Wet-storage solutions for floating offshore wind in Ireland

A MaREI, ESB and SFPC Collaboration

DeepWind | 17 January 2025 | Dr. R O'Connell
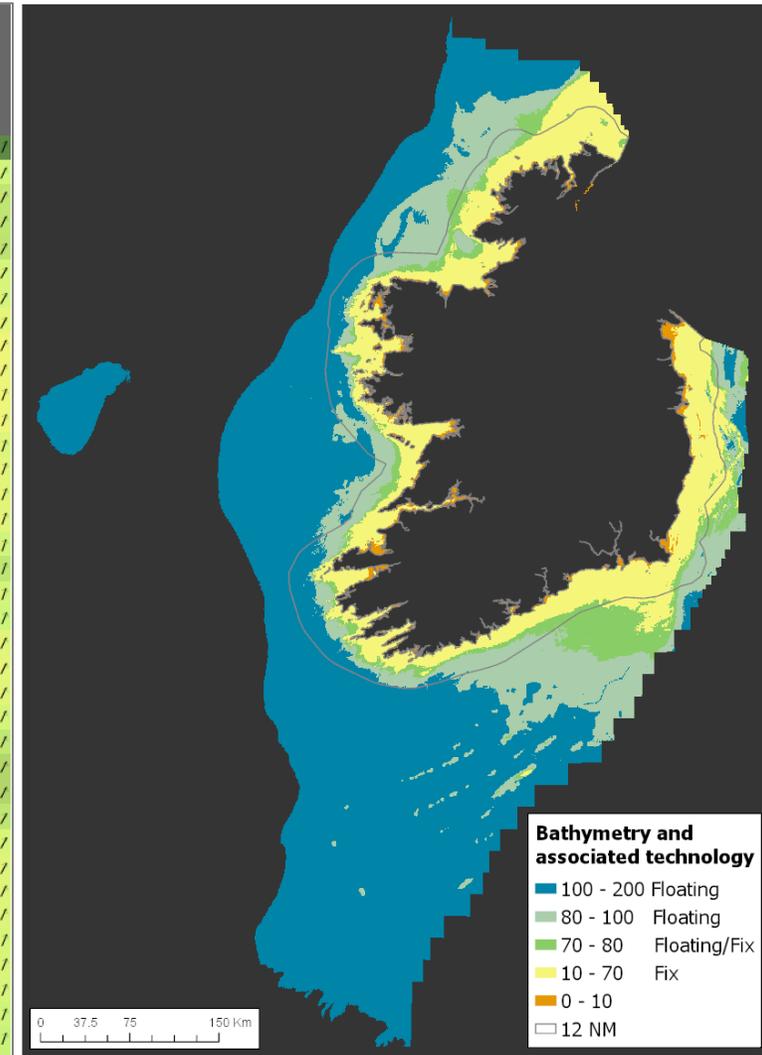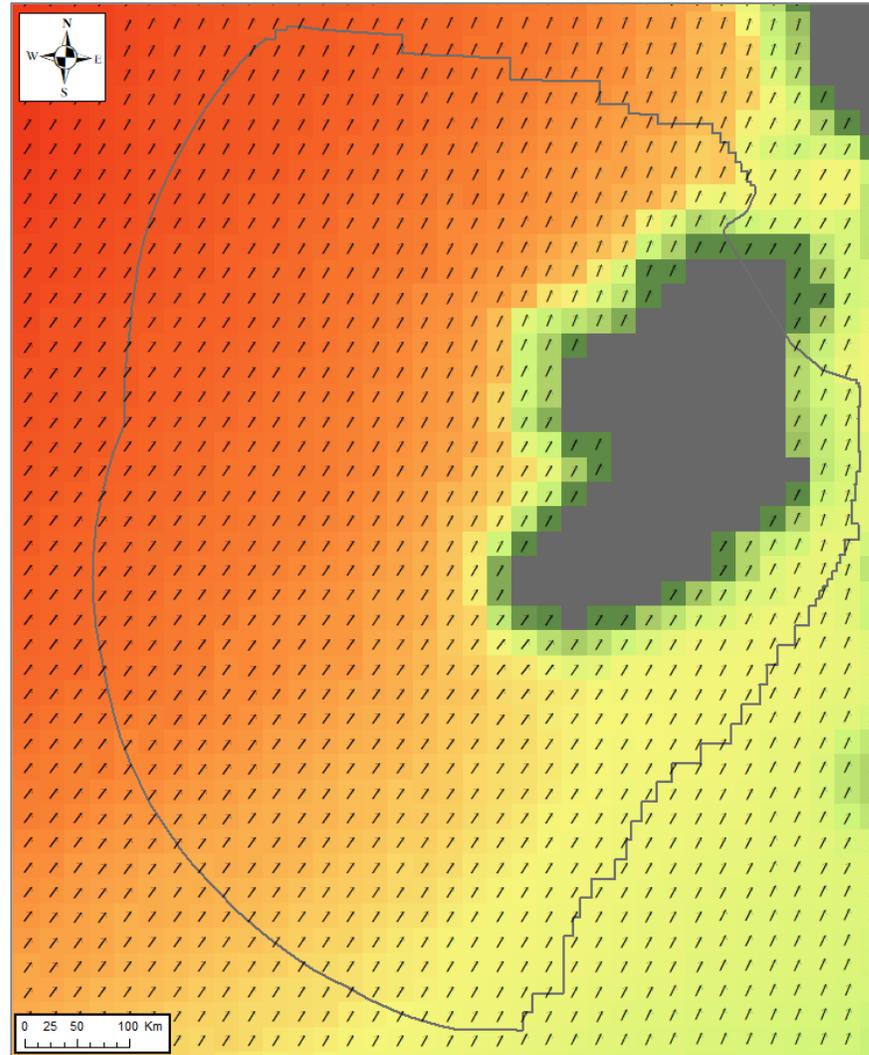
Contents

- Background and Rationale

- Data

- Methodology

- Results

- Conclusion

Ireland's Offshore Wind Opportunity

- Currently, Ireland is still reliant on fossil fuel imports. Nevertheless, recent policy shift are towards renewables. Fixed offshore wind development is now ramping up in the Irish Sea and Celtic Sea.

- The offshore wind energy potential arising from Ireland's Atlantic seaboard however is among Europe's leading renewable energy opportunities.

- With a maritime area more than seven times the size of its landmass, ideal wind conditions, and strategic location on the Atlantic Ocean's doorstep (greater depth), Floating Offshore Wind (FLOW) generation could deliver up to 30 gigawatts of energy by 2050 – six times more than current domestic electricity demand.

Bathymetry and associated technology
- 100 - 200 Floating
- 80 - 100 Floating
- 70 - 80 Floating/Fix
- 10 - 70 Fix
- 0 - 10
- 12 NM

Maps: EirWind Project (MaREI, UCC)

What is wet storage for FLOW?

For large scale FLOW projects, it is anticipated that WTGs (and their associated sub-structures) will need to be temporarily stored in port until deployment becomes possible during an appropriate weather window.

Image: TUGDOCK (https://tugdock.com/technology/)

Why is wet storage likely to be necessary for regions such as Ireland?

- The harsh wave climate off Ireland's west coast will result in narrow weather windows for FLOW installation.
- Locations with such weather restrictions will almost certainly require an additional lay-down area during installation.
- FLOWTs will need to be temporarily stored in port until deployment becomes possible during an appropriate weather window.

Image: AFLOAT (https://afloat.ie/)

Weather Window Availability (Apr to Oct)

Thresholds considered:
- Wave Height: 2m Hs
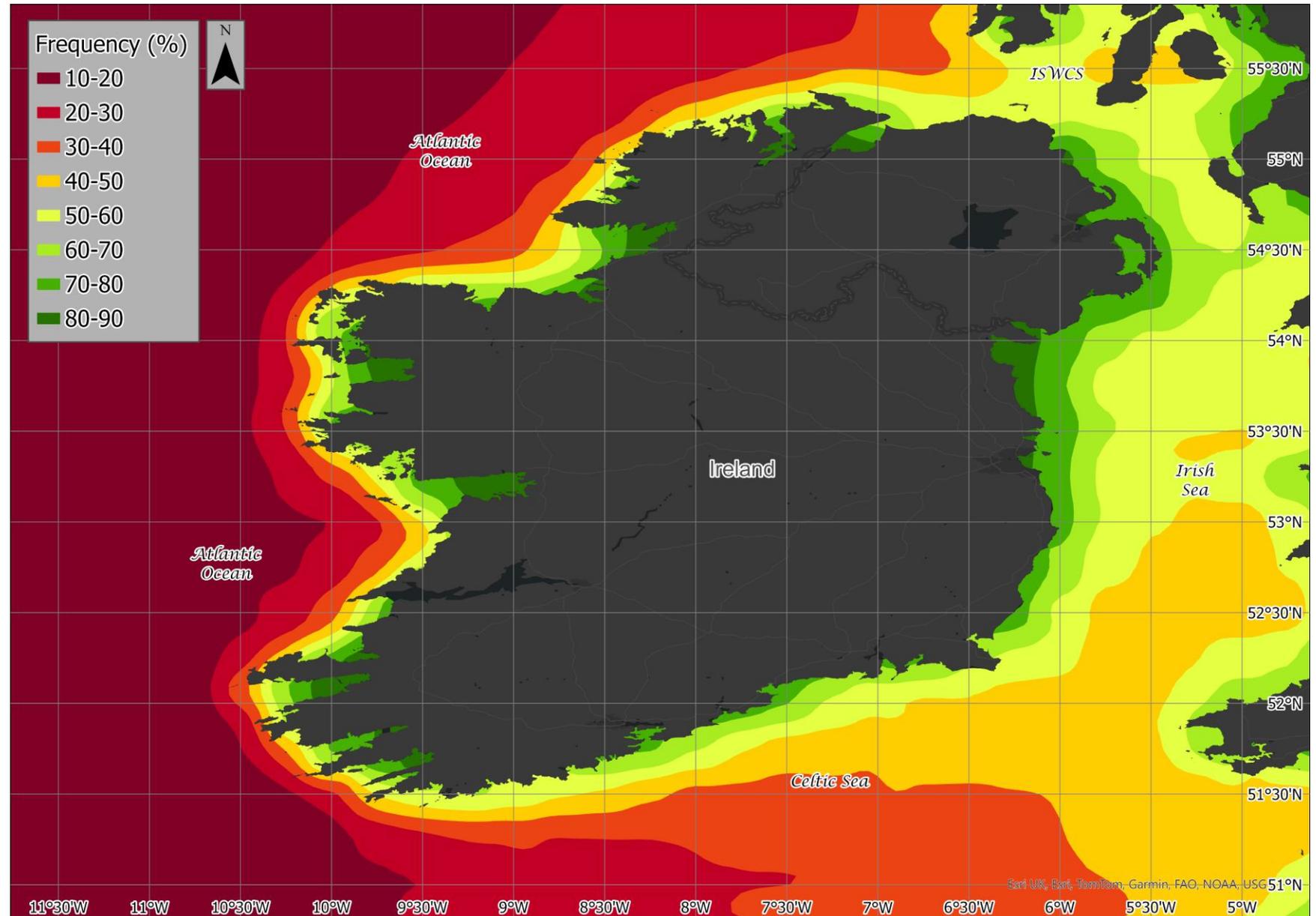- Wind Speed: 10 m/s
- Duration: <u>06 Hrs</u>
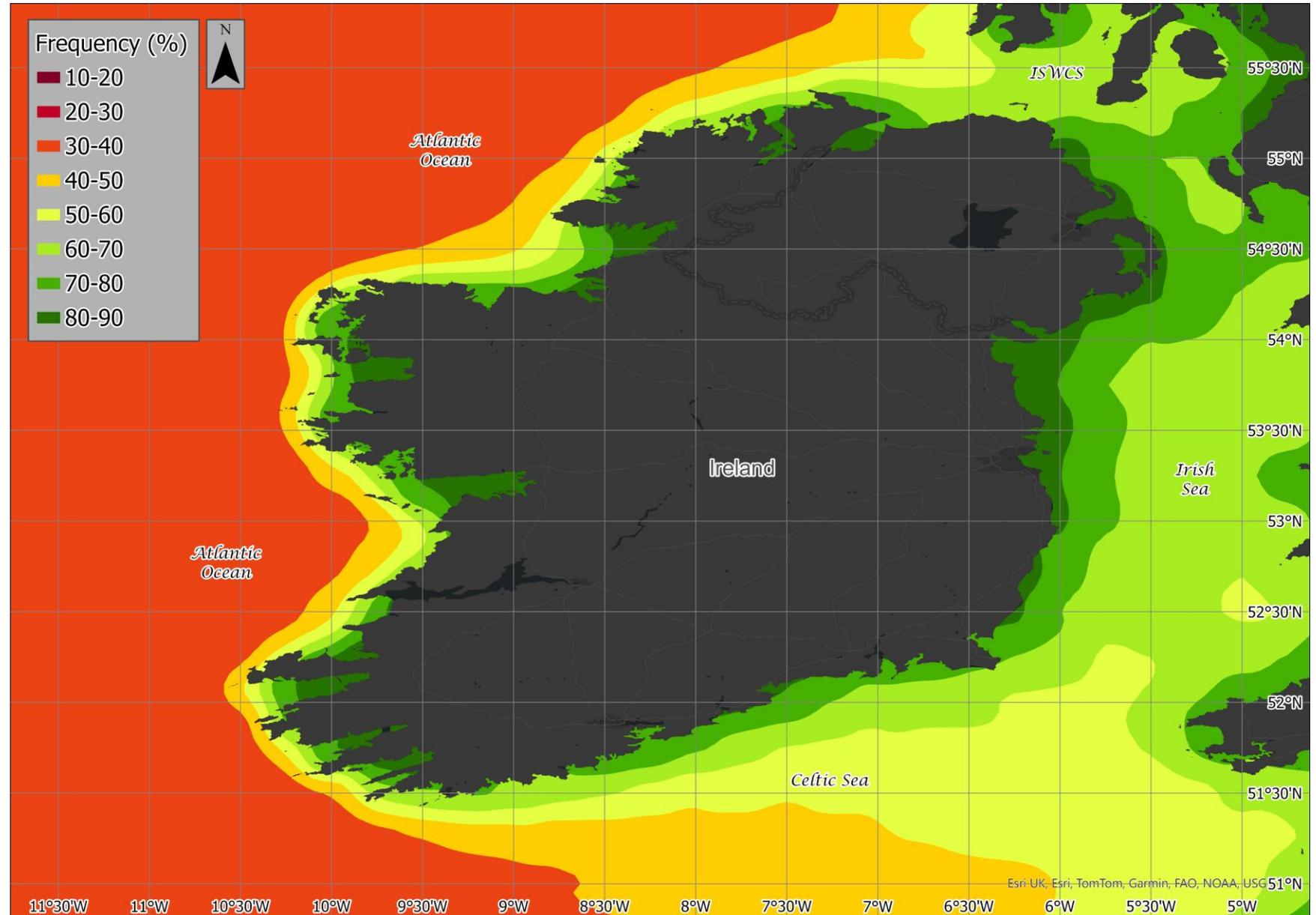
Maps generated using Python and ArcGIS Pro

Weather Window Availability (Apr to Oct)

Thresholds considered:
- Wave Height: 2m Hs
- Wind Speed: 10 m/s
- Duration: <u>12 Hrs</u>
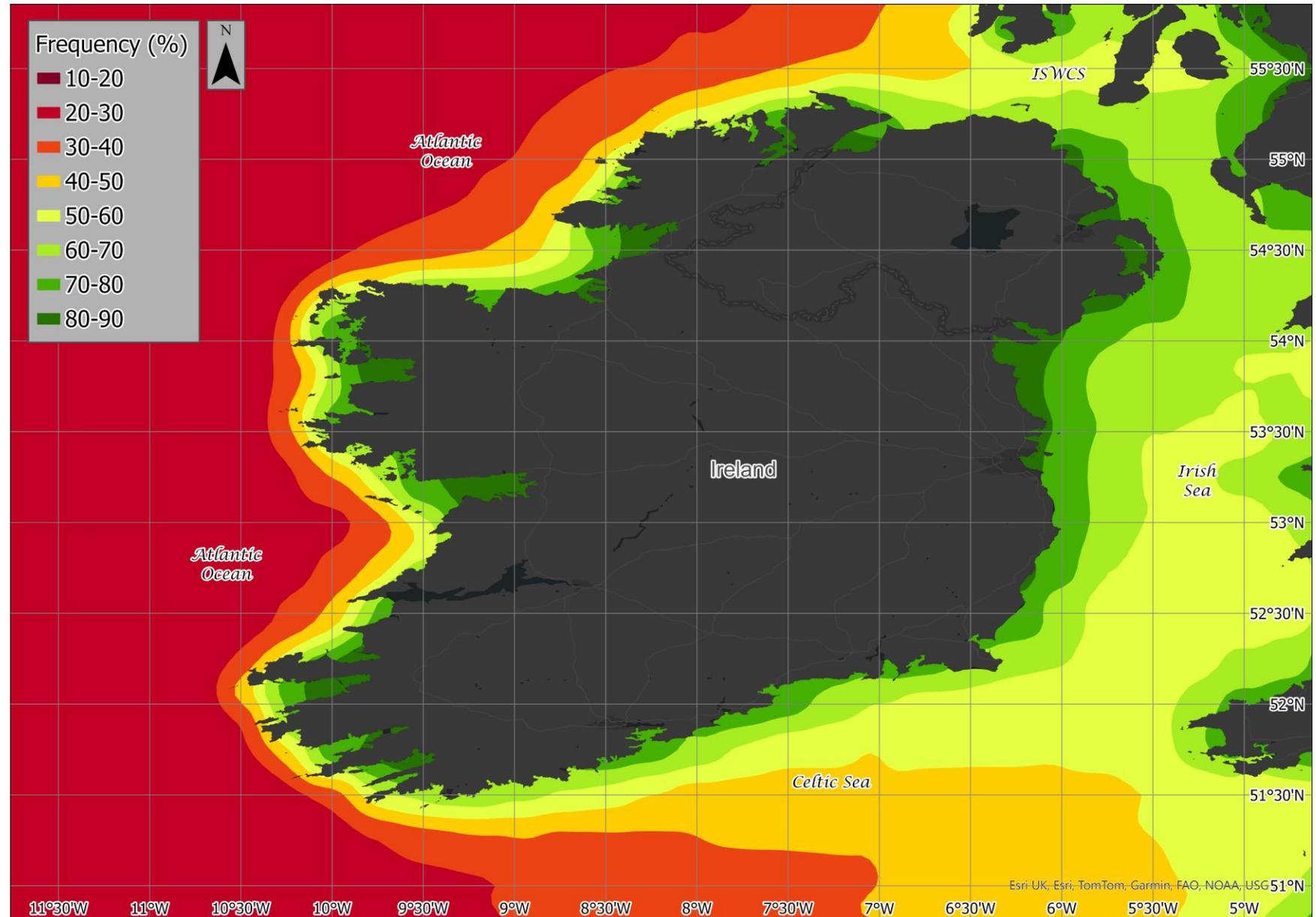
Maps generated using Python and ArcGIS Pro

Weather Window Availability (Apr to Oct)

Thresholds considered:
- Wave Height: 2m Hs
- Wind Speed: 10 m/s
- Duration: 24 Hrs

Maps generated using Python and ArcGIS Pro

Wet-Storage Project Elements

- Literature Review

- GIS Study

- Stakeholder Engagement

- Layout and Mooring Study

- Cost Analysis

Wet-Storage Project Elements

- Literature Review

- <mark>GIS Study</mark>

- Stakeholder Engagement

- Layout and Mooring Study

- Cost Analysis

Study Assumptions

- Floating wind project scale and location – 800MW off the Irish coast

- Foundation size – L: 85-125m, W: 75-120m, H: 35-50m (with catenary mooring system)

- WTG size – Max. Rotor Diameter: 270m, Max. hub height : 165m, Max. tip height: 300m

- Met-Ocean – Integrated: Hs: <2m, U: 30m/s, Current: <2m/s

- Min. depth required for wet storage – Integrated: 13m

- Seabed – ≠ to 'Rock or other substrata' (as per the Folk-5 classification system)

- Quantity in wet storage – Integrated: 5-10 units

- Area required for wet storage – Integrated: 725-1,290 ha (with 250m buffer around spread)
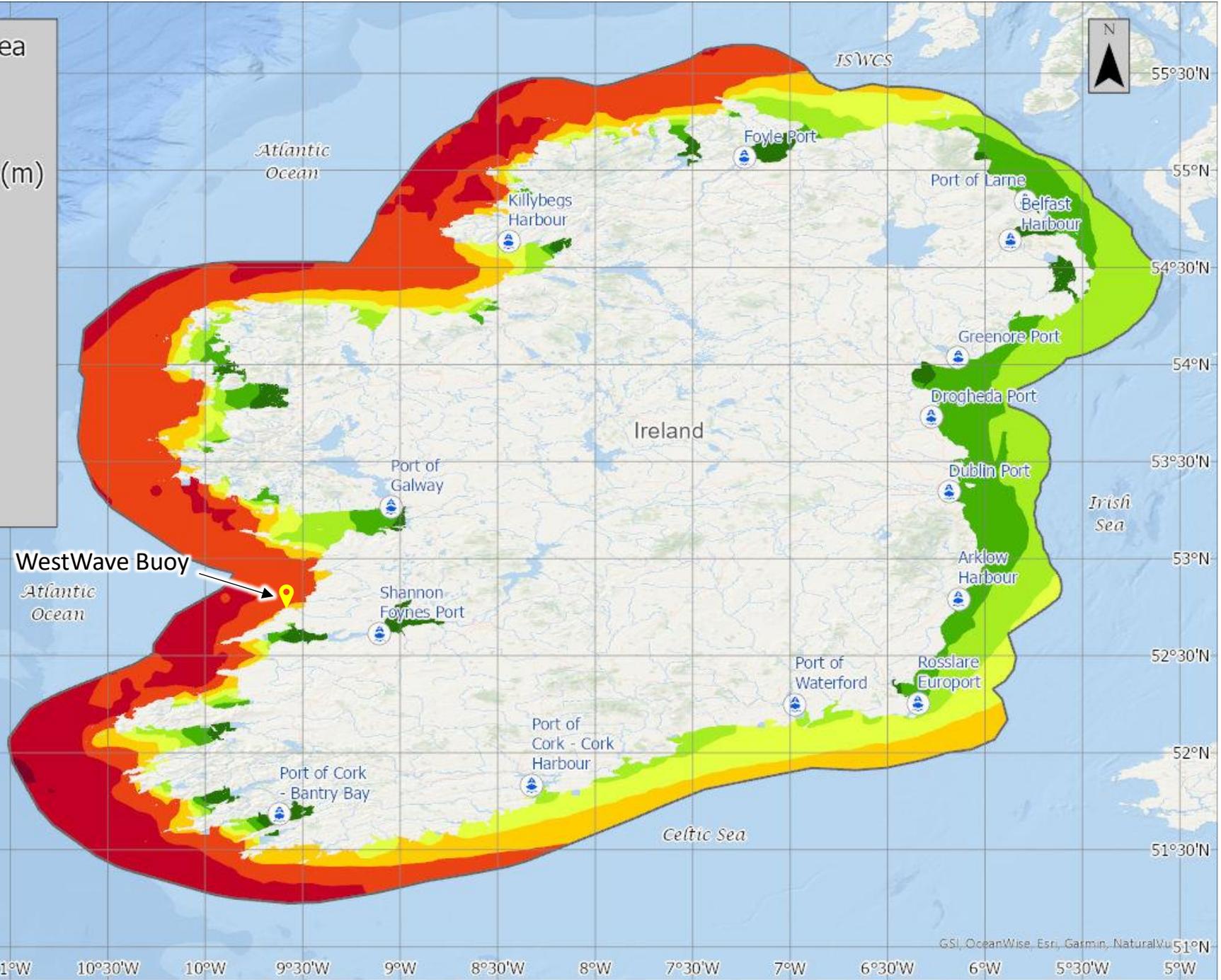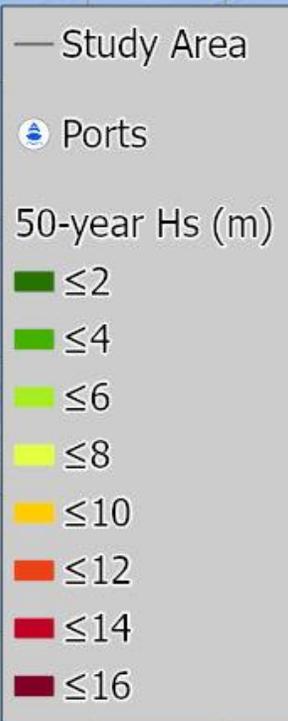
- Installation period: Apr.–Oct.
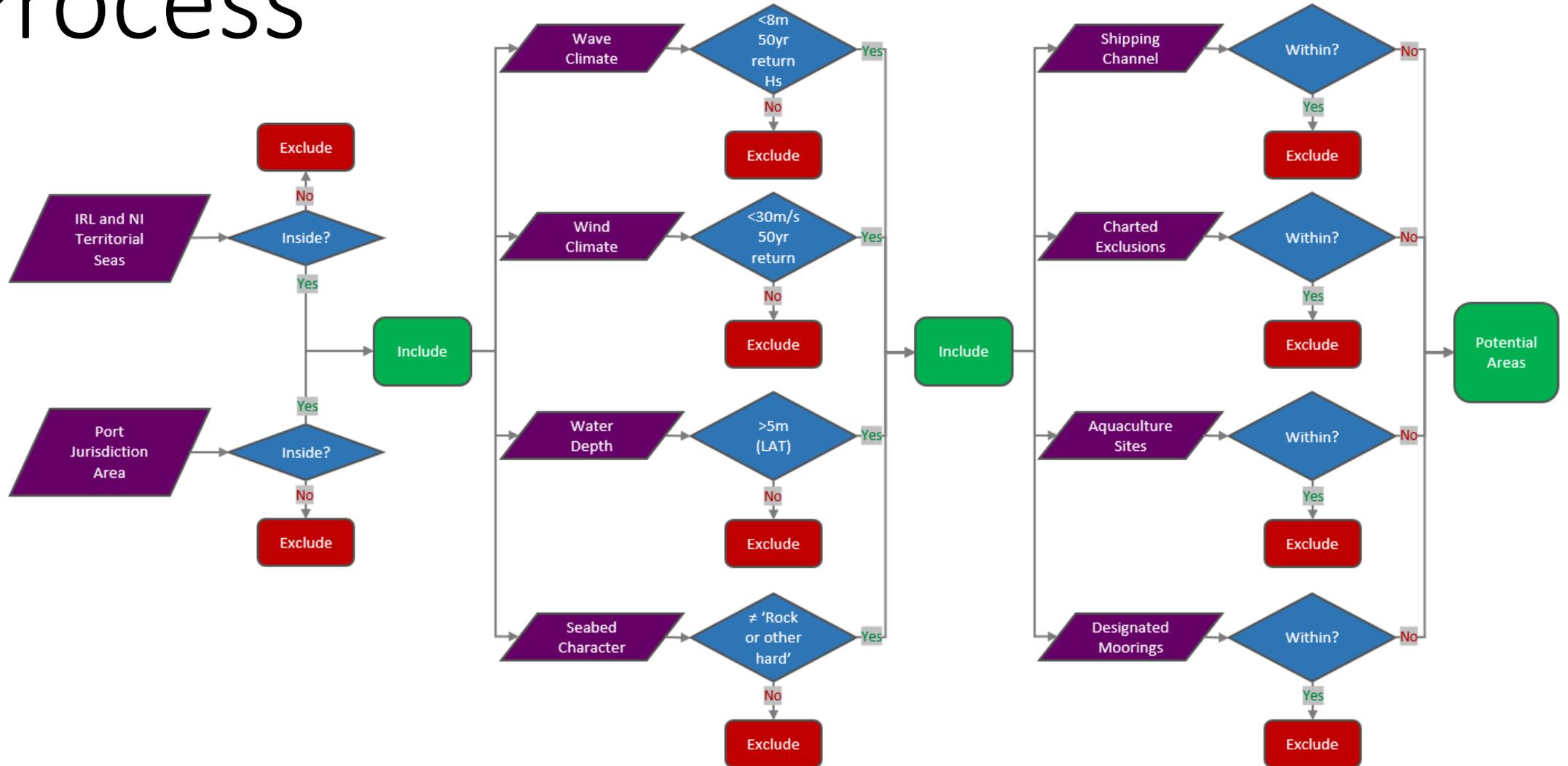
Process
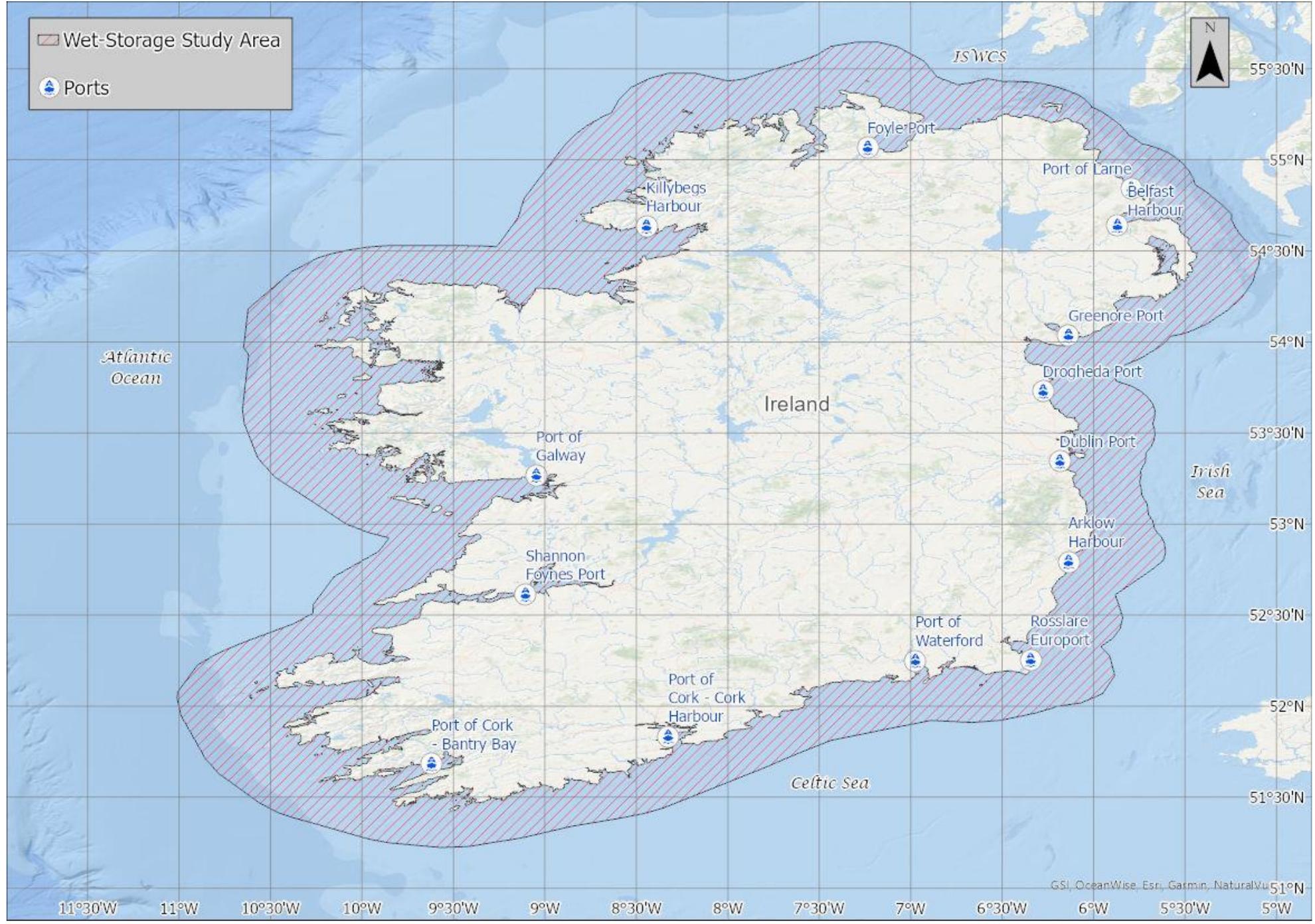
Study Area
- Irish Territorial Seas
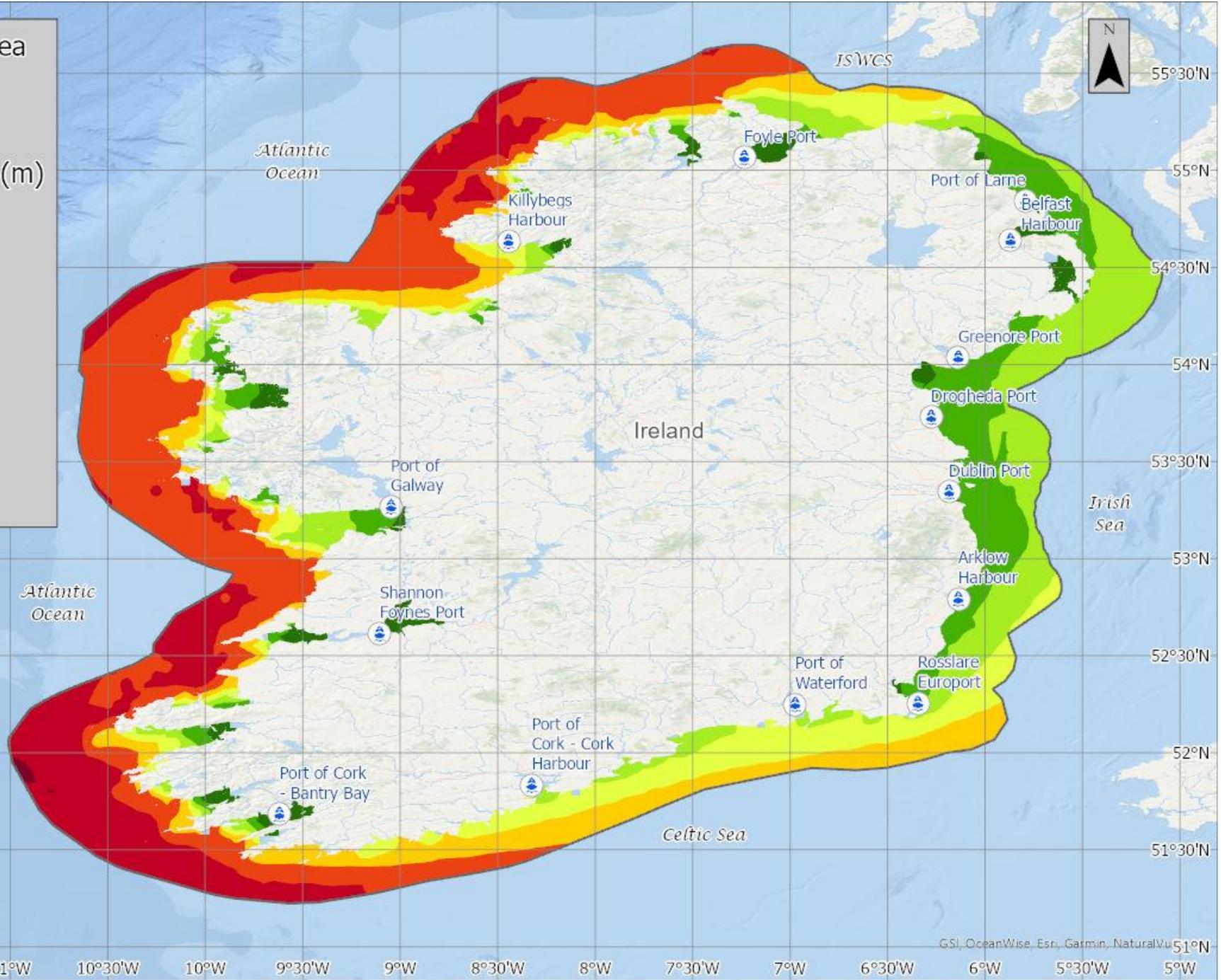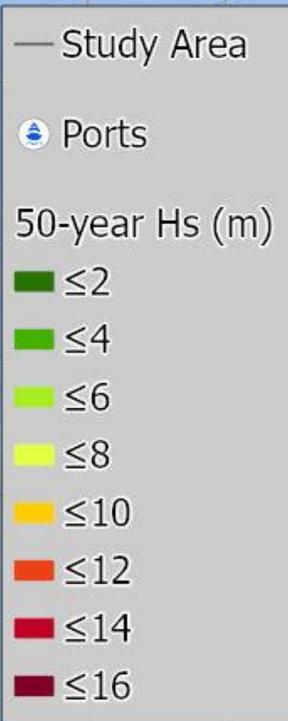
Wave Climate (CMS)
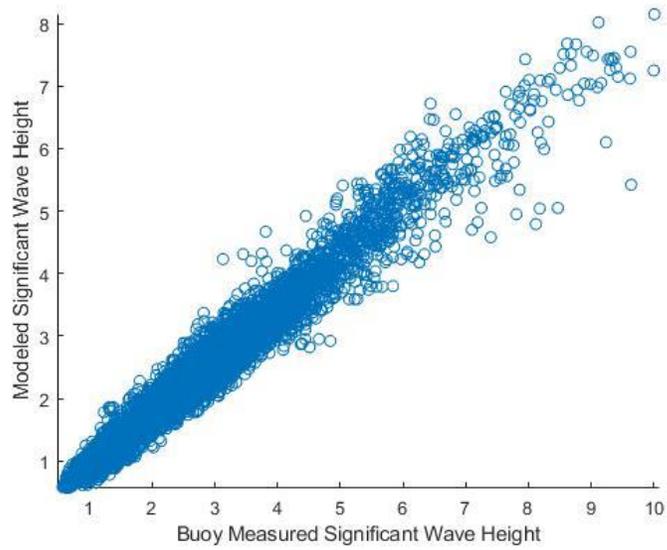- 50 year RP Hs*

*subjective

Validation
- Location and Parameters

$$Bias = \frac{1}{N}\sum_{i=1}^{N} e_i$$
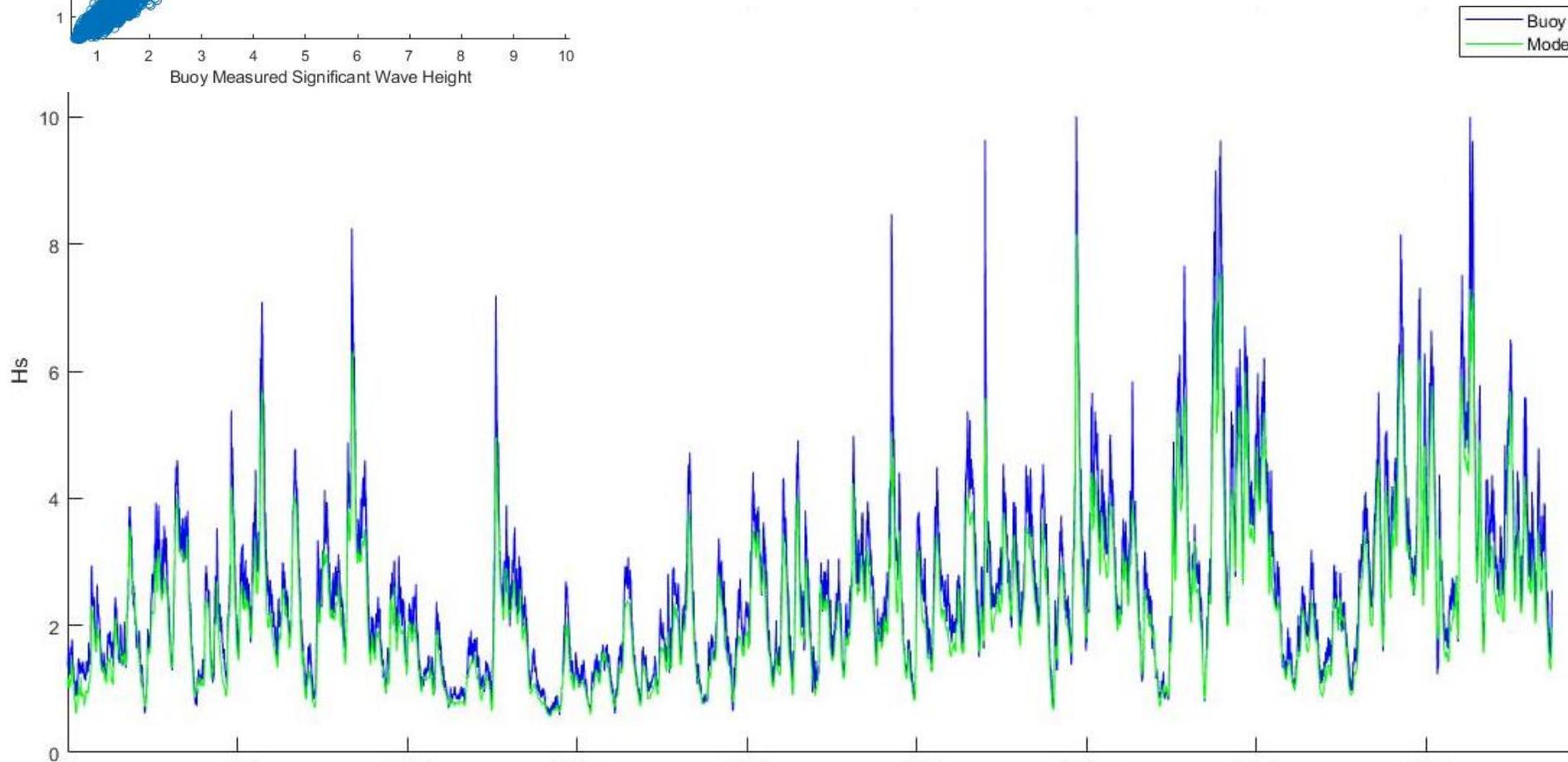
$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N} e_i{}^2}$$
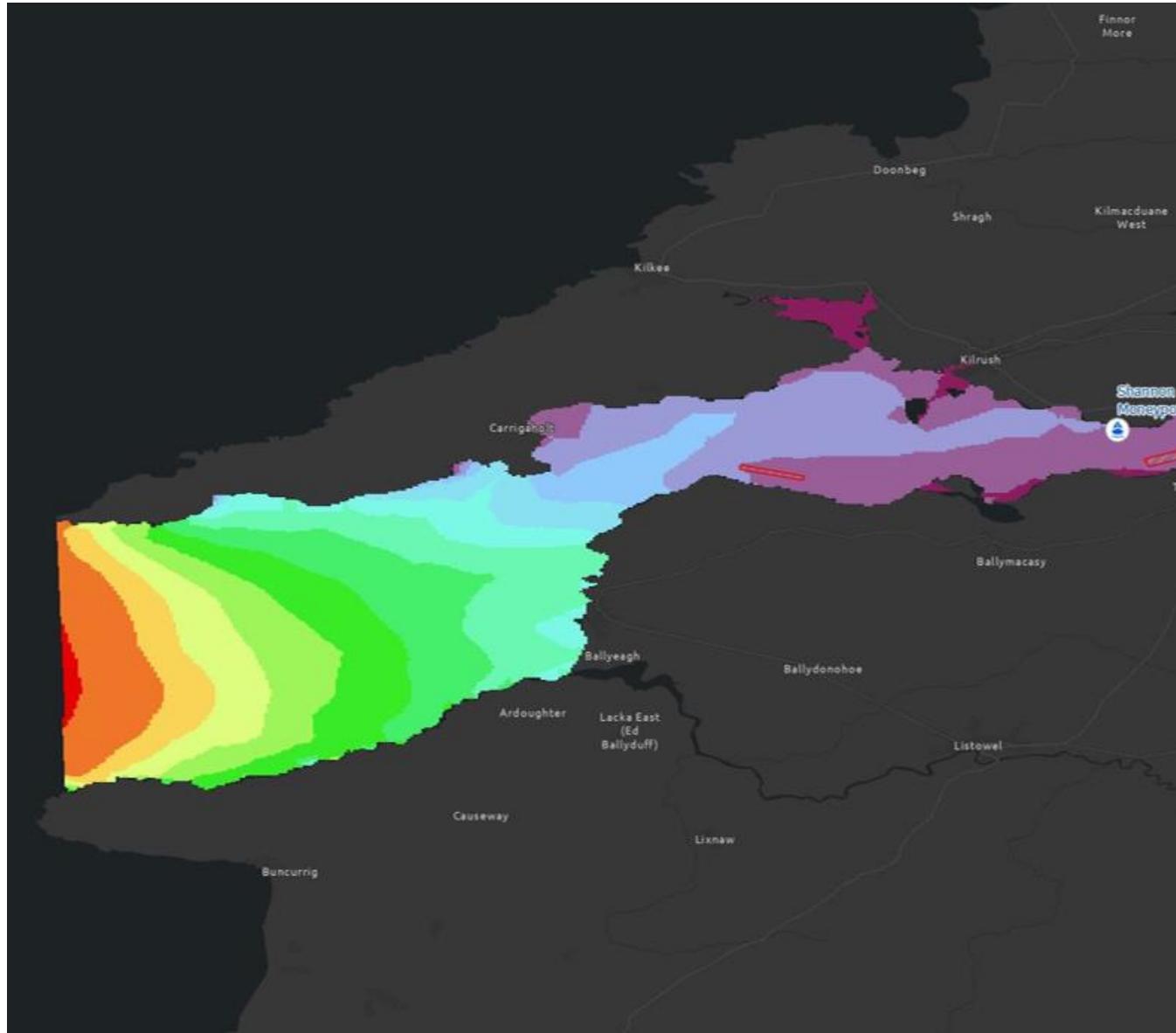
$$SI = \frac{RMSE}{U}$$

$$R = \frac{1}{\sigma_U \sigma_u (N-1)} \sum_{i=1}^{N}(U_i - U)(u_i - u)$$

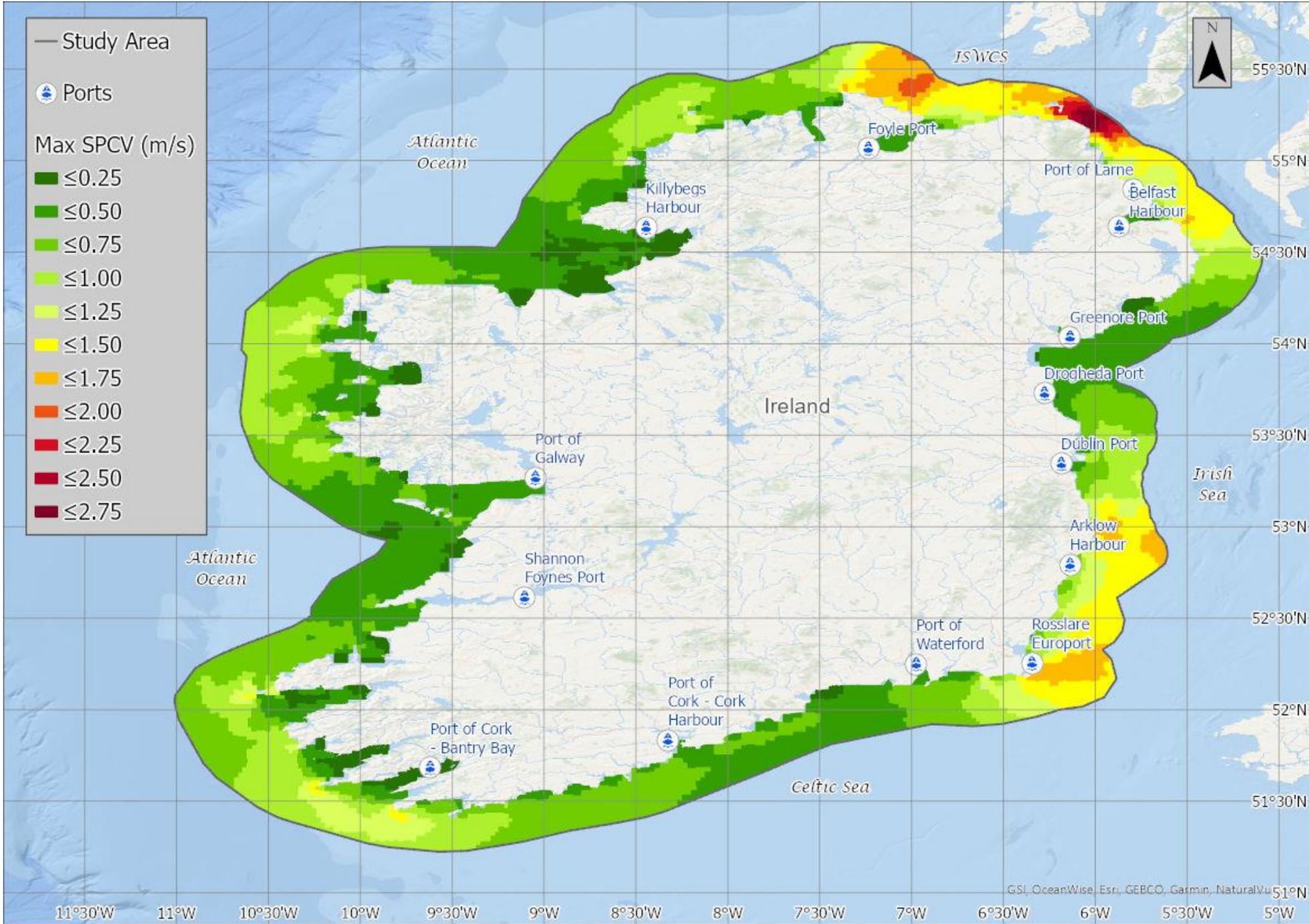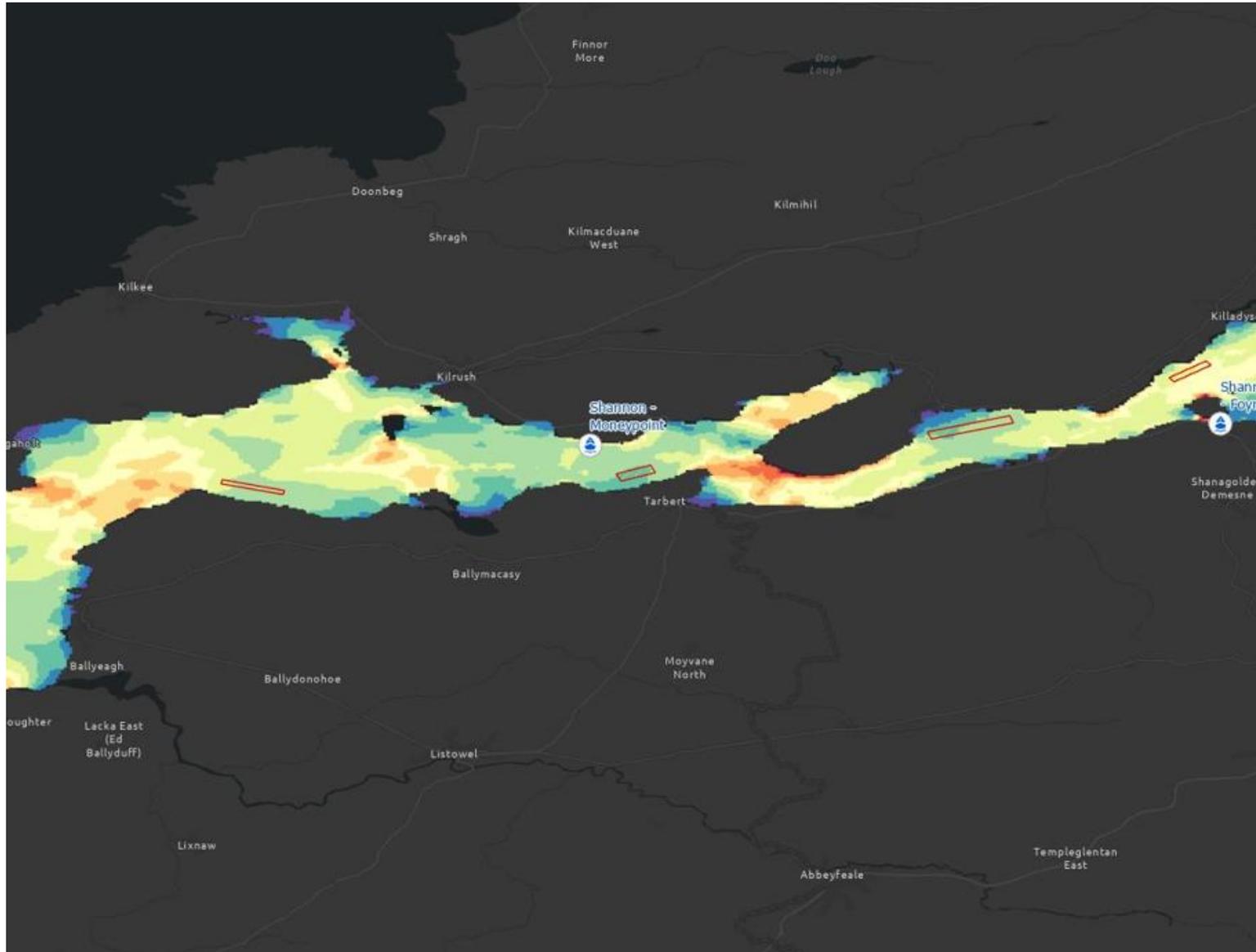| Significant Wave Height					
Buoy	$\bar{x}$ (m)	Bias (m)	RMSE	SI	R
WestWave	2.2447	0.3459	0.4773	0.2126	0.9807

Validation
- Results

Wave Climate (CMS)
- 50 year RP Hs

- Extension of wave model into some enclosed areas (i.e. ports) required use of DHI's MIKE-21 software for downscaling.
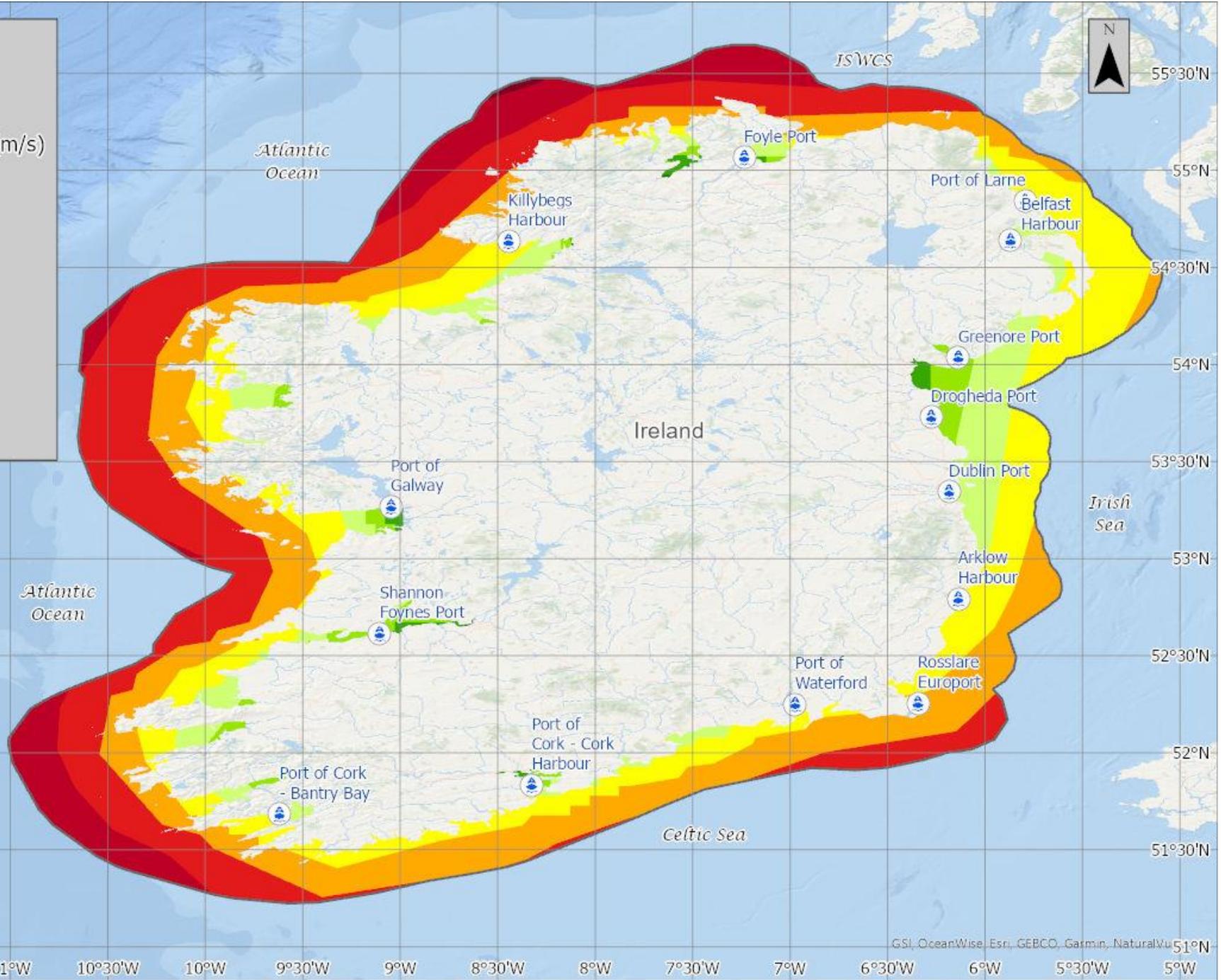
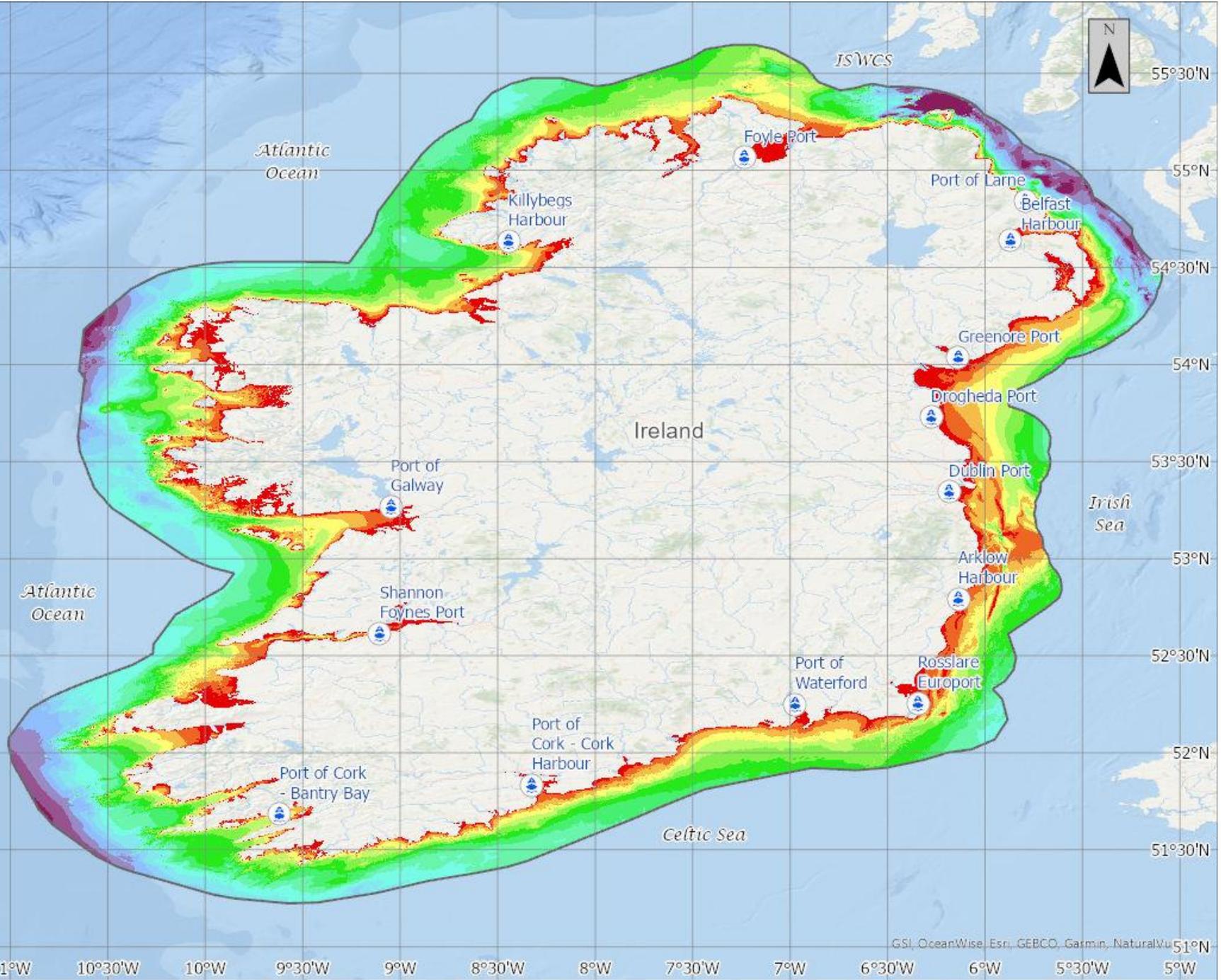Max Current Speed (Marine Institute) - Spring Peaks

Max Current Speed
(Marine Institute)
 - Spring Peaks

- Extension of current
  speed model into some
  enclosed areas (i.e.
  ports) required use of
  DHI's MIKE-21 software
  for downscaling.

Wind Climate (ERA5) - 50 year RP Wind Speed
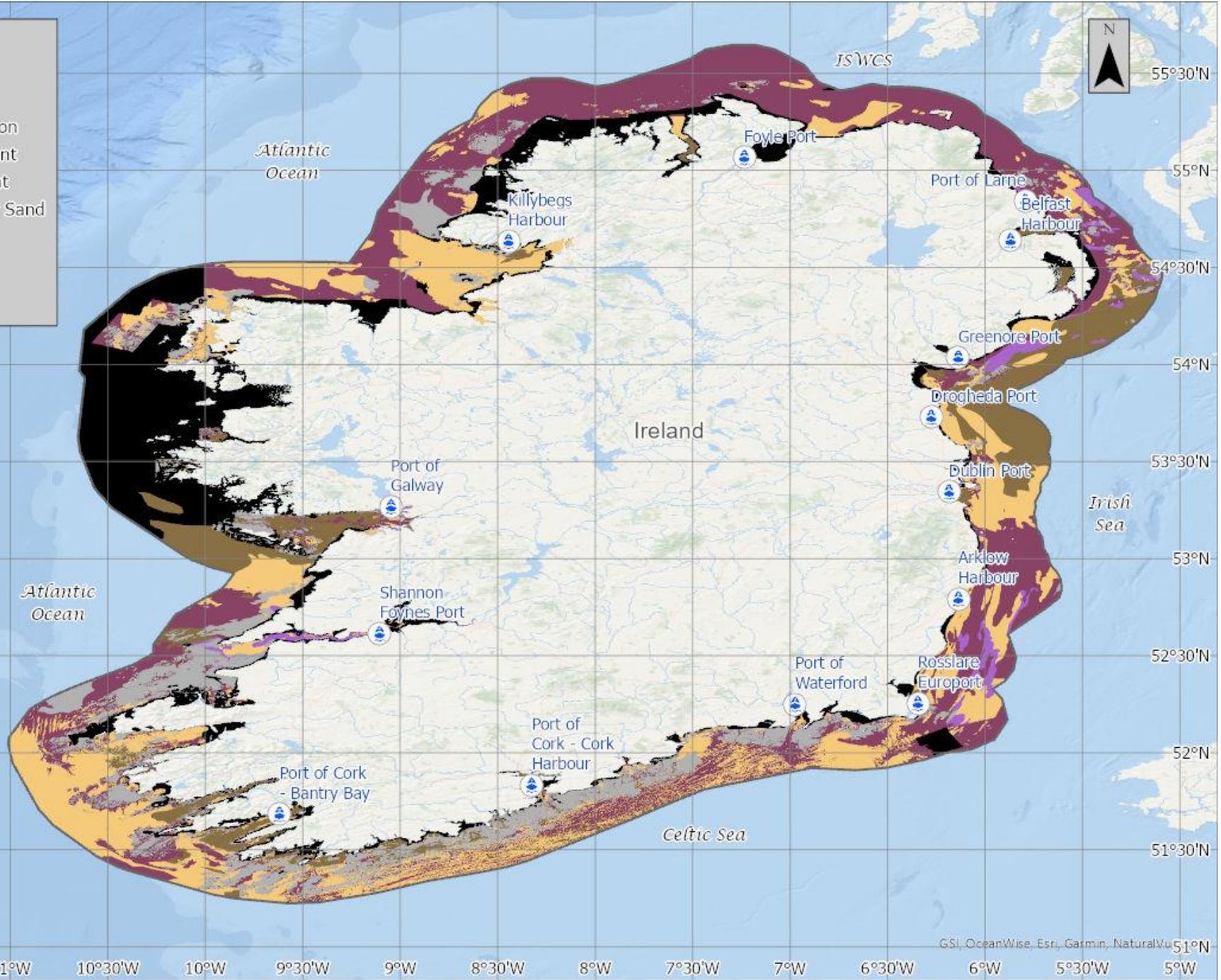
Bathymetry (m - LAT)
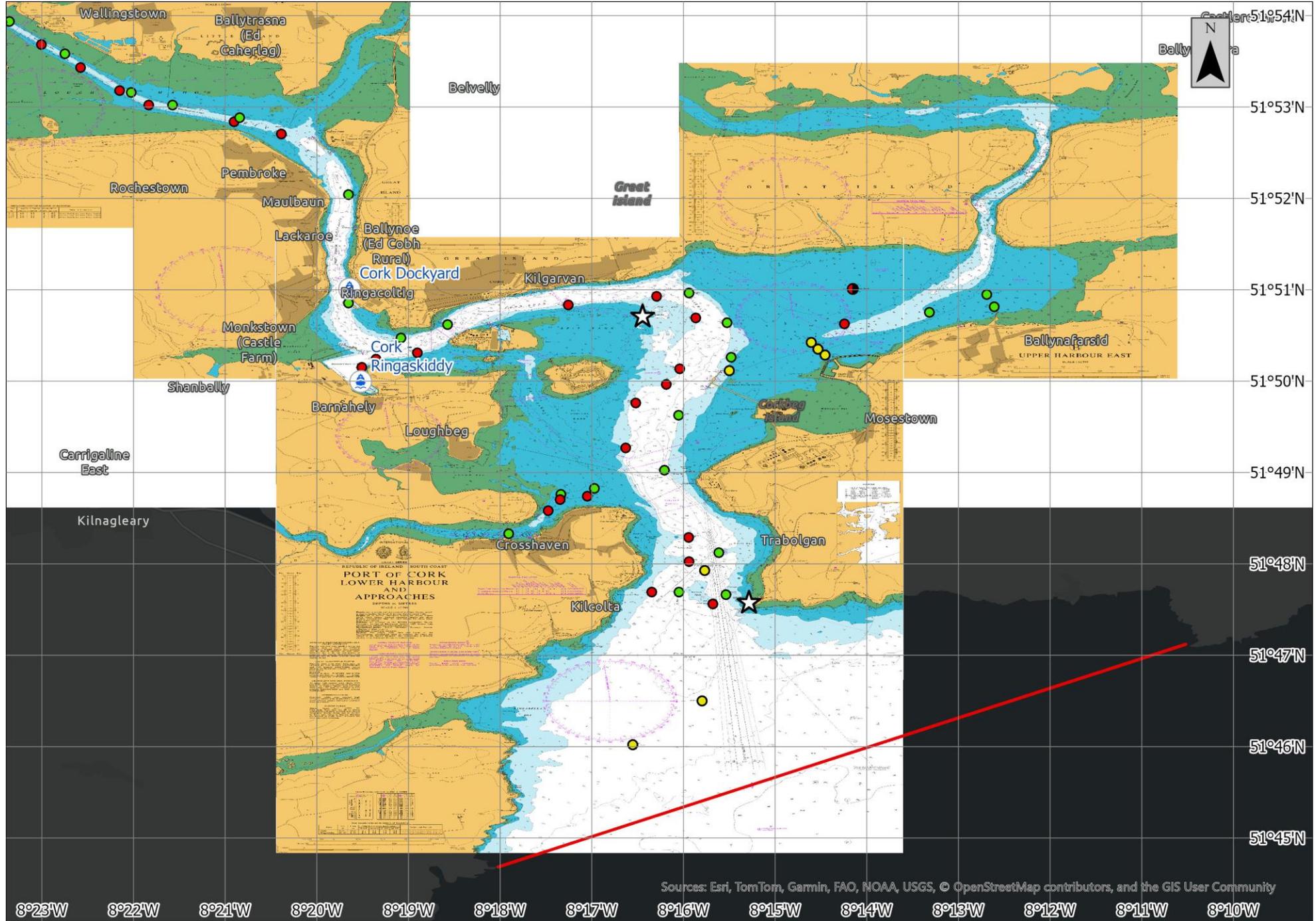
Seabed Character - Folk 5 Scale

Surface buoys have been digitised from chart data.
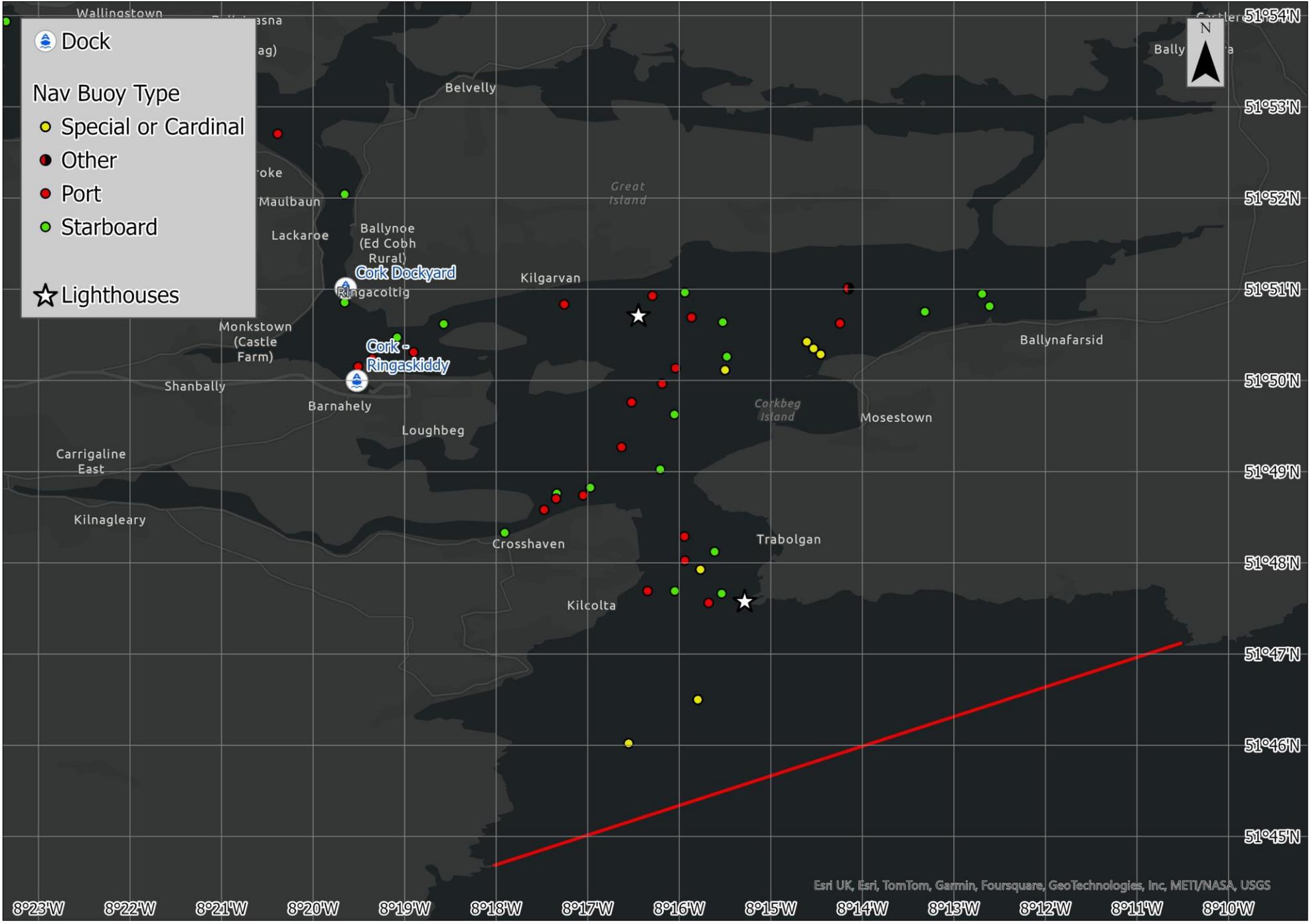
Surface buoys have been digitised from chart data.
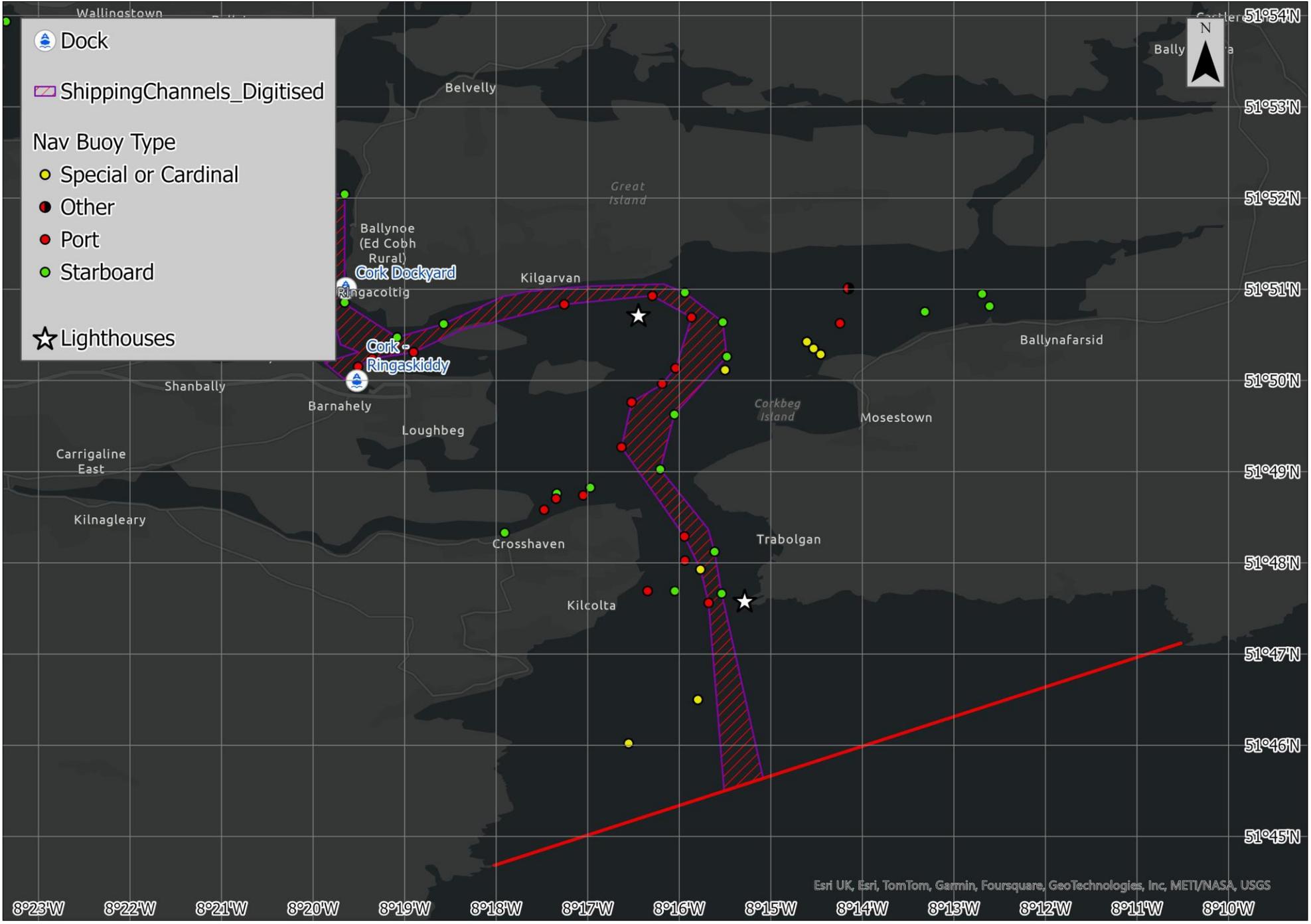
Shipping channels have been digitised from the later marker buoys.
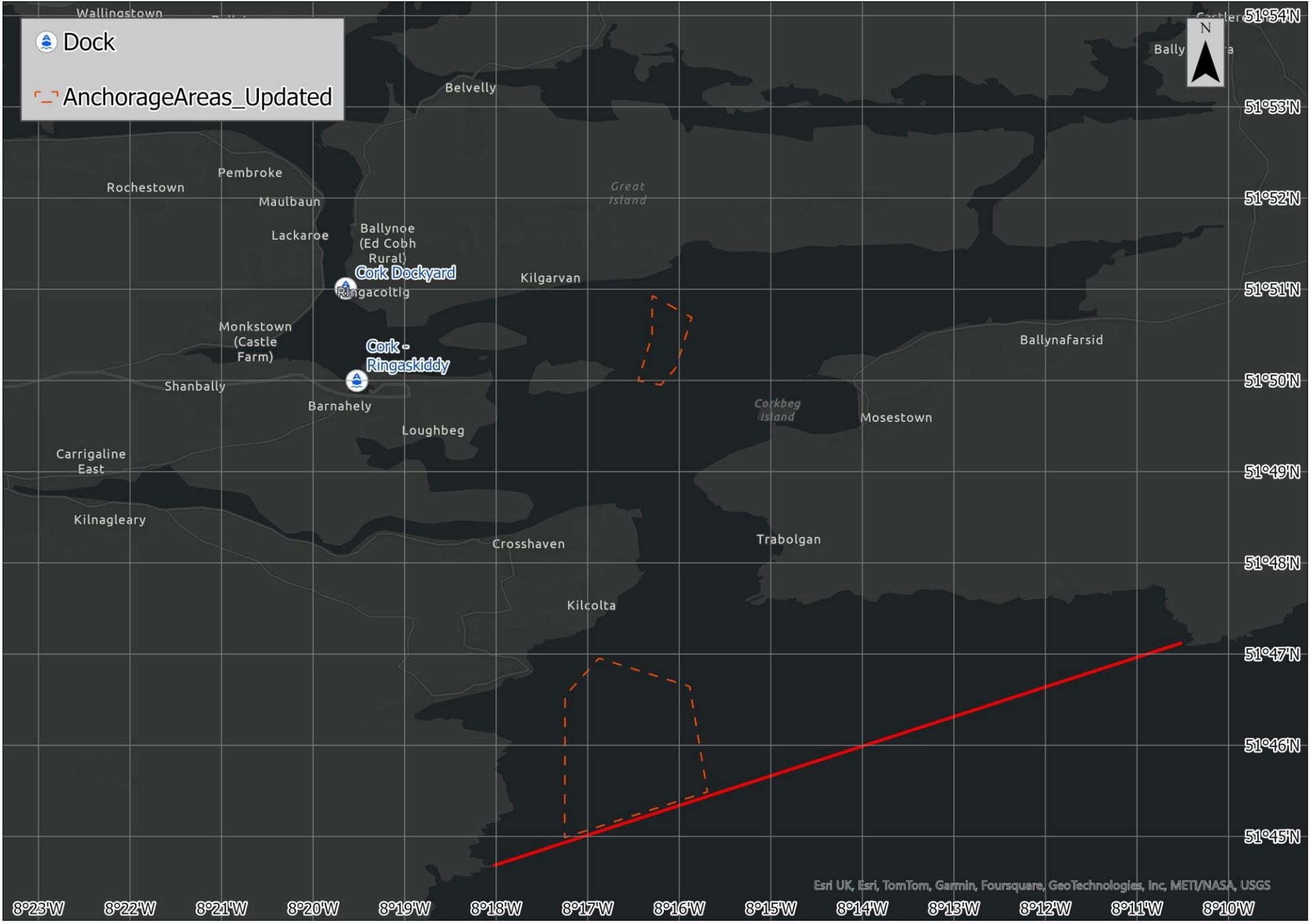
Anchorage Areas* - digitised from chart data.

*subjective (on/off)

Cables/Pipelines and Restricted Areas - digitised from chart data.

Aquaculture Sites
(Dept. of Agriculture
food and the Marine)

Run
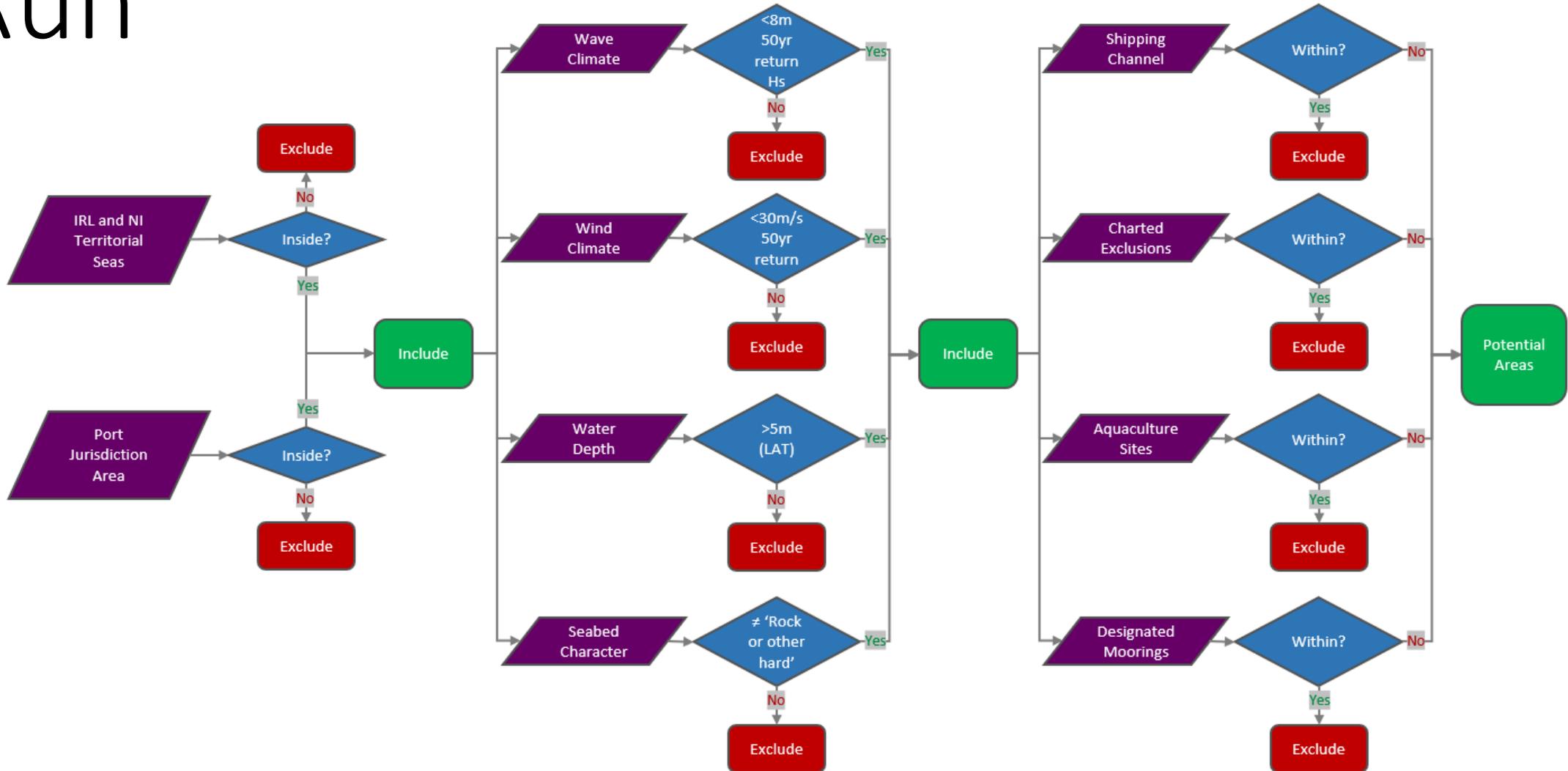
Results

Potential areas at different depth thresholds for the standalone floater
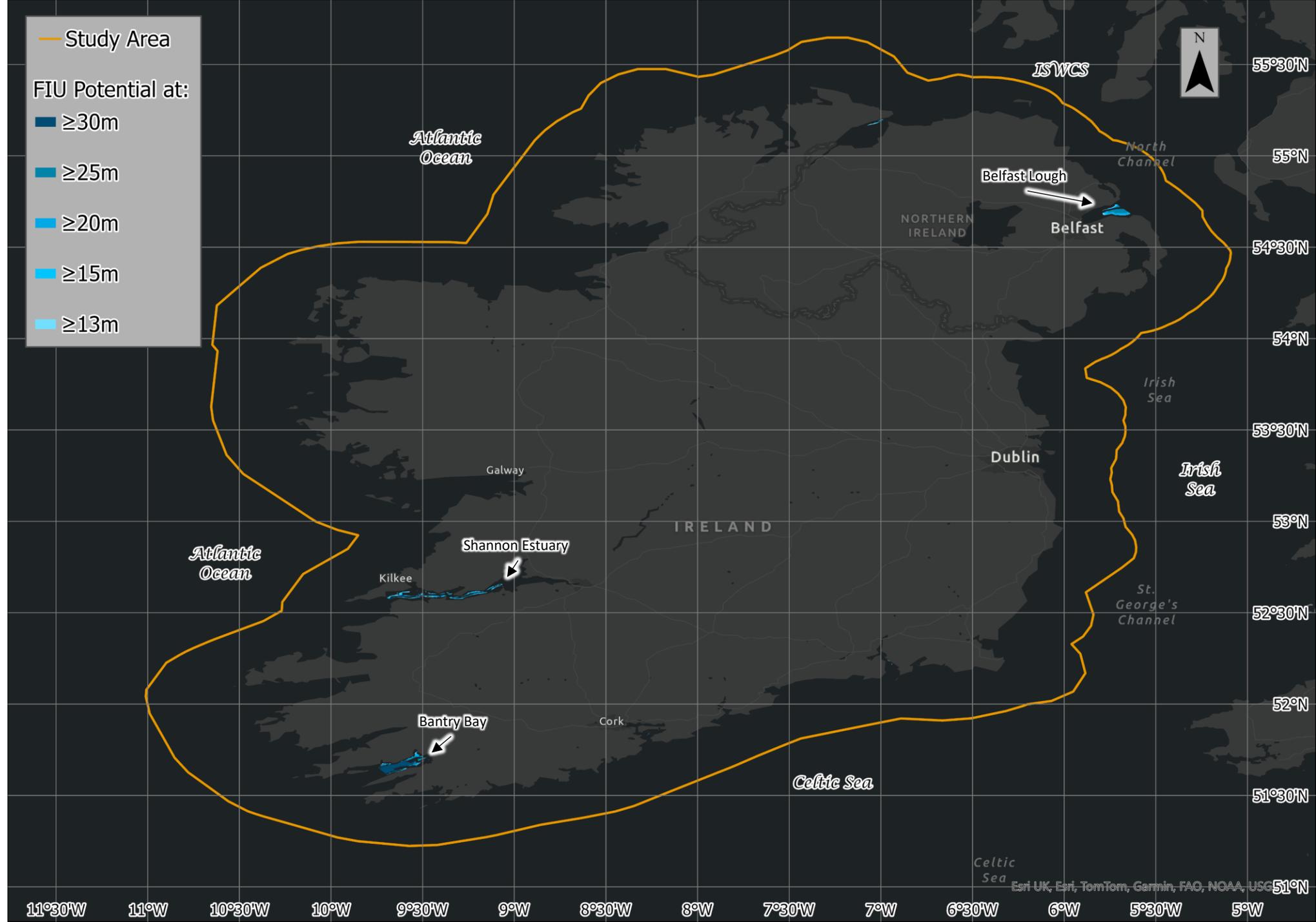
Results
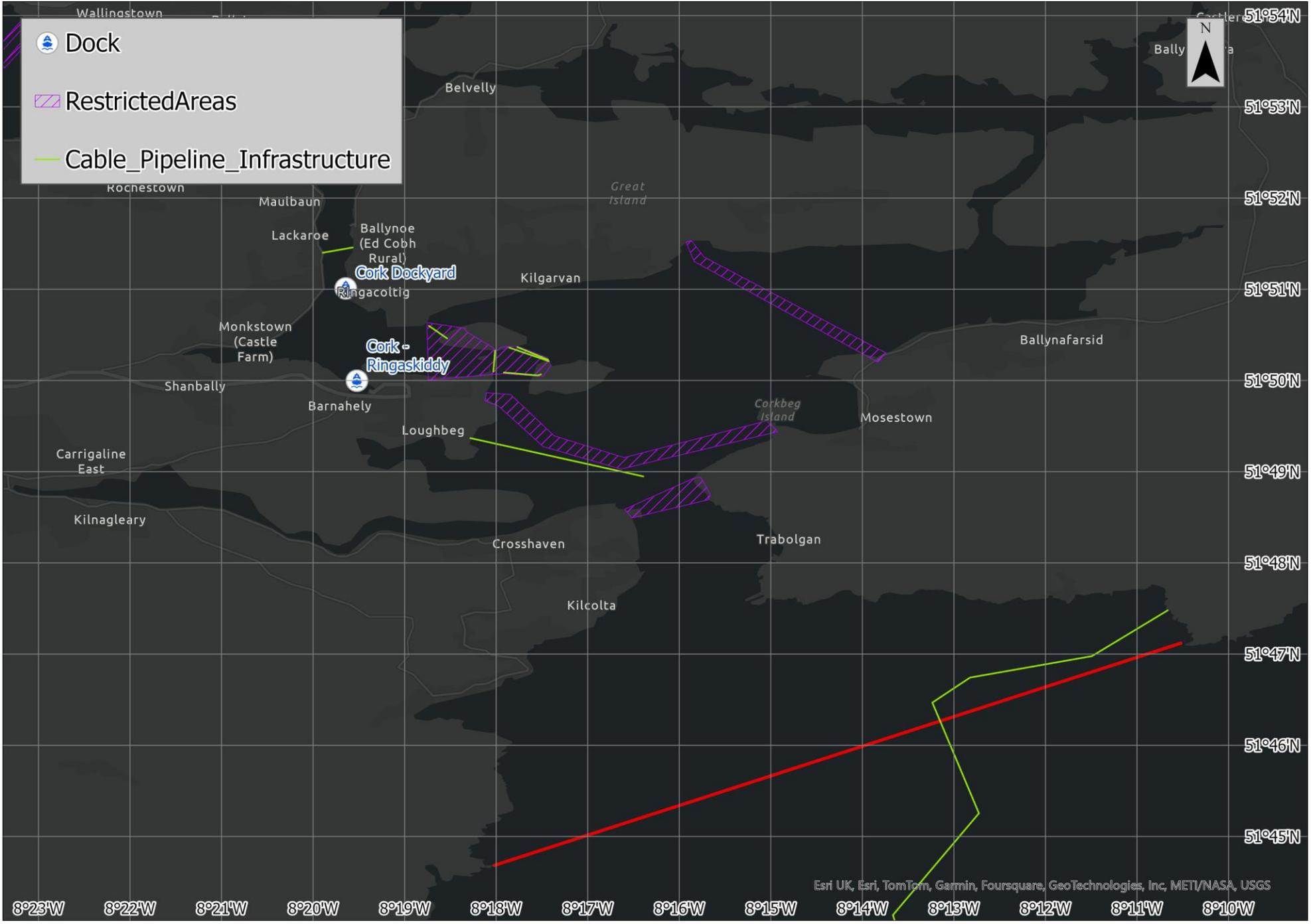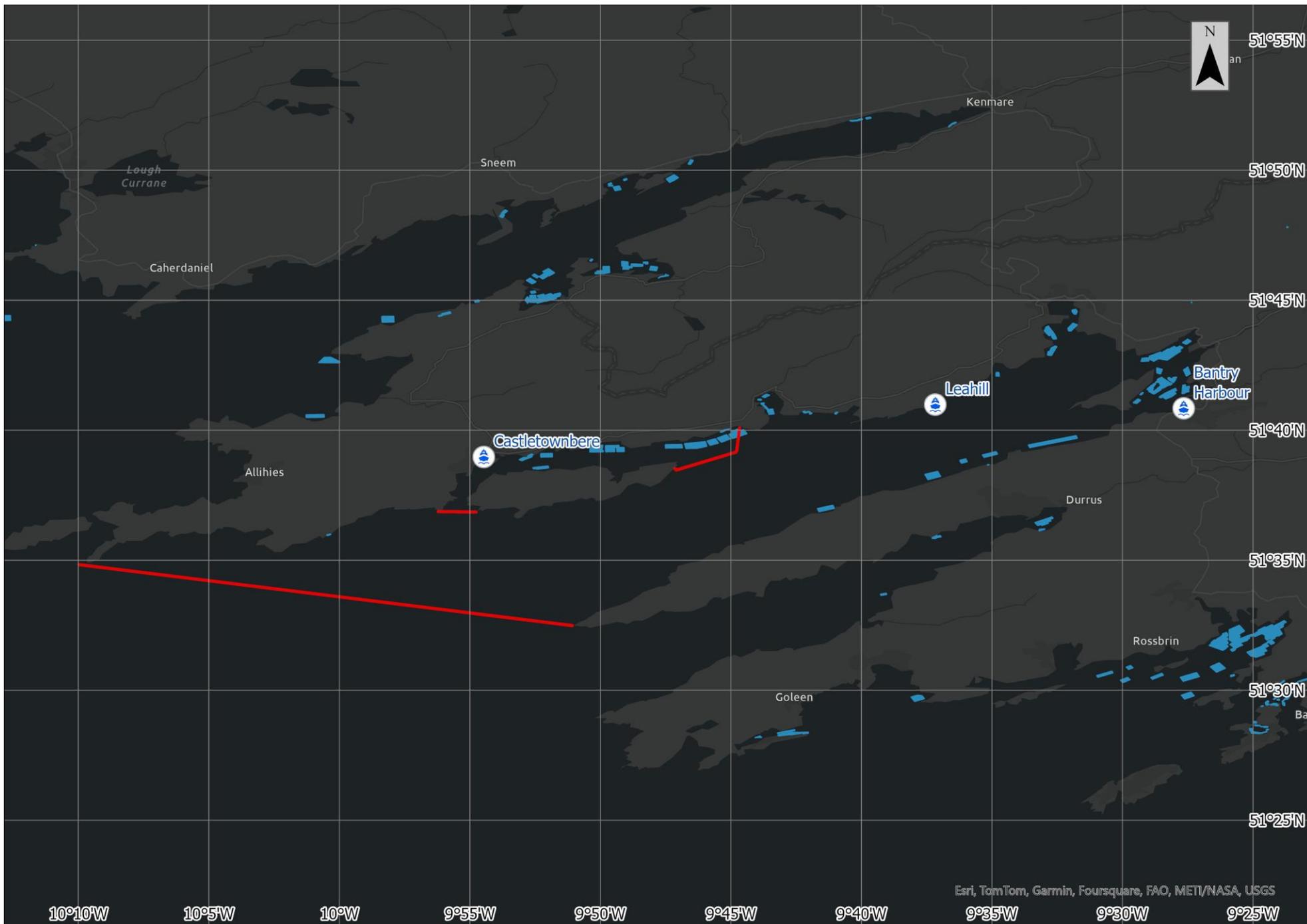
Potential areas at different depth thresholds for the fully integrated unit – Bantry Bay

Legend:
- Dock/Jetty
- Anchorage Areas
- 50 Yr 2m Hs Limit
- Port Limit

FIU Potential at:
- ≥30m
- ≥25m
- ≥20m
- ≥15m
- ≥13m
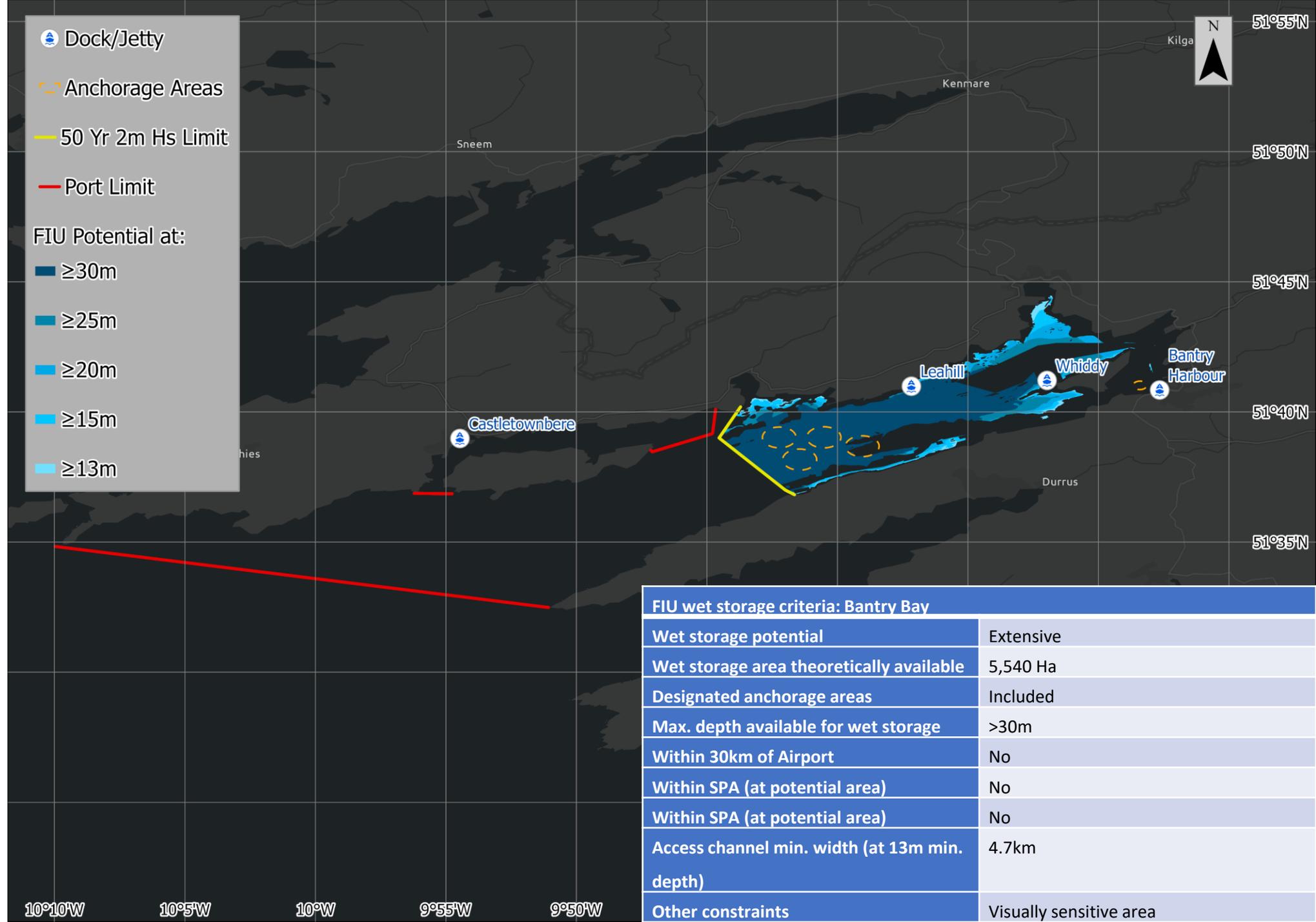
FIU wet storage criteria: Bantry Bay	
Wet storage potential	Extensive
Wet storage area theoretically available	5,540 Ha
Designated anchorage areas	Included
Max. depth available for wet storage	>30m
Within 30km of Airport	No
Within SPA (at potential area)	No
Within SPA (at potential area)	No
Access channel min. width (at 13m min. depth)	4.7km
Other constraints	Visually sensitive area

Results

Potential areas at different depth thresholds for the fully integrated unit – Shannon Estuary


Legend:
- Dock/Jetty
- Anchorage Areas
- 50 Yr 2m Hs Limit
- Port Limit
- Airport

FIU Potential at:
- ≥30m
- ≥25m
- ≥20m
- ≥15m
- ≥13m

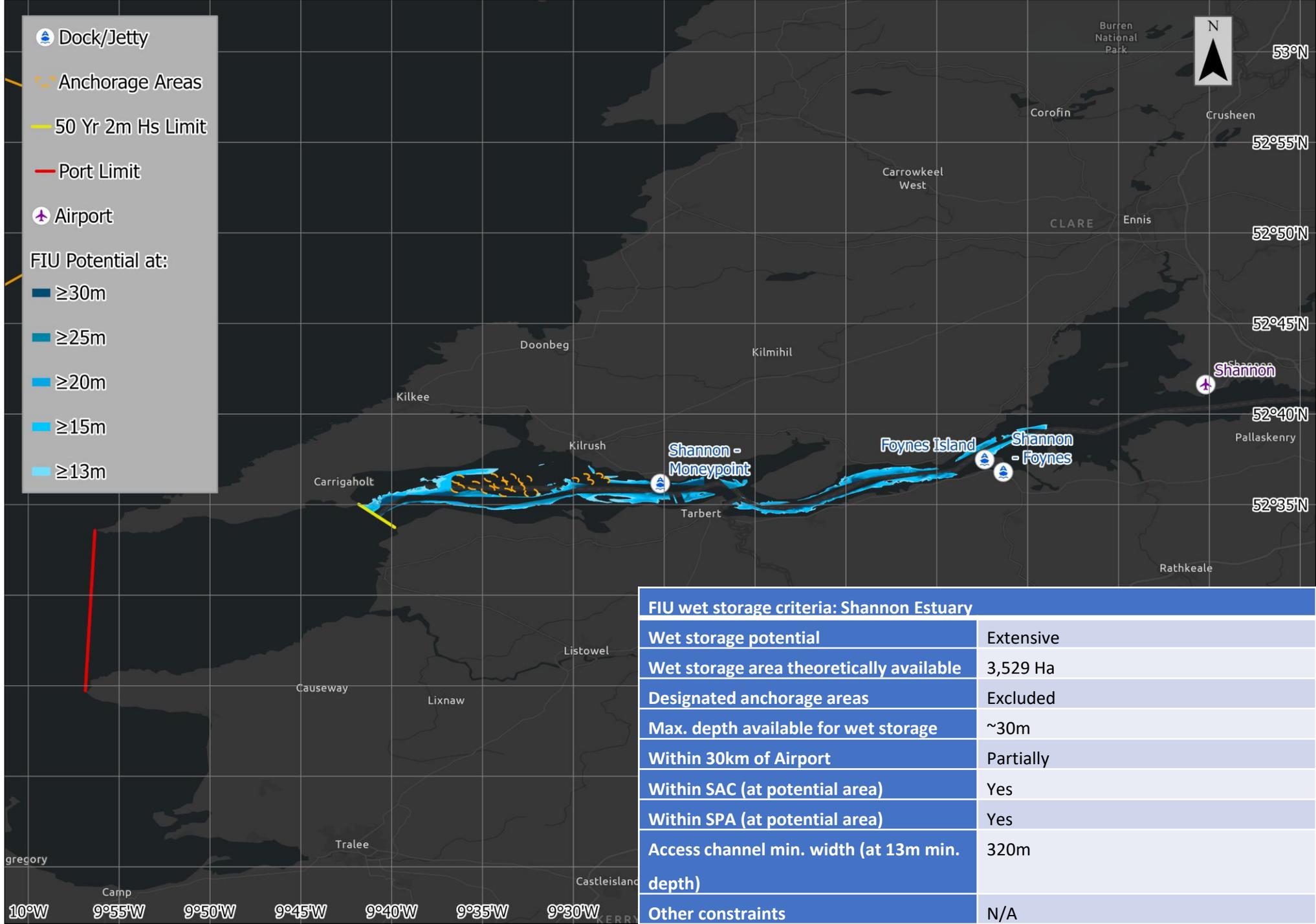| FIU wet storage criteria: Shannon Estuary	
Wet storage potential	Extensive
Wet storage area theoretically available	3,529 Ha
Designated anchorage areas	Excluded
Max. depth available for wet storage	~30m
Within 30km of Airport	Partially
Within SAC (at potential area)	Yes
Within SPA (at potential area)	Yes
Access channel min. width (at 13m min. depth)	320m
Other constraints	N/A

Results

Shannon Estuary:
Wet Storage Site
Options
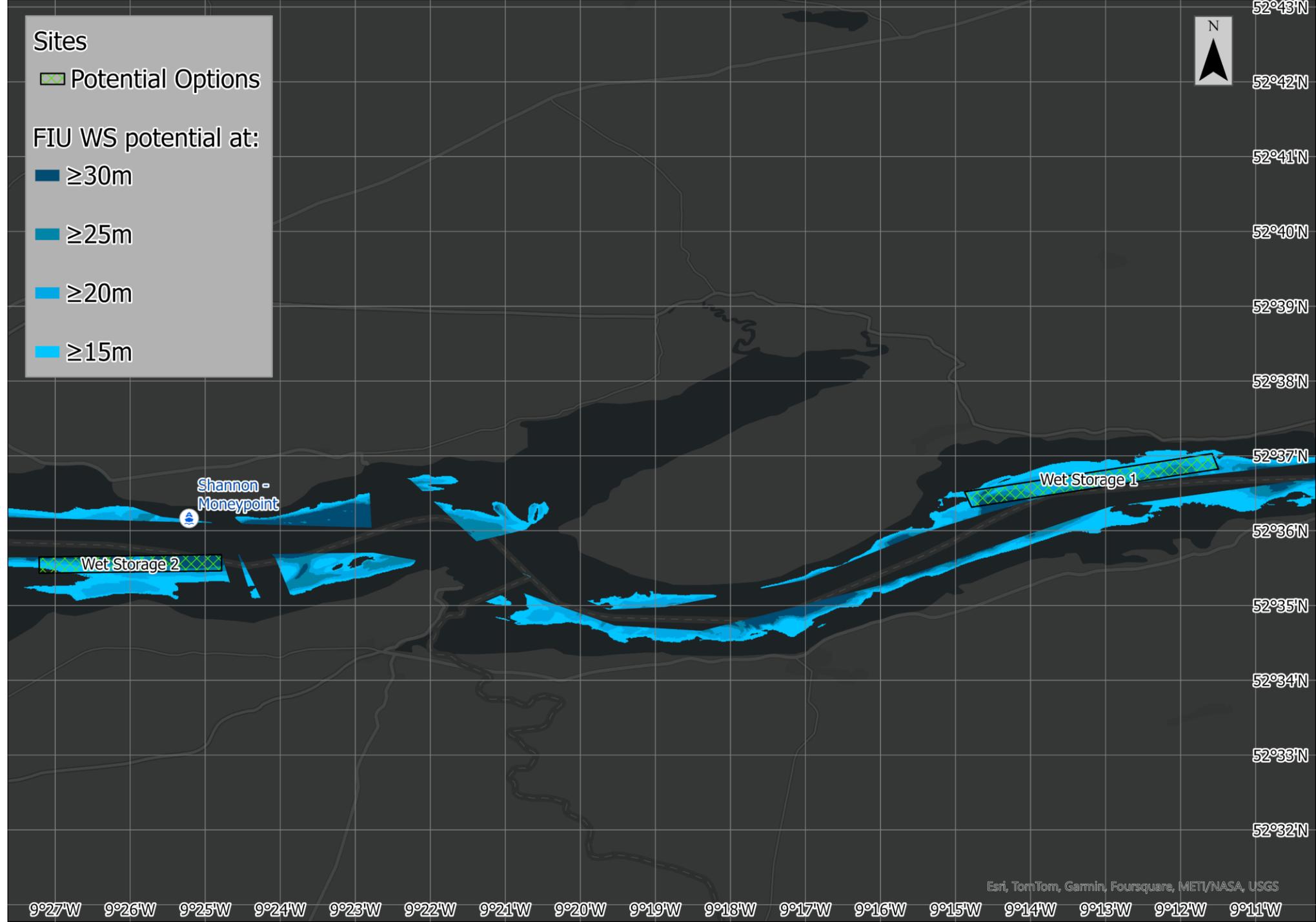
Results

Potential areas at different depth thresholds for the fully integrated unit – Belfast Lough

Legend:
- ⚓ Dock/Jetty
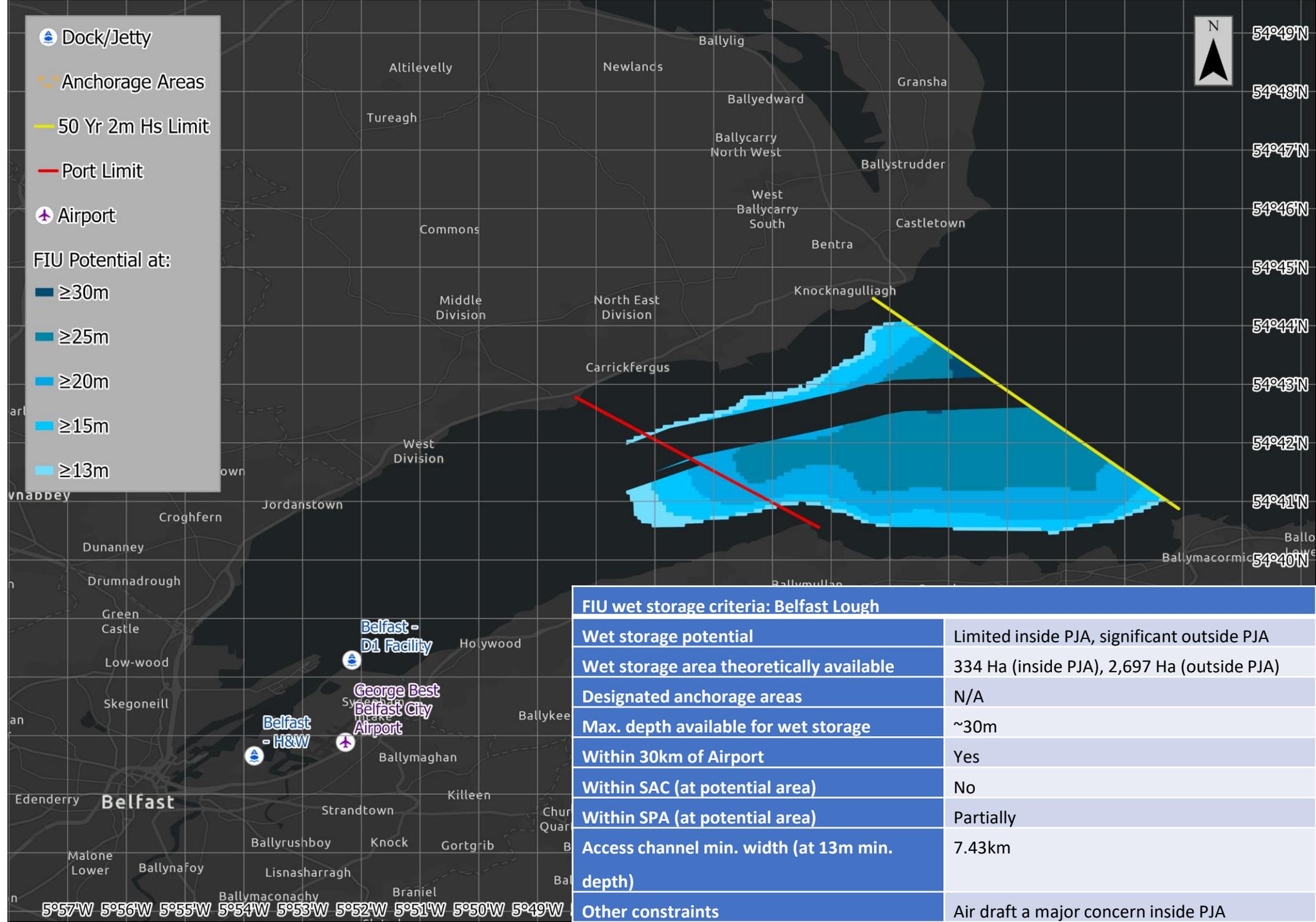- Anchorage Areas
- — 50 Yr 2m Hs Limit
- — Port Limit
- ✈ Airport

FIU Potential at:
- ≥30m
- ≥25m
- ≥20m
- ≥15m
- ≥13m

FIU wet storage criteria: Belfast Lough	
Wet storage potential	Limited inside PJA, significant outside PJA
Wet storage area theoretically available	334 Ha (inside PJA), 2,697 Ha (outside PJA)
Designated anchorage areas	N/A
Max. depth available for wet storage	~30m
Within 30km of Airport	Yes
Within SAC (at potential area)	No
Within SPA (at potential area)	Partially
Access channel min. width (at 13m min. depth)	7.43km
Other constraints	Air draft a major concern inside PJA

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Results

Bantry Bay: Wet
Storage Site
Options
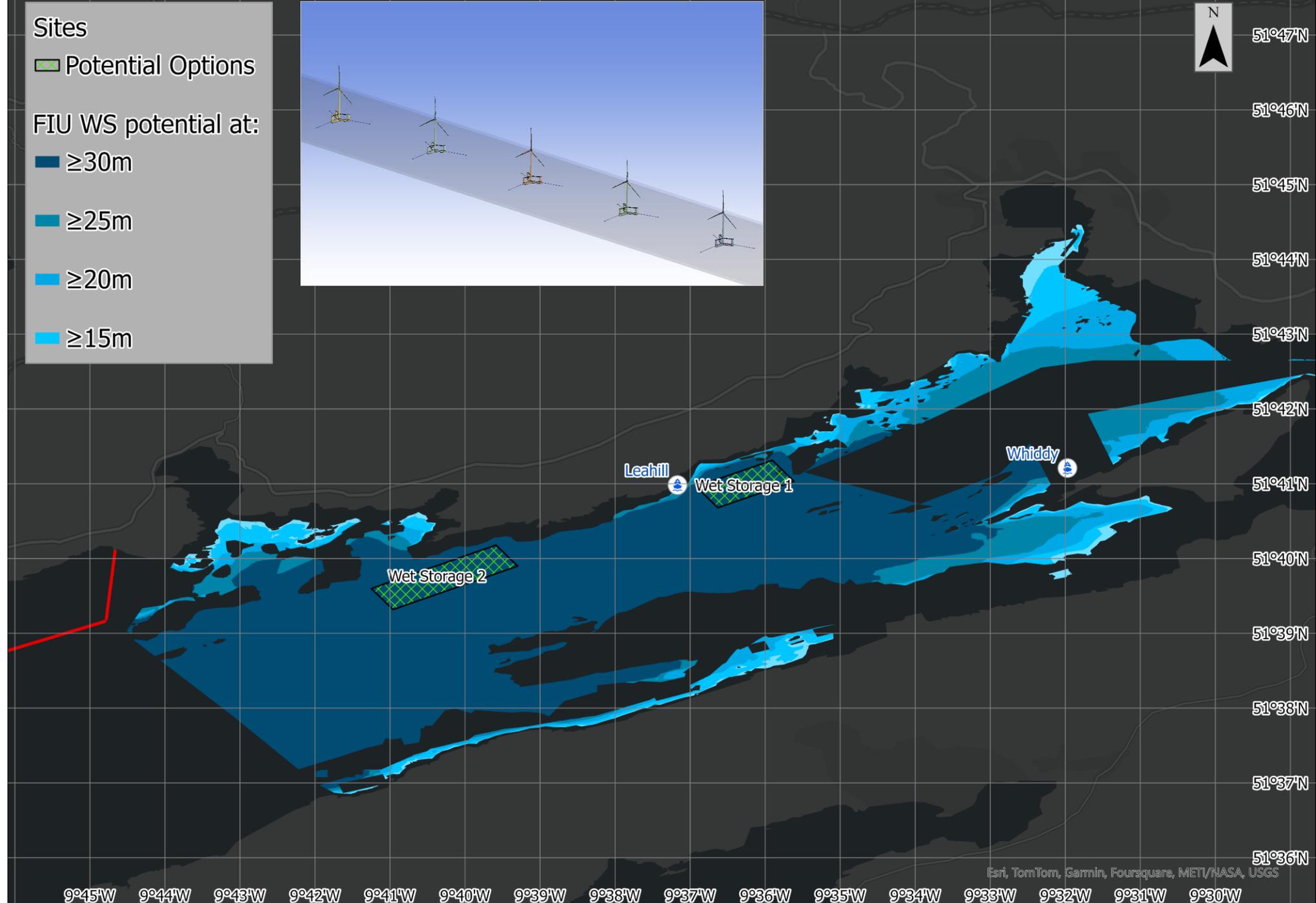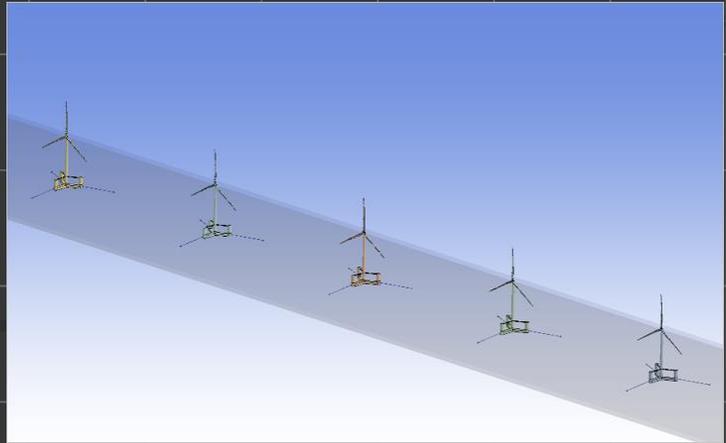
Results

Shannon Estuary: Wet Storage Site Options
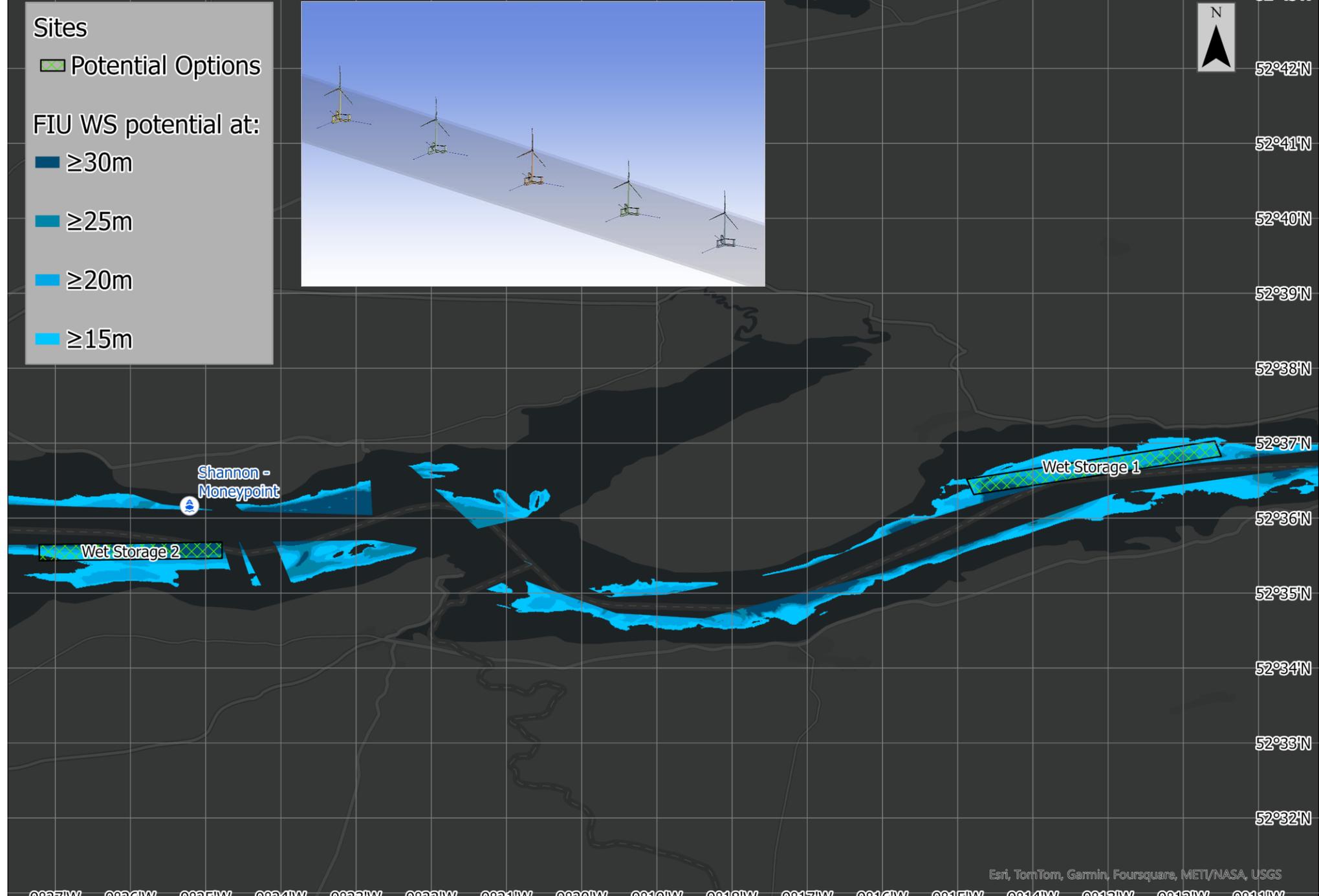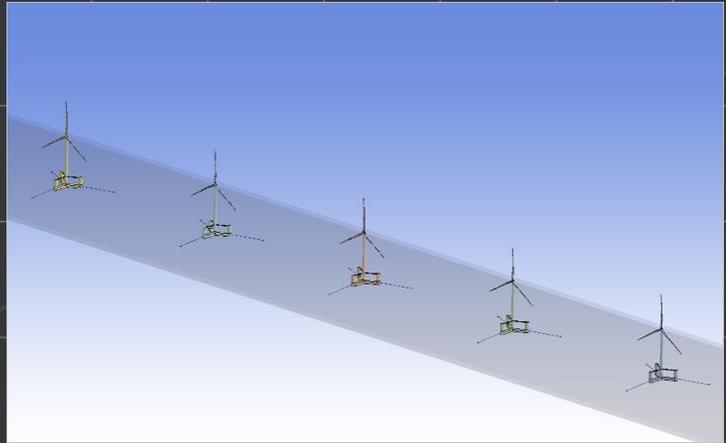
Conclusion

- The interpretation of values for the multitude of geospatial criteria relevant to the assessment of wet storage site suitability is often subjective and varies between port authorities or developers (e.g. use of anchorage areas, importance of port boundaries, Hs limits, etc.). Decision should hence be on a case-by-case basis.

- Wave models from the Copernicus Marine Service correlate well with in-situ/buoy data in the region of interest, but extension into enclosed areas/ports may require downscaling.

- Despite it's long and indented coastline, there are a limited number of ports geographically suited to wet storage in Ireland (3).

- Future work: apply data/method (or similar) to other countries/regions on course for FLOW.

Thank you!

Contact: ross.oconell@ucc.ie

Image: DOCK90 (https://www.principlepower.com/windfloat/)