ABWP Phase I Decommissioning

Coastal Processes Modelling

Volume 3, Appendix 4.2



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Project name ABWP Phase I Decommissioning

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Contents

1 Introduction 9
2 Numerical Model Framework 10
3 Model Simulations 11
3.1 Model Simulations Performed 11
3.1.1 Vessel Access Channel Dredging Scenarios 11
3.1.2 Channel Backfilling and Maintenance (Plough) Dredging 13
3.1.3 Internal Monopile Dredging 17
3.2 Model Parameterisation 17
3.3 Results 19
3.3.1 Access Channel Dredging Scenarios 19
3.3.2 Maintenance (Plough) Dredging 25
3.3.3 Internal Monopile Dredging 27
3.3.4 Summary 29
4 Sediment Dispersion Associated with Grapnel Run Activities 31
4.2 Methodological approach 31
4.3 Results 32
5 Cumulative Effects 34
6 References 39

List of Tables

Table 3.1: Summary of modelled vessel access channel dredging scenarios and dredge volumes. 13
Table 3.2: Summary of the modelled maintenance dredging scenario and dredge volumes. A contingency has been applied to Channels 1, 6 and 7 (cells shaded orange), although interpretation of the 2025 bathymetry indicates that maintenance dredging at these locations is not required. 16
Table 3.3: Summary of the modelled internal MP dredging scenario and dredge volumes 17
Table 3.4: The three grain size classes simulated 18
Table 3.5: Summary of the findings obtained from the three access channel dredging scenarios. 19
Table 3.6: Summary of the findings obtained from the maintenance (plough) dredging scenario. 25
Table 3.7: Summary of the findings obtained from the internal MP dredging scenario. 27
Table 4.1: Summary of the sediment dispersion associated with grapnel run activities along the export and inter-array cable routes. 32

List of figures

Figure 1: Sediment Transport Modelling Scenario Locations 12
Figure 2: Sediment Transport Modelling – Scenario 2 maximum SSCs and Depositional Thicknesses. 20
Figure 3: Sediment Transport Modelling – Scenario 2 timeseries of maximum SSC across the domain ... 21
Figure 4: Sediment Transport Modelling – Scenario 4 maximum SSCs and Depositional Thicknesses. 22
Figure 5: Sediment Transport Modelling – Scenario 4 timeseries of maximum SSC across the domain ... 23
Figure 6: Sediment Transport Modelling – Scenario 6 maximum SSCs and Depositional Thicknesses. 24
Figure 7: Sediment Transport Modelling – Scenario 6 timeseries of maximum SSC across the domain ... 25
Figure 8: Sediment Transport Modelling – Scenario 8 maximum SSCs and Depositional Thicknesses 26
Figure 9: Sediment Transport Modelling – Scenario 8 timeseries of maximum SSC across the domain ... 27
Figure 10: Sediment Transport Modelling – Scenario 9 maximum SSCs and Depositional Thicknesses ... 28
Figure 11: Sediment Transport Modelling – Scenario 9 timeseries of maximum SSC across the domain . 29
Figure 12: Maximum SSC and depositional thickness across all dredging activities 30
Figure 13: Sediment Dispersion Zone for Grapnel Runs Along the offshore export cable route 33
Figure 14: ABWP Phase II maximum Suspended Sediment Concentration 35
Figure 15: ABWP Phase II Maximum Deposition Thickness 36
Figure 16: Maximum Cumulative Suspended Sediment Concentration 37
Figure 17: Maximum Cumulative Deposition Thickness 38

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Glossary

Term	Meaning
Arklow Bank Wind Park (ABWP) Phase I	Arklow Bank Wind Park (ABWP) Phase I comprises: • Offshore infrastructure seaward of High Water Mark (HWM), including: – Seven Wind Turbine Generators (WTG) with a combined capacity of 25.2 MW; – One meteorological (met) mast; – Inter-array cables connecting the WTGs and met mast; and – One offshore export cable connecting WTG T4 with landfall at HWM; • Onshore infrastructure landward of HWM including: – One onshore cable connecting landfall at HWM with the onshore substation; and – One onshore substation compound, where the onshore substation and ancillary infrastructure are located.
ABWP Phase II	ABWP Phase II comprises: • Offshore Infrastructure, including: – 53 or 47 WTGs and two Offshore Substation Platforms (OSPs) located within the "Array Area"; – Inter-array cables connecting WTGs with the OSPs; and – Two offshore export cables; • Onshore grid connection infrastructure, including a 220 kV substation at Shelton Abbey with an associated connection to the existing National Electricity Transmission Network; • Operations and Maintenance Facility (OMF) at South Dock, Arklow Harbour; and • EirGrid Upgrade Works.
Arklow Energy	Arklow Energy Limited, the entity seeking planning permission for the Proposed Works, i.e. the applicant.
Backfilling	Placement of excavated material back into the trench or excavation after removal.
Bed-level Change	A change in seabed elevation resulting from sediment erosion, transport, or deposition.

Term	Meaning
Bulking Factor	A multiplicative factor applied to *in situ* sediment volumes to account for volume increase due to excavation, handling, and disturbance during dredging activities.
Competent authority	Are those authorities that are entitled to give authorisation or consent to a plan or project. In the planning system, this means planning authorities and An Coimisiún Pleanála. There are, however, a wide range of other competent authorities in respect of other consent regimes e.g. EPA (environmental licencing), Minister for Agriculture, Food and the Marine (forestry, aquaculture and foreshore management), and various state bodies that have authority to undertake development under Part 9 of the Planning and Development Regulations (e.g. An Garda Síochána, defence forces, the courts service). The competent authority for this planning application is An Coimisiún Pleanála (ACP).
Consent	This shall include any licence, permission, permit, approval or other such authorisation granted by a public authority for any activity, or project where the authority is obliged to have regard to the requirements of the Environmental Impact Assessment (EIA) and/or Habitats Directive(s) (MacCabe Durney Barnes (MDB), 2017).
Cumulative effect	The addition of many minor or insignificant effects, including effects of other projects, to create larger, more significant effects (EPA, 2022). Cumulative effects within this EIAR comprise those arising from the Proposed Works with other developments, i.e. plans and projects that are 'reasonably foreseeable' (Planning Inspectorate (PINS), 2024).
Cumulative effects assessment	Assessment of potential environmental effects resulting from the Proposed Works cumulatively with other plans, projects or reasonably foreseeable activities.
Decommissioning	The final closing down and putting into a state of safety of a development, project or process when it has come to the end of its useful life (EPA, 2022).
Depositional Thickness	The thickness of sediment predicted to accumulate on the seabed as a result of deposition from suspended plumes of sediment.
Dredged material	Seabed material arising from localised dredging potentially required to facilitate safe vessel access during Proposed Works Offshore, and / or extraction of seabed material located inside monopile (MP) foundations, as part of MP decommissioning.
Dumping	Any deliberate disposal in the maritime area (including side-cast dredging, plough dredging, water injection dredging and other such dredging techniques of a substance or material from or in conjunction with a vessel or aircraft or offshore installation (Dumping at Sea Act 1996 (as amended)).
Dynamic Plume	The initial, high-concentration sediment plume formed at the point of discharge, driven by density differences between sediment-laden water and ambient seawater.
Effect	The consequence of an impact on a receptor. For example, in the offshore environment, vessel activity (activity) results in increased levels of underwater noise (impact), with the potential to disturb marine mammals (effect).
Environmental Impact Assessment (EIA)	Process of assessment of the effects of a project or development proposal on the environment. In the planning area, it is undertaken by a planning authority or An Coimisiún Pleanála during the consideration of applications for planning permission, taking account of an Environmental Impact Assessment Report (EIAR). The projects which require EIA are listed in Annex I and Annex II of the EIA Directive, as amended (Office of the Planning Regulator, n.d.).
Environmental Impact Assessment Report (EIAR)	A report or statement of the effects, if any, that Proposed Works, if carried out, would have on the environment. It is prepared by the developer to inform the EIA process (Office of the Planning Regulator, n.d.).
Flexible Mesh	A numerical grid structure that allows spatial resolution to vary across the model domain, enabling efficient simulation of complex coastal and shelf-sea environments.
Grapnel Run	A cable recovery technique involving dragging a grapnel along the seabed, causing shallow and temporary seabed disturbance.
High Water Mark (HWM)	Level reached by the sea at high tide, measured as the mean of high tides.

Term	Meaning
Impact	A change brought about by the Proposed Works.
Inter-array cables	Subsea power lines that link individual wind turbine generators (WTGs) together in an offshore wind farm, forming an electrical network. In ABWP Phase I, inter-array cables connect WTGs and the met mast to each other and have an overall length of 7.4 km.
Lowest Astronomical Tide (LAT)	Exact, lowest theoretical sea level that can be predicted to occur under average meteorological conditions.
Maximum design scenario (MDS)	Represents 'realistic worst case' assessment parameters for each impact.
Meteorological (Met) mast	A mast with a number of meteorological sensors located at different heights to record meteorological and sea condition data
Monopile (MP)	Hollow steel cylinder driven into the seabed typically used to anchor an offshore wind turbine generator (WTG). In ABWP Phase I, MPs support the seven WTGs as well as the meteorological (met) mast.
Morphodynamics	The study of morphological changes in seabed features driven by sediment transport processes.
Offshore export cable	Subsea power cable that transports the total generated power from an offshore wind farm to the onshore power grid. In ABWP Phase I, the offshore export cable connects the wind turbine generator (WTG) T4 to landfall with an approximate overall length of 15.6 km. At landfall, the offshore export cable transitions to the onshore cable connecting to the onshore substation.
Offshore Site	Part of the Site where Proposed Works Offshore are proposed to take place. In this application for planning permission, the Offshore Site comprises the Sub Lease Area, where the ABWP Phase I wind turbine generators (WTGs), met mast and inter-array cables are located, and the offshore export cable 10 m corridor connecting WTG T4 to the landfall at high water mark (HWM) near Arklow Harbour.
Passive Plume	The phase of a sediment plume that is transported by ambient currents after initial dynamic plume collapse.
Planning permission	Formal, legal approval required from a local planning authority or An Coimisiún Pleanála (ACP) to carry out development. The Proposed Works require planning permission submitted from ACP under Section 291 of the Planning and Development Act 2000, as amended.
Proposed Works	The Proposed Works include decommissioning of ABWP Phase I offshore infrastructure (Proposed Works Offshore) and decommissioning of ABWP Phase I onshore infrastructure (Proposed Works Onshore).
Settling Velocity	The downward velocity at which a sediment particle falls through the water column under gravity.
Scour protection	Engineered barrier typically placed on the seabed around WTG foundations and subsea cables to prevents sediment erosion caused by accelerated water currents and waves, safeguarding the WTG's stability and protecting subsea cables. In ABWP Phase I, scour protection was originally introduced in the form of rock armour, however, this proved ineffective, and was removed in 2005. Since then, scour protection has been introduced through sandbags.
Sub Lease Area	Area where the ABWP Phase I WTGs, met mast and inter-array cables are located, as defined in the Sub Lease granted by Sure Partners Limited (SPL) to Arklow Energy Limited (Arklow Energy) to construct and operate ABWP Phase I.
Transition Piece	The steel connection structure between the tower and the monopile (MP) foundation.
Trench / Channel Infilling Rate	The rate at which sediment accumulates within a dredged trench or channel, typically expressed as bed-level rise per unit time.
Wind Turbine Generator (WTG)	Structure that converts the kinetic energy of ocean winds into electrical energy. ABWP Phase I includes seven GE Energy 3.6s WTGs with a rated capacity of 3.6 megawatts (MW) per WTG.

Acronyms

Acronym	Meaning
ABWP	Arklow Bank Wind Park
ADCP	Acoustic Doppler Current Profiler
BHD	Backhoe dredger
CSD	Cutter Suction Dredger
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
FM	Flexible Mesh
HWM	High Water Mark
JUB	Jack-up barge
LAT	Lowest Astronomical Tide
MBES	Multi-beam Echosounder
MDS	Maximum Design Scenario
MM	Meteorological Mast
MP	Monopile
O&M	Operations and Maintenance
OWF	Offshore Wind Farm
SSC	Suspended Sediment Concentration
T[number]	Turbines 1 to 7
UKC	Under-Keel Clearance
W/D	Water Depth
WTG	Wind Turbine Generators

Units

Unit	Meaning
Kg	kilogram
km	Kilometres
m	meter
m^2	square meter
m^3	cubic meter
mm	millimeter
s	second
%	percentage

1 INTRODUCTION

1.1.1.1 Arklow Energy Ltd (Arklow Energy) is currently seeking planning permission to decommission the Arklow Bank Wind Park (ABWP) Phase I (hereafter 'the Proposed Works'), an Offshore Wind Farm (OWF) located approximately 10 km off the east coast of Ireland. The Proposed Works include decommissioning of ABWP Phase I offshore infrastructure (Proposed Works Offshore) and decommissioning of ABWP Phase I onshore infrastructure (Proposed Works Onshore).

1.1.1.2 The Proposed Works Offshore will be undertaken within the Offshore Site (see **Volume 2, Chapter 3: Proposed Works Description**), which includes:

- The Sub Lease Area, located on the long narrow Arklow Bank sand bank, situated approximately 10 km off the coast of Arklow, south-east Ireland, where seven wind turbine generators (WTGs) and foundations, associated scour protection, 7.4 km of inter-array cables and one met mast are located; and
- A 10 m wide cable corridor along the 15.6 km offshore export cable route connecting WTG T4 to the landfall point at High Water Mark (HWM).

1.1.1.3 This appendix presents numerical sediment plume modelling undertaken to predict the temporal and spatial distribution of suspended sediments generated during the Proposed Works Offshore, and inform **Volume 3, Chapter 4: Coastal Processes, Water and Sediment Quality** of the Environmental Impact Assessment Report (EIAR).

1.1.1.4 This appendix presents the methodology, assumptions, and results of sediment plume modelling undertaken to characterise plume extent, concentration, and duration arising from the Proposed Works Offshore. The modelling outputs are used to assess potential changes to sediment transport processes and suspended sediment concentrations.

1.1.1.5 This appendix is informed by:

- **Volume 2, Chapter 1: Introduction**; and
- **Volume 2, Chapter 3: Proposed Works Description.**

2 NUMERICAL MODEL FRAMEWORK

2.1.1.1 The numerical modelling undertaken utilises an existing, pre-established hydrodynamic and sediment transport model, rather than the development of a new model framework. The model is based on a dynamically coupled two-dimensional (2D) hydrodynamic and sediment transport setup implemented within the MIKE 21 flexible mesh (FM) framework, which has been developed, calibrated, and validated in a series of peer-reviewed studies focusing on tidally dominated continental shelf environments in the Irish Sea (Creane *et al*., 2023; Creane *et al*., 2025). Details of the model architecture, numerical formulation, spatial domain, mesh resolution strategy, boundary conditions, and sediment parameterisation are provided in Creane *et al*. (2023).

2.1.1.2 The underlying hydrodynamic model has been validated against tide gauge and Acoustic Doppler Current Profiler (ADCP) observations and measurements, demonstrating strong agreement for water levels, current speeds, and current directions across the wider Irish Sea domain and at location-specific validation points (Creane *et al*., 2023; Creane *et al*., 2025). Hydrodynamic validation methodology and performance metrics are documented in Creane *et al*. (2023). The sediment transport component incorporates non-cohesive sediment processes and has been validated using a combination of water-sample-derived suspended solids concentrations, ADCP-derived suspended sediment concentration (SSC) estimates, and comparison repeat high-resolution bathymetry survey data. Sediment transport and morphodynamic validation, including comparisons of measured and modelled bed-level change, are presented in Creane *et al.* (2023), providing confidence in both suspended and bedload transport representations.

2.1.1.3 This modelling framework has been applied previously to investigate sandbank morphodynamics, suspended sediment dynamics, sediment budgets, and the influence of hydrodynamic forcing, including tidal asymmetry, wind, and wave effects (Creane *et al*., 2023; Creane *et al.*, 2025). Examples of prior applications of the model to sandbank mobility, residual circulation, and morphodynamic stability are described in Creane *et al.* (2023). The use of an existing, peer-reviewed model enables the present assessment to build directly on a robust and well-understood numerical foundation, reducing uncertainty associated with model formulation while ensuring consistency with established regional-scale processes documented in the literature.

3 MODEL SIMULATIONS

3.1 Model Simulations Performed

3.1.1 Vessel Access Channel Dredging Scenarios

3.1.1.1 Numerical modelling of vessel access channel dredging was performed exclusively for excavation of the –6.0 m Lowest Astronomical Tide (LAT) target seabed level, see **Volume 2, Chapter 3**. This excavation depth represents what is considered to be the worst-case scenario for sediment release, as it corresponds to the largest dredging volumes, longest dredging durations, and greatest mass of sediment made available for mobilisation/dispersion across all of the WTG and met mast locations.

3.1.1.2 It is anticipated that shallower dredging depth scenarios (e.g. –4.5 m LAT) would result in proportionately lower excavation volumes and reduced sediment release rates. On this basis, explicit modelling of the -4.5 m LAT scenario was not performed, as the resultant SSC plumes and depositional footprints would be fully bounded by the –6.0 m LAT results. This approach is conservative and aligns with the application of the maximum design scenario (MDS) principle adopted throughout this assessment and **Volume 2, Chapter 4** of the EIAR.

3.1.1.3 Within the –6.0 m LAT scenario, the full range of feasible dredging methods and disposal mechanisms were also considered, comprising:

- Cutter Suction Dredger (CSD) with side casting disposal;
- CSD with pipeline disposal; and
- Backhoe Dredger (BHD) with side casting disposal.

3.1.1.4 Sediment release locations were defined immediately adjacent to each access channel, positioned in the deepest practicable water and retained within the Sub Lease Area, on the same side of the Arklow Bank crest as the relevant access channel. These assumptions reflect realistic operational constraints on vessel manoeuvrability, keeps the disposed material within the local seabed transport regime and avoids creating sediment transport pathways across the Arklow Bank system. The release locations are presented in **Figure 1.**

3.1.1.5 Dredging durations were calculated from scenario specific excavation volumes and representative average production rates (see **Volume 2, Chapter 3: Proposed Works Description**). CSD scenarios assume a mean dredging rate of 10,000 m³/day, while BHD scenarios assume 7,000 m³/day. Side casting disposal was represented as discrete releases of approximately 1,000 m³, discharged over short duration events (~5 minutes), producing transient peak release rates. Pipeline disposal was modelled as a continuous release at the average dredging rate, discharged at between 1 m and 2 m below the sea surface. Each turbine and met mast location was simulated consecutively, with maximum simulation durations selected to fully capture plume development, dispersion, and settling as a MDS scenario. **Table** 3.1 summarises the access channel dredging scenarios modelled.

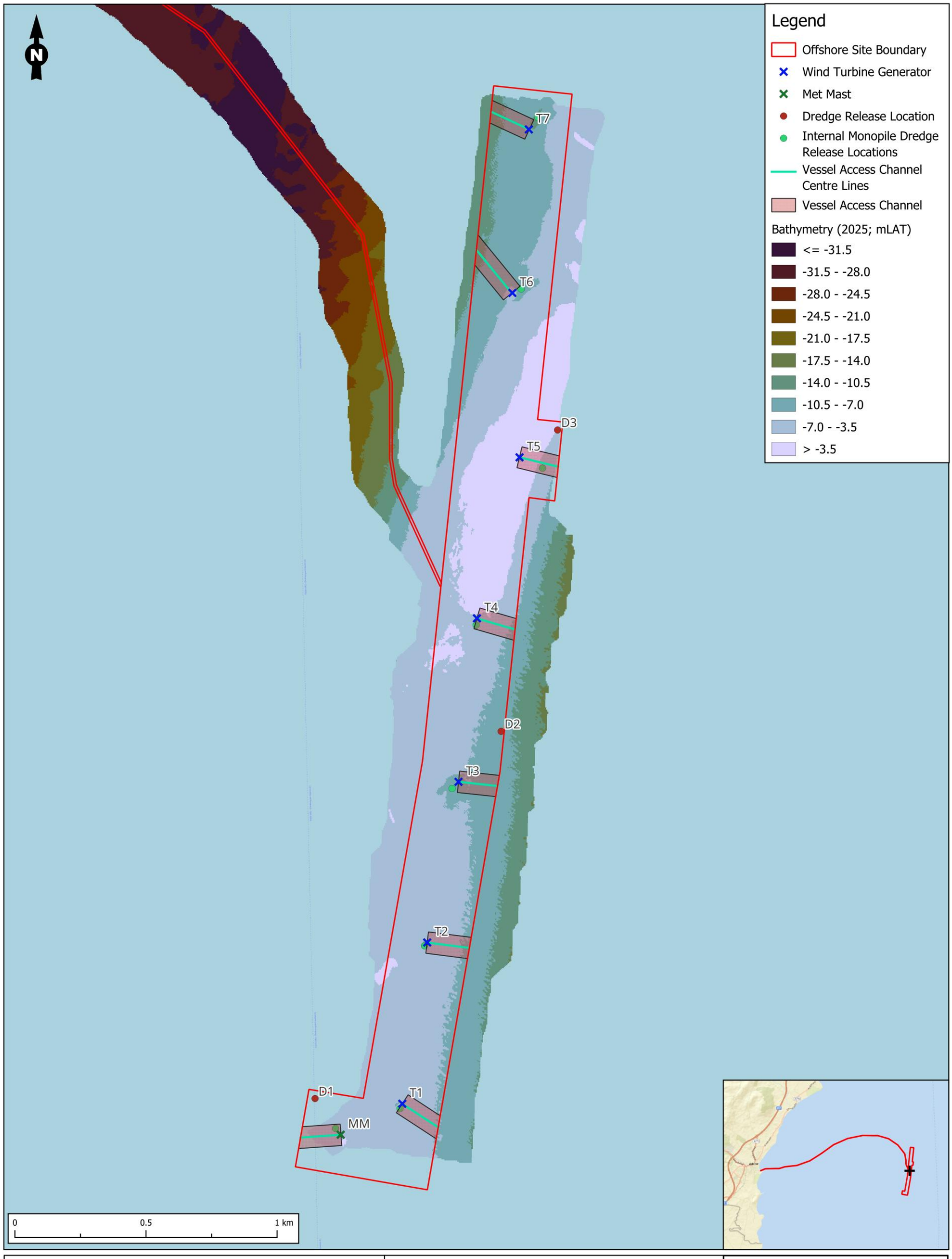


Figure Title: Sediment Transport Modelling Scenario Locations	Project No./Filery ID: 1620011606-002 / REH2024N01993		Client: Arklow Energy Limited
Project Name: ABWP Phase I Decommissioning	Date: May 2026	Prepared By: AS	RAMBOLL
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Coordinate System: IRENET95 Irish Transverse Mercator. Projection: Transverse Mercator. Datum: IRENET95.

Figure 1: Sediment Transport Modelling Scenario Locations

Table 3.1: Summary of modelled vessel access channel dredging scenarios and dredge volumes.

Scenario ID	Dredging Method	Disposal Method	Location ID	Disposal ID	Dredge Volume incl. 15% (m³)
SC-2	Cutter Suction Dredger (CSD)	Side-casting	Met Mast (MM)	D1	4,752.95
			Turbine T2	D1	867.10
			Turbine T3	D2	0.58
			Turbine T4	D2	62,392.10
			Turbine T5	D3	123,814.75
SC-4	Cutter Suction Dredger (CSD)	Pipeline discharge	Met Mast (MM)	D1	4,752.95
			Turbine T2	D1	867.10
			Turbine T3	D2	0.58
			Turbine T4	D2	62,392.10
			Turbine T5	D3	123,814.75
SC-6	Backhoe Dredger (BHD)	Side-casting	Met Mast (MM)	D1	4,752.95
			Turbine T2	D1	867.10
			Turbine T3	D2	0.58
			Turbine T4	D2	62,392.10
			Turbine T5	D3	123,814.75

3.1.2 Channel Backfilling and Maintenance (Plough) Dredging

3.1.2.1 Following completion of access channel dredging to −6.0 m LAT, numerical modelling of seabed sediment transport was performed in the area of interest to assess the rate of natural seabed recovery within the access channels and to determine the potential requirements for maintenance dredging during the Proposed Works Offshore. The assessment utilises depth-integrated sediment transport outputs from the calibrated sediment-transport model (see **Section 2**) and applies a conservative, worst-case interpretation of sediment entry to, and retention within, the dredged channels.

Channel Backfilling

3.1.2.2 The backfilling methodology explicitly separates (i) the supply of sediment to the channel, governed by ambient sediment transport reaching the channel margins, from (ii) the accumulation of sediment within the channel, governed by the channel geometry. This approach ensures conservation of mass and avoids non-physical assumptions of lateral sediment convergence across the channel footprint.

Sediment Transport

3.1.2.3 Depth-integrated horizontal sediment transport components in the east–west (q_E) and north–south (q_N) directions were extracted from gridded raster outputs of the sediment-transport model. These datasets represent net depth-integrated transport per unit width. Each vessel access channel was represented by a centreline geometry (see **Figure 1)**, from which channel

length was derived. Channel width was defined from design inputs and applied uniformly along each channel. The orientation of each channel was calculated from the centreline bearing, enabling calculation of sediment transport normal to the channel axis, which governs the potential for sediment to enter the channel.

3.1.2.4 Depth-integrated sediment transport normal to the channel axis ($q_{\perp}$) was calculated as:

$$q_{\perp} = | q_E \cos\alpha | + | q_N \sin\alpha |$$

(1)

3.1.2.5 where α is the clockwise bearing of the channel axis from north, and q_E and q_N are the depth-integrated transport components.

3.1.2.6 A conservative, worst-case assumption was adopted whereby:

- Channel sidewalls are assumed to be vertical, eliminating any side-slope stability limitation.
- Trapping efficiency is assumed to be unity, such that all sediment reaching the channel edges is retained.
- Only sediment that physically reaches the channel margins is assumed to contribute to infilling; sediment transport occurring away from the channel edges is not assumed to laterally converge into the channel, as no physical mechanism exists for this under ambient flow conditions.

3.1.2.7 The volumetric sediment flux entering each channel was normalised by access channel length to define a mean sediment supply per unit channel length. Bed-level rise (shallowing) within the access channel was then represented as a depth-averaged bed-level rise across the defined access channel width, consistent with a worst-case assumption of even accumulation following sediment entry at the access channel margins. This formulation yields an access channel infilling rate ($\mathrm{d}z/\mathrm{d}t$), expressed for reporting purposes in cm hr^{-1}. This approach ensures that sediment entry is controlled physically at the access channel edges, while sediment accumulation is governed by the defined access channel geometry, maintaining consistency with conservation-of-mass principles and avoiding non-physical assumptions of lateral sediment convergence across the access channel footprint.

Maintenance Threshold and Plough Activation

3.1.2.8 Maintenance dredging was assumed to be triggered once natural infilling reduced the access channel depth from −6.0 m LAT to a defined maintenance threshold, typically −5.75 m LAT. This corresponds to a vertical bed-level rise of approximately 0.25 m and represents a conservative operational buffer for safe vessel access[1]. Using the calculated bed-level rise rates, the time required to reach the maintenance threshold was estimated for each access channel. Given the defined maintenance period, the number of required plough dredging activations per access channel was then calculated; these values are presented in **Table 3.2.**

Maintenance Dredging

3.1.2.9 Plough dredging was identified as the appropriate maintenance technique to maintain a navigable access channel once the threshold depth is reached. Ploughing requirements were calculated on an access channel-by-channel basis, accounting for access channel dimensions, infill rates, and maintenance period duration, and include a 15% contingency on estimated sediment volumes. The resulting plough dredging volumes form the basis for the maintenance dredging scenarios represented in the numerical model. A maintenance period (i.e. period where a navigable water depth is required to be maintained) of 9.5 days was selected to align with the

[1] A value of 0.25 m was adopted as it represents approximately half of the typical vessel under-keel clearance (UKC) applicable to the proposed activities.

maximum proposed duration of decommissioning activities per location[2] (see **Volume 2, Chapter 3**).

3.1.2.10 Across all access channels, the total sediment volume resulting from plough dredging (including contingency) is approximately 86,000 m³, distributed across multiple short-duration maintenance activations. Individual plough releases are significantly smaller than capital dredging releases and occur close to the seabed. **Table 3.2** summarises the derived plough dredging requirements applied within the modelling for the −6.0 m LAT access channels.

3.1.2.11 Plough dredging was represented within the numerical model as a series of discrete, near-bed release events, with sediment released approximately 1 m above the seabed. As with all other modelled scenarios, seabed resuspension processes were disabled to isolate the effects of sediment mobilisation only associated with the Proposed Works Offshore. The resulting SSC plumes are therefore localised and fully bounded by the access channel dredging scenarios modelled elsewhere in this report.

[2] 9.5 days represents the duration required to decommission an individual Transition Piece / Monopile, representing the activity with the longest duration requiring a vessel access channel (see Volume 2, Chapter 3: Proposed Works Description).

Table 3.2: Summary of the modelled maintenance dredging scenario and dredge volumes. A contingency has been applied to Channels 1, 6 and 7 (cells shaded orange), although interpretation of the 2025 bathymetry indicates that maintenance dredging at these locations is not required.

Scenario ID	Channel ID	Channel Width (m)	Channel Length (m)	Bed Rise (cm/hr)	Vertical Rise Target (m)	Time to Plough Activation (days)	Maintenance Period (Days)	Required Plough Operations to maintain navigable depth	Sediment Volume Released per activation (m^3) + 15% contingency	Total Volume Released (m^3) + 15% contingency
8	1	82	164.76	0.41	0.25	2.51	9.5	4	4000	16000
	6	82	212.33	0.37	0.25	2.81	9.5	4	5500	20500
	7	82	159.78	0.15	0.25	6.79	9.5	2	4000	8000
	5	82	151.73	0.24	0.25	8.68	9.5	3	4000	11000
	4	82	151.92	0.12	0.25	16.87	9.5	2	4000	7500
	3	82	149.94	0.13	0.25	16.05	9.5	2	4000	7500
	2	82	162.16	0.19	0.25	11	9.5	2	4000	8000
	MM	82	154.31	0.17	0.25	12.18	9.5	2	4000	7500
	Total								33,500	86,000

3.1.3 Internal Monopile Dredging

3.1.3.1 Internal dredging of soil plugs within monopiles (MPs) was simulated separately due to its highly localised footprint and comparatively small sediment volumes. Soil plug removal was modelled as being conducted via submersible dredge pump at representative production rates, with individual dredging volumes typically ranging from a few tens of cubic metres up to approximately 170 m³ per MP. **Table 3.3** summarises the derived internal MP dredging input data applied within the modelling.

3.1.3.2 Sediment is assumed to be disposed of via outfall from a small-diameter pipeline located within close proximity to each MP, with releases occurring at between 1 m and 2 m below the sea surface. Each MP was simulated individually using continuous, low-rate releases consistent with realistic dredging techniques for these operations. Although volumetrically minor relative to access channel dredging, inclusion of internal MP dredging ensures comprehensive representation of all material sediment-disturbance activities associated with the Proposed Works Offshore.

Table 3.3: Summary of the modelled internal MP dredging scenario and dredge volumes

Scenario ID	Location	Target MP internal dredging depth (m LAT)	Length of soil plug to be dredged (2003 seabed level - Target MP internal dredging depth) (m)	Volume of soil plug to be dredged (m^3)
9	T1	-11.34	6.64	136.00
	T2	-9.59	4.39	90.00
	T3	-11.55	6.35	130.00
	T4	-11.09	6.29	129.00
	T5	-9.67	6.97	143.00
	T6	-11.89	6.89	141.00
	T7	-12.75	8.35	171.00
	Met mast	-13.55	10.85	28.00
	Total			968.00

3.2 Model Parameterisation

3.2.1.1 Sediment dispersion within the numerical model is represented using suitably parameterised particles as a proxy for assessing the dispersion, concentration, and depositional footprint (thickness on the seabed) of material liberated during the proposed works. Within the model, sediment is represented as discrete particle classes, each assigned inherent hydraulic characteristics (e.g. settling velocity, horizontal and vertical dispersion). These particles are advected by the ambient hydrodynamic flow and dispersed through turbulent processes in two dimensions.

3.2.1.2 The model calculates the trajectory of each particle through time and outputs instantaneous SSC fields for each sediment class. A corresponding mass is assigned to each particle released within the model, defined as a function of the volume of sediment released, the volume of the receiving model cell, and the minimum target concentration to be resolved (set at 1 mg l^{-1}). The model was not configured to simulate erosion, entrainment, resuspension, or subsequent transport of sediment following deposition on the seabed; deposited material therefore remains immobile for the remainder of each simulation.

3.2.1.3 To account for material expansion and disturbance effects associated with dredging and handling, bulking factors were applied to all access channel dredging and internal MP dredging scenarios prior to sediment release being represented within the numerical model. Bulking

factors were applied by sediment class to convert in situ sediment volumes to representative released volumes and masses, ensuring consistency with standard dredging practice and conservative estimation of sediment availability for mobilisation.

3.2.1.4 The following bulking factors were applied:

- Coarse sand and gravel: 1.15
- Sand: 1.25
- Clay and silt: 1.40

3.2.1.5 These factors were applied uniformly across all simulated access channel dredging and internal MP dredging scenarios, based on the site-specific sediment grain-size composition. Application of bulking factors increases the effective released volume and mass of sediment represented within the model and therefore provides a conservative basis for predicting suspended sediment concentrations and depositional footprints.

3.2.1.6 The mechanism by which sediment is released strongly influences both near-field and far-field plume behaviour. Sediment discharge initially forms a dynamic plume, driven by the density contrast between the sediment-laden mixture and the surrounding seawater, and descends rapidly through the water column. As the dynamic plume mixes with ambient water, it transitions into a passive plume, which is transported and dispersed by tidal currents and turbulent processes. To represent these processes in numerical models, it is common practice to apply an empirical coefficient limiting the proportion of fine sediment entering the passive plume. A 10% loss of fine sediment (sand, silt and clay) to the passive plume is considered a realistic representation of physical behaviour, based on published literature (e.g. Becker et al., 2015). However, this loss factor has not been applied to the modelling outputs presented here, in order to maintain consistency with the ABWP Phase II sediment-transport modelling framework (MetOceanWorks, 2024). Consequently, 100% of the modelled fine sediment fraction is assumed to enter the passive plume, representing a very conservative assumption with respect to SSC magnitude and plume extent.

3.2.1.7 Coarser gravel-sized material is assumed to deposit almost instantaneously on the seabed in the immediate vicinity of the release location and is therefore not included in the simulated passive plume transport. For dredging activities, sediment liberated into the water column is released within the model domain at between 1 m and 2 m below the sea surface or 1 m above the seabed, depending on the disposal mechanism.

3.2.1.8 Particle parameterisation was derived from site-specific grain size data (Svitzer, 2002; Aquatic Services Unit, 2011, 2022) collected proximal to the activities of interest, supported by sediment transport coefficients reported by Soulsby (1997). Three sediment grain-size classes were defined for model input, with representative mean values applied and sediment volumes apportioned according to observed particle size distributions. These data were derived from sediment samples collected proximal to the activity of interest (i.e. either from sediment samples coincident with bedform fields, or sediment samples proximal to cable routes). Three grain size classes were defined for input to the model (**Table 3.4**). The mean value of each grain size class was utilised, and the volume of sediment apportioned according to the mean value from relevant samples.

3.2.1.9 Cumulative seabed deposition was estimated using a flux-based method, integrating grain-size-dependent sediment settling rates derived from suspended sediment concentrations through time, with local and global mass-conservation constraints applied. Results were validated through comparison with equivalent deposition patterns derived directly from MIKE model outputs.

Table 3.4: The three grain size classes simulated.

Grain Size Class	Size range (mm)	Median Grain Size (mm)	Settling velocity (m s^{-1})
Coarse Sand and Gravel	0.6 – 64.0	32.30	N/A*
Fine to Medium Sand	0.064 – 0.590	0.33	0.042

Grain Size Class	Size range (mm)	Median Grain Size (mm)	Settling velocity (m s^{-1})
Clay and Silt	0.001 – 0.0063	0.001	0.001

* Note an arbitrary high value was chosen to ensure that this material is immediately deposited on the seabed.

3.3 Results

3.3.1 Access Channel Dredging Scenarios

3.3.1.1 During the modelled scenarios, suspended sediment plumes created during access channel dredging operations were predicted to enhance SSC, local to dredge operations, and across the wider environment, transiently. **Figure 2**, **Figure 4** and **Figure 6** present the maximum spatial footprint of SSCs and the associated depositional footprint for Scenarios 2, 4 and 6, respectively. An additional timeseries of maximum SSC across the domain for Scenarios 2, 4 and 6 is presented in **Figure 3**, **Figure 5** and **Figure 7**, respectively. **Table 3.5** presents summary statistics for each respective scenario.

Table 3.5: Summary of the findings obtained from the three access channel dredging scenarios.

Scenario ID	Transport Direction	Transport Distance (km)	Time required to return to background SSC (days)
SC-2	North - South	7	31
SC-4	North - South	6.2	20
SC-6	North - South	6.8	42

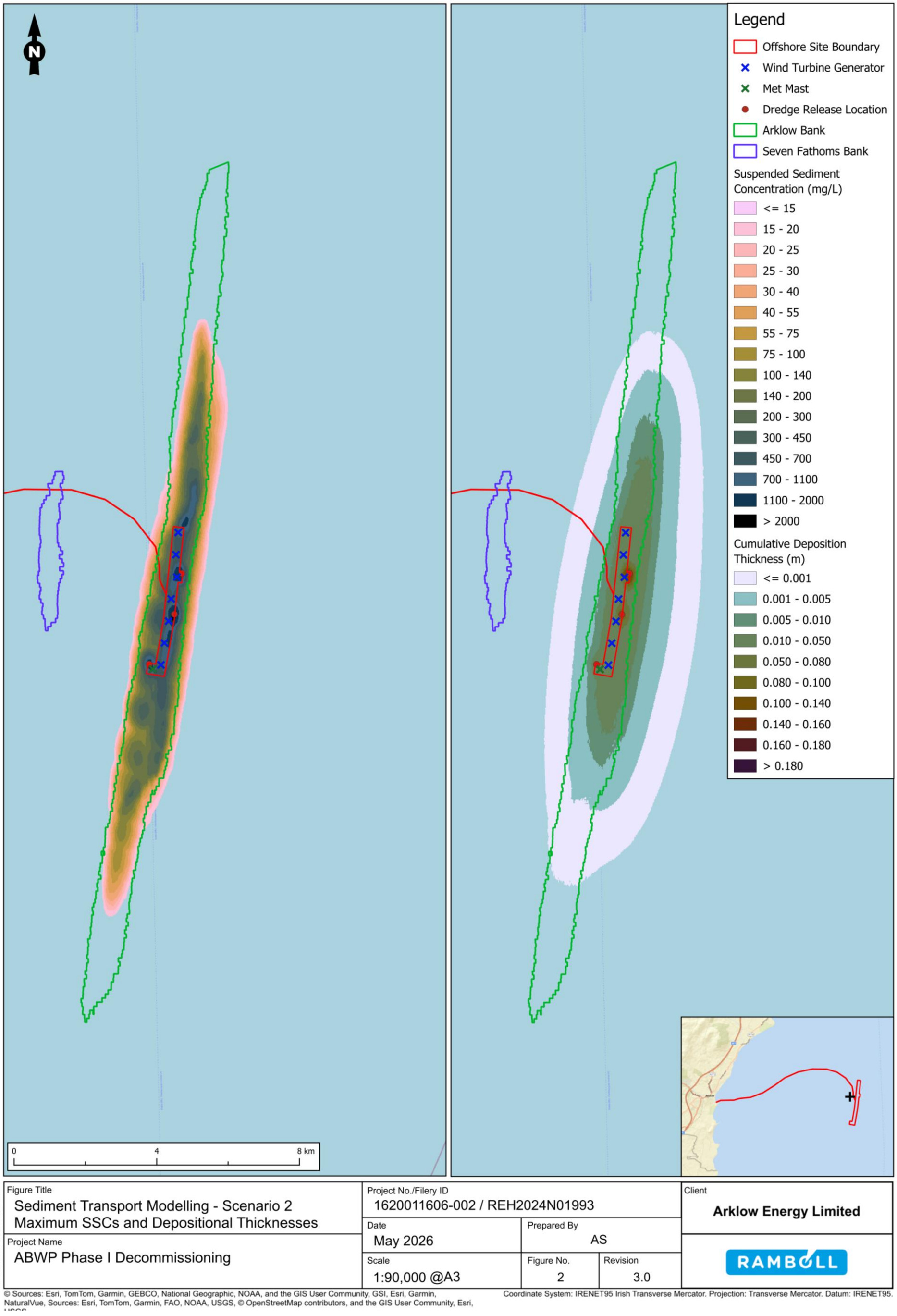


Figure 2: Sediment Transport Modelling – Scenario 2 maximum SSCs and Depositional Thicknesses.

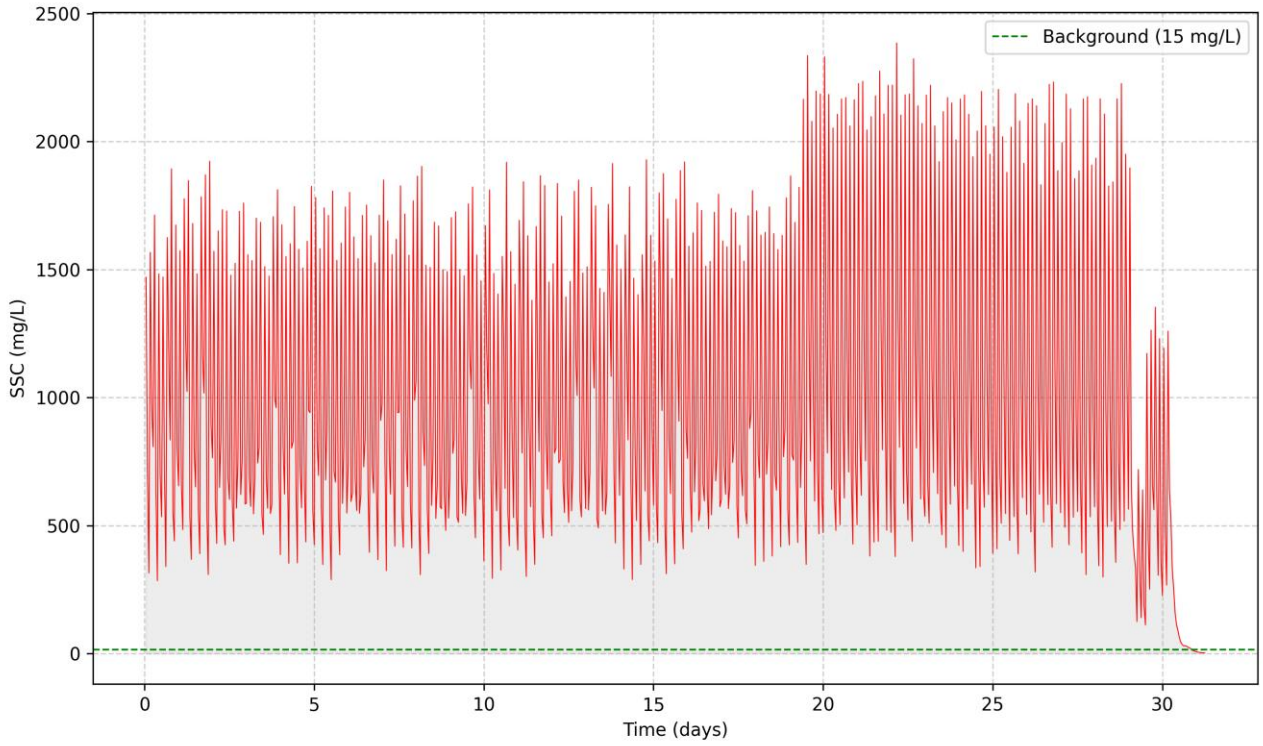


Figure 3: Sediment Transport Modelling – Scenario 2 timeseries of maximum SSC across the domain

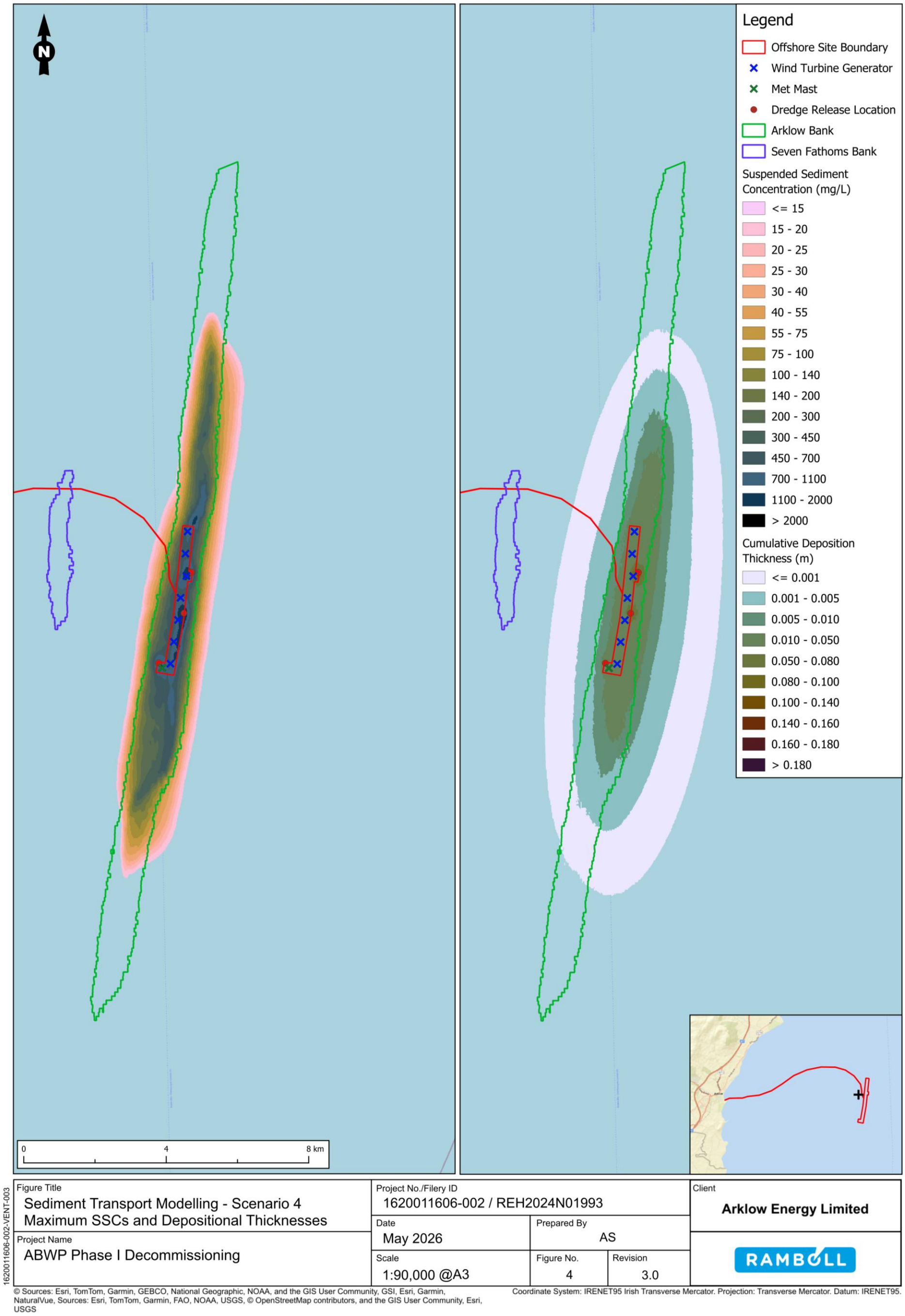


Figure 4: Sediment Transport Modelling – Scenario 4 maximum SSCs and Depositional Thicknesses.

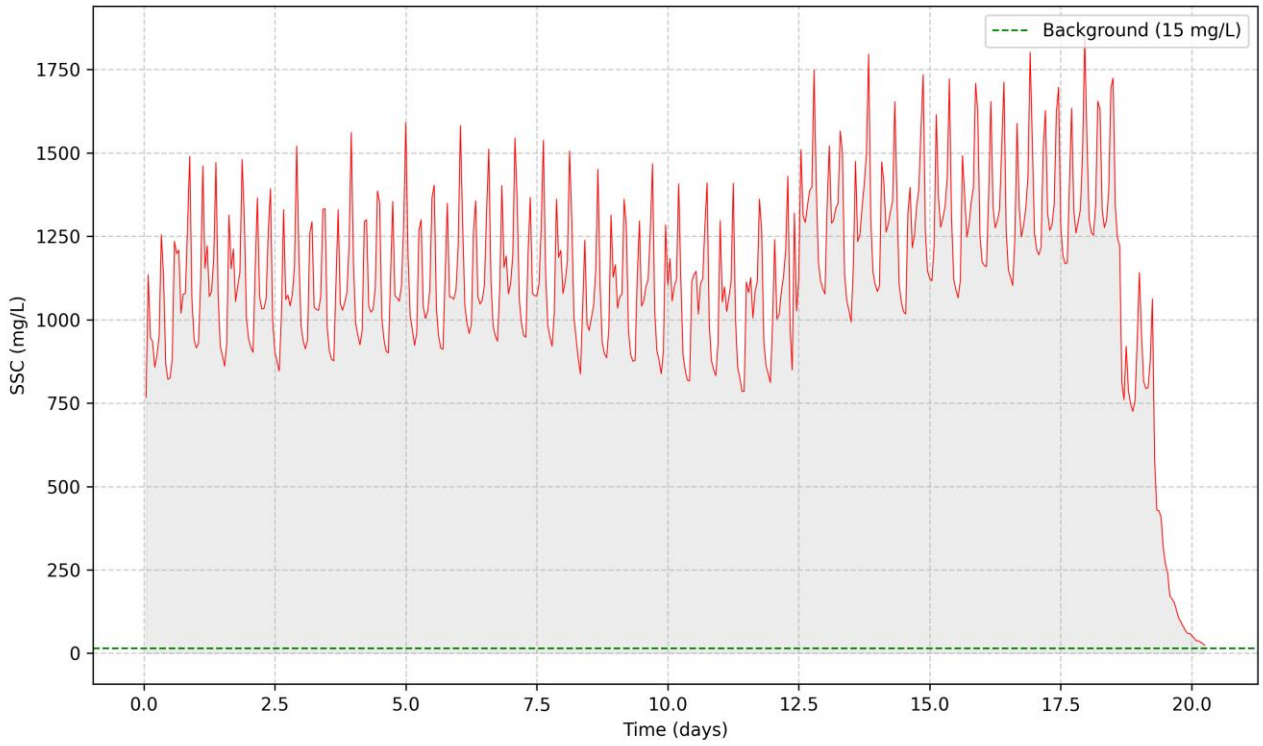


Figure 5: Sediment Transport Modelling – Scenario 4 timeseries of maximum SSC across the domain

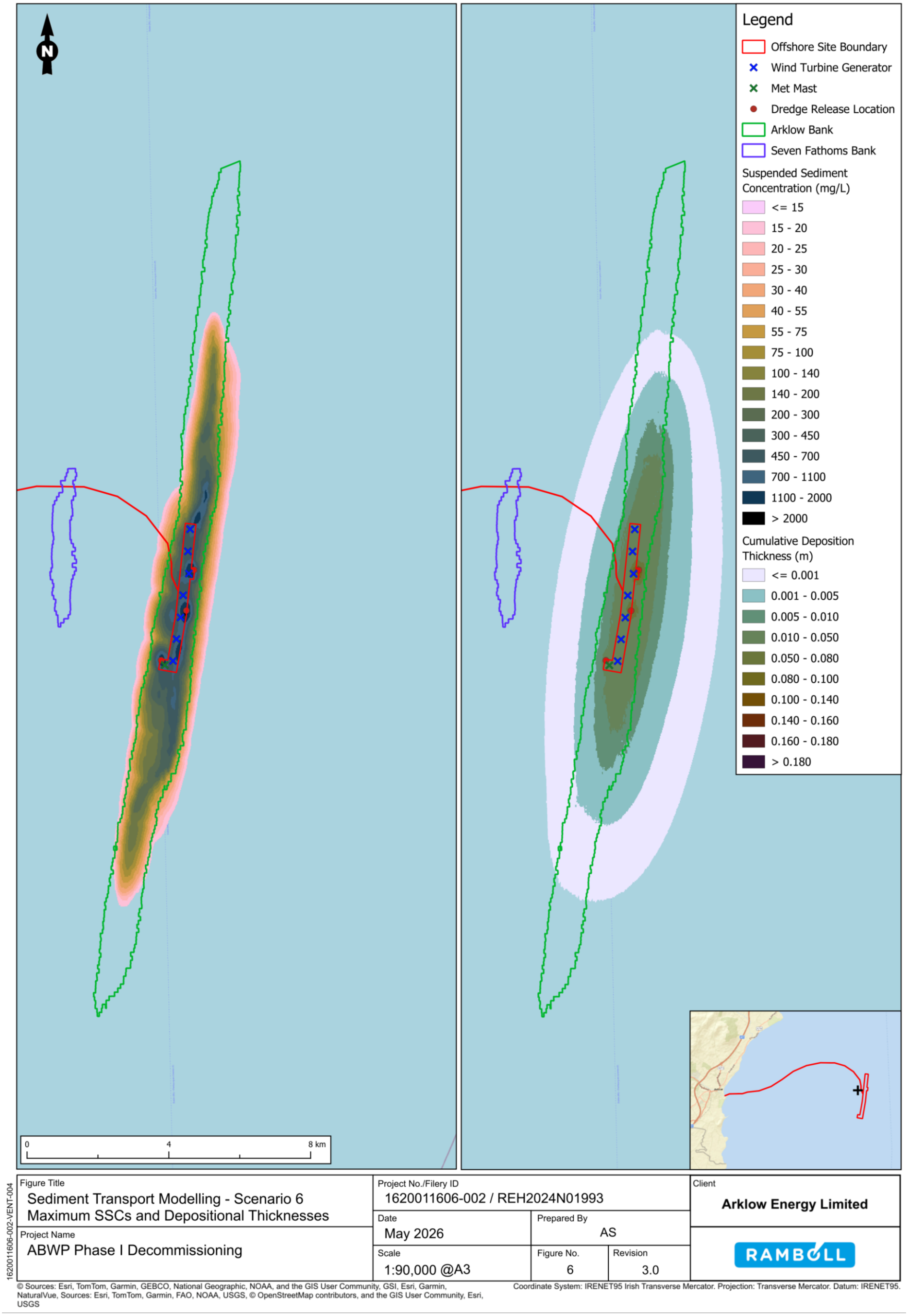


Figure 6: Sediment Transport Modelling – Scenario 6 maximum SSCs and Depositional Thicknesses.

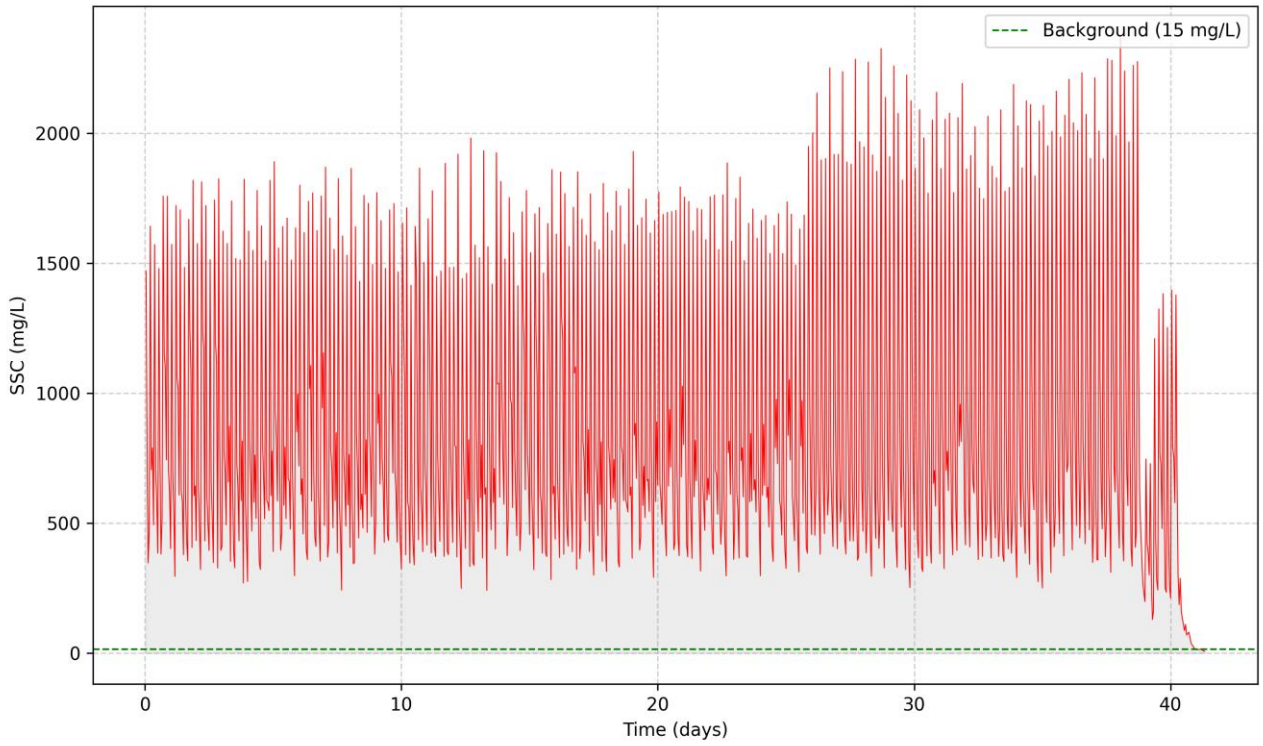


Figure 7: Sediment Transport Modelling – Scenario 6 timeseries of maximum SSC across the domain

3.3.2 Maintenance (Plough) Dredging

3.3.2.1 During the modelled scenarios, suspended sediment plumes created during maintenance (plough) dredging operations were predicted to enhance SSC, local to dredge operations, and across the wider environment, transiently. **Figure 8** presents the maximum spatial footprint of SSCs and the associated depositional footprint. An additional timeseries of SSC across the domain is presented in **Figure 9. Table 3.6** presents summary statistics for each respective scenario.

Table 3.6: Summary of the findings obtained from the maintenance (plough) dredging scenario.

Scenario ID	Transport Direction	Transport Distance (km)	Time required to return to background SSC (days)
SC-8	North - South	6.8	2

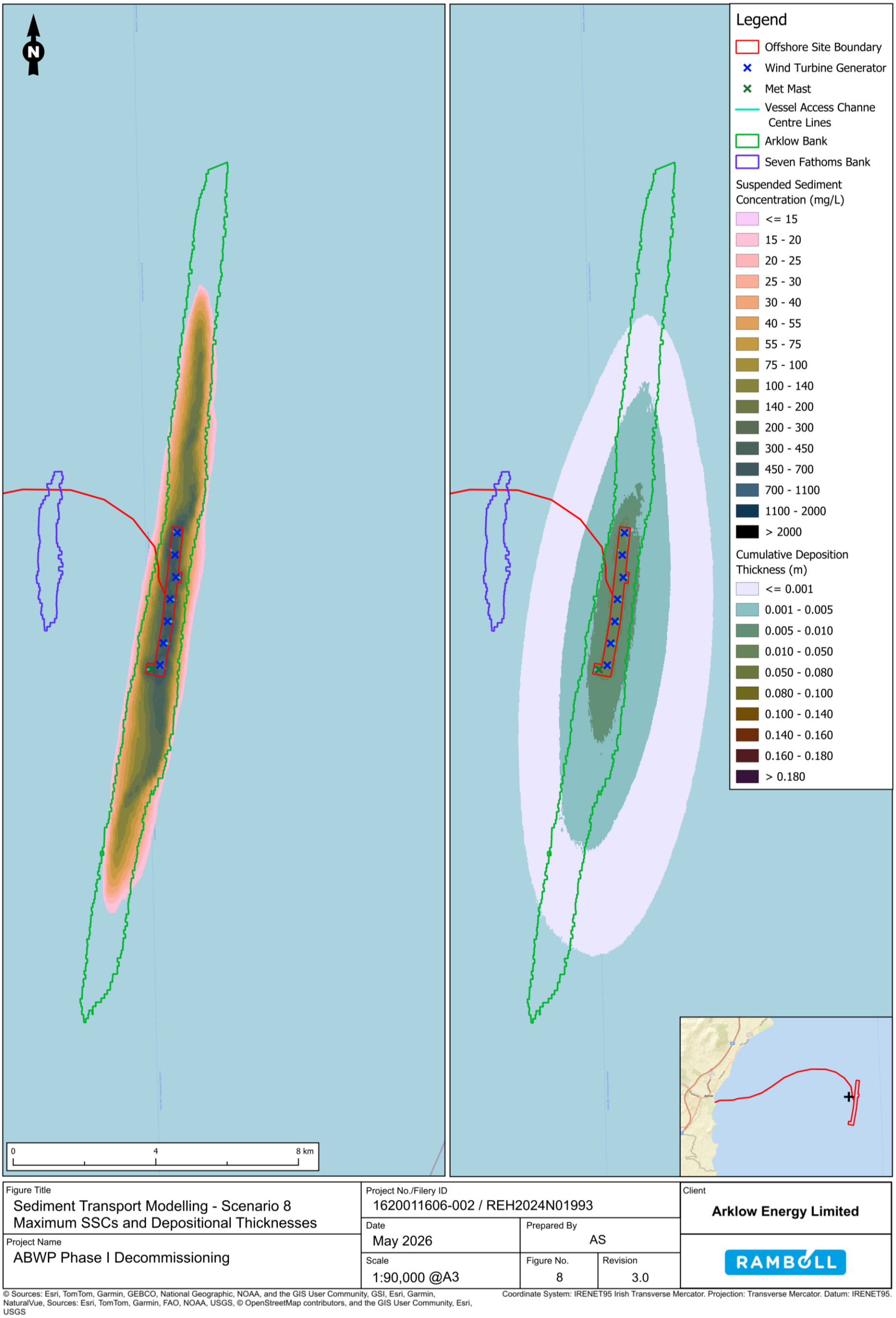


Figure 8: Sediment Transport Modelling – Scenario 8 maximum SSCs and Depositional Thicknesses

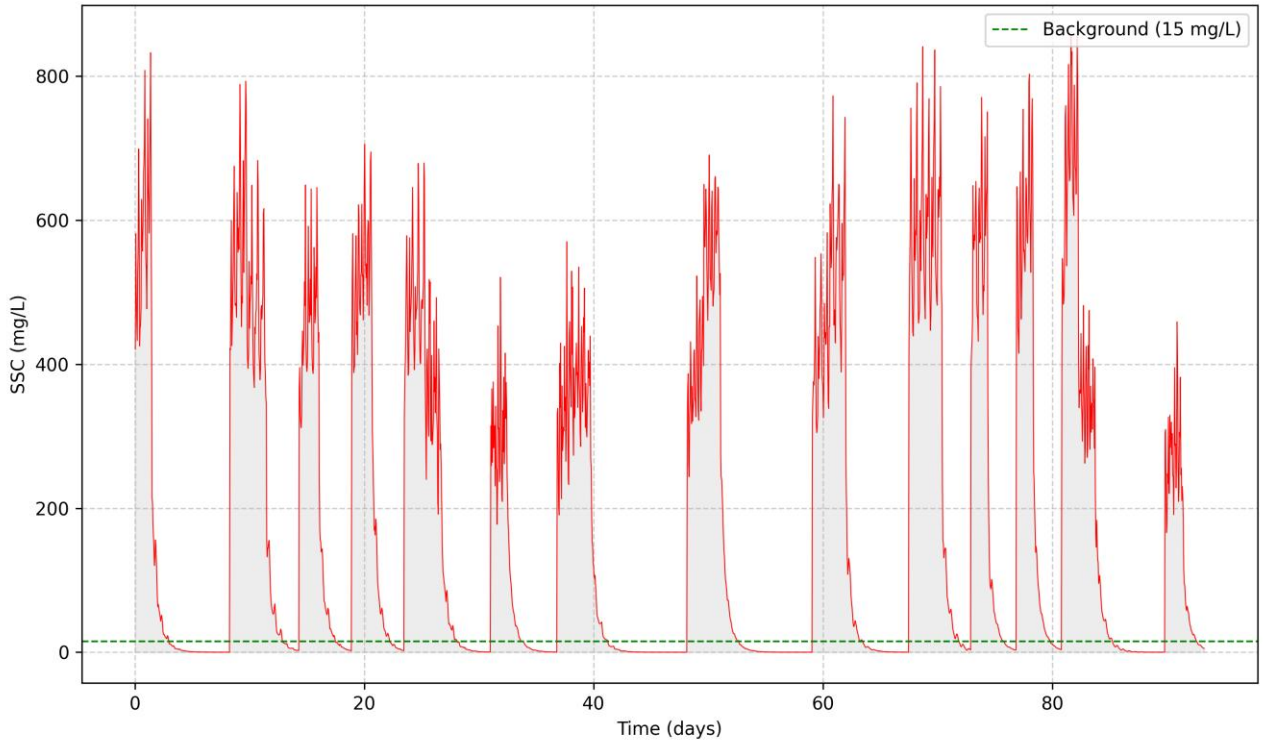


Figure 9: Sediment Transport Modelling – Scenario 8 timeseries of maximum SSC across the domain

3.3.3 Internal Monopile Dredging

3.3.3.1 During the modelled scenarios, suspended sediment plumes created internal MP dredging operations were predicted to enhance SSC, local to dredge operations, and across the wider environment, transiently. **Figure 10** presents the maximum spatial footprint of SSCs and the associated depositional footprint. An additional timeseries of SSC across the domain is presented in **Figure 11**. **Table 3.7** presents summary statistics for each respective scenario.

Table 3.7: Summary of the findings obtained from the internal MP dredging scenario.

Scenario ID	Transport Direction	Transport Distance (km)	Time required to return to background SSC (days)
SC-9	North - South	4.3	2

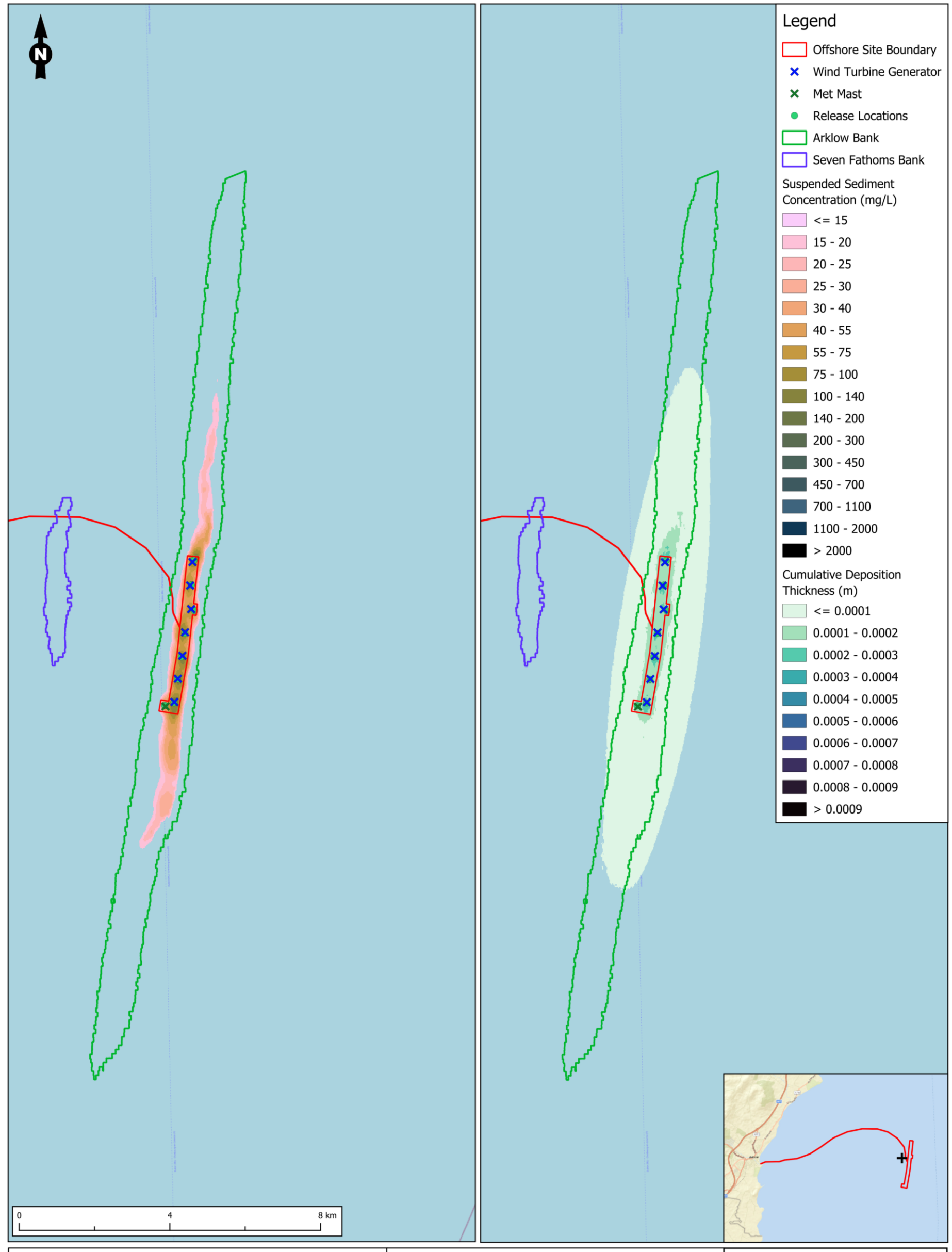


Figure 10: Sediment Transport Modelling – Scenario 9 maximum SSCs and Depositional Thicknesses

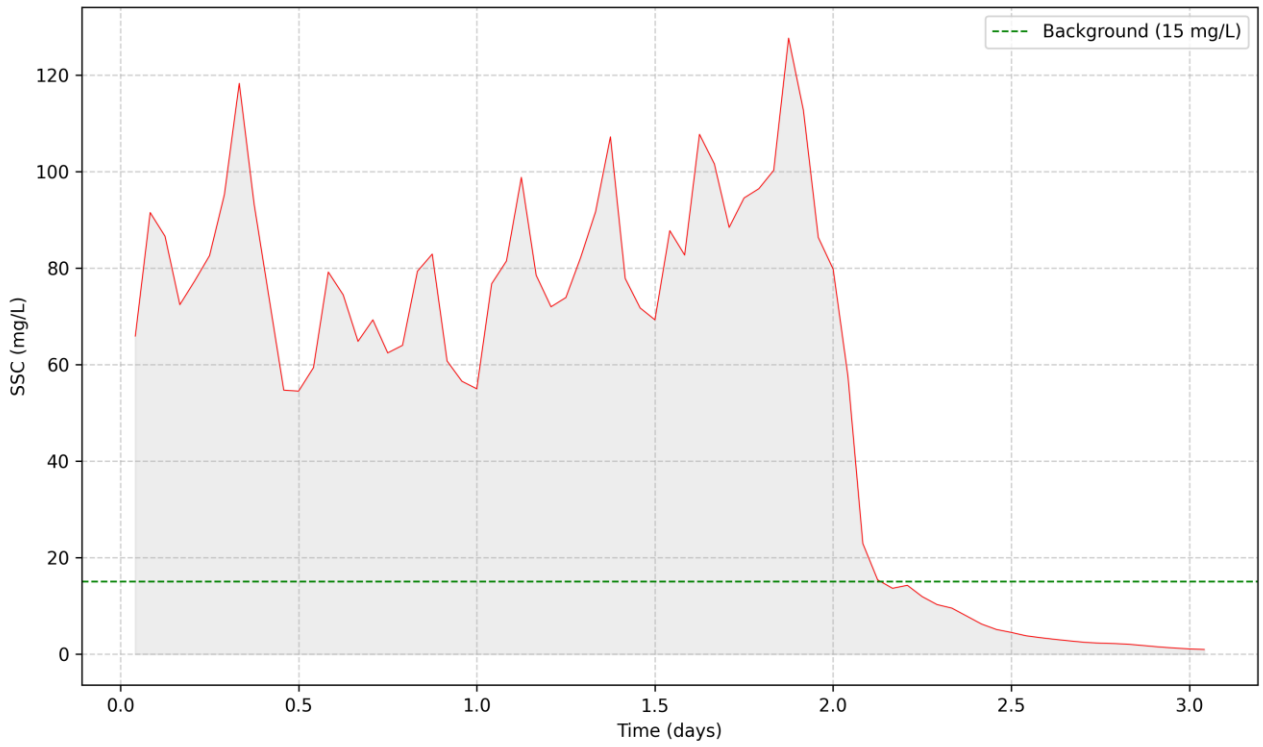
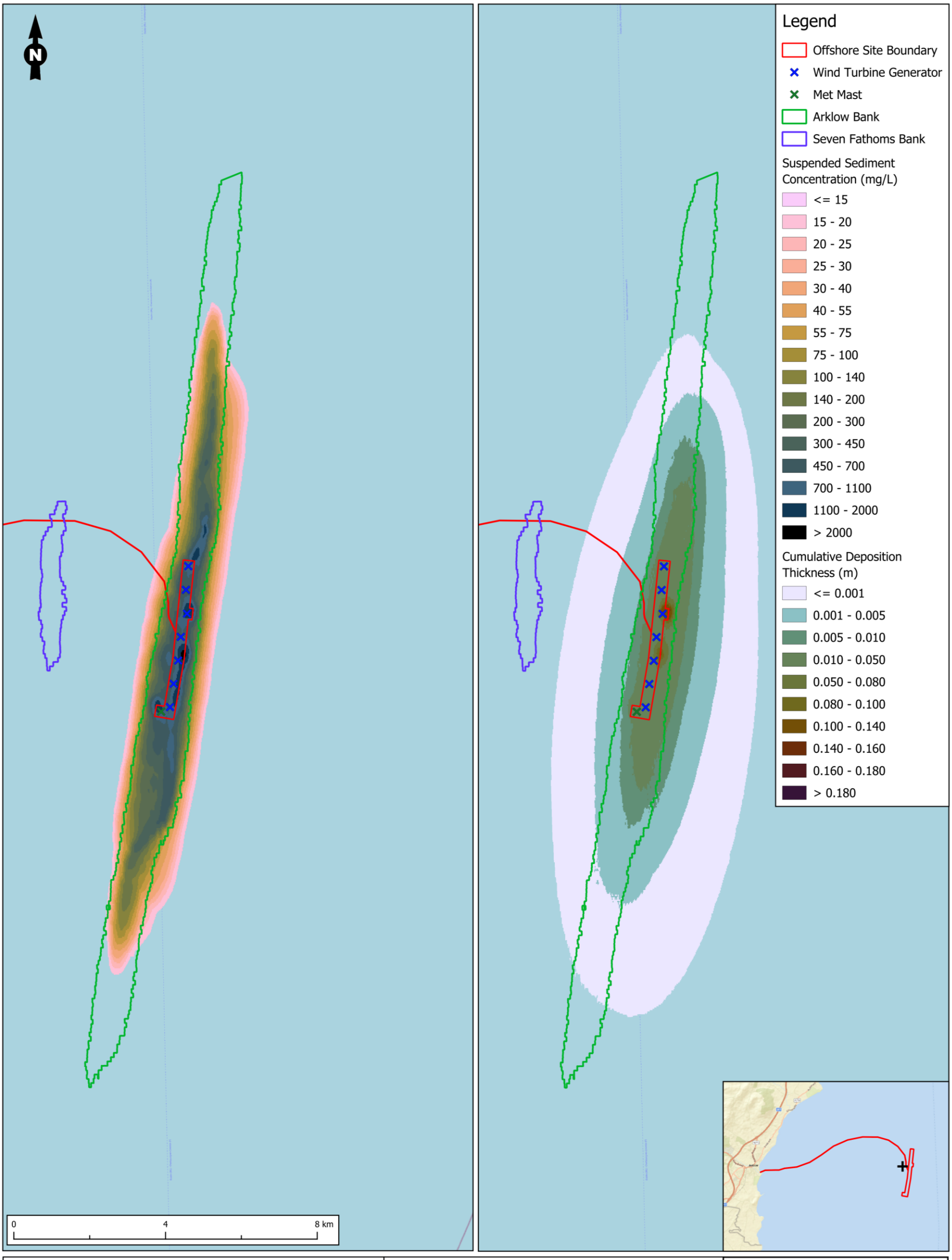


Figure 11: Sediment Transport Modelling – Scenario 9 timeseries of maximum SSC across the domain

3.3.4 Summary

3.3.4.1 **Figure 12** illustrates the maximum, though transient, spatial extent of SSCs and associated depositional footprint generated over the full dredging campaign during the Proposed Works Offshore, incorporating results from all modelled scenarios (Scenario 1 to Scenario 9).



1620011606-002-VENT-007

Figure Title: Maximum SSC and depositional thickness across all dredging activities	Project No./Filery ID: 1620011606-002 / REH2024N01993		Client: Arklow Energy Limited
Project Name: ABWP Phase I Decommissioning	Date: May 2026	Prepared By: AS	RAMBOLL
	Scale: 1:90,000 @A3	Figure No.: 12	Revision: 2.0

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Coordinate System: IRENET95 Irish Transverse Mercator. Projection: Transverse Mercator. Datum: IRENET95.

Figure 12: Maximum SSC and depositional thickness across all dredging activities

4 SEDIMENT DISPERSION ASSOCIATED WITH GRAPNEL RUN ACTIVITIES

4.1.1.1 Removal of the offshore export cable and inter-array cables may require the use of grapnel runs to locate and recover sections of the cable where burial has been achieved through natural seabed processes. Grapnel runs are characterised by shallow, linear seabed contact and result in the temporary mobilisation of a limited volume of surface sediment immediately adjacent to the cable alignment.

4.1.1.2 Given the localised and short-duration nature of grapnel disturbance, a screening-level, semi-qualitative assessment was undertaken to estimate the likely spatial extent of sediment redistribution associated with these activities. The purpose of the assessment is to define a conservative, physically-based sediment influence zone along the export cable route, rather than to predict suspended sediment concentrations or detailed plume dynamics.

4.2 Methodological approach

4.2.1.1 Sediment dispersion was assessed using a horizontal settling length-scale approach, which estimates the maximum horizontal distance that sediment particles may travel under tidal advection during the time taken to settle back to the seabed following brief resuspension. The resulting horizontal dispersion length-scale was applied spatially as a buffer along the export cable route to define an Indicative Qualitative Sediment Influence Zone associated with grapnel run activities. This approach is proportionate to the scale of the activity and is consistent with screening-level assessments commonly adopted for cable intervention works where sediment release volumes are small and highly localised.

4.2.1.2 The horizontal dispersion length-scale (L) was calculated as:

$$L = U_{DA} \times \frac{H}{w_s} \quad \textbf{(2)}$$

4.2.1.3 where:

- U_{DA} is the depth-averaged peak current speed (m s^{-1}),
- H is the resuspension height (m), and
- w_s is the particle settling velocity (m s^{-1}).

4.2.1.4 Particle Size Analysis (PSA) data along the export cable route (Svitzer, 2002; Aquatic Services Unit, 2011, 2022) indicate that seabed sediments are strongly sand-dominated, with only a minor contribution from fine material. The most conservative particle size distribution along the route comprises approximately:

- 94.31% sand;
- 4.97% gravel; and,
- 0.74% mud (silt and clay).

4.2.1.5 The location of the selected PSA data point is shown in **Figure 13**. Given this composition, sediment behaviour is controlled by the sand fraction, and cohesive plume behaviour associated with fine sediments is not expected to be a controlling process. Settling velocities adopted for the assessment are consistent with those used elsewhere in this report (**Section 3.2**) and are summarised below:

- Fine to medium sand (median grain size 0.33 mm): settling velocity = 0.042 m s^{-1};
- Coarse sand and gravel: settling Velocity = 0.1 m s^{-1}; and
- Clay and silt (minor fraction): settling velocity = 0.001 m s^{-1}.

4.2.1.6 Hydrodynamic forcing was characterised using depth-averaged tidal current data, with the maximum peak current speed along the export cable route identified as 2.0 m s^{-1}.

Depth-averaged velocities were retained for this assessment as a conservative proxy for near-bed currents. Grapnel runs involve shallow seabed contact and do not involve excavation or sustained release of sediment. A conservative resuspension height of 1 m was assumed to represent temporary lifting of sediment into the lower water column during grapnel interaction.

4.3 Results

4.3.1.1 The settling length scale calculations indicate a maximum settling time of approximately 17 minutes and a corresponding horizontal dispersion distance of approximately 2 km under peak tidal conditions, considering the finest sediment fraction (Clay and silt). Considering the dominant sediment grain size, Fine to medium sand, a settling duration of 24 seconds and a corresponding horizontal dispersion distance of approximately 48 m is anticipated. This distance represents the maximum horizontal extent of short-lived sediment redistribution associated with grapnel run activities along the export and inter-array cable routes. While finer sediment exhibits lower settling velocities, it constitutes less than 1% of the sediment composition and therefore does not control the spatial extent of seabed disturbance. Gravel-sized material is expected to deposit adjacent to the disturbance (≤ 20 m). The spatial extent of each respective sediment dispersion zone is presented in **Figure 13**, with a summary of the results presented in **Table 4.1**.

Table 4.1: Summary of the sediment dispersion associated with grapnel run activities along the export and inter-array cable routes.

Grain Size Class	Settling Duration (s)	Dispersion zone (m)
Coarse Sand and Gravel	10	20
Fine to Medium Sand	24	48
Clay and Silt	1000	2000

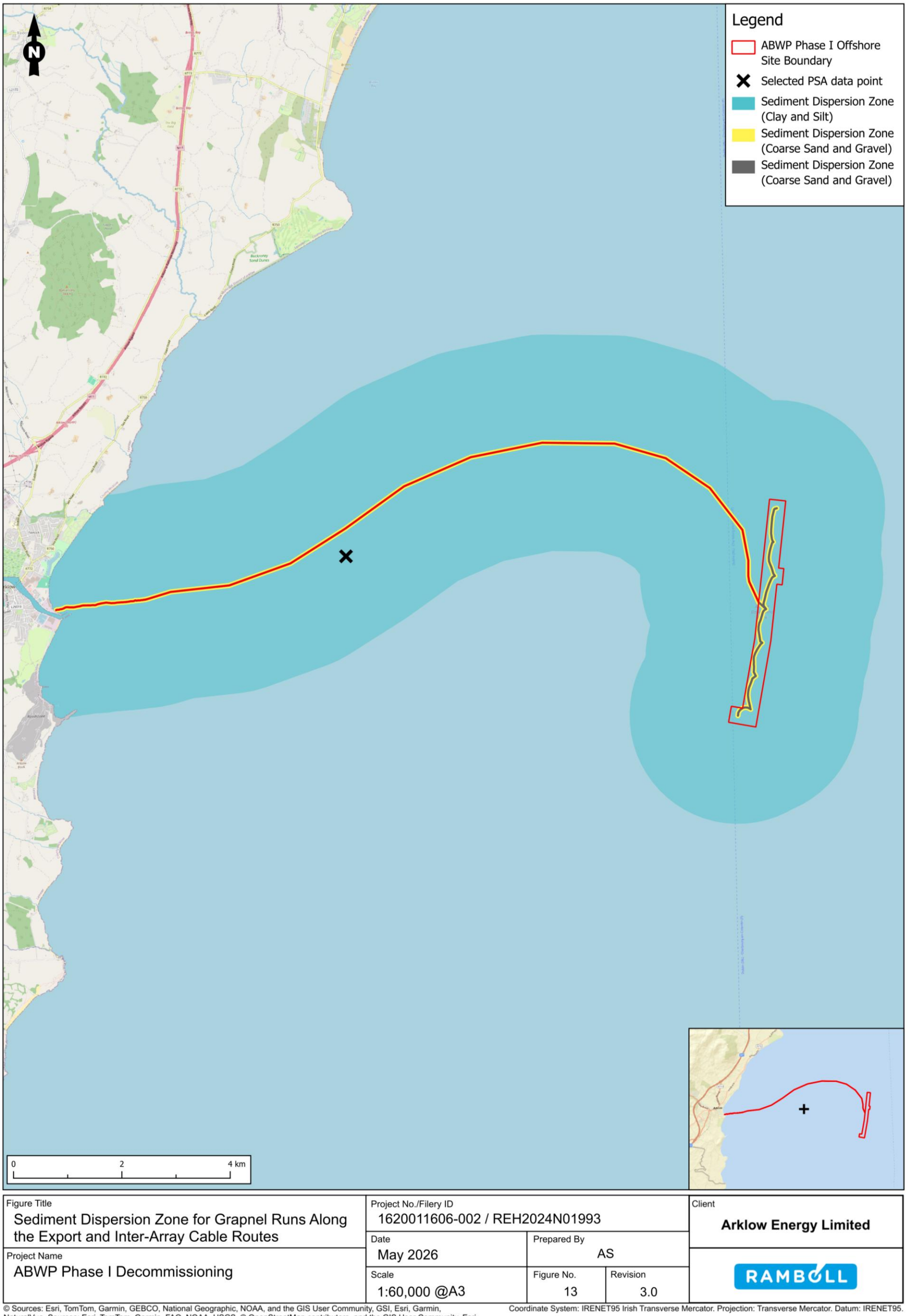


Figure 13: Sediment Dispersion Zone for Grapnel Runs Along the offshore export cable route

5 CUMULATIVE EFFECTS

5.1.1.1 In addition to the individual sediment dispersion and deposition outputs, a cumulative effects assessment was undertaken to provide an integrated view of potential sediment effects arising from multiple modelling components. The assessment focuses on identifying areas where sediment influence may overlap spatially and supports a conservative interpretation of the combined sedimentary response.

5.1.1.2 The cumulative effects assessment was scoped to include only those projects with a realistic potential for spatial and temporal overlap within the study area. On this basis, ABWP Phase II (GoBe, 2024) is the only project identified for inclusion, as no other consented or reasonably foreseeable developments within the vicinity are expected to generate overlapping sediment dispersion or deposition footprints. The maximum suspended sediment footprint and depositional thickness associated with the ABWP Phase II development is presented in **Figure 14** and **Figure 15**.

5.1.1.3 Cumulative sediment metrics were derived by spatially combining maximum raster outputs from the independent modelling workflows. Cell-wise summation was applied to generate cumulative surfaces for (i) suspended sediment metrics, and (ii) seabed sedimentation and thickness. The resulting cumulative outputs, which assume Proposed Works Offshore and ABWP Phase II activities will occur at the same time, are presented in Figure 16 and Figure 17, respectively.

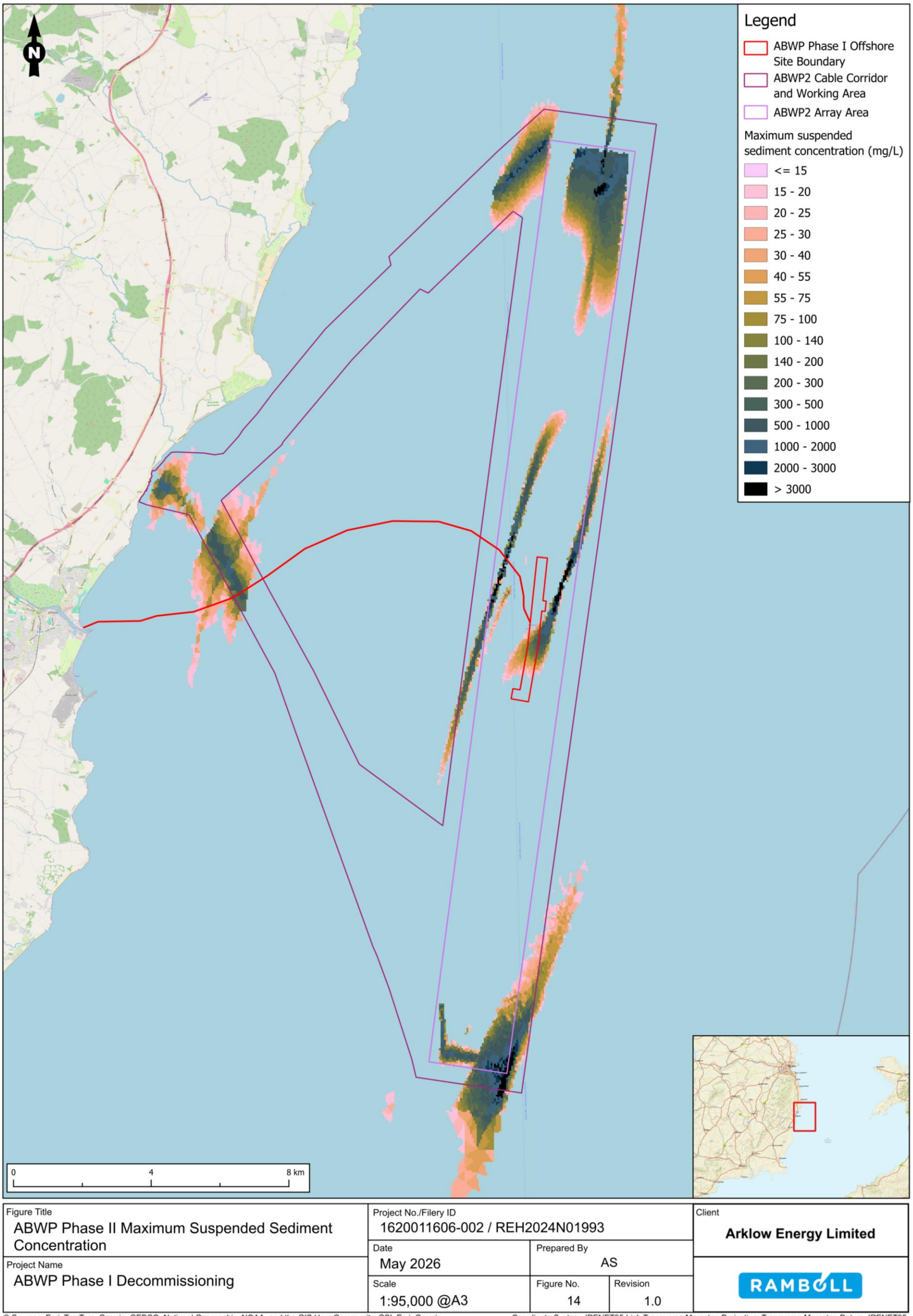


Figure 14: ABWP Phase II maximum Suspended Sediment Concentration

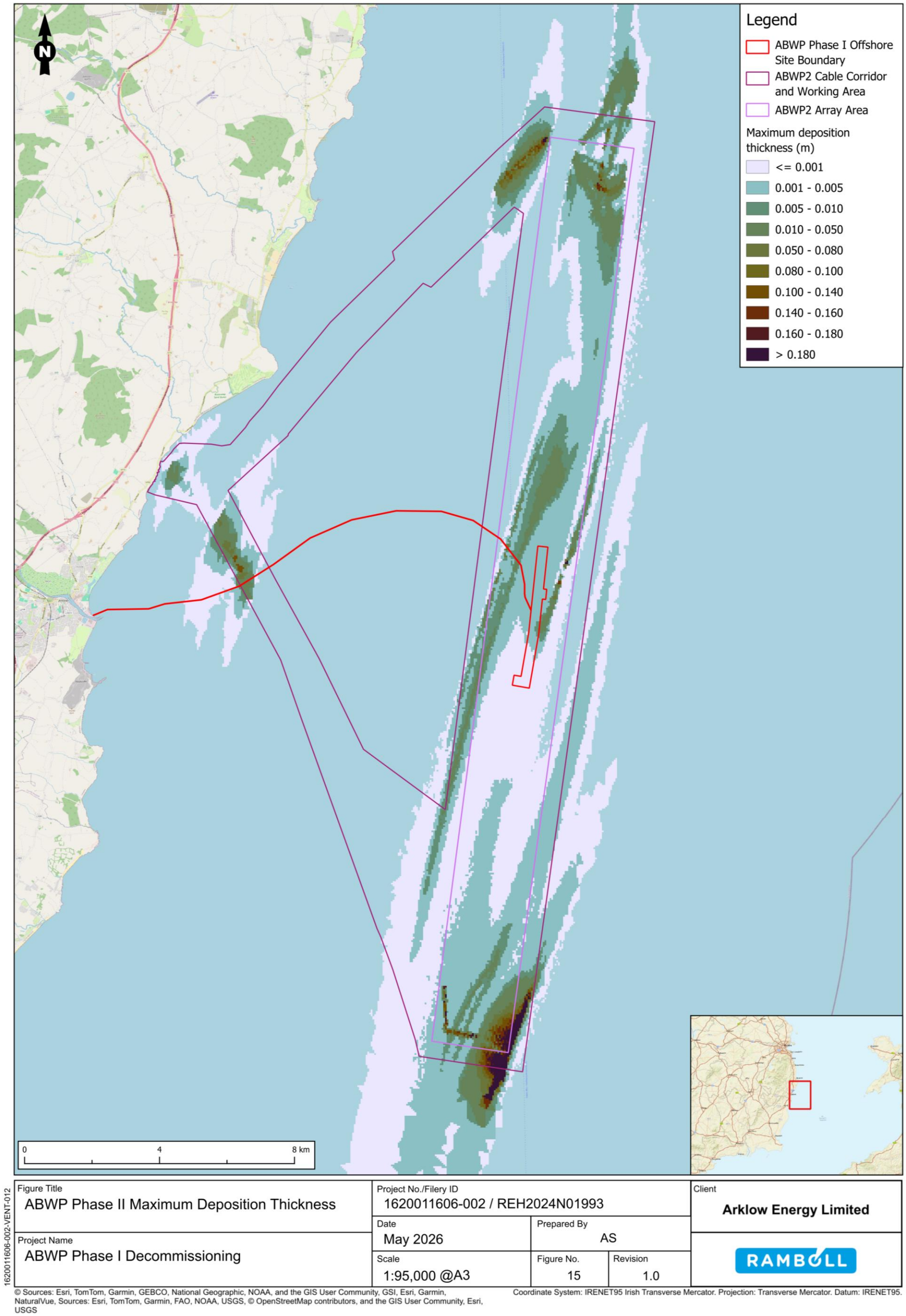


Figure 15: ABWP Phase II Maximum Deposition Thickness

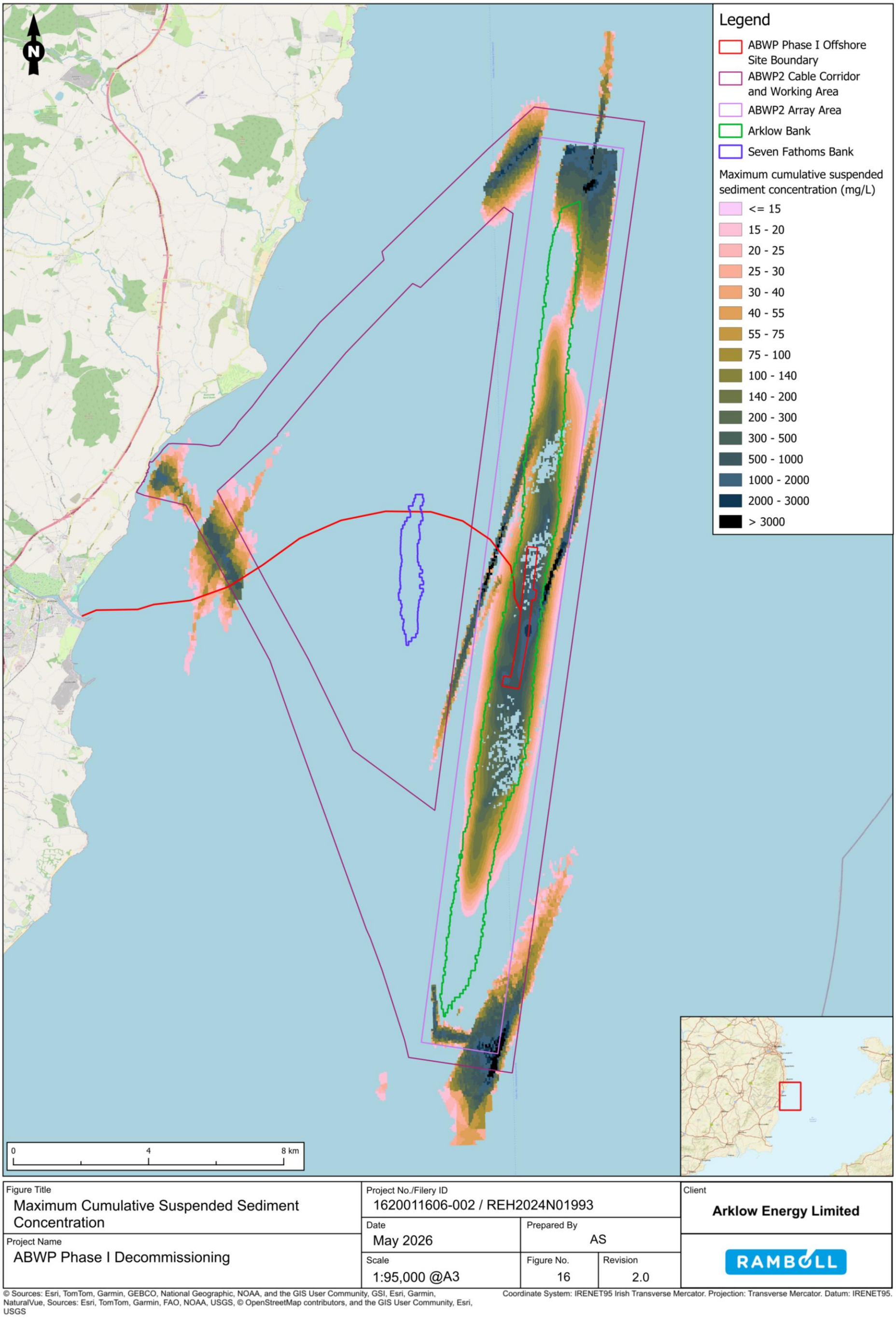


Figure 16: Maximum Cumulative Suspended Sediment Concentration

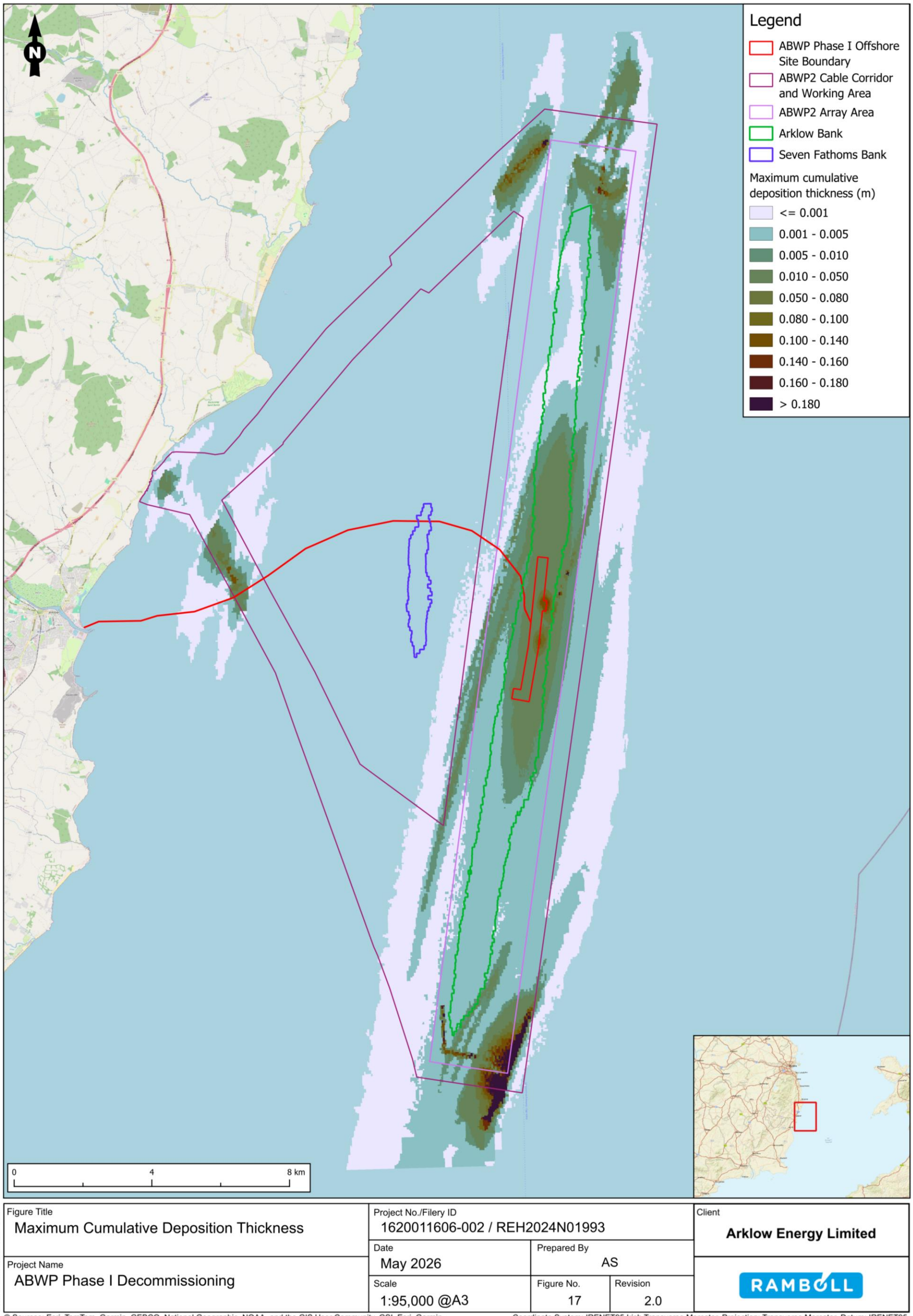


Figure 17: Maximum Cumulative Deposition Thickness

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