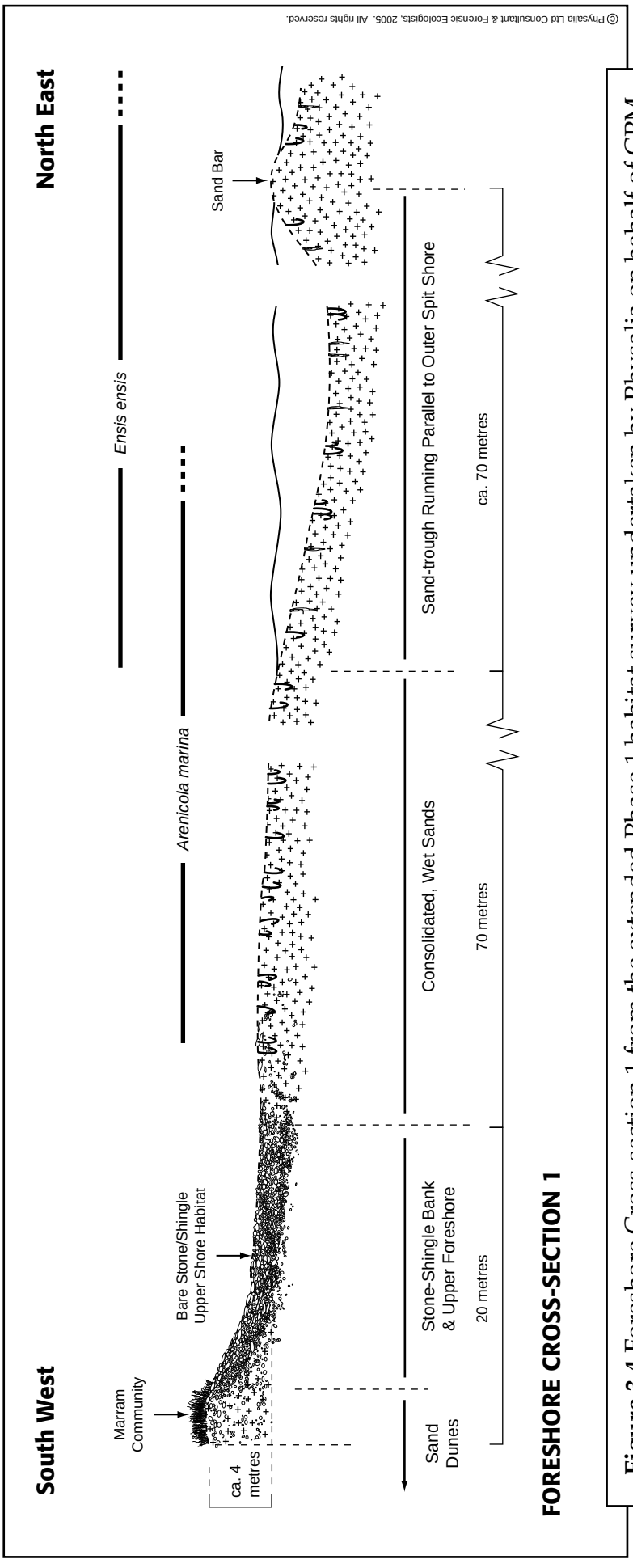


Figure 3.4 Foreshore Cross-section 1 from the extended Phase 1 habitat survey undertaken by Physalia on behalf of CPM Limited in October 2005 with particular reference to foreshore/littoral and shallow subtidal fauna associated with the proposed marina development at Whiteness, Moray Firth. See Figure 2.2 for locations of foreshore cross-sections.

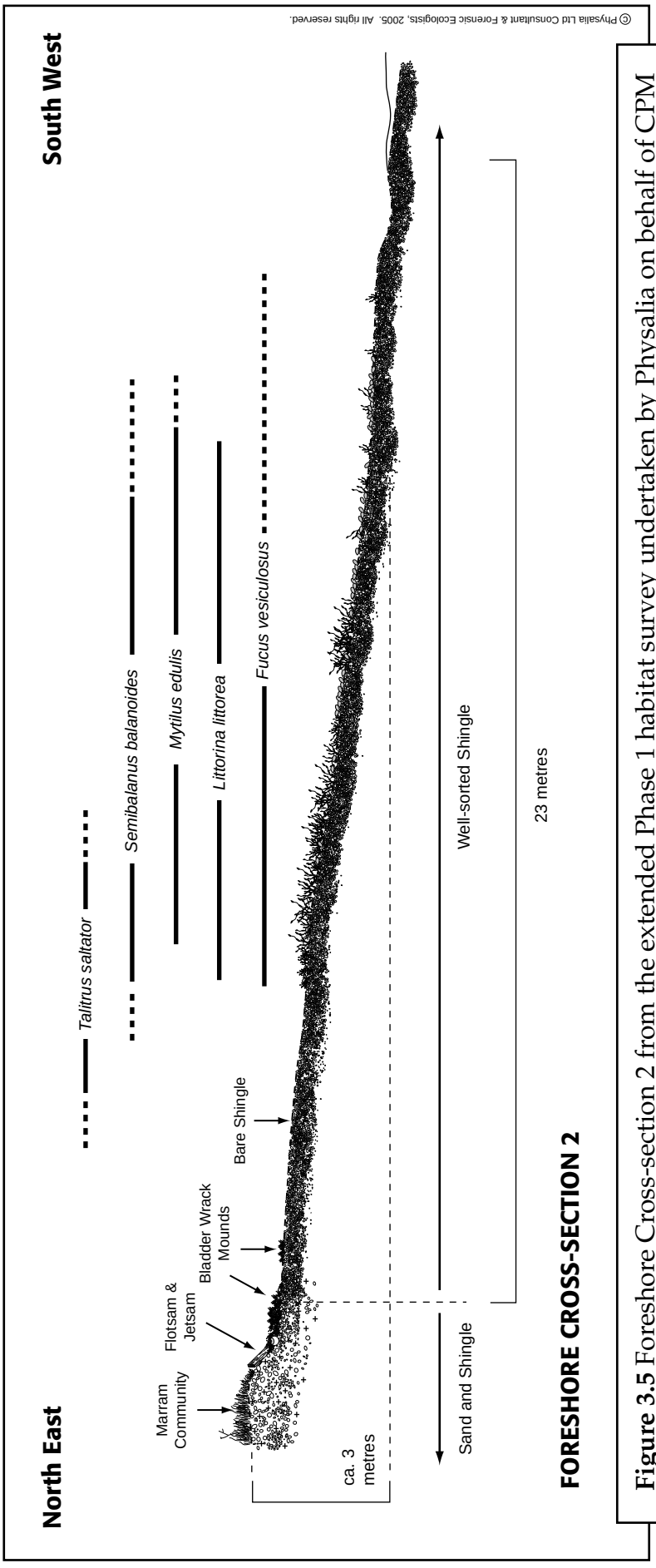


Figure 3.5 Foreshore Cross-section 2 from the extended Phase 1 habitat survey undertaken by Physalia on behalf of CPM Limited in October 2005 with particular reference to foreshore/littoral and shallow subtidal fauna associated with the proposed marina development at Whiteness, Moray Firth. See Figure 2.2 for locations of foreshore cross-sections.

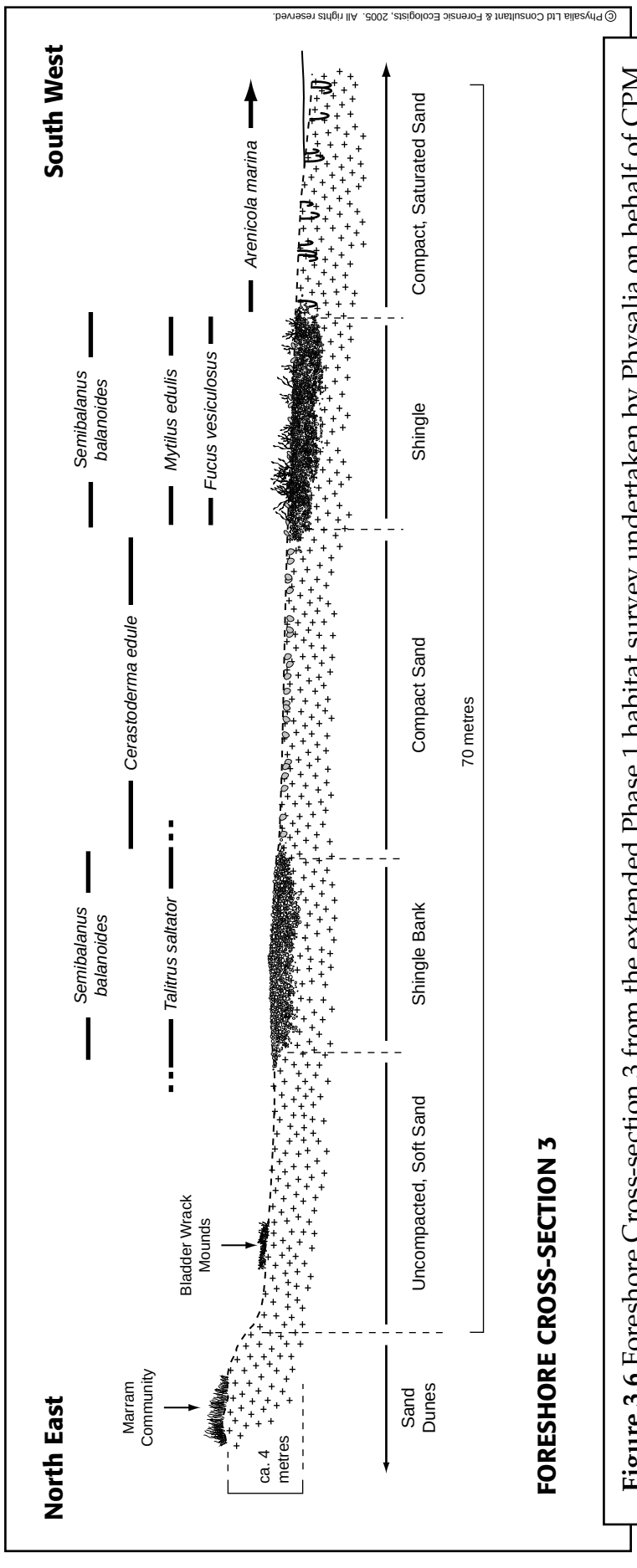


Figure 3.6 Foreshore Cross-section 3 from the extended Phase 1 habitat survey undertaken by Physalia on behalf of CPM Limited in October 2005 with particular reference to foreshore/littoral and shallow subtidal fauna associated with the proposed marina development at Whiteness, Moray Firth. See Figure 2.2 for locations of foreshore cross-sections.

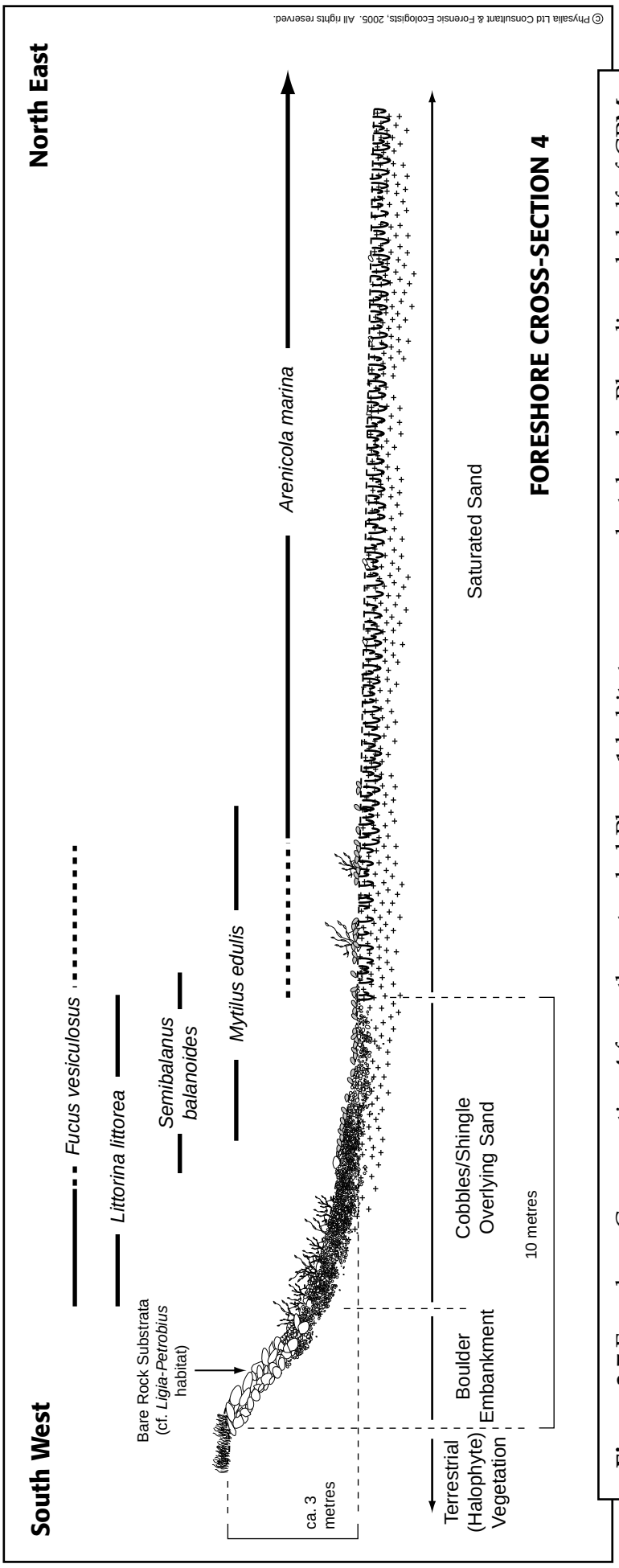


Figure 3.7 Foreshore Cross-section 4 from the extended Phase 1 habitat survey undertaken by Physalia on behalf of CPM Limited in October 2005 with particular reference to foreshore/littoral and shallow subtidal fauna associated with the proposed marina development at Whiteness, Moray Firth. See Figure 2.2 for locations of foreshore cross-sections.

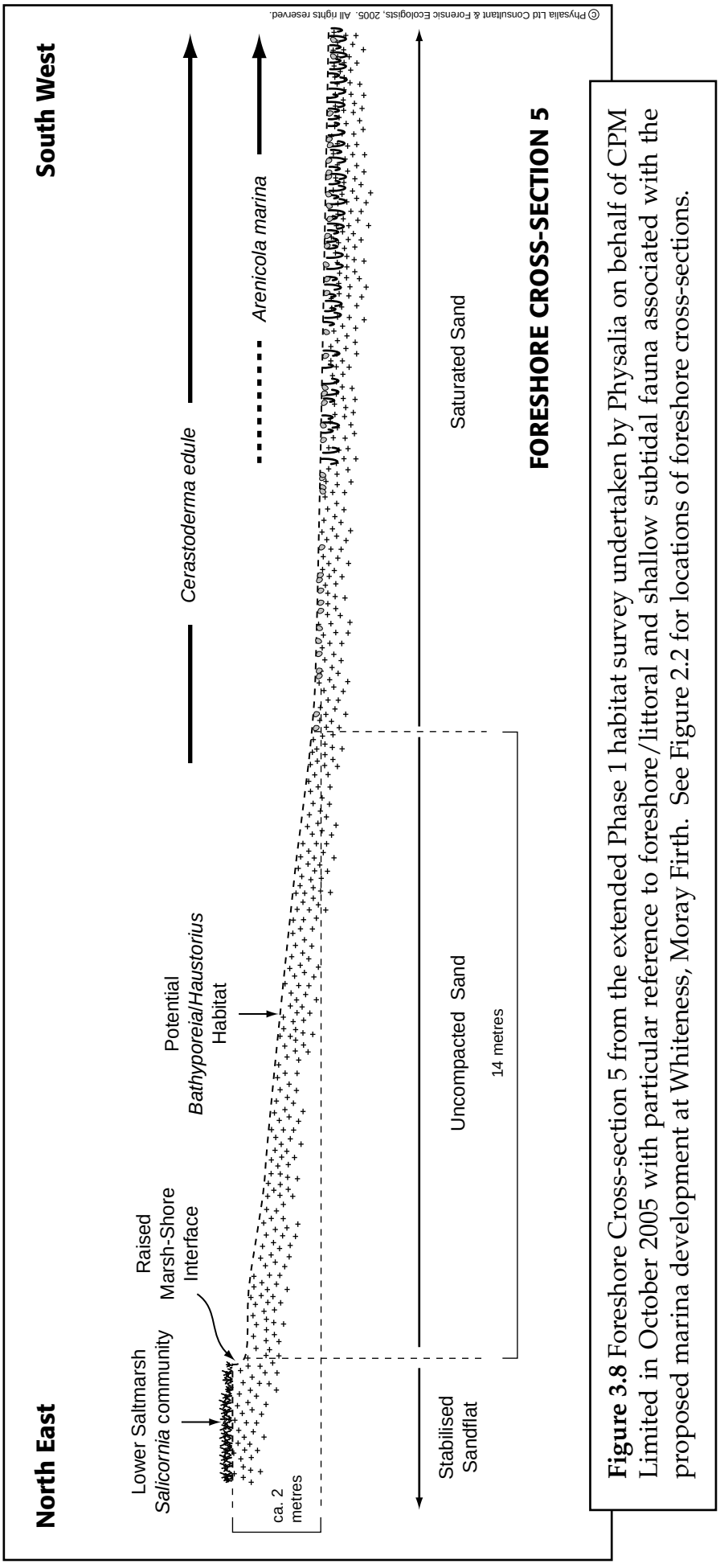


Figure 3.8 Foreshore Cross-section 5 from the extended Phase 1 habitat survey undertaken by Physalia on behalf of CPM Limited in October 2005 with particular reference to foreshore/littoral and shallow subtidal fauna associated with the proposed marina development at Whiteness, Moray Firth. See Figure 2.2 for locations of foreshore cross-sections.

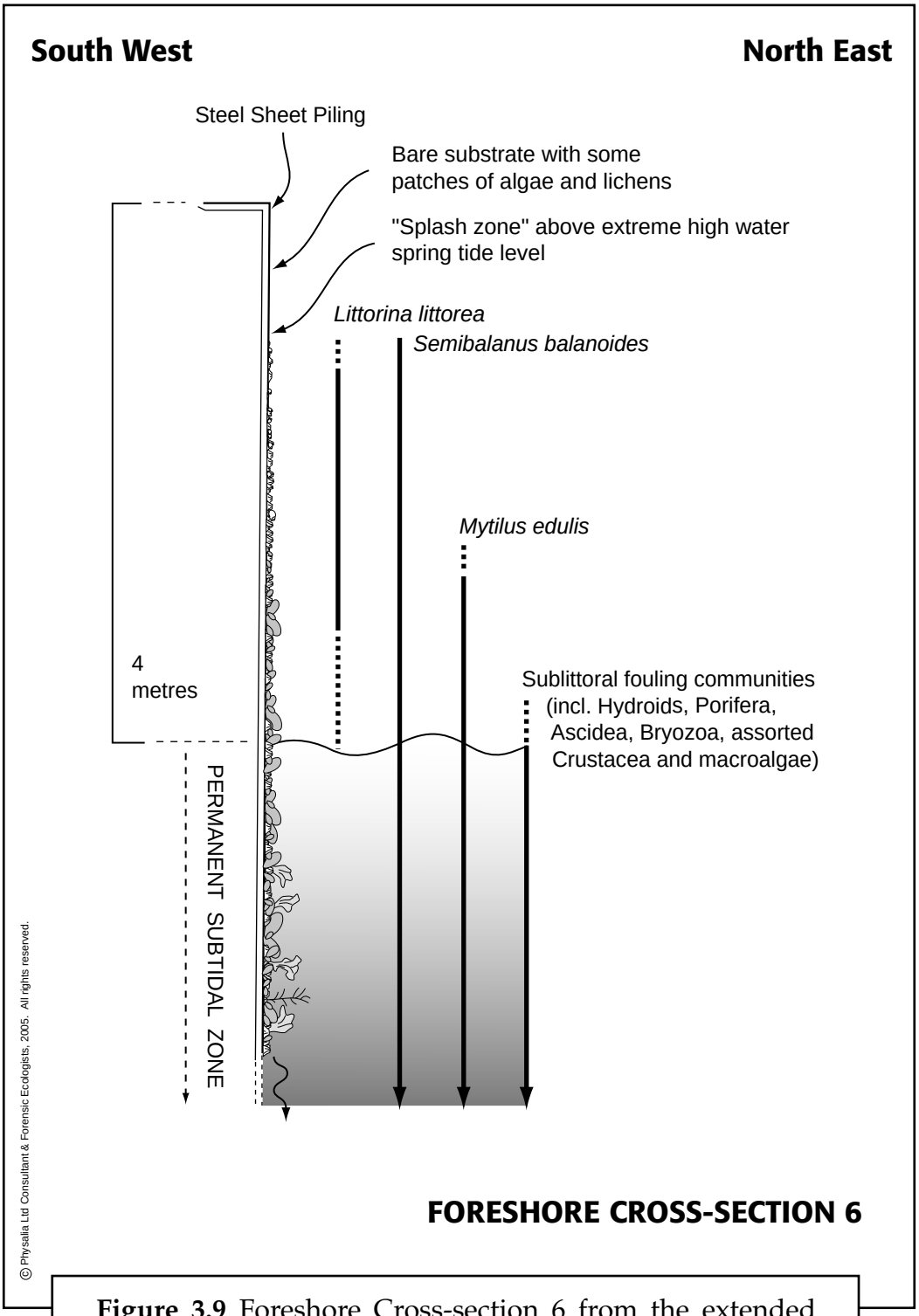


Figure 3.9 Foreshore Cross-section 6 from the extended Phase 1 habitat survey undertaken by Physalia on behalf of CPM Limited in October 2005 with particular reference to foreshore/littoral and shallow subtidal fauna associated with the proposed marina development at Whiteness, Moray Firth. See Figure 2.2 for locations of foreshore cross-sections.

E INTERTIDAL AND BENTHIC BIOTOPE SURVEY DATA (SAVILLS, 2013)

Table 8.9: MNCR Biotope Classification for the Development Site/Dredging Channel

Habitat	Location	Ref	Littoral Mixed Sediments/Description	UK Bap Habitat
Intertidal	More exposed areas at the lagoon entrance (both shores).	LS.LSa.MoSa	Barren or amphipod-dominated mobile sand shores. Mudflats and sandflats not covered by seawater at low tide.	N/A
	Western/more exposed shoreline assessed within the lagoon and adjacent to the development site.	LS.LSa.FiSa	Polychaete/amphipod dominated fine sand shores. Mudflats and sandflats not covered by seawater at low tide.	N/A
	Northern/more sheltered shoreline assessed within the lagoon and adjacent to the development site/spit.	LS.LCS.Sh.BarSh	Littoral coarse sediment. Shingle pebble and gravel shores (barren).	N/A
	Northern/more sheltered shoreline assessed within the lagoon and adjacent to the development site/spit.	LS.LSa.MuSa	Polychaete/bivalve dominated muddy sand shores. Mudflats and sandflats not covered by seawater at low tide. Typical of large shallow inlets and bays.	Intertidal mud flats
Subtidal	All sample points within the lagoon/dredging channel.	SS.SSa.SSaLS	Sublittoral sands and muddy sands. Sublittoral sand in low or reduced salinity (lagoons). Sandbanks which are slightly covered by sea water all the time.	Saline lagoon
	Sample points (1-2) within the lagoon/ dredging channel.	SS.SSa.IFiSa.IMoSa	Infralittoral mobile clean sand with sparse fauna.	Subtidal sands and gravels
	Sample point (5) within the lagoon/ dredging channel.	SS.SSa.IFiSa.NcirBat	Nephtys cirrosa and Bathyporeia spp. in infralittoral sand.	Subtidal sands and gravels
	Open water at the lagoon entrance and beyond.	SS.SSa.CFiSa	Circalittoral fine sand. Sandbanks which are slightly covered by sea water all the time.	Subtidal sands and gravels

Plate 8–1: Start of Transect (Inner Lagoon/Sample 5).

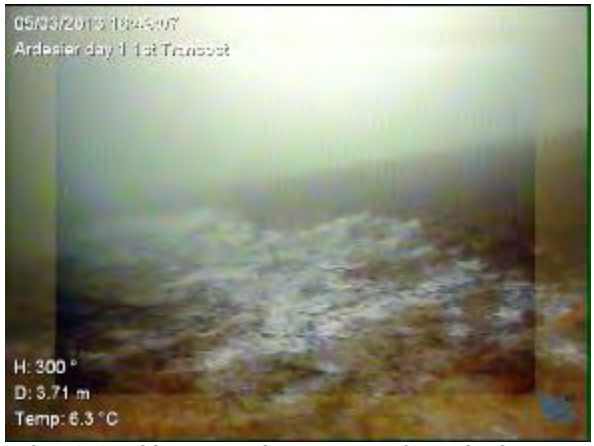


Plate 8–2: Mid Transect (Inner Lagoon/Sample 4).

Plate 8–3: Start of Transect/Spider Crab (Inner Lagoon).

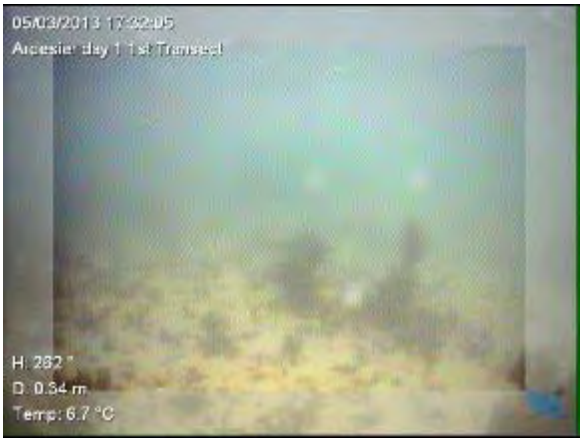


Plate 8–4: End of Transect (Outer Lagoon).

Plate 8–5: Proposed disposal site (Moray Firth).

Plate 8–6: Dredging channel (open water/Moray Firth).

ROV Surveys

8.113 ROV video surveys were also carried out for these locations. A selection of the still images that were taken during the subtidal ROV survey are presented above (Plates 8–1 to 8–6). These images were taken along a transect within the lagoon, and along the proposed dredging channel up to the spit (context: to record any soft sediment dwelling/protected species, or non-native species, that may be present in this sheltered water). Single images were also taken at

the main disposal site to the North West of the development site, and the open water section of the proposed dredging channel (Moray Firth).

Benthic Grab Samples and Analysis

8.114 The composition and abundance of benthic invertebrate fauna from the five sampling locations are presented in Table 8.10 below. In order, samples were taken from the outer to inner lagoon (along the proposed dredging channel), and spot locations were mapped (on the survey vessel plotter), and re-visited/sampled along the ROV flight path (see Map 8.3).

Table 8.10: Benthic Invertebrate Fauna Analysis

PHYLUM	GENUS	SPECIES	ITI GRP	SAMPLE				
				1	2	3	4	5
NEMERTEA			3	1	3			15
<1CM NEMATODA			4		P			P
ANNELIDA	*Pholoe*	*assimilis*	3					2
	Pholoe	*inornata*	3					1
	Harmothoe	*glabra*	3					2
	Polynoidae	*juv*	3					1
	Eteone	*longa agg*	3	3				6
	Phyllodoce	*mucosa*	3					1
	Sphaerodorum	*gracilis*	3					1
	Glycera	*sp juv*	3					1
	Psamathe	*fusca*	3					1
	Microphthalmus	*spp*	2					2
	Streptosyllis	*websteri*	2					4
	Sphaerosyllis	*taylori*	3					2
	Nephtys	*cirrosa*	3			3		1
	Nephtys	*hombergii*	3	1				2
	Ophryotrocha	*spp*	4					14
	Aricidea	*catherinae*	2					1
	Paraonidae juv		2					2
	Scoloplos	*armiger*	3					13
	Prionospio	*fallax*	2					1
	Scolelepis	*korsuni*	2	1		1		
	Pygospio	*elegans*	2		3	2		1
	Spio	*filicornis*	1					1
	Spio	*martinensis*	1					3
	Aphelochaeta	*marioni*	2					1
	Chaetozone	*christiei*	2					22
	Chaetozone	*setosa agg*	2					2
	Chaetozone	*vivipara*	2					5

PHYLUM	GENUS	SPECIES	ITI GRP	SAMPLE				
				1	2	3	4	5
	Chaetozone	*spp juv*	2					27
	Chaetozone	*spp (damaged)*	2					34
	Capitella	*spp*	4	11				143
	Ophelina	*acuminata juv*	4					2
	Ophelia	*rathkei*	2		2			
OLIGOCHAETA	*Tubificoides*	*pseudogaster agg*	4					6
CRUSTACEA	*Harpacticoida*		2					17
	Ampelisca	*brevicornis*	1					2
	Bathyporeia	*sarsi*	1	1	2			1
	Bathyporeia	*elegans*	1		1			
	Bathyporeia	*guilliamsoniana*	2		1			
	Gammarus	*sp*	1					1
	Atylus	*swammerdamei*	3					1
	Eurydice	*pulchra*	3		3			5
	Carcinus	*maenus juv*	3					1
MOLLUSCA	*Peringia*	*ulvae*	2	1				1
	Mytilus	*edulis juv*	1					6
	Dosinia	*lupinus juv*	1					1
	Parvicardium	*pinnulatum juv*	1					1
	Spisula	*subtruncata*	1	1				
	Abra	*alba juv*	2					7
	Angulus	*fabula*	1					2
	Angulus	*fabula juv*	1		1			25
	Corbula	*gibba juv*	2					1
ECHINODERMATA	*Asteroidea juv*		□					2
INSECTA			□					1
	Acarina		□					1
UNIDENTIFIED								
TOTAL				20	16	6	0	396

8.115 The Infaunal Trophic Index (ITI) for each sample is presented in Table 8.11 and sediment descriptions are presented in Table 8.11.

Table 8.11: ITI Assessment for Benthic Invertebrate Fauna

ITI ASSESSMENT FOR SUB TIDAL BENTHIC INVERTEBRATE FAUNA						
Infaunal Trophic Index (ITI)	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Total
Group 1 – Suspension feeders	2	3	0	0	9	14

Group 2 – Surface detritus feeders	2	3	2	0	13	20
Group 3 – Surface deposit feeders	3	2	1	0	16	22
Group 4 - Sub – surface deposit feeders	1	1	0	0	5	7
ITI Score	54.21	63.00	55.60	0	53.53	55.07

Table 8.12: Sample Sediment Descriptions

SAMPLE NUMBER	SEDIMENT DESCRIPTION
1	Fine sand, small amount of leaf litter, twigs and shell fragments.
2	Fine sand, small pieces of gravel, few shell fragments, no leaf litter.
3	Fine sand, shells, shell fragments, small amount gravel, no leaf litter.
4	Fine muddy sand, shell fragments, small amount vegetation/detritus.
5	Muddy sand/silt, with detritus, leaf litter and shell fragments.

Oceanographic Assessment

Existing Data

8.116 Details of oceanographic and coastal modelling studies are included in Chapter 11.

Field Surveys

8.117 With reference to the quality elements used for classification of surface water status (coastal waters) under the Water Framework Directive, and the ROV/benthic grab surveys that were carried out (intertidal and subtidal), the proposed development site and dredging channel was assessed (see Table 8.13).

Table 8.13: Related Oceanographic Assessment of the Dredging Channel (WFD and ROV/MNCR Surveys)

Coastal Waters		
Hydromorphological elements supporting the ecology		Descriptions (with reference to the ROV/MNCR surveys)
Morphological conditions	Depth variation	Depth ranges along the length of the dredging channel from the lagoon (0.3-7m HW), end of spit (0m), to the open water of the Moray Firth (12m HW).
	Structure and substrate of the	Hard-soft substrate - predominantly fine sand/muddy sand (lagoon), fine sand/shingle (spit), and fine sand (open water of