3FMProject

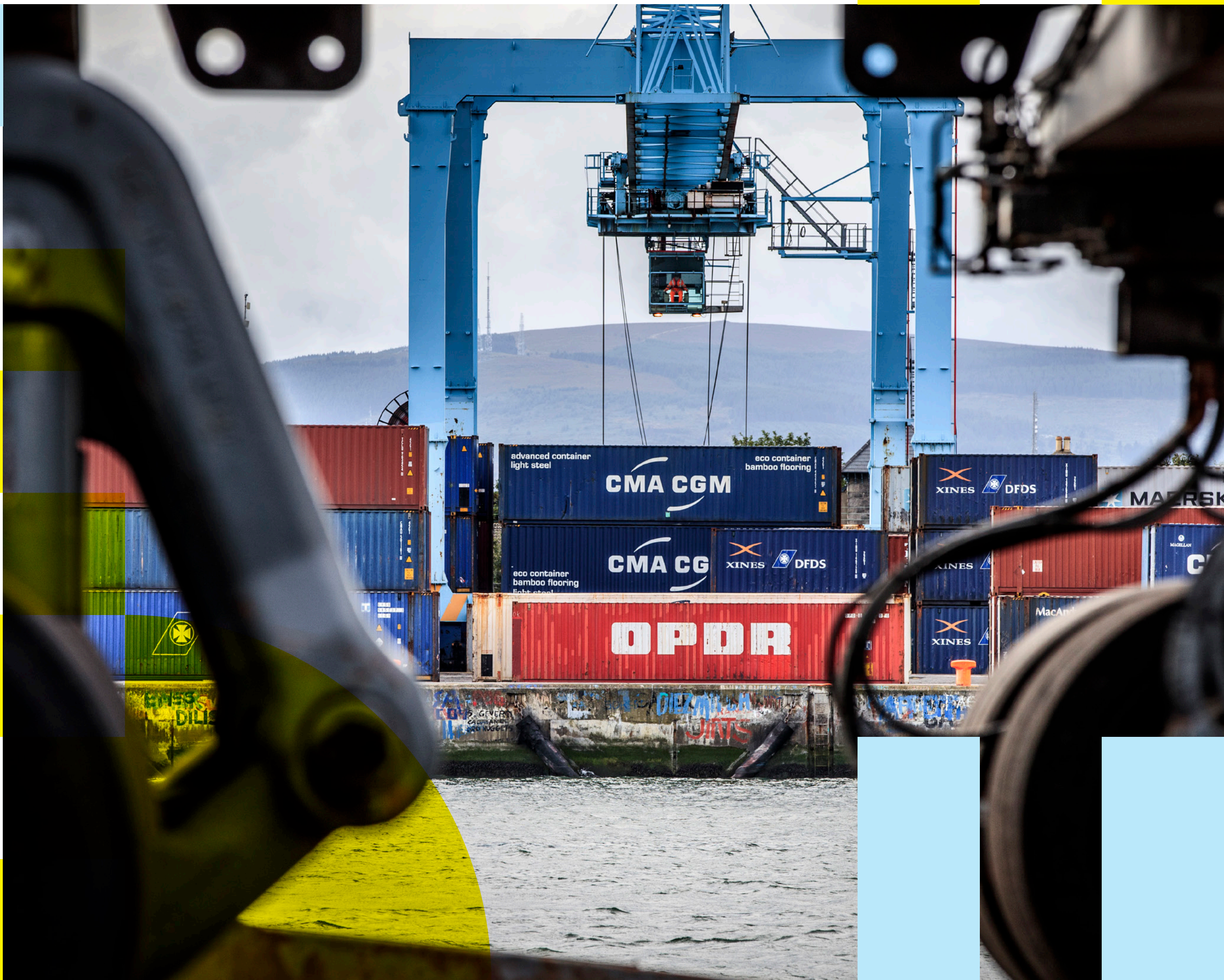
Bringing Dublin Port To 2040

Environmental Impact Assessment Report

Chapter 13

Material Assets - Coastal Processes

Volume 2 Part 3



COMHLACHT CHALAFORT ÁTHA CLIATH DUBLIN PORT COMPANY

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Third & Final Masterplan Project

13 MATERIAL ASSETS - COASTAL PROCESSES

13.1 Introduction

This chapter assesses the potential impact of the 3FM Project on the coastal processes in the Dublin Port and Dublin Bay areas and includes information about the tidal regime, the inshore wave climate and sediment dispersion to enable the competent authority to assess the potential impacts on coastal processes.

The assessment presented in this chapter is based on the project description detailed in Chapter 5 of this EIAR. Additional technical information of relevance to this chapter can also be found in the following appendices:

- Appendix 13-1 – Detailed description of hydraulic modelling software.
- Appendix 13-2 – Model calibration and validation.
- Appendix 13-3 – Dispersion of thermal plume modelling validation report.
- Appendix 13-4 – Cumulative impact of sediment deposition and dispersion with activities permitted under (S0004-03 and S0024-02)
- Appendix 8-2 - Particle Size Analyses (*used to inform the sediment transport modelling*).

13.2 Assessment Methodology

13.2.1 Modelling Methodology

RPS used the MIKE 21/3 hydrodynamic numerical modelling software package developed by DHI, to address potential coastal processes issues. This was achieved by developing a range of two dimensional and three dimensional numerical models to represent:

- The pre-project scenario (in this case, post-Alexandra Basin Redevelopment (ABR) Project and MP2 Project); and
- The post-project scenario with the 3FM Project works in place.

These models were used in conjunction with hydrographic survey data and site specific water quality monitoring data to assess the construction and operational impacts of the 3FM Project in the context of the following coastal processes:

- The dispersion and settlement of sediment plumes generated during dredging operations;
- The dispersion of sediment material disposed of at the offshore dump site;
- The tidal regime;
- Sediment dynamics and the morphological response of the seabed within Dublin Port;
- The inshore wave climate;
- Dispersion of thermal plumes relating to industrial activities within Dublin Port; and
- Flood risk to the surrounding areas.

The impact of the 3FM Project on these coastal processes has been quantified by using difference plots throughout this chapter, i.e., post-project minus pre-project conditions. As such, the extent and magnitude of potential impacts as a result of the 3FM Project can be clearly compared against baseline conditions. To conclude the assessment, mitigation measures are proposed to reduce impacts, where appropriate. This enables a “with mitigation” assessment to be made of any residual impact as a result of the construction and operational phases of the 3FM Project and/or in combination with other projects in the vicinity of Dublin Port.

13.2.2 Coastal Process Modelling Software

A suite of coastal process models, based on the MIKE software developed by DHI, was used to assess the potential impact of the 3FM Project on the coastal processes within Dublin Port and Bay. The MIKE system is a state of the art, industry standard, modelling system, based on a flexible mesh approach. This software was developed for applications within oceanographic, coastal and estuarine environments.

A brief synopsis of the MIKE system and modules used for this assessment is outlined below whilst a full description can be found in Appendix 13-1:

1. **MIKE 21 & MIKE 3 Flow Model FM system -** Using these flexible mesh modelling systems, it is possible to simulate the mutual interaction between currents, waves and sediment transport by dynamically coupling the relevant modules in both two and three dimensions. Hence, a full feedback of the bed level changes on the waves and flow calculation can be included.

2. **The Hydrodynamic module** – Simulates water level variations and flows in response to a variety of forcing functions in lakes, estuaries and coastal regions. The HD Module is the basic computational component of the MIKE 21 and MIKE 3 Flow Model systems providing the hydrodynamic basis for the Sediment Transport and Spectral Wave modules

   The Hydrodynamic module solves the two/three-dimensional incompressible Reynolds averaged Navier-Stokes equations subject to the assumptions of Boussinesq and of hydrostatic pressure. Thus, the module consists of continuity, momentum, temperature, salinity and density equations. When being used in three dimensions, the free surface is taken into account using a sigma coordinate transformation approach whereby the vertical layer is divided into a discrete number of layers fixed proportionally to water depth.

3. **The Spectral Wave module** – Simulates the growth, decay and transformation of wind-generated waves and swell in offshore and coastal areas and accounts for key physical phenomena including wave growth by wave action, dissipation, refraction, shoaling and wave-current interaction.

4. **The Sediment Transport module -** Simulates the erosion, transport, settling and deposition of sediment in marine and estuarine environments and includes key physical processes such as forcing by waves, flocculation and sliding. The module can be used to assess the impact of marine developments on erosion and sedimentation patterns by including common structures such as jetties, piles or dikes.

5. **The Mud Transport module –** Simulates the erosion, transport, and deposition of *cohesive* sediments in water bodies. This multi-fraction, multi-layer model incorporates wave dynamics, salt-flocculation, and sediment consolidation and can be used to assess the spreading and behaviour of dispersion of sediment using built-in dredging module.

13.2.3 Coastal Process Models and Data Sources

The models used to assess the impact of the 3FM Project on the coastal processes were developed from RPS' present-day Dublin Bay model.

RPS' present-day Dublin Bay model was created using flexible mesh technology to provide detailed information on the coastal processes around Dublin Port and Dublin Bay. The model uses mesh sizes varying from 250,000 m^2 (equivalent to 500 m x 500 m squares) at the outer boundary of the model down to a very fine 32 m^2 (equivalent to *c.*6 m x 6 m squares) within the vicinity of the proposed development The bathymetry of this model was developed using data gathered from hydrographic surveys of the Dublin Port and Tolka estuary which have been regularly undertaken since 2017 and supplemented by data from the Irish National Seabed Survey, INFOMAR and other local surveys collated by RPS for the Irish Wave and Water level Study (ICWWS, 2020). The extent, mesh structure and bathymetry of this model is illustrated in Figure 13.1.

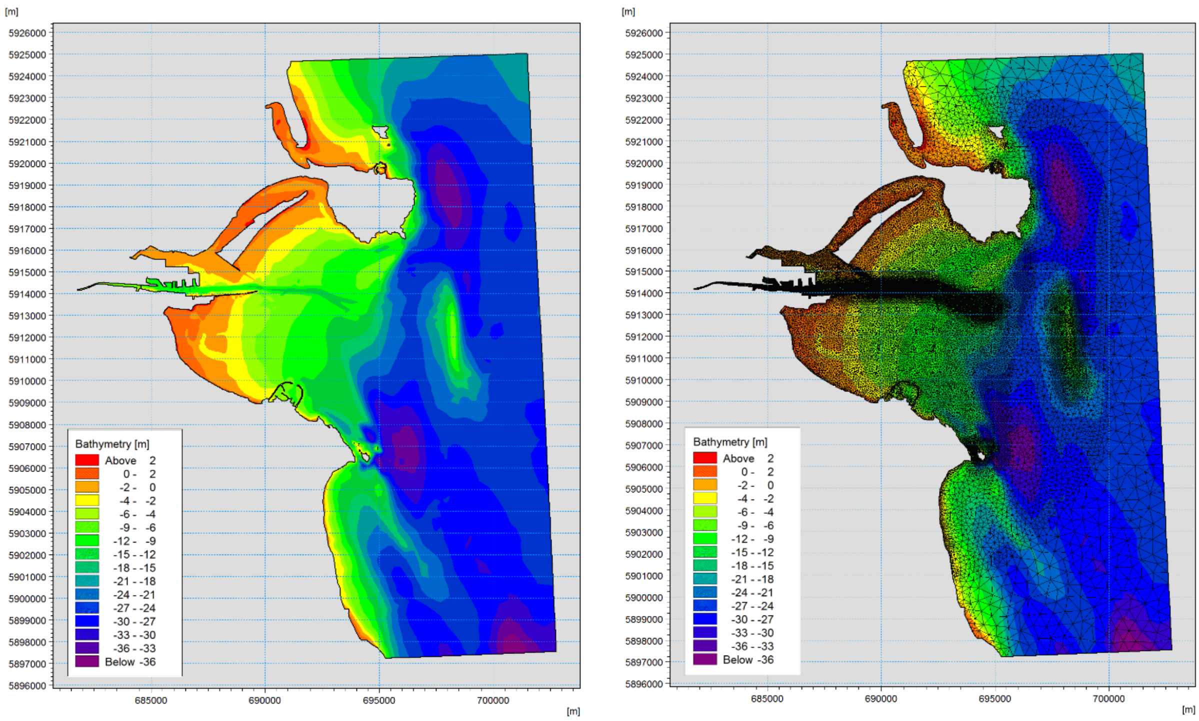

Figure 13.1: Extent and bathymetry (left) and mesh structure (right) of the Dublin Bay model

The Dublin Bay model was then updated to produce a 2D version of the model that represented the pre-3FM Project scenario (in this case, this represents the post-ABR Project and MP2 Project layout within Dublin Port). The Dublin Bay model was further updated to produce a second 2D version of the model which represented Dublin Port post implementation of the 3FM Project. As such the post-project scenario model had updated bathymetry at the SPAR, Maritime Village, Area K, Turning Circle and Area N.

Importantly, the post-project scenario model also included the extensive pile configuration Area N. In line with DHI guidance, each individual pile was represented using the "structure" function in MIKE. The effect of these structures is modelled as sub-grid structures by an additional volume force to the momentum equation in the column of cells where the structure is located. A drag-law is used to capture the increasing resistance imposed by the piers as the flow speed increases. The detailed representation of piles in the vicinity of Area N is illustrated in Figure 13.5.

These two-dimensional models were used to appraise the impact of the 3FM Project on the existing tidal regime, the inshore wave climate and the dumping and dispersion of dredge material at the licensed offshore disposal site. However, as the coastal processes within Dublin Port are highly three-dimensional owing to the freshwater input from the Rivers Liffey, Tolka and Dodder, it was necessary to develop 3D versions of the pre and post-project scenario models. These 3D models were also used to assess the potential impact of the 3FM Project on the dispersion of thermal plumes generated by various assets that discharge into, or abstract water from the inner Liffey channel.

As illustrated in Figure 13.2, the offshore boundary of the 3D versions of the pre and post-project scenario models extended from the Ben of Howth to Dalkey and includes the Dublin Bay area. These 3D models were comprised of up to six discrete vertical sigma layers and were used to assess the sediment plumes generated during the various dredging operations within Dublin Port and the operational performance of the 3FM Project.

The bathymetry of the pre and post-project scenario models in the Dublin Port area is illustrated in Figure 13.3 and Figure 13.4 respectively. A summary of the models that were developed for the 3FM Project assessment and their purpose is summarised in Table 13.1.

Table 13.1 Summary of the numerical models developed for the 3FM Project assessment and their purpose

Numerical Model	2D Version	3D Version
Present day Dublin Bay	• Initial Calibration	• Thermal plume dispersion Calibration
Pre-project scenario (Dublin Port with ABR and MP2 Projects in place)	• Tidal regime • Wave climate • Sediment disposal	• Tidal regime • Thermal plume dispersion
Post-project scenario (Dublin Port with ABR, MP2 and 3FM Projects in place)	• Tidal regime • Wave climate • Sediment disposal	• Tidal regime • Dredging & dispersion • Operational performance of the 3FM Project • Thermal plume dispersion

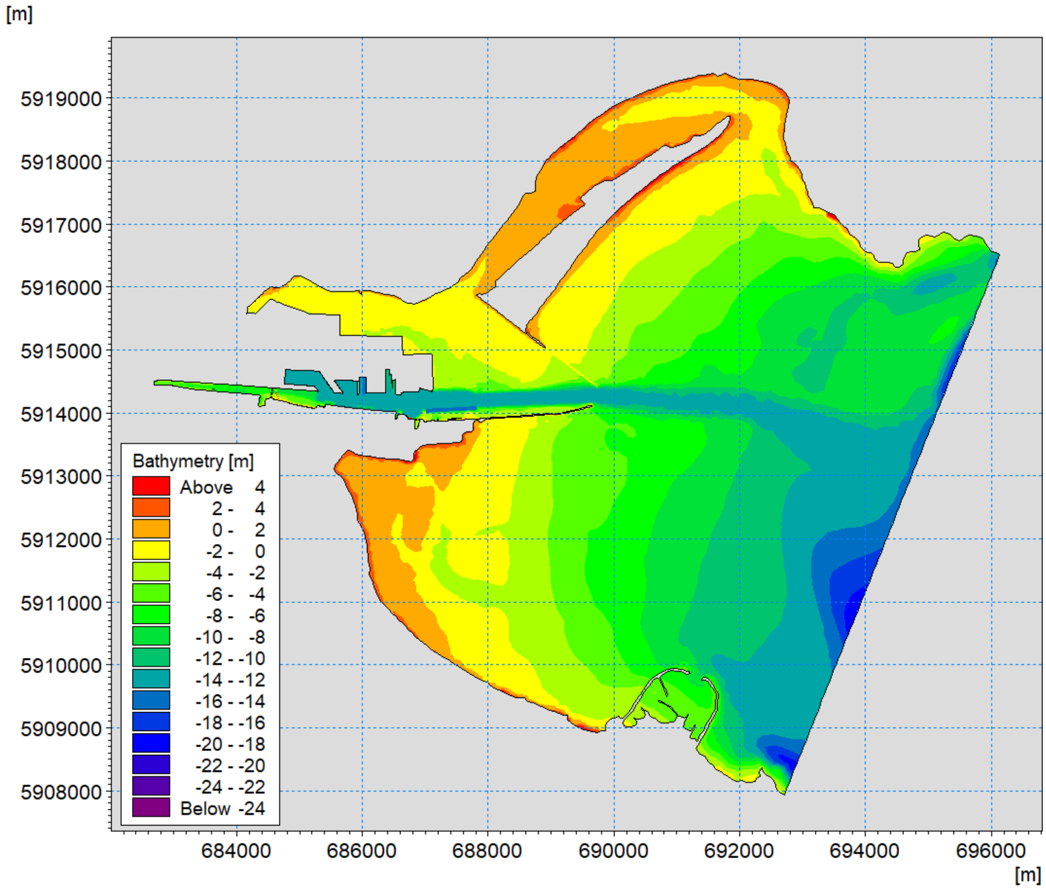

Figure 13.2: Extent and bathymetry of the 3D Dublin Port post 3FM Project model

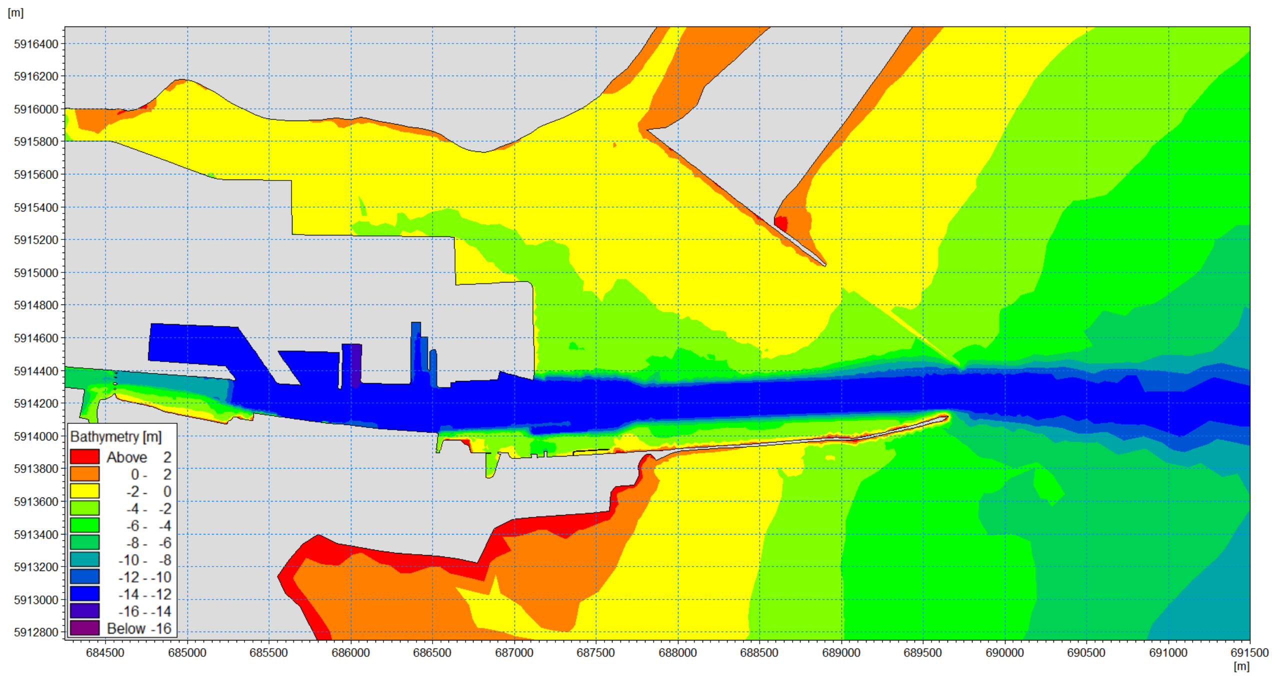

Figure 13.3: Bathymetry of the Dublin Port pre 3FM Project (post ABR & MP2 Project) model – levels illustrated to Mean Sea Level

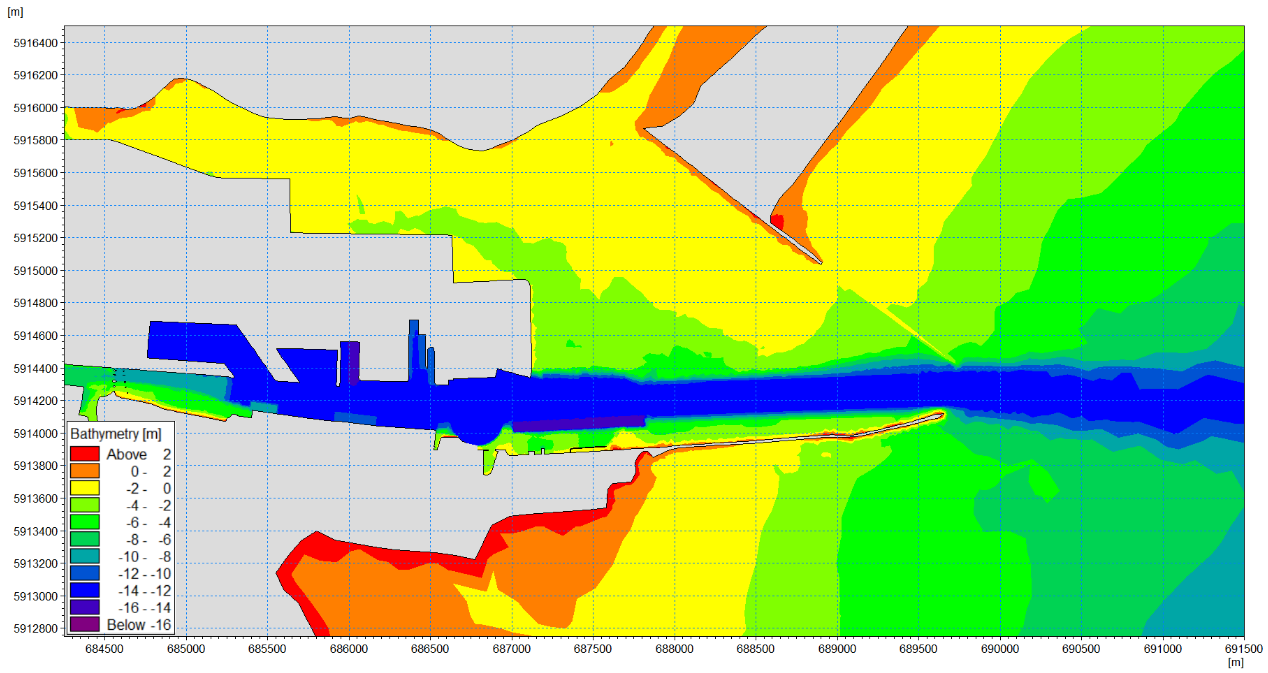

Figure 13.4: Bathymetry of the Dublin Port post 3FM Project model including all dredged pockets – levels illustrated to Mean Sea Level

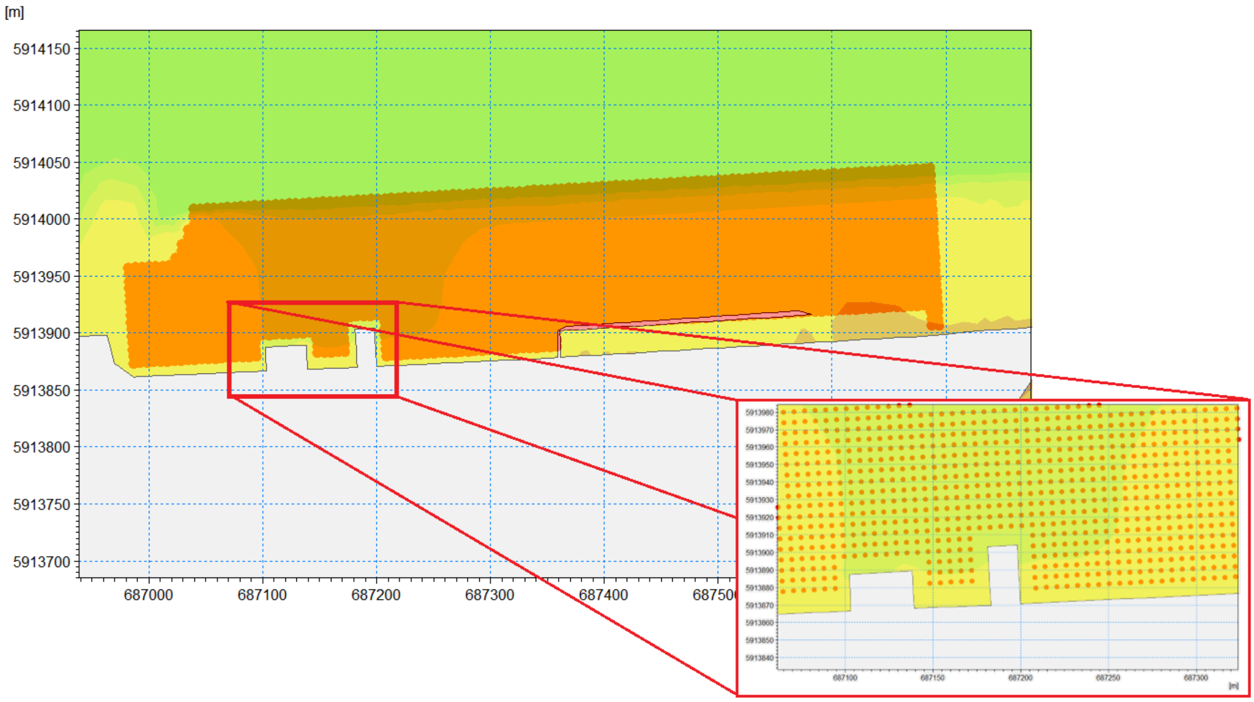

Figure 13.5: Detailed representation of >2500 pile structures in the vicinity of Area N

In addition to the extensive bathymetric surveys of Dublin Port and the Tolka estuary area, a comprehensive sediment survey of the Tolka estuary was undertaken by Hydrographic Surveys Ltd in December 2017. Additional bathymetry and particle size survey information was subsequently collected by Hydromaster between 2022 and 2023. The outputs of the Particle Size Analyses (PSA), which were used to inform the input parameters for the sediment transport simulations, are presented in Appendix 8-2.

Tidal current meter and surface elevation data recorded by multiple Acoustic Doppler Current Profilers (ADCPs) instruments that were deployed over various hydrographic surveys was used to calibrate and validate the present-day Dublin Bay model. This calibration process is described in full detail in Appendix 13-2.

Current velocities have also been continuously recorded at the centre of the dump site between September 2017 and April 2021. These recordings have also been used to validate the Dublin Bay model reported in the Annual Environmental Report (AER) 2022 to the EPA under Dumping at Sea Permit S0024-02.

The model verification process confirmed that the present Dublin Bay model provides a very good representation of the coastal processes in the Dublin Port and Dublin Bay areas.

Prior to assessing the potential impact of the 3FM development, the thermal plume model was calibrated based on the present-day scenario. This calibration process is described in full detail in Appendix 13-3. ESB supplied three thermal plume survey reports to enable model verification and therefore increase confidence in the outcomes of the numerical modelling studies. The thermal plume model development and calibration process was independently audited by DHI and determined to be fit for the purpose of undertaking a comparative study to evaluate the impacts of the proposed development of 3FM on existing thermal discharges and intakes in Dublin Port (see Section 13.5.2.3 and Appendix 13-3).

13.2.3.1 Boundary Conditions

The tidal boundary conditions for the 2D pre-project and post-project scenario models were taken from RPS' Irish Seas Tidal Surge Model (ISTSM). This model was developed using flexible mesh technology with the mesh size (model resolution) varying from circa 24 km along the offshore Atlantic boundary to circa 200 m around the Irish coastline. The extent and bathymetry of the ISTSM tidal surge model is presented in Figure 13.6. RPS also utilised their Irish Coastal Protection Strategy Study (ICPSS) east coast wave model to gather wave boundary data for the Dublin Bay model to ensure that the hydrodynamic influence of the offshore Kish and Codling banks were accounted for in the model. The extent and bathymetry of the ICPSS east coast wave model is presented in Figure 13.6.

Tidal boundary condition data for the 3D models were taken from the 2D pre-project and post-project scenario models.

All open sea boundaries were applied to the model as Flather boundaries whereby temporarily and spatially varying water level and current velocities are specified along the boundary. Flather boundaries are one of the most efficient boundary condition methods to downscale coarse model simulations to higher resolution areas as it avoids instabilities commonly associated with water level boundaries.

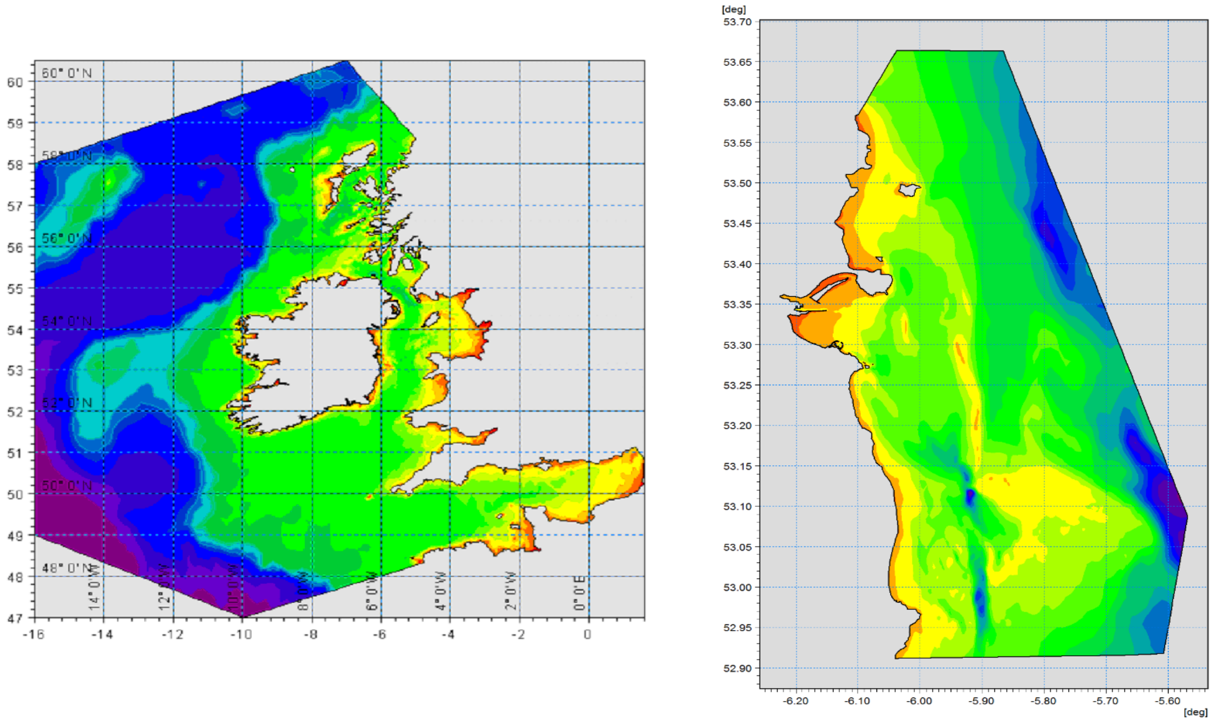

Figure 13.6 Extent and bathymetry of the ISTSM tidal surge model (left) and east coast wave model (right)

13.2.3.2 River Flows

The mean annual river flow values presented Table 13.2 in for the Liffey, Dodder and Tolka were used in the numerical model simulations of the tidal regime. Mean winter river flows were used to model the dispersion and fate of sediment plumes arising from the capital dredging works as dredging works are to be restricted to winter months only. Both the mean winter and annual river flows used for various rivers are presented in Table 13.2.

Table 13.2 Mean annual discharge rates from the Liffey, Dodder and Tolka used in the coastal process models

Source	Wet weather discharge rate (m^3/s)	Dry weather discharge rate (m^3/s)
Liffey	25.0	2.0
Dodder	4.0	0.5
Tolka	3.0	0.5

13.3 Receiving Environment

In this section of the environmental appraisal, the following processes were considered based on a pre-3FM Project scenario (Dublin Port with the ABR & MP2 Projects in place):

- **Tidal regime:** Current speeds and direction.
- **Wave patterns:** Significant wave heights and directions.
- **Dispersion:** Dispersion of sediments and of thermal plumes associated with assets discharging into or abstracting water from Dublin Port.

This assessment was undertaken with reference to both the simulated model data and, where applicable, hydrographic survey data (see Section 13.2.3) and site-specific water quality monitoring data made available by Dublin Port Company's Environmental Monitoring Programme (ongoing for the ABR & MP2 Projects).

13.3.1 Tidal Regime within Dublin Port (Baseline scenario)

The MIKE 21 Hydrodynamic module described in Section 13.2.3 was used in conjunction with the pre-3FM Project scenario (Dublin Port with the ABR & MP2 Projects in place) 2D model to derive baseline tidal regime information within Dublin Port.

Typical tidal flow patterns for a spring ebb and spring flood tide are presented in Figure 13.7 and Figure 13.8 These tidal flow diagrams illustrate that the current speeds in the central navigation channel are marginally higher during mid-ebb conditions relative to mid-flood conditions owing to the contribution of flow from the Liffey, Dodder and Tolka.

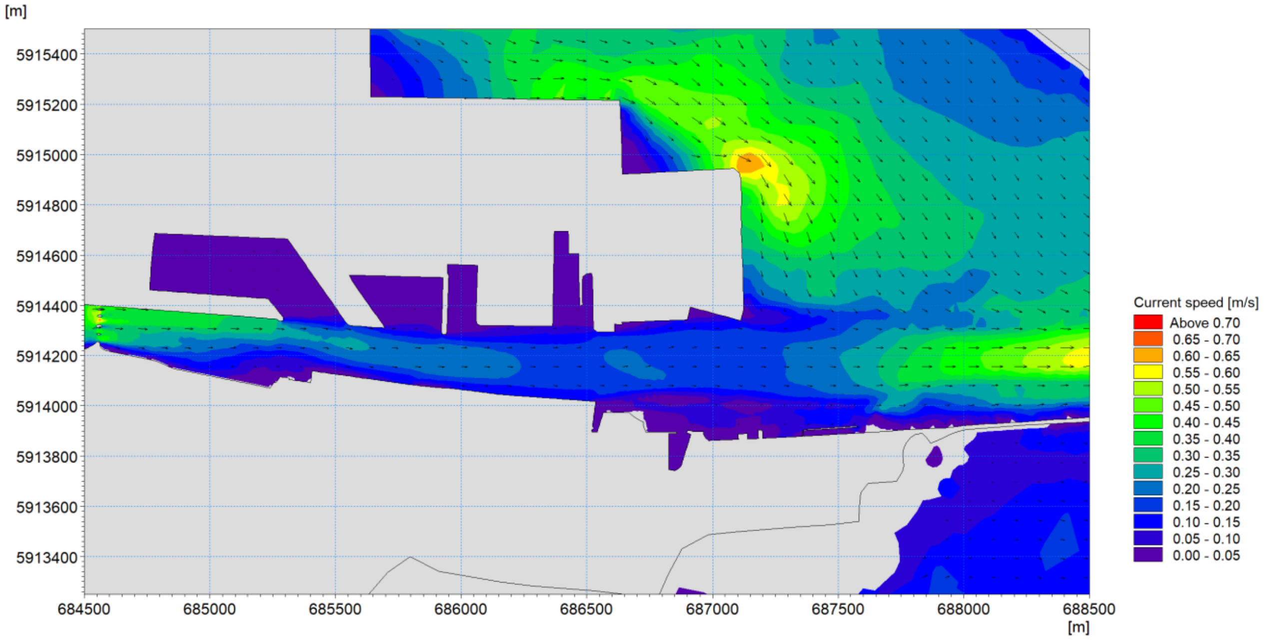

Figure 13.7: Typical spring mid ebb tidal flow patterns – Pre-3FM Project

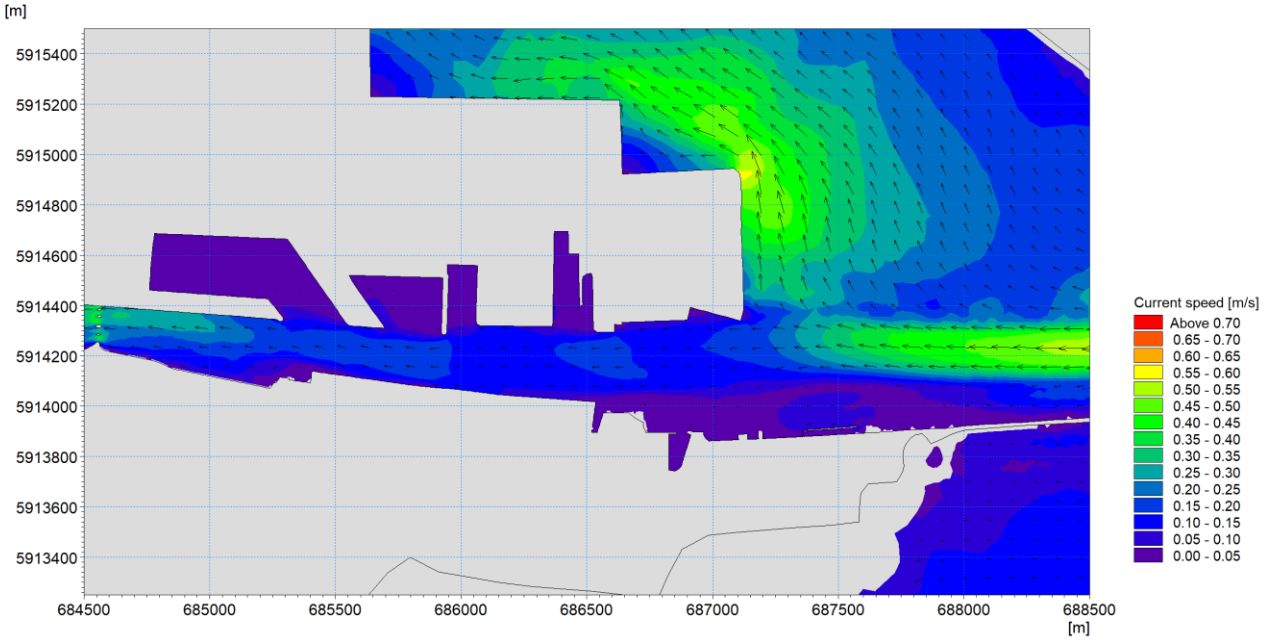

Figure 13.8: Typical spring mid flood tidal flow patterns – Pre-3FM Project

13.3.2 Wave Climate within Dublin Port (Baseline scenario)

Offshore wave data for points at 5.66°W, 55.50°N and 5.66°W, 55.25°N were taken from the UK Met Office European wave model used as a source to select the largest event for each of the north east, east and south east directions. The three hourly data included wind wave and swell wave components in the form of the significant wave height, mean wave period, peak wave period and mean wave directions. The offshore wave climate data used in the wave transformation simulations are summarised in Table 13.3.

The MIKE 21 Spectral Wave module described in Section 13.2.3 was used in conjunction with the pre-3FM Project scenario 2D model to transform the offshore wave conditions for the north easterly, easterly and south easterly storm events into the nearshore. These offshore wave conditions are summarised in Table 13.3.

It should be noted that the Spectral Wave module was considered the most appropriate method to assess the inshore wave climate as the alternative Boussinesq wave harbour disturbance model does not account for wind wave generation. This a particularly important factor for much of the inner Port area whereby the wave climate is often dominated by wind waves generated over short fetches.

Figure 13.9, Figure 13.10 and Figure 13.11 present the inshore wave heights in Dublin Bay at spring high tide during north easterly, easterly and south easterly storm events respectively. It will be seen from these figures that based on these simulations the largest waves that propagate into Dublin Port occur during easterly storm events at spring high water.

The wave was continuously recorded at the centre of the dump site between September 2017 and April 2021. These recordings have also been used to validate the predictions of storm waves entering Dublin Bay (reported in the Annual Environmental Report (AER) 2022 to the EPA under Dumping at Sea Permit S0024-02.

Table 13.3 Offshore wave climate data used to simulate the inshore wave climate

Storm Event	Significant wave height (m)	Peak wave period (s)	Mean wave direction (°N)
North Easterly	4.6	8.9	29
Easterly	5.5	8.2	98
South Easterly	5.4	10.4	148

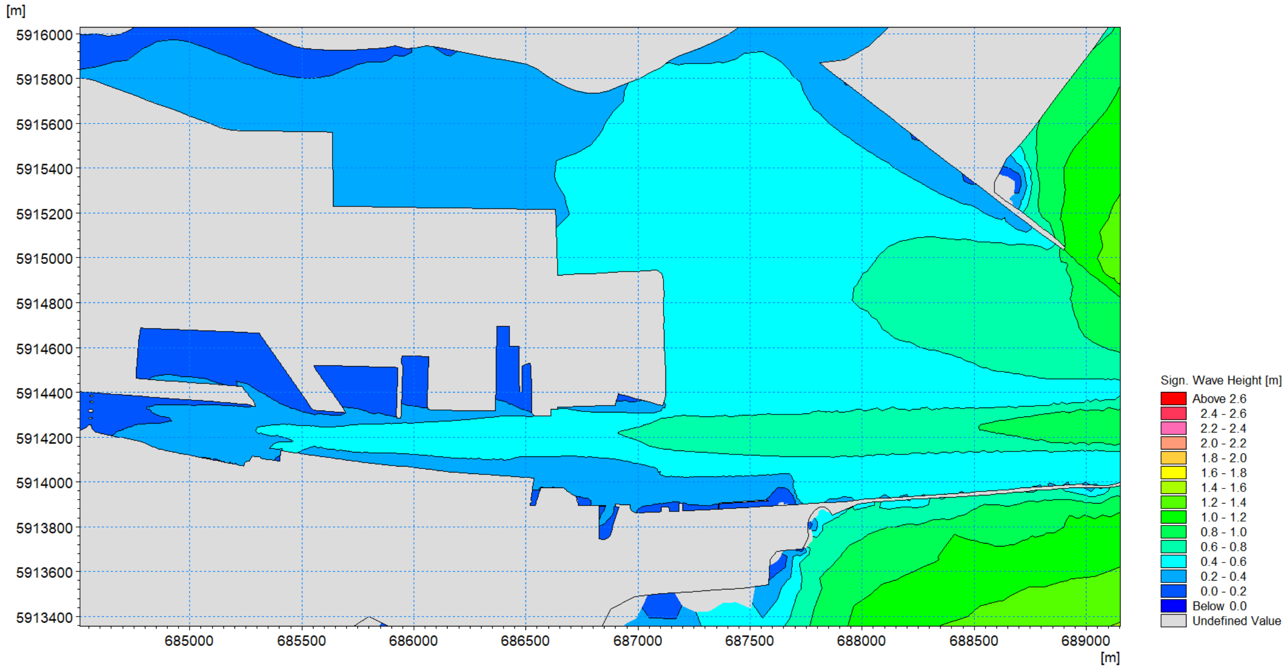

Figure 13.9: North Easterly storm wave heights at spring high water – Pre-3FM Project

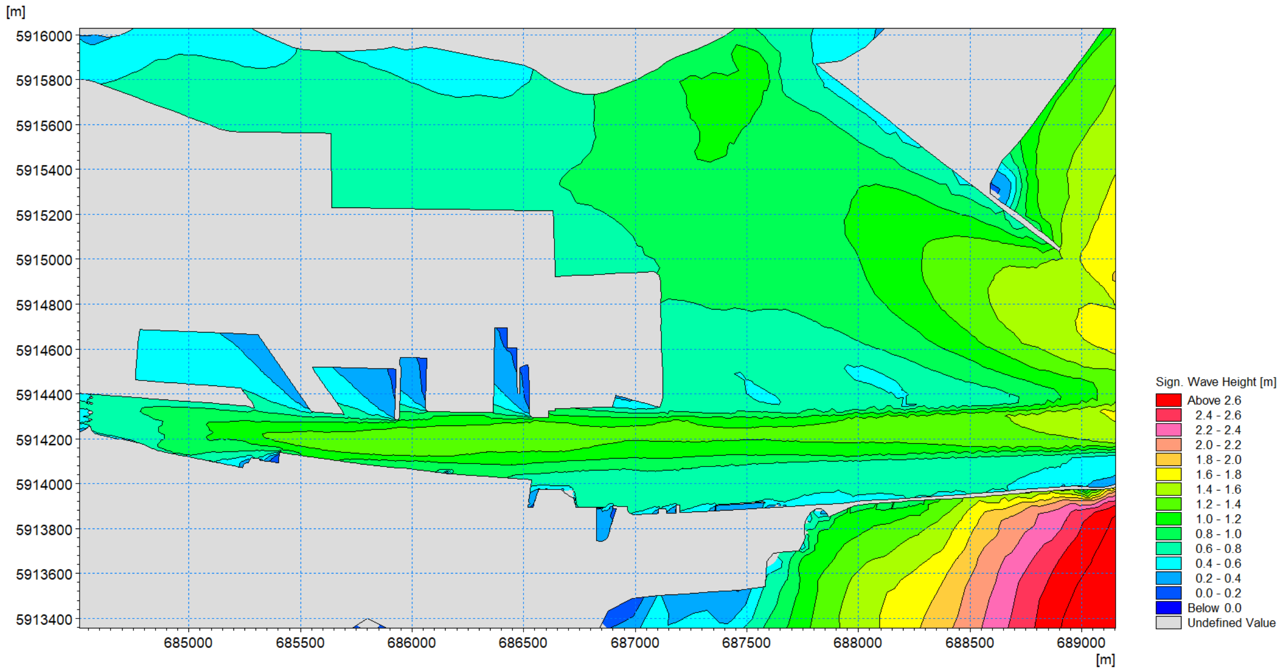

Figure 13.10: Easterly storm wave heights at spring high water – Pre-3FM Project

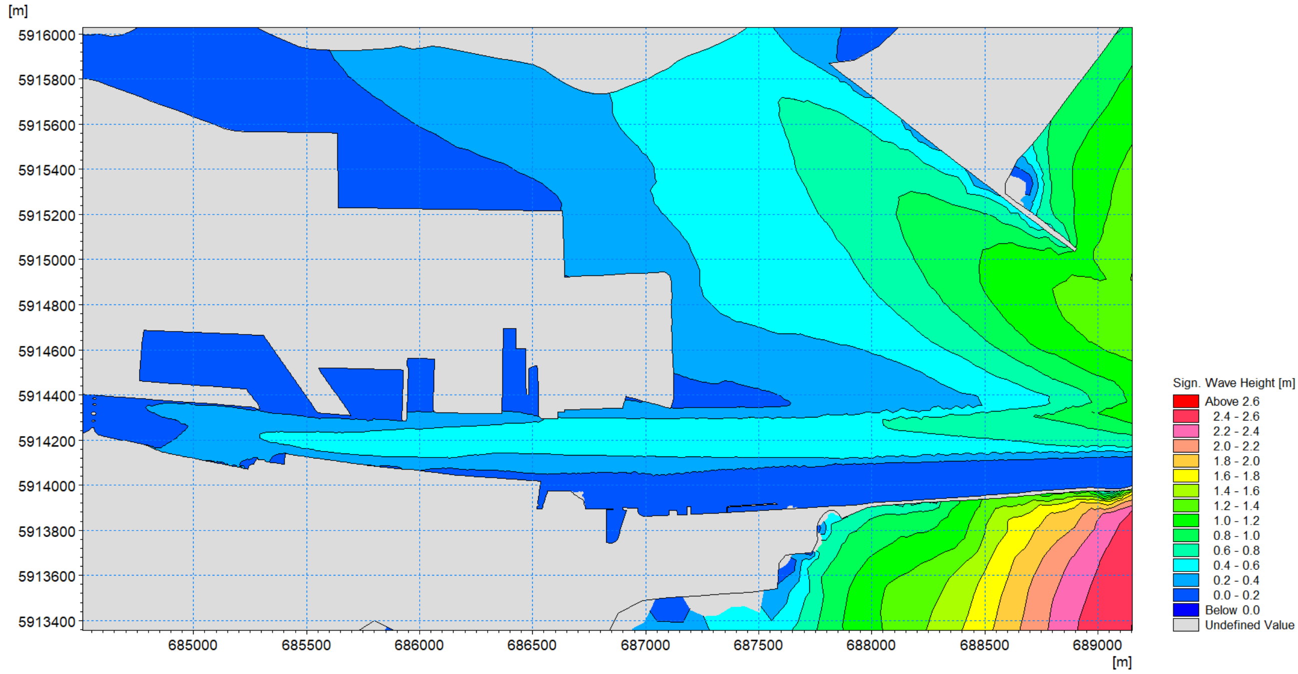

Figure 13.11: South Easterly storm wave heights at spring high water – Pre-3FM Project

13.3.3 Dispersion within Dublin Port (Baseline scenario)

The surrounding waters of Dublin Port are of vital to the operation of several regionally important industrial plants. Water is abstracted from the Liffey by four power plants within the Dublin Port area: the North Wall Station; Synergen – Dublin Bay Power Plant; Covanta Waste to Energy Plant and Poolbeg Power Station. The location of the various power station intake systems is illustrated in Figure 13.12.

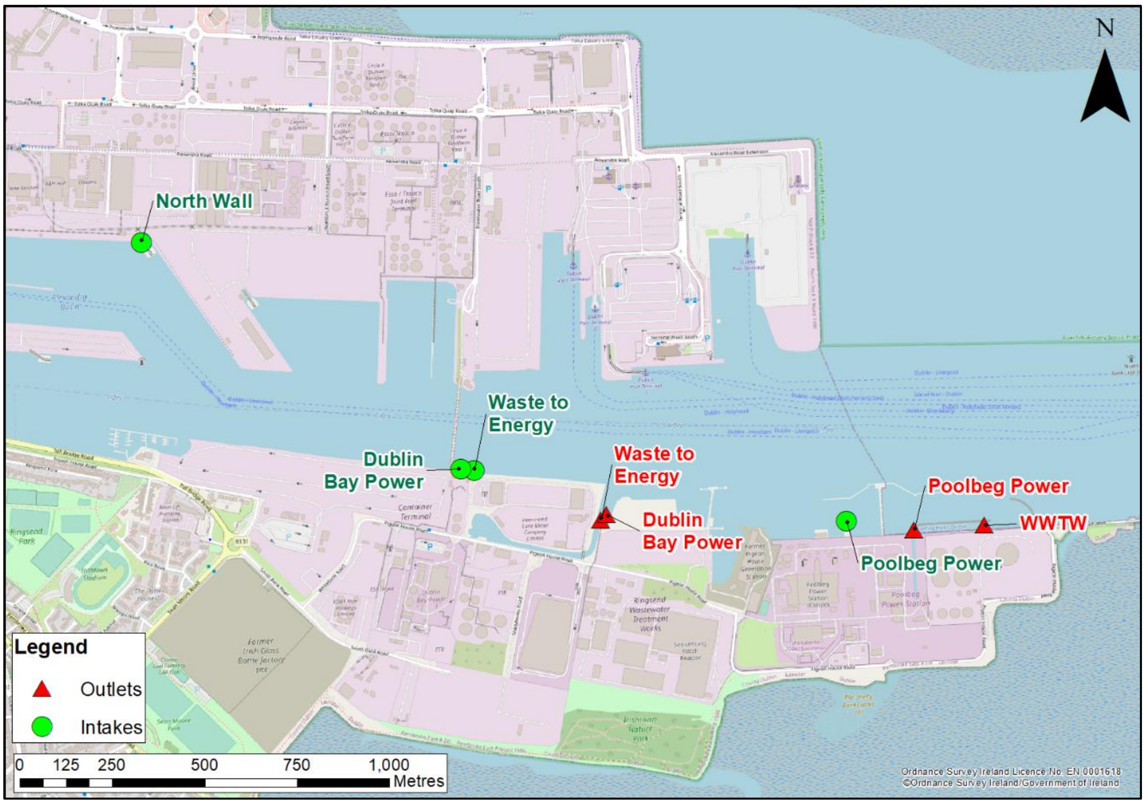

Figure 13.12: Indicative locations of relevant intakes/outfalls within Dublin Port

Water is abstracted as part of the electricity generation process and/or for cooling water components. Any change to the thermal properties of the water abstracted from the Liffey therefore has the potential to impact upon the plant's cooling system which may result in environmental or operational impacts.

The MIKE 3 Hydrodynamic module described in Section 13.2.3 was used in conjunction with the pre-3FM Project scenario (Dublin Port with the ABR & MP2 Projects in place) 3D model to derive baseline thermal plume dispersion information within Dublin Port.

The flow and temperature characteristics for the assets illustrated in Figure 13.12 that discharge into Dublin Port and which were represented in the model are shown in Table 13.4[1]. These variables are based on *measured* maximum discharge characteristics as verified through consultation with relevant stakeholders that operate these assets.

For the purposes of this assessment, the Tolka, Liffey and Dodder river flows were taken as dry weather, low flow conditions (see Table 13.2) as it is during these conditions when least mixing of effluents occur and temperature increases within the water column can be greatest.

Table 13.4 Measured maximum discharge characteristics for relevant assets in Dublin Port

Source	Discharge m^3/s	ΔT degree C	Outlet	Intake
Dublin Bay Power	6.40	+7.60	Spillway	Mid depth
Waste to Energy	3.90	+8.72	Spillway	Mid depth
Poolbeg Power Station	9.00	+6.96	Impoundment with weir	Mid depth
Wastewater Treatment	6.05	+3.00	Impoundment with weir	n/a

Typical thermal plume patterns for the mid–flood, high water, mid-ebb and low water phases of a typical spring tide and spring flood tide are presented in Figure 13.13 through to Figure 13.16. It should be noted that these plots represent thermal plumes in the near surface layer of the water column. Given that warm water is less dense than colder water and therefore floats to the surface, these plots represent a realistic worst case scenario. The depth averaged thermal plumes would therefore be considerably lower than presented in these Figures.

It will be seen from Figure 13.13 through to Figure 13.16 that the increase in surface water temperatures above baseline (i.e., 12°C) is generally less than 4°C within the vicinity of both the Waste to Energy and Poolbeg outfall assets.

It is important to note that these thermal plume plots are based on dry weather, low flow conditions (see Table 13.2). As such, the dispersion of thermal plumes during normal or winter flow conditions would be much more confined to the southern half of the navigation channel.

The dispersion of suspended sediments, associated with construction activities such as dredging and disposal, were also modelled, using the MIKE 3 Hydrodynamic module, to assess any impacts on the sediment transport regime.

[1] Note that the *licensed* maximum discharge characteristics for these assets is presented in Table **13.7**.

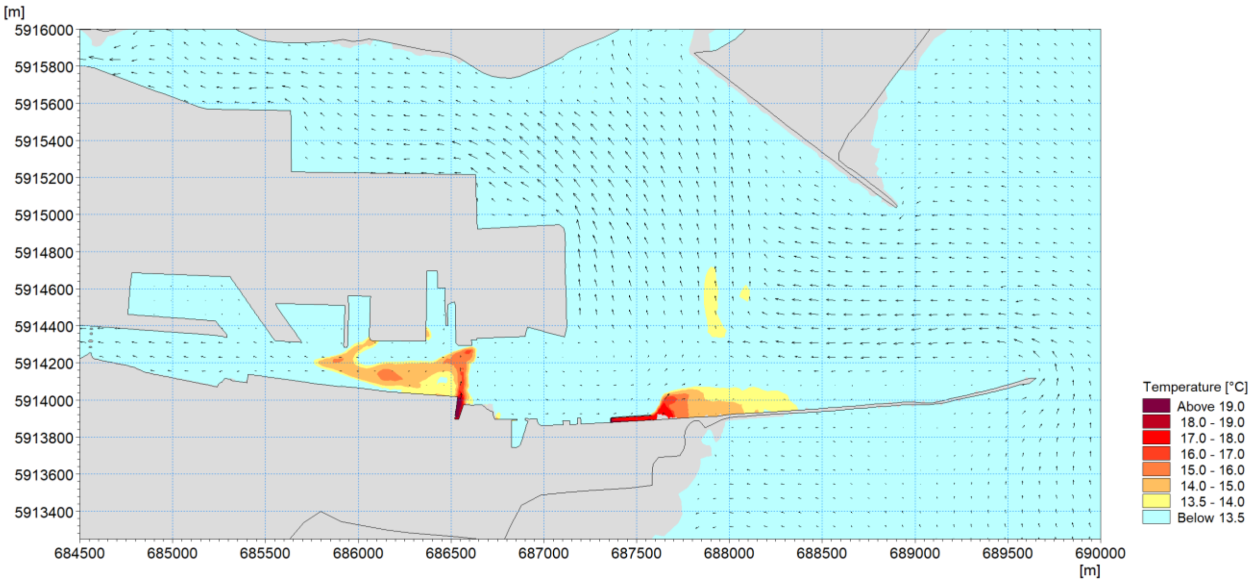

Figure 13.13: Near surface thermal plume envelopes during a typical spring mid flood tide – Pre-3FM Project

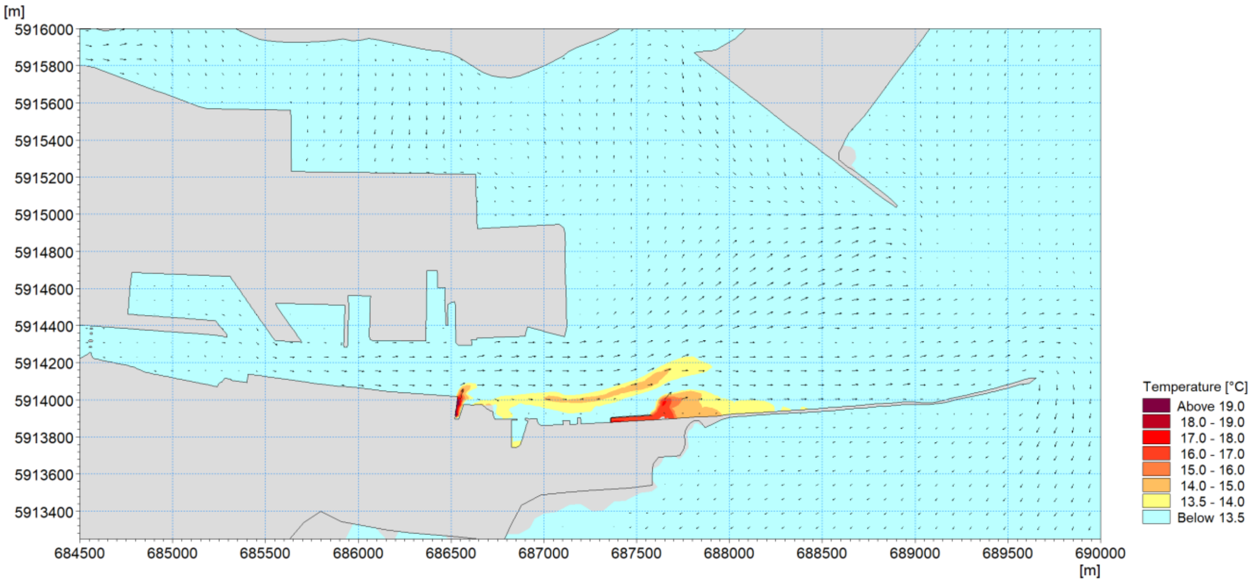

Figure 13.14: Near surface thermal plume envelopes during a typical spring high tide – Pre-3FM Project

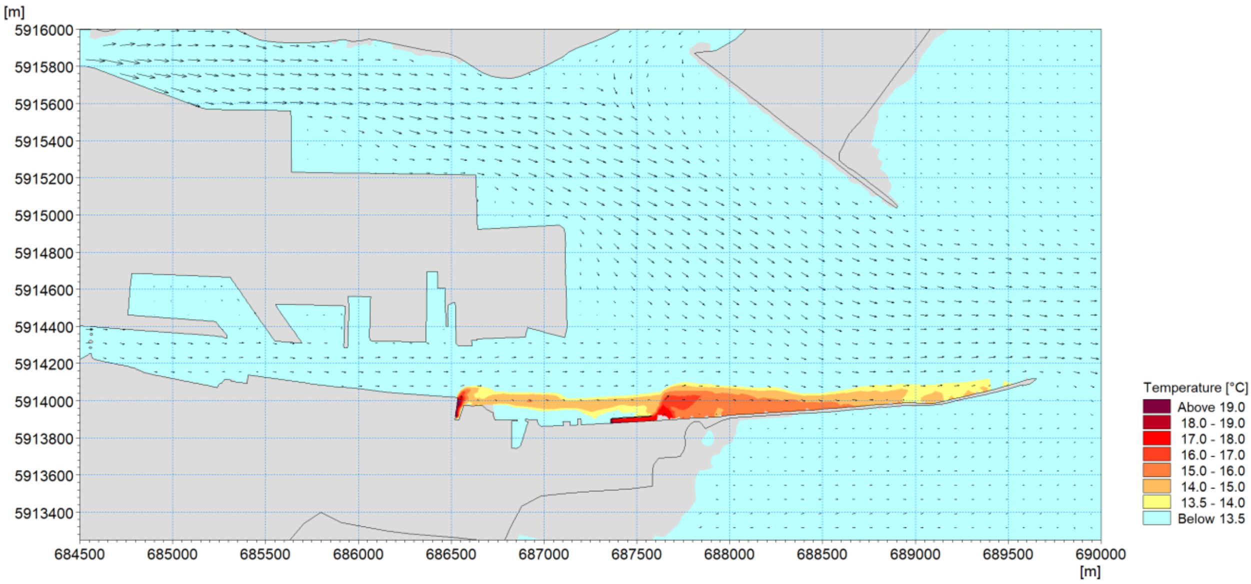

Figure 13.15: Near surface thermal plume envelopes during a typical spring mid ebb tide – Pre-3FM Project

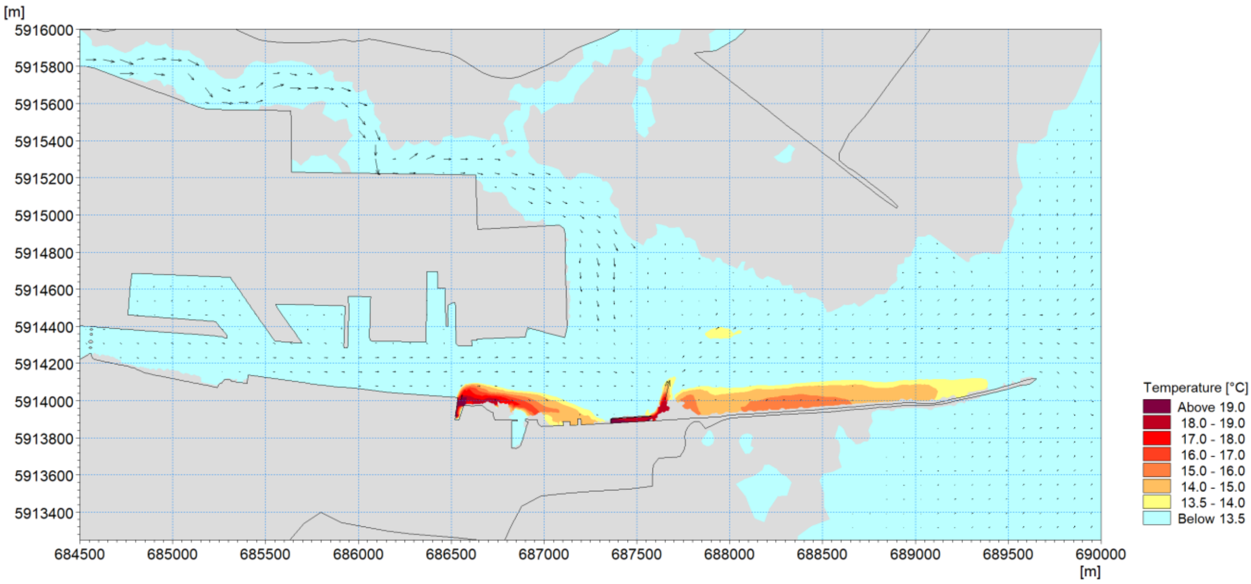

Figure 13.16: Near surface thermal plume envelopes during a typical spring low tide – Pre-3FM Project

13.4 Likelihood of Impacts

The impact on coastal processes arising from the 3FM Project is assessed in relation to the construction phase of the project and the subsequent operational phase. Various elements of construction and operation and the types of impacts on the tidal, wave and sediment transport regimes that they could potentially result in are identified for assessment in the following sections.

The assessment has been informed by a robust numerical modelling programme and, where applicable, hydrographic survey data (see Section 13.2.3) and site-specific water quality monitoring data made available by Dublin Port Company's Environmental Monitoring Programme (ongoing for the ABR & MP2 Projects).

13.4.1 Construction Phase Impacts

The major elements of the construction programme are outlined in Chapter 5. In context of coastal process, the elements of the 3FM Project that have the potential to result in construction phase impacts are outlined below:

- Capital Dredging and Disposal at Sea:
  - Capital dredging works within the navigation channel at:
    - Maritime village & SPAR viaduct.
    - Area K (new Ro-Ro terminal)
    - Turning circle
    - Area N (new Lo-Lo terminal for exports)
  - Disposal of dredge spoil at the dumping site

Temporary impacts on water quality have the potential to occur during the construction phase of the works. Mobilised suspended sediment release through capital dredging and disposal activities are the principal potential sources of environmental impact. The potential impacts from the increase in background suspended sedimentation concentrations and deposition levels as a result of the capital dredging and disposal operations during the construction phase are assessed in Section 13.5.1.

The proposed piling works at Area N are not expected to result in an increase of suspended sediments given that all piles will be driven as opposed to augured. Similarly, the locating piles which are required to secure the positions of the temporary ramp structures at the Turning Circle and Berth 46 will not impact coastal processes owing their streamlined form and close proximity to quay lines whereby current velocities are relatively low.

To accommodate users of the existing 100 berth floating marina during the construction of the Maritime Village, temporary moorings on a chain system will be established on the north side of the navigation channel at North Wall Quay near Berth 18. The impact of this temporary marina on coastal process will be commensurate to that of the existing structure and has therefore not been considered further in this chapter.

13.4.2 Operational Phase Impacts

Port development consisting of the construction of structures and/or changes in the configuration of the seabed bathymetry through capital dredging works has the potential to impact on coastal processes. In context of the 3FM Project, the following elements have the potential to impact on coastal processes:

- Installation of SPAR abutments
- Dredging and re-development at the Maritime village
- Dredging at Area K
- Removal of the nib structure and construction of a Ro-Ro linkspan ramp at Area K.
- Excavation and reclamation work at Pigeon house road
- Dredging at the Turning circle
- Piling and dredging at Area N

In particular, these elements of work have the potential to impact the following coastal processes during the operational phase of the project:

- Tidal current patterns within Dublin Port and Dublin Bay
- Sedimentation and erosion patterns within Dublin Port and Dublin Bay
- The inshore wave climate within Dublin Port and surrounding area
- The dispersion of thermal plumes generated by various power plants within the Dublin Port area
- Prevailing water levels and the existing flood risk in Dublin Port and the surrounding area

The operational phase impacts in context of these coastal processes are assessed in Section 13.5.2.

13.5 Description of Potential Impacts

13.5.1 Construction Phase Impacts

13.5.1.1 Potential Impacts as a result of capital dredging works

As described in Chapter 5, the 3FM Project will include:

- Capital dredging to achieve a depth of -3 m CD at the Maritime Village.
- Localised dredging at Area K to facilitate the placement of scour protection.
- Capital dredging at Pigeon House road to create a -10.0m CD deep 325 m diameter turning circle.
- Capital dredging at Area N to -13.0 m CD to create a new 800 m berthing pocket for container vessels and to -3.0 m CD to accommodate construction activities.

All proposed dredging works are on the southern side of the navigation channel as shown in Figure 13.17. The dredging operations will result in the removal of 1,189,000 m^3 of marine sediments for disposal at sea. A breakdown of the dredging requirements is presented in Table 13.5.

Notwithstanding the application of extensive mitigation measures, the process of dredging unavoidably causes disturbance of sediment on the channel bed and dispersal of some material in the water column. Disposal of dredge spoil at the licenced dumping site in Dublin Bay also results in sediment release. These losses may have potential impacts on biodiversity (Chapter 7) and water quality (Chapter 9) in the form of a suspended sediment plume within the water column. The potential impacts arising from these factors has therefore been assessed in the following sections of the report.

A chemical sediment analysis of the sediments to be dredged from the Port's navigation channel and basins found that the material is suitable for conventional dumping at sea. However, at Maritime village, the Marine Institute has recommended that the top 1.0 m of sediment is taken ashore, stabilised and reused within the Port Estate, where possible (see Chapter 8 Land, Solis, Geology and Hydrogeology).

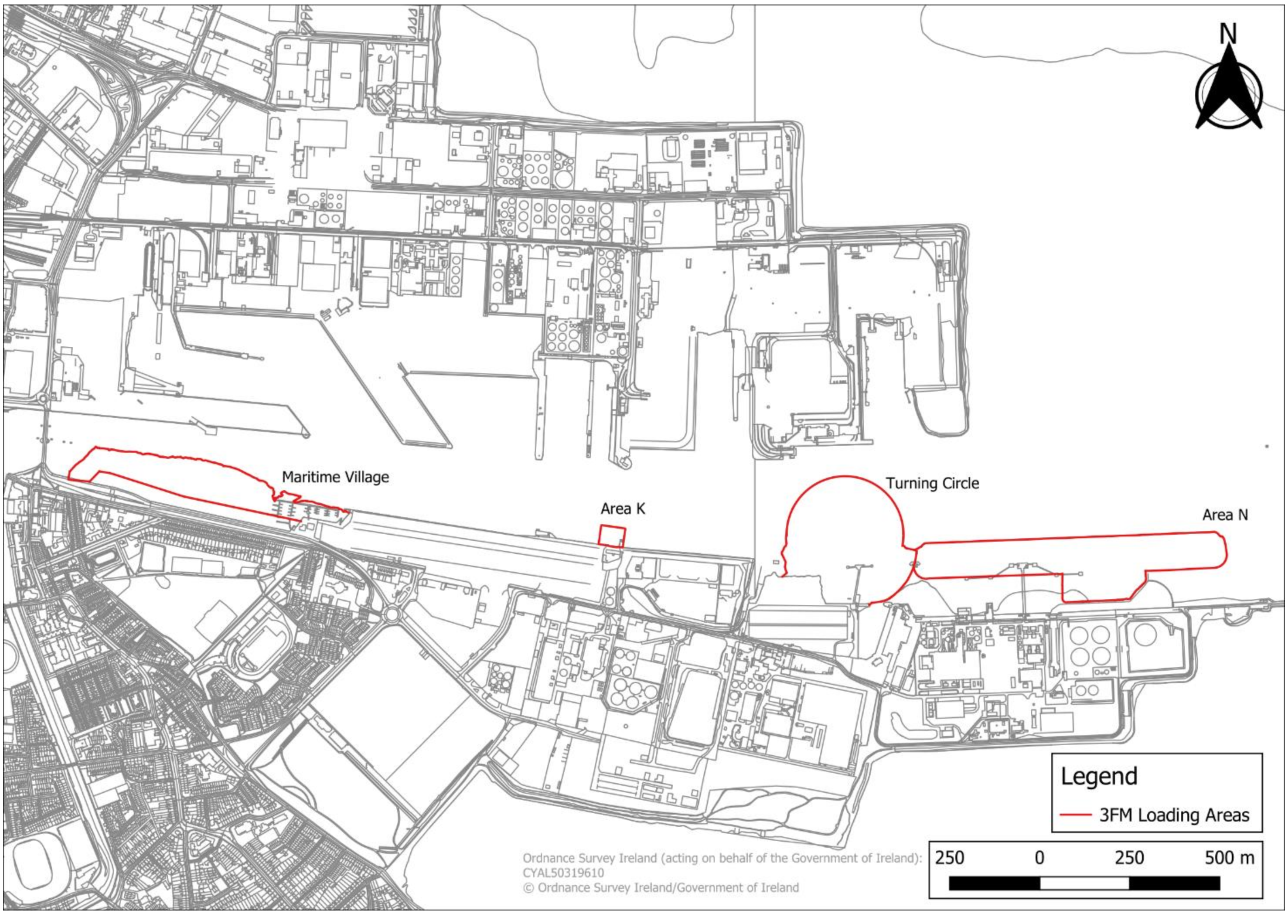

Figure 13.17: 3FM Project Dredging Areas

Table 13.5 Breakdown of dredging requirements for the 3FM Project

Location	Dredged Depth	Volume
Maritime Village – *capital dredging*	-3.0 m CD	197,000 m^3
Area K - Ro-Ro Terminal – *Localised Scour Protection to 220 kV cables*	-12.5 m CD	13,000 m^3
Turning Circle – *capital dredging*	-10.0m CD	444,000 m^3
Area N - Lo-Lo Terminal Berthing Pocket – *capital dredging*	-13.0 m CD	533,000 m^3
	-3.0 m CD	72,000 m^3
Total Dredge Volume		**1,259,000 m^3**
Volume not suitable for disposal at sea (top 1.0m at Maritime Village)		**70,000 m^3**
Total Dredge Volume suitable for disposal at sea		**1,189,000 m^3**

Particle Size Analysis described in Chapter 8 (Land, Solis, Geology and Hydrogeology) indicated that the material to be dredged as part of the 3FM Project is comprised of three discrete fractions with mean diameters of 200 µm, 20 µm and 3 µm, with each fraction constituting approximately 1/3 of the total volume of sediment to be dredged.

Extensive water quality monitoring using real time turbidity measurements recorded during previous dredging campaigns (Dumping at Sea Permits S0024-01 AER 2017 through to AER 2022) has shown that during disposal of dredged fine sands at the licensed disposal site, the fine sand falls rapidly to the bottom and any sediment plume is short lived and is not widely dispersed. However, sediments to be dredged in the 3FM Project are finer and contain a substantial silt fraction.

Therefore, plume modelling was undertaken for the silt fractions with silt losses of 1% at the dredger head being introduced as a sediment source in the bottom layer of the model. The other key parameters relating to the dredging simulations presented in the following Sections of this Chapter are set out in Table 13.6.

As the Liffey channel in Dublin Port is influenced by several fresh water river inflows and by water discharged into or abstracted from various outfall and intake assets, stratification of the water column can occur under certain tidal conditions in the Liffey channel particularly in the central section of the harbour. Therefore, the plume modelling simulations were undertaken using the MIKE 3 Hydrodynamic model described in Section 13.2.3. This model was coupled with the Sediment Transport module and included temperature and salinity effects. For the purposes of sediment dispersion modelling, i.e., the assessment of dredging operations, the Tolka, Liffey and Dodder river flows were taken as the winter average flows (Table 13.2).

The flow and temperature characteristics for the power station and other assets that discharge into Dublin Port and which were represented in the model are shown in Table 13.7. These variables are based on licensed maximum discharge characteristics as described in relevant Integrated Pollution Control (IPC) licenses issued by the Environmental Protection Agency (EPA) and verified through consultation with relevant stakeholders that operate these assets.

Four individual simulations were run to simulate the dredging operations at Area A, Area K, the Turning Circle and within the vicinity of the Maritime Village and the SPAR. Each simulation was run for a period of one month to represent sediment dispersion across all tidal conditions with results then being scaled according to represent the full dredging operation in each area. The output from these simulations is presented in the following Sections of this chapter.

Table 13.6 Dredging simulation input parameters

Parameter	Value
Trailer Suction Hopper Dredger capacity	4,100 m^3
Ratio of sediment/entrained water during loading	0.3
Average density of material inside hopper	1.65 t/m^3
Average Trip Frequency between Dublin Port and Disposal site	3.0 hours
Average Time to Fill Dredger Hopper	1.5 hours
Time to release load	90 seconds
Overspill Trailer Suction Hopper Dredger – **Hopper**	0%
Sediment loss at Trailer Suction Hopper Dredger – **Dredge head**	1% of silts

Table 13.7 Licensed maximum discharge characteristics for relevant assets in Dublin Port

Source	Discharge m³/s	ΔT degree C	Outlet	Intake
Dublin Bay Power	8.40	9.50	Surface layer	Mid depth
Waste to Energy	6.60	9.50	Surface layer	Mid depth
Poolbeg Power Station	12.00	14.00	Surface layer	Surface layer
Wastewater Treatment	8.04	n/a	Surface layer	n/a

In line with the 3FM Draft Construction Environmental Management Plan (CEMP) no over-spill from the dredger's hopper was included in any of the four model simulations. As customary, DPC will continue to notify the power station operators in advance of each dredging campaign. This will allow operators to temporarily stop abstracting water from the Liffey for a short duration in the event that dredging is required within the immediate vicinity of their intake works.

Other key relevant mitigation measures that will apply to each dredging campaign in the 3FM Project are presented in Section 13.6.1.

Dredging at within the vicinity of Maritime Village and the SPAR

The dispersion of silts during ongoing dredging is illustrated by a series of plume diagrams that show the suspended sediment concentration of silt in the water column resulting from the dredging operations. Figure 13.18 to Figure 13.21 represent the dispersion of silt material at times of low water, mid flood, high water and mid ebb at a time during the simulated dredging campaign when the suspended sediment concentrations may be expected to be at their highest values (i.e., when the dredger is active at the site).

These figures show that the suspended sediment concentration plumes are confined to the southern half of the navigation channel at all times. The sediment concentrations of the plumes are generally less than 75 mg/l beyond the immediate dredge area. The lateral extent of the 10 mg/l plume envelope is generally less than 600 m under most tidal conditions but can reach *c.*900 m during certain spring mid-flood conditions. Suspended sediment plumes did not extend beyond the corner of Capital Dock during the 1 month simulation period.

Monitoring of the Liffey and Tolka Estuaries between East Link Bridge and the entrance to the Port at Poolbeg Lighthouse has been undertaken by the ABR and MP2 Projects (see Chapter 9 Water Quality and Flooding). Measurements of turbidity at the North Bank Light (adjacent to the Tolka Estuary) over the period 2017 – 2022 have ranged from 0 to 163 NTU with a 95%ile value of 15.0 NTU and a mean of 3.9 NTU (n=169,576)[2]. This equates to a suspended solids range of 0 to 400 mg/l with a 95%ile value of 37.5 mg/l and a mean of 9.75 mg/l. While there is a relatively small and very local predicted increase in suspended solids due to dredging at the Maritime Village, this falls within the background range measured close to this location during normal Port operations.

[2] Maximum and minimum values in the range reflect extreme outlier values they are not representative of general ambient water quality. The percentile values listed give a more robust indication of the true dispersal of the measurements, and clearly most of the measurements (90% of them) range between 0 NTU and the 95 percentile value of 15 NTUs.

The predicted deposition of the silt fractions lost to the water column during the dredging of the Maritime Village at the end of a simulated one-month dredging campaign is presented in Figure 13.22. This Figure shows that there is virtually no sediment material deposited outside of the dredge area and that the deposition of sediment is generally confined to within the immediate area of the dredging operation where deposition levels can reach up to 128 g/m^2. It should be noted that dredging proceeds until the specified design depth is reached and any material deposited within the dredge area will be removed by the dredger until the specification is met.

The estimated natural sediment load from the upstream Liffey catchment is estimated at about 200,000 tonnes per annum (DPC Maintenance Dredge AER 2022, Dumping at Sea Permit S0004-02). If dispersed over the Port area between East Link and Poolbeg Light and the Tolka Estuary this is roughly equivalent to a natural sediment load of 30 kg/m^2 in any year. The small level of deposition predicted as a result of dredging at the Maritime Village is therefore highly unlikely to pose any risk through siltation.

It can, therefore, be concluded that the dredging operations required for the Maritime Village will not result in any significant impact to either the water quality in terms of suspended sediments, or the nearby environmentally designated areas in terms of sediment deposition.

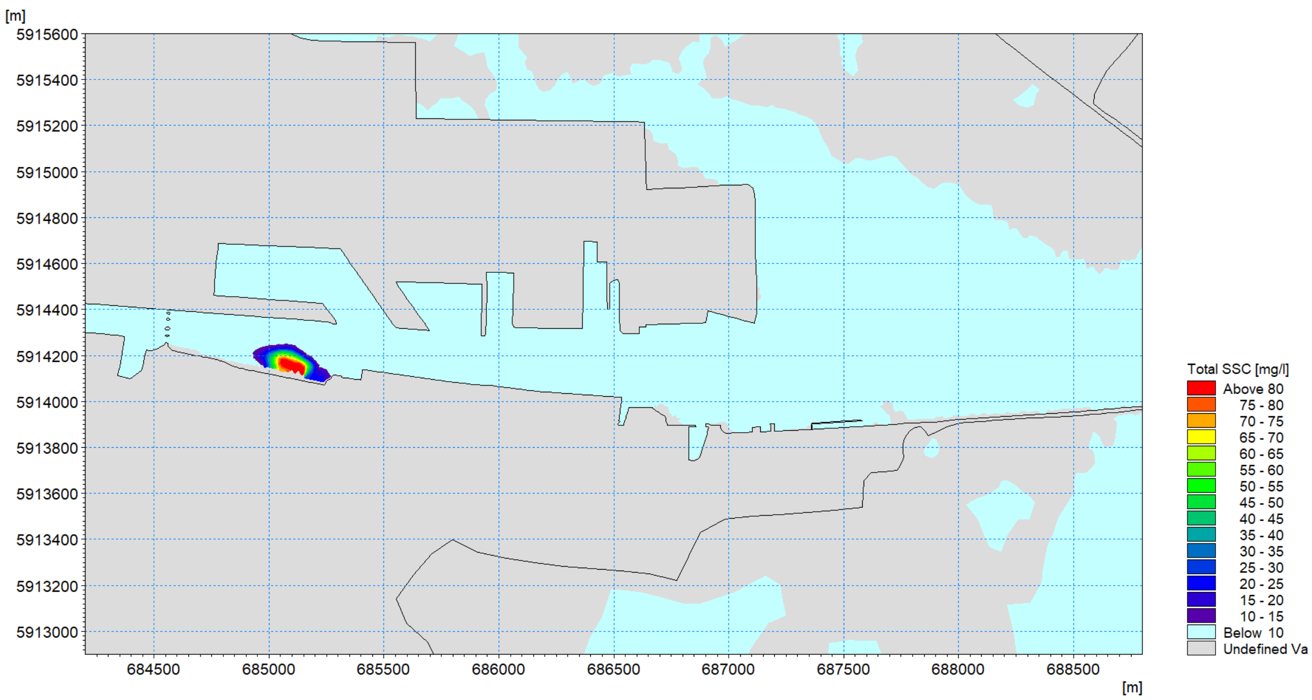

Figure 13.18: Suspended sediment concentration plume in the bottom layer during a typical low water phase of a spring tidal cycle whilst dredging the Maritime Village

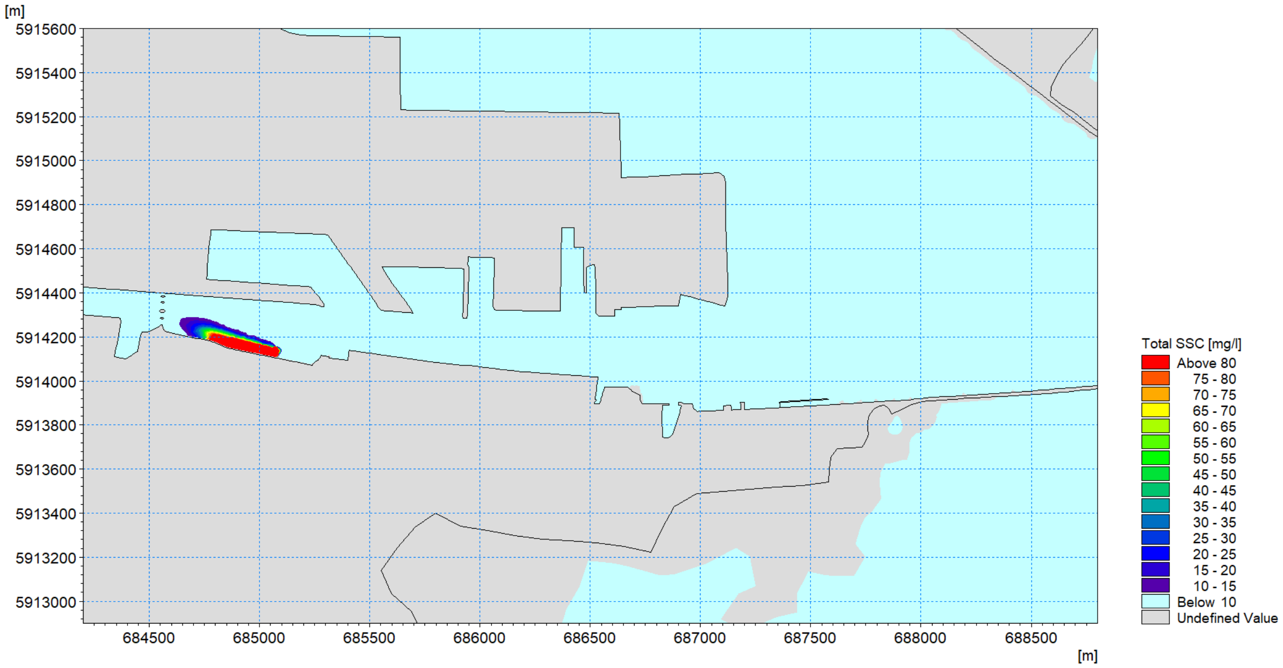

Figure 13.19: Suspended sediment concentration plume in the bottom layer during a typical mid flood phase of a spring tidal cycle whilst dredging the Maritime Village

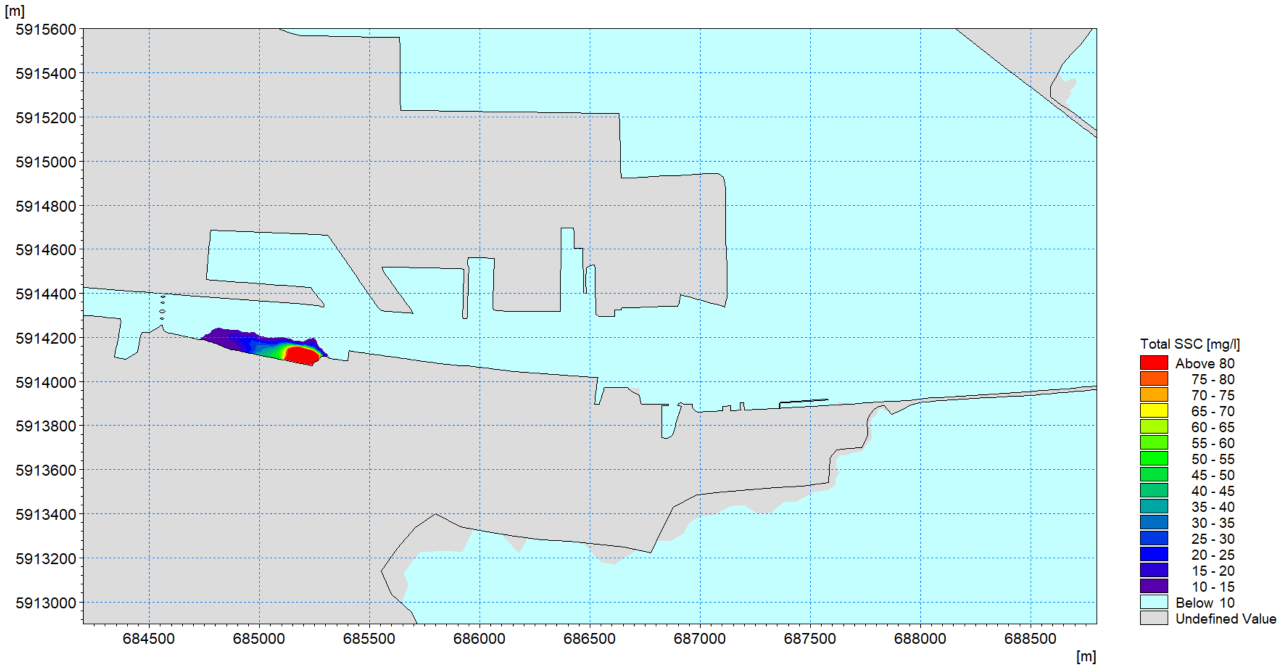

Figure 13.20: Suspended sediment concentration plume in the bottom layer during a typical high water phase of a spring tidal cycle whilst dredging the Maritime Village

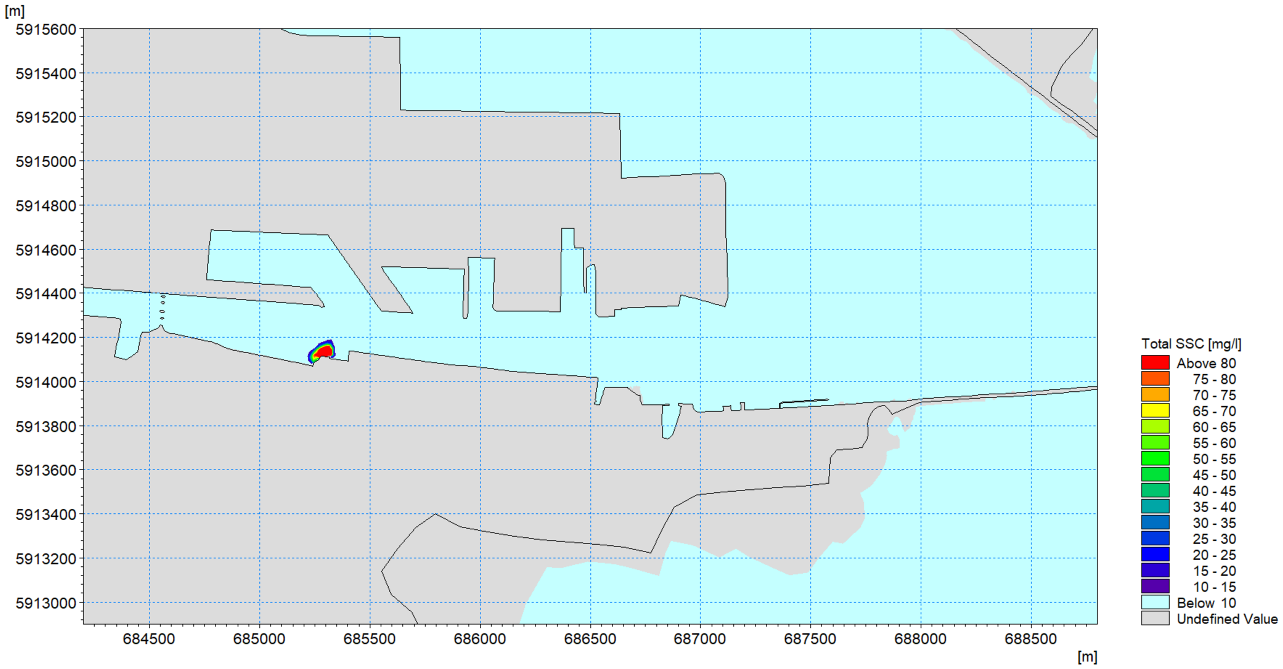

Figure 13.21: Suspended sediment concentration plume in the bottom layer during a typical mid ebb phase of a spring tidal cycle whilst dredging the Maritime Village

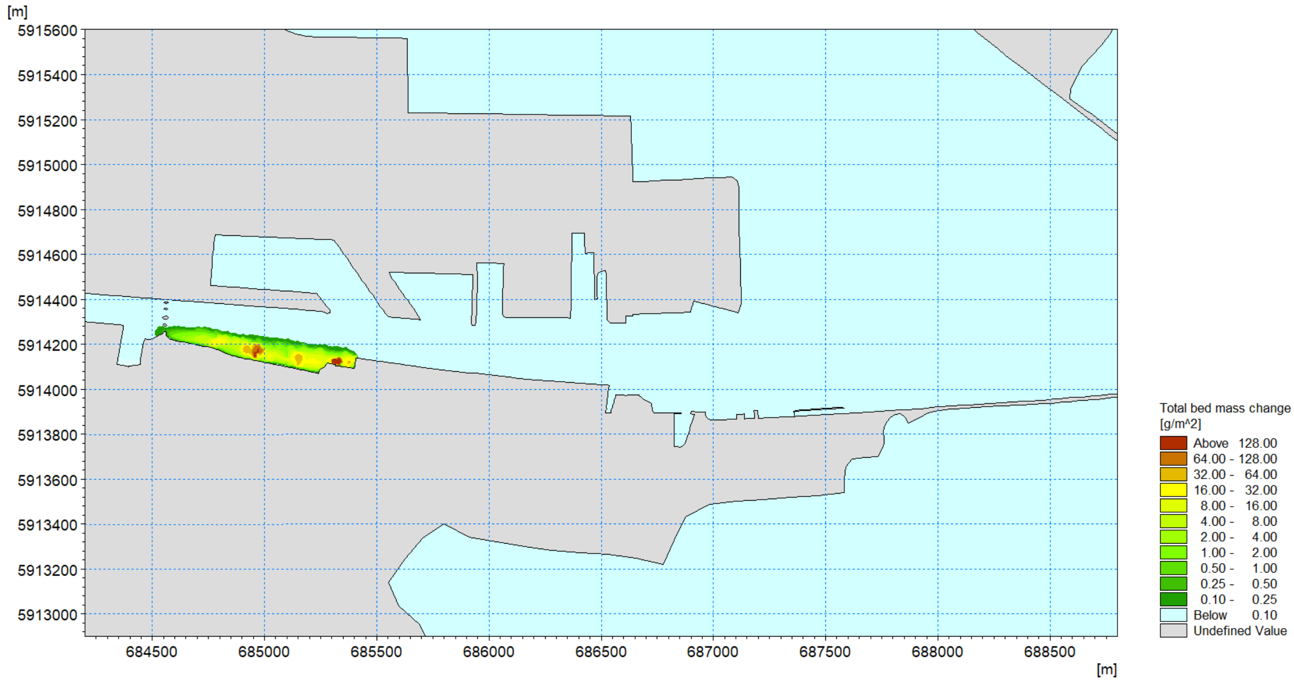

Figure 13.22: Deposition of sediment following the dredging operations at the Maritime Village

Dredging at Area K

The impact of dredging at Area K on suspended sediment concentrations is shown by a series of plume diagrams. Figure 13.23 to Figure 13.26 represent the dispersion of silt material at times of low water, mid flood, high water and mid ebb at a time during the dredging operation when the suspended sediment concentrations may be expected to be at their highest values (i.e., when the dredger is active at the site).

It will be seen from these figures the suspended sediment concentration plumes are confined to the southern half of the navigation channel. The sediment concentration of the plumes is generally less than 35 mg/l beyond the immediate dredge area. As set out in the previous section, this is a relatively small and very local predicted increase in suspended solids due to the dredging works and is well within the background range experienced at this location during normal Port operations. The lateral extent of the 10 mg/l plume envelope is generally less than 500 m under most tidal conditions.

The predicted deposition of the silt fractions lost to the water column following the dredging campaign at Area K is presented in Figure 13.27. This Figure shows that the volume of material deposited following the dredge operations is generally less than 10.0 g/m^2 and that the deposition of sediment is generally confined to within the immediate area of the dredging operation. By comparison with natural background sediment loads (previous section) such a small level of deposition is highly unlikely to pose any risk through siltation and no further mitigation is required. Again, any material deposited within the dredge area will be removed by the dredger until the specification is met.

It can, therefore, be concluded that, when considered in terms of background conditions, the dredging operations required for Area K will not result in any significant impact to either the water quality in terms of suspended sediments, or the nearby environmentally designated areas in terms of sediment deposition. No further mitigation is required.

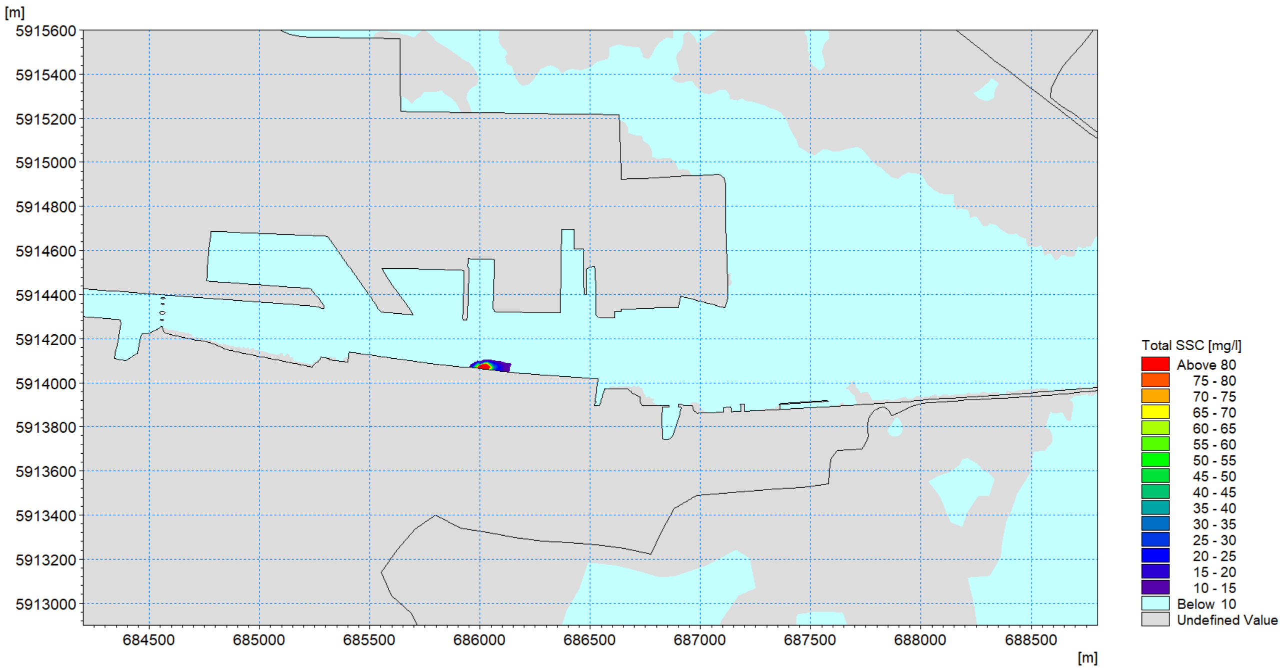

Figure 13.23: Suspended sediment concentration plume in the bottom layer during a typical low water phase of a spring tidal cycle whilst dredging Area K

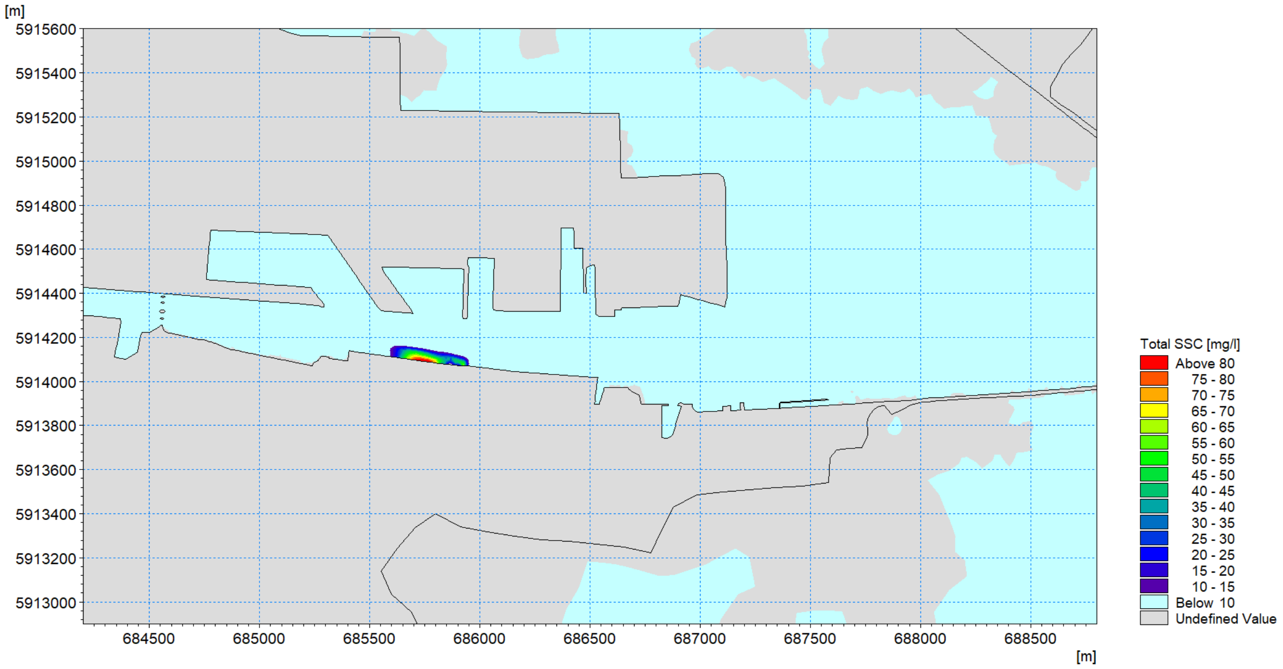

Figure 13.24: Suspended sediment concentration plume in the bottom layer during a typical mid flood phase of a spring tidal cycle whilst dredging Area K

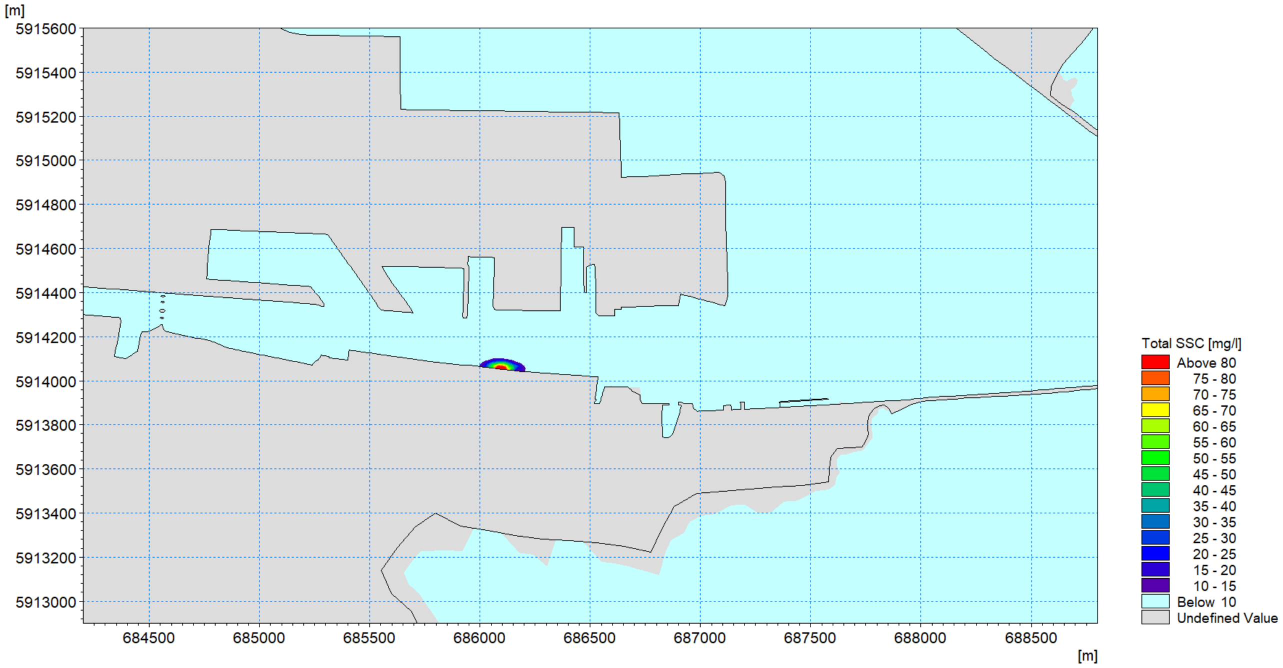

Figure 13.25: Suspended sediment concentration plume in the bottom layer during a typical high water phase of a spring tidal cycle whilst dredging Area K

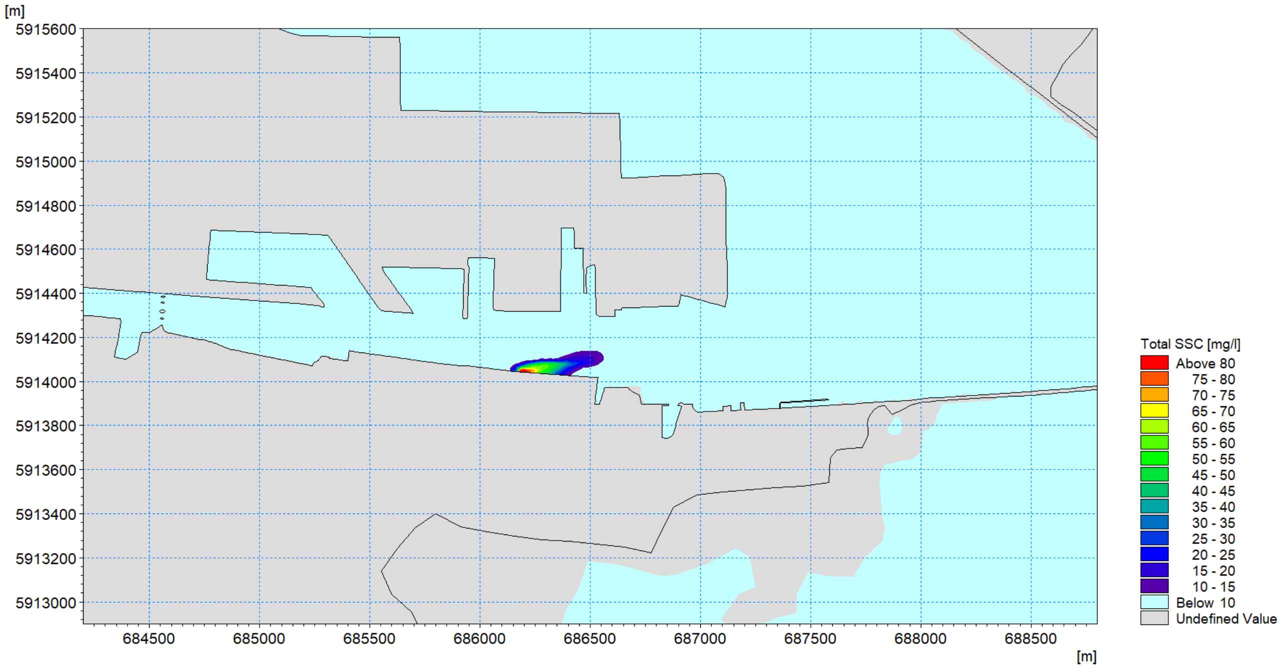

Figure 13.26: Suspended sediment concentration plume in the bottom layer during a typical mid ebb phase of a spring tidal cycle whilst dredging Area K

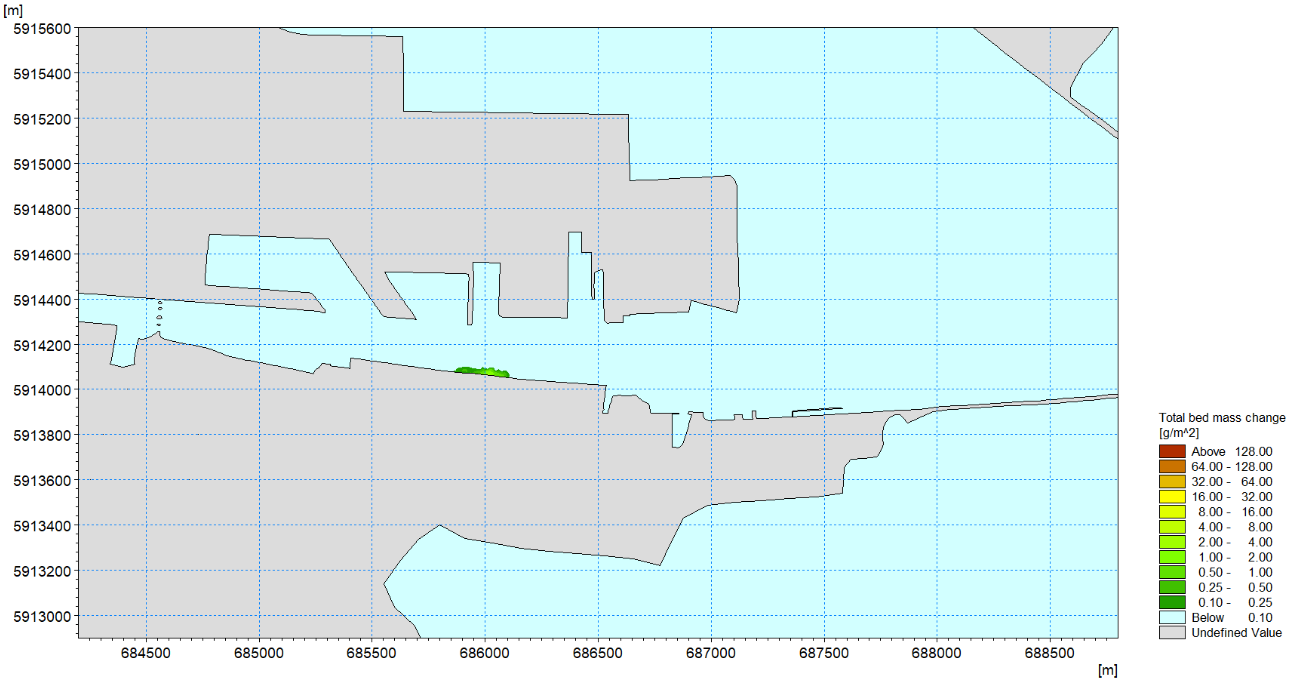

Figure 13.27: Deposition of sediment following the dredging operations at Area K

Dredging at the Turning Circle

The impact of dredging at the Turning Circle on suspended sediment concentrations is shown by a series of plume diagrams. Figure 13.28 to Figure 13.31 represent the dispersion of silt material at times of low water, mid flood, high water and mid ebb at a time during the dredging operation when the suspended sediment concentrations may be expected to be at their highest values (i.e., when the dredger is active at the site).

It will be seen from these figures that the concentration of suspended sediment plumes is greater in this area relative to suspended sediment concentrations associated with dredging works at the Maritime Village and Area K. This can be attributed to shallow water depths close inshore at Pigeon House. Even with shallow water depths, the suspended sediment concentration plumes are confined to the southern half of the navigation channel. The sediment concentration of the plumes is generally less than 25 mg/l beyond the immediate dredge area.

As set out previously, this is a relatively small and very local predicted increase in suspended solids due to the dredging works and is well within the background range experienced during normal Port operations. The lateral extent of the 10mg/l plume envelope is generally less than 500 m under most tidal conditions.

The predicted deposition of the silt fractions lost to the water column following the dredging campaign at the Turning Circle is presented in Figure 13.32. This Figure shows that the volume of material deposited following the dredge operations is generally less than 32.0 g/m^2 and that the deposition of sediment is generally confined to within the immediate area of the dredging operation. By comparison with natural background sediment loads (see previous section) such a small level of deposition is highly unlikely to pose any risk through siltation and no further mitigation is required.

It can, therefore, be concluded that, when considered in terms of background conditions, the dredging operations required for the Turning Circle will not result in any significant impact to either the water quality in terms of suspend sediments, or the nearby environmentally designated areas in terms of sediment deposition. No further mitigation is required.

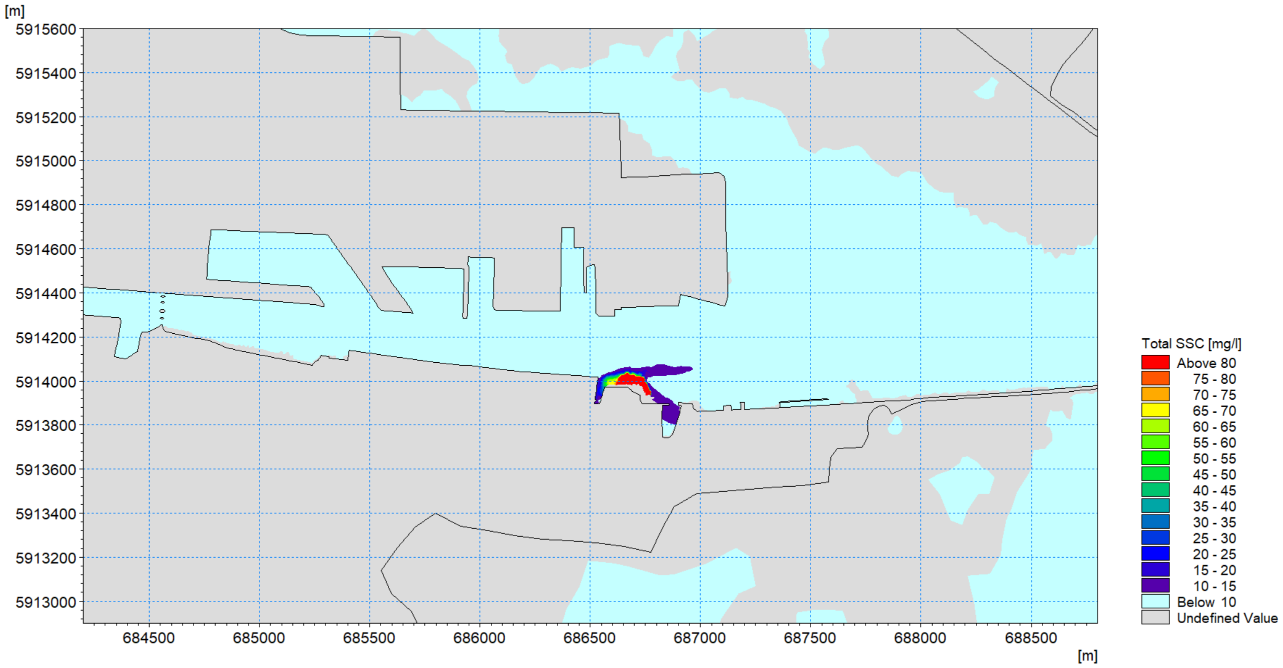

Figure 13.28: Suspended sediment concentration plume in the bottom layer during a typical low water phase of a spring tidal cycle whilst dredging the Turning Circle

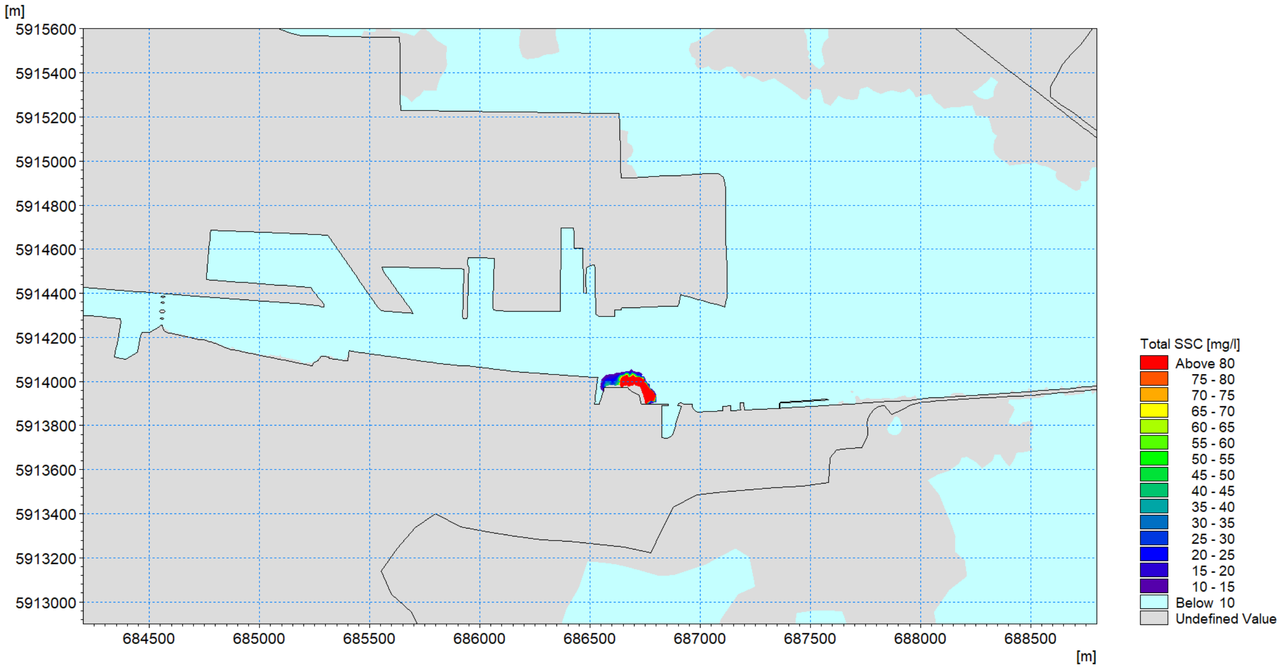

Figure 13.29: Suspended sediment concentration plume in the bottom layer during a typical mid flood phase of a spring tidal cycle whilst dredging the Turning Circle

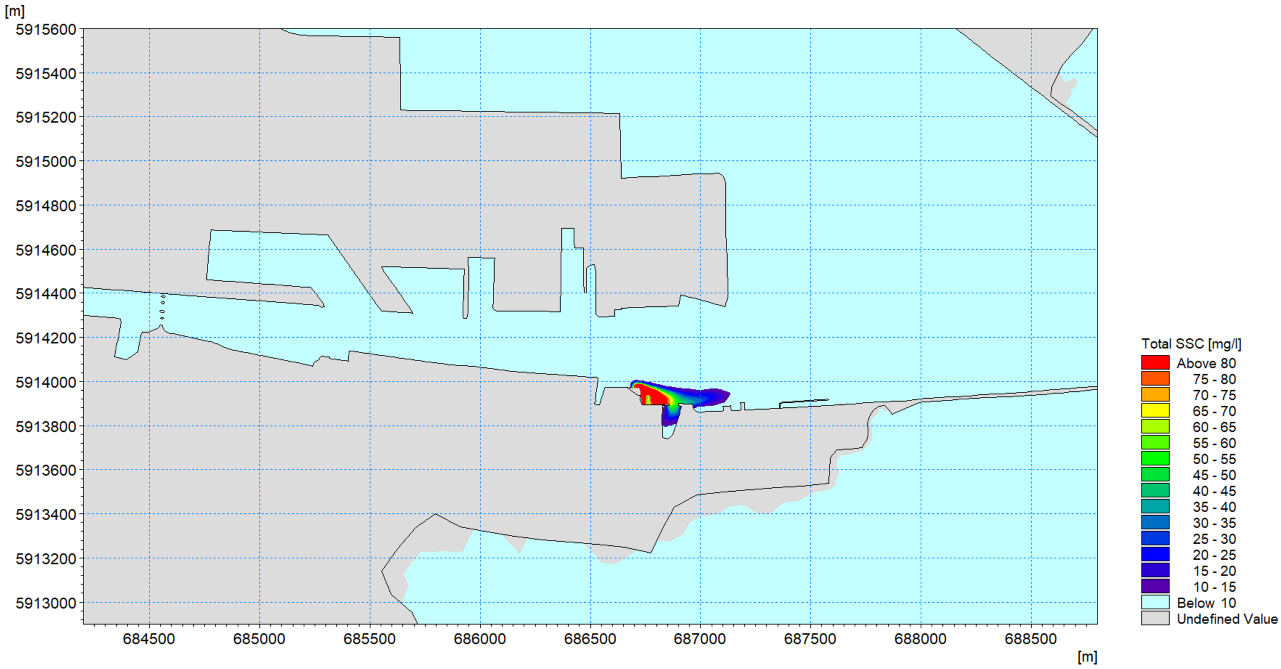

Figure 13.30: Suspended sediment concentration plume in the bottom layer during a typical high water phase of a spring tidal cycle whilst dredging Turning Circle

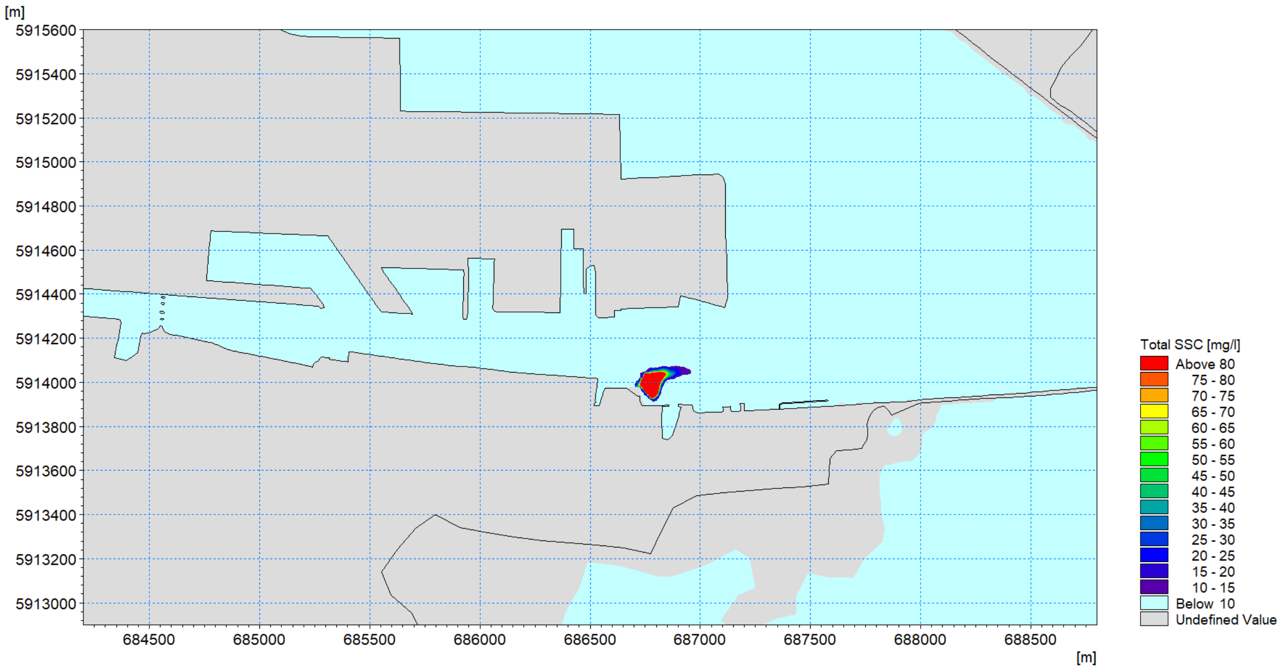

Figure 13.31 Suspended sediment concentration plume in the bottom layer during a typical mid ebb phase of a spring tidal cycle whilst dredging the Turning Circle

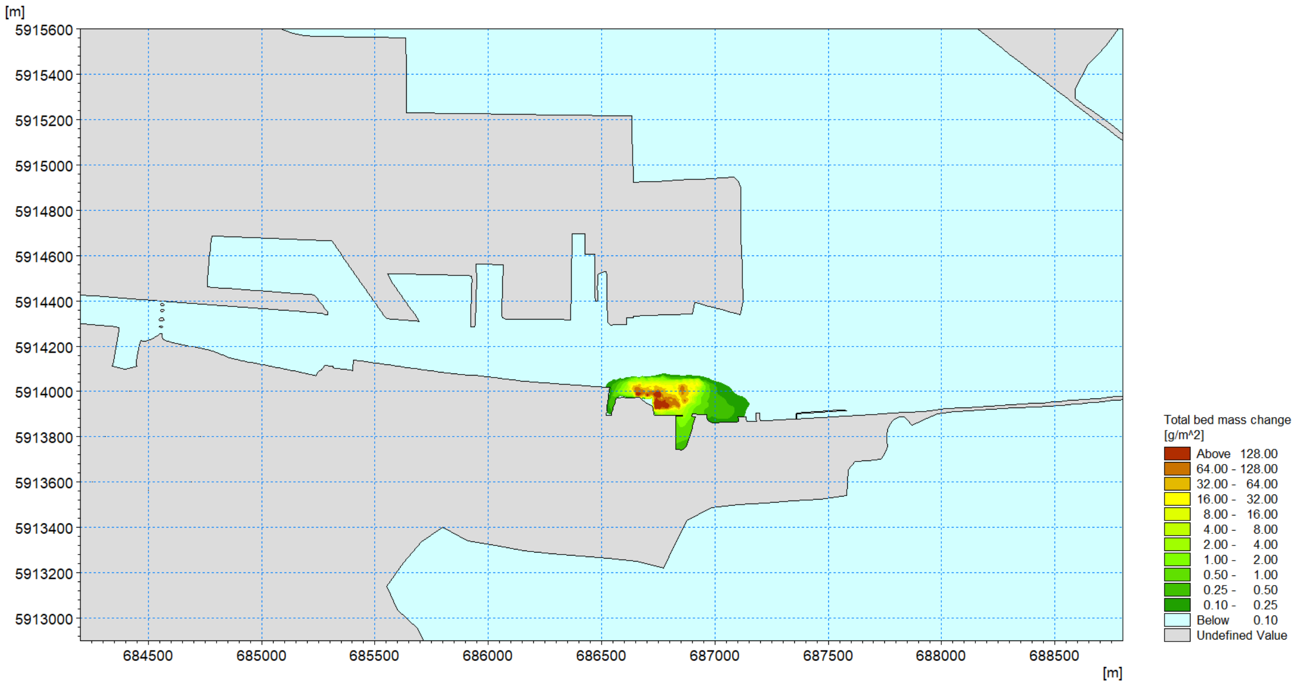

Figure 13.32: Deposition of sediment following the dredging operations at the Turning Circle

Dredging at Area N

The impact of dredging the berthing pocket at Area N on suspended sediment concentrations is shown by a series of plume diagrams. Figure 13.33 to Figure 13.36 represent the dispersion of silt material at times of low water, mid flood, high water and mid ebb at a time during the dredging operation when the suspended sediment concentrations may be expected to be at their highest values (i.e., when the dredger is active at the site).

It will be seen from these figures the suspended sediment concentration plumes are confined to the southern half of the navigation channel. The sediment concentration of the plumes is generally less than 30 mg/l beyond the immediate dredge area. As set out in the previous section, this is a relatively small and very local predicted increase in suspended solids due to the dredging works and is well within the background range experienced at this location during normal Port operations. The lateral extent of the 10 mg/l plume envelope is generally less than 750 m under most tidal conditions.

The predicted deposition of the silt fractions lost to the water column following the berthing pocket dredging campaign at Area N is presented in Figure 13.37. This Figure shows that the volume of material deposited following the dredge operations is generally less than 16.0 g/m^2 and that the deposition of sediment is generally confined to within the immediate area of the dredging operation.

Similarly, the impact of dredging construction access at Area N on suspended sediment concentrations is shown in Figure 13.38 to Figure 13.41 for the same four stages of the tide when the dredger is active at the site. It should be noted that the dredging volume for the construction access is significantly less than the berthing pocket, i.e. less than 15% and would therefore occur over a much shorter period, typically less than one week. The sediment concentration of the plumes is generally less than 60 mg/l beyond the immediate dredge area with the greatest increases for short periods during the flood tide when the sediment is advected into much shallower water. The volume of material deposited following the construction access dredging operation is in the same order as the berthing pocket i.e. generally less than 16.0 g/m^2. This is presented in Figure 13.42 and illustrates that deposition occurs in the immediate vicinity of the works and would not accumulate with the deposition associated with berthing pocket dredging at Area N.

By comparison with natural background sediment loads (previous section) such a small level of deposition is highly unlikely to pose any risk through siltation and no further mitigation is required. Again, any material deposited within the dredge area will be removed by the dredger until the specification is met.

It can, therefore, be concluded that, when considered in terms of background conditions, the dredging operations required for Area N will not result in any significant impact to either the water quality in terms of suspend sediments, or the nearby environmentally designated areas in terms of sediment deposition. No further mitigation is required.

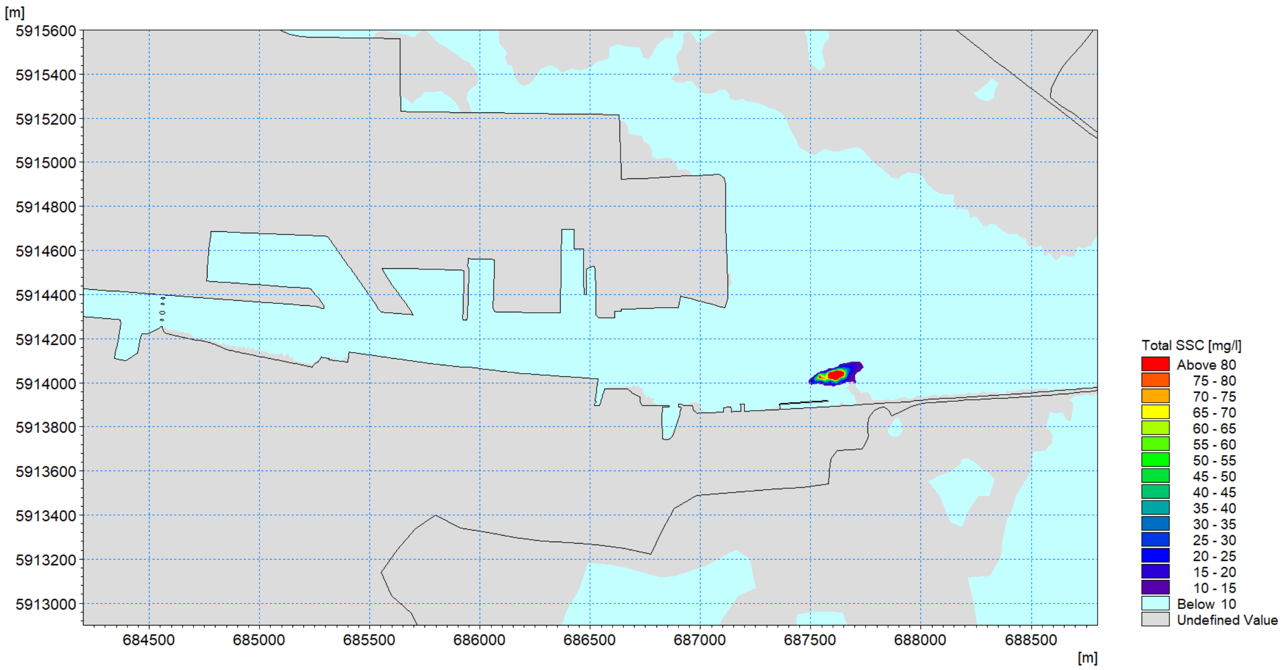

Figure 13.33: Suspended sediment concentration plume in the bottom layer during a typical low water phase of a spring tidal cycle whilst dredging the berthing pocket at Area N

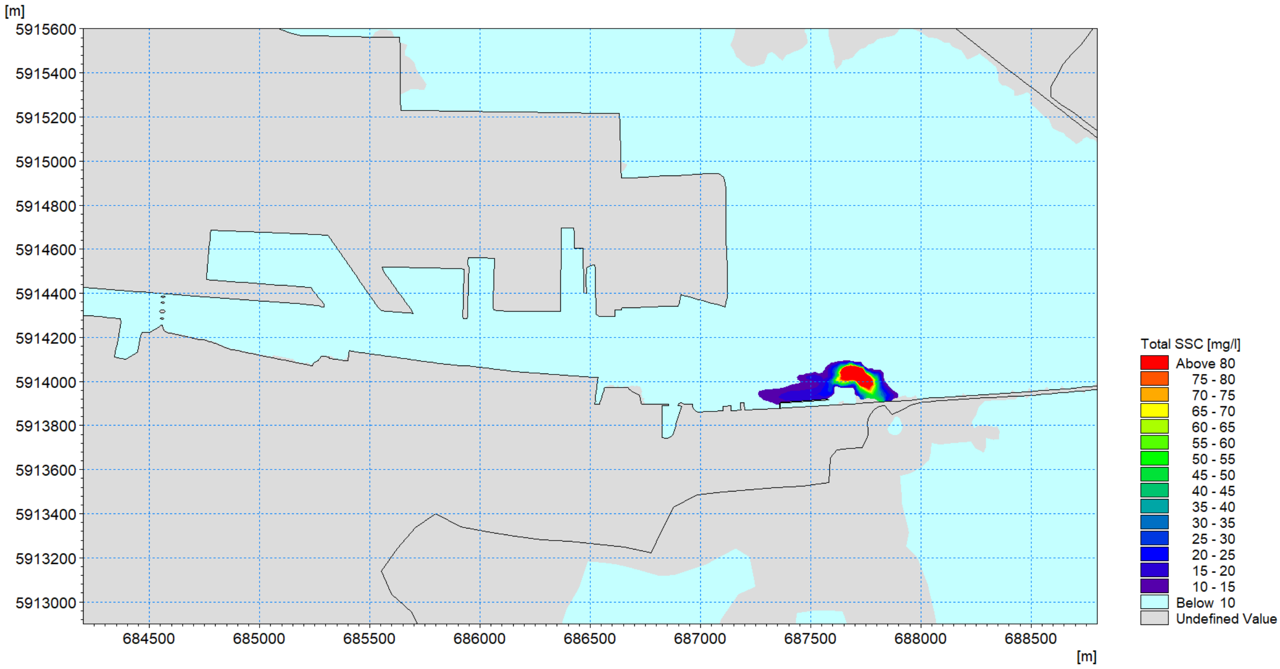

Figure 13.34: Suspended sediment concentration plume in the bottom layer during a typical mid flood phase of a spring tidal cycle whilst dredging the berthing pocket at Area N

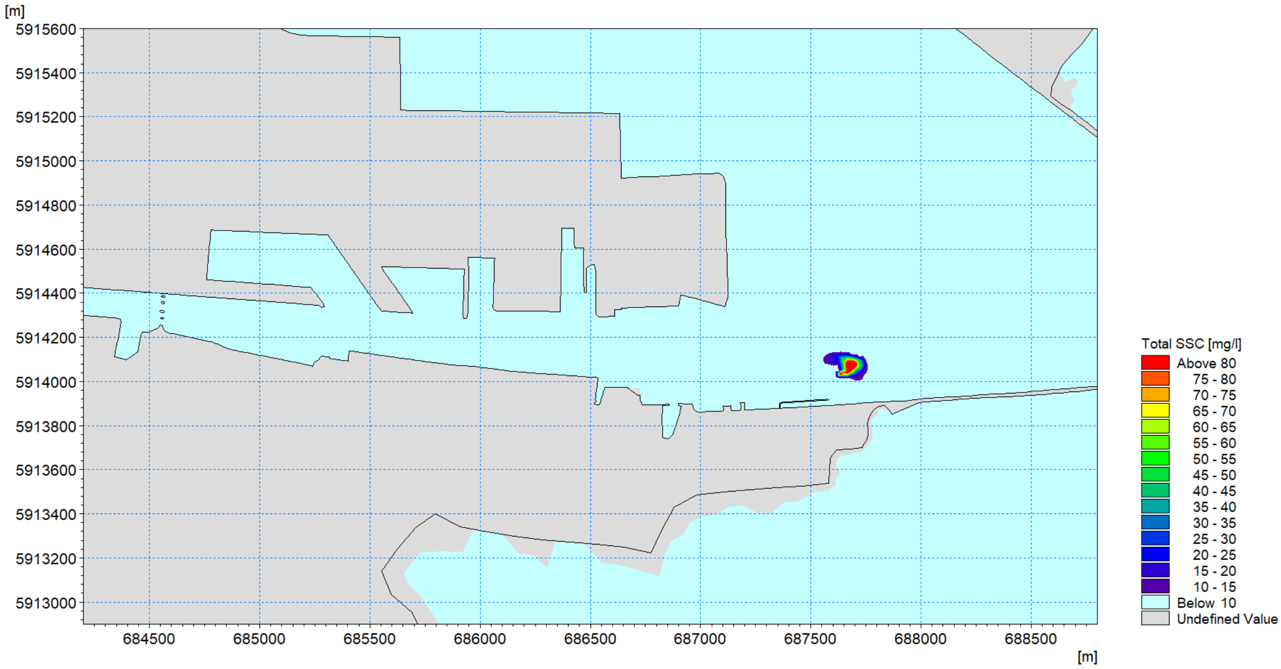

Figure 13.35: Suspended sediment concentration plume in the bottom layer during a typical high water phase of a spring tidal cycle whilst dredging the berthing pocket at Area N

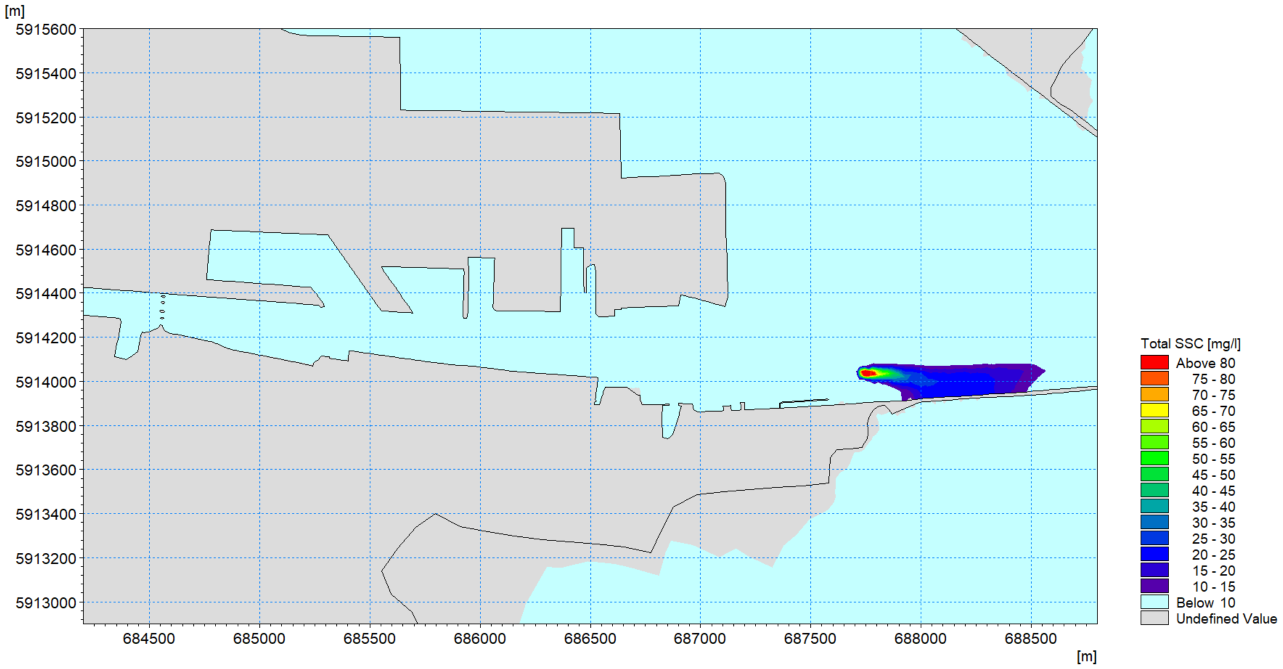

Figure 13.36: Suspended sediment concentration plume in the bottom layer during a typical mid ebb phase of a spring tidal cycle whilst dredging the berthing pocket at Area N

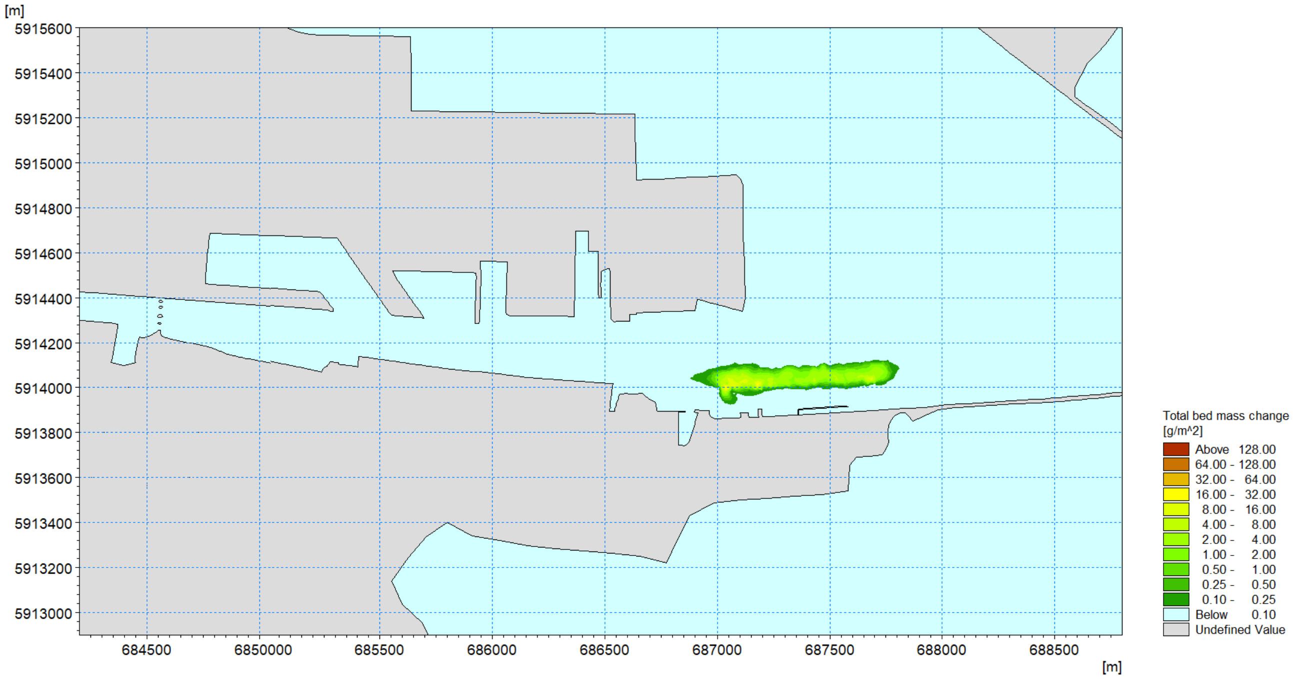

Figure 13.37: Deposition of sediment following the dredging operations for the berthing pocket at Area N

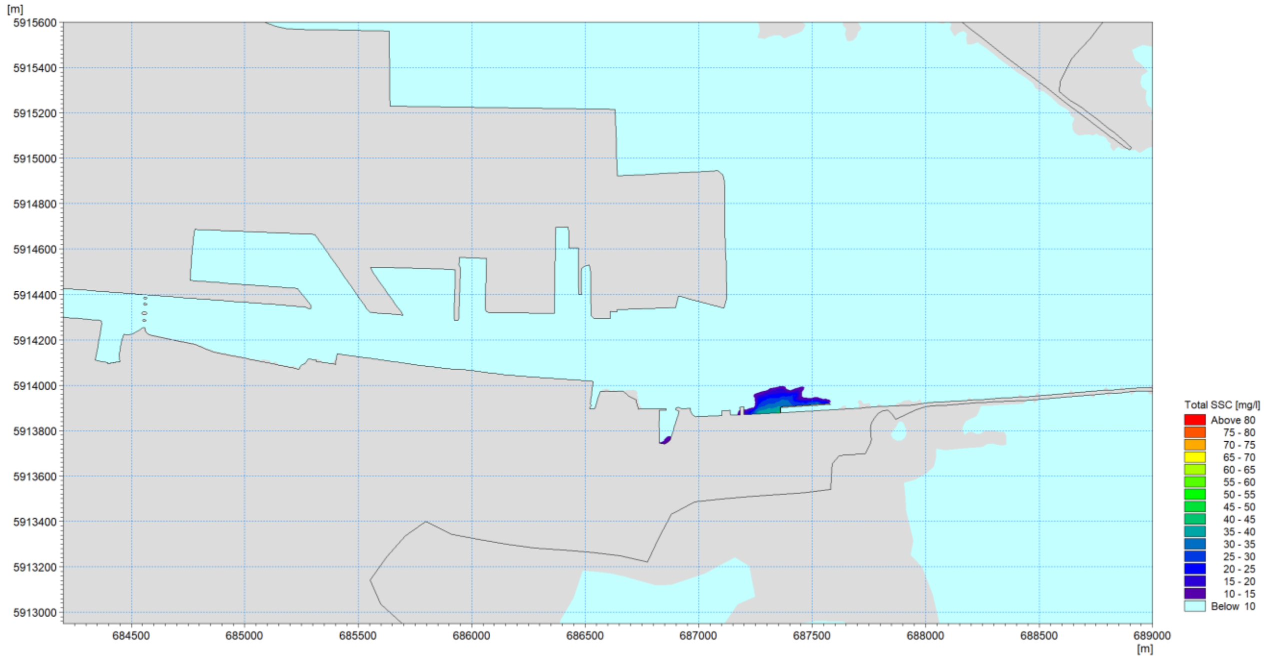

Figure 13.38: Suspended sediment concentration plume in the bottom layer during a typical low water phase of a spring tidal cycle whilst dredging construction access at Area N

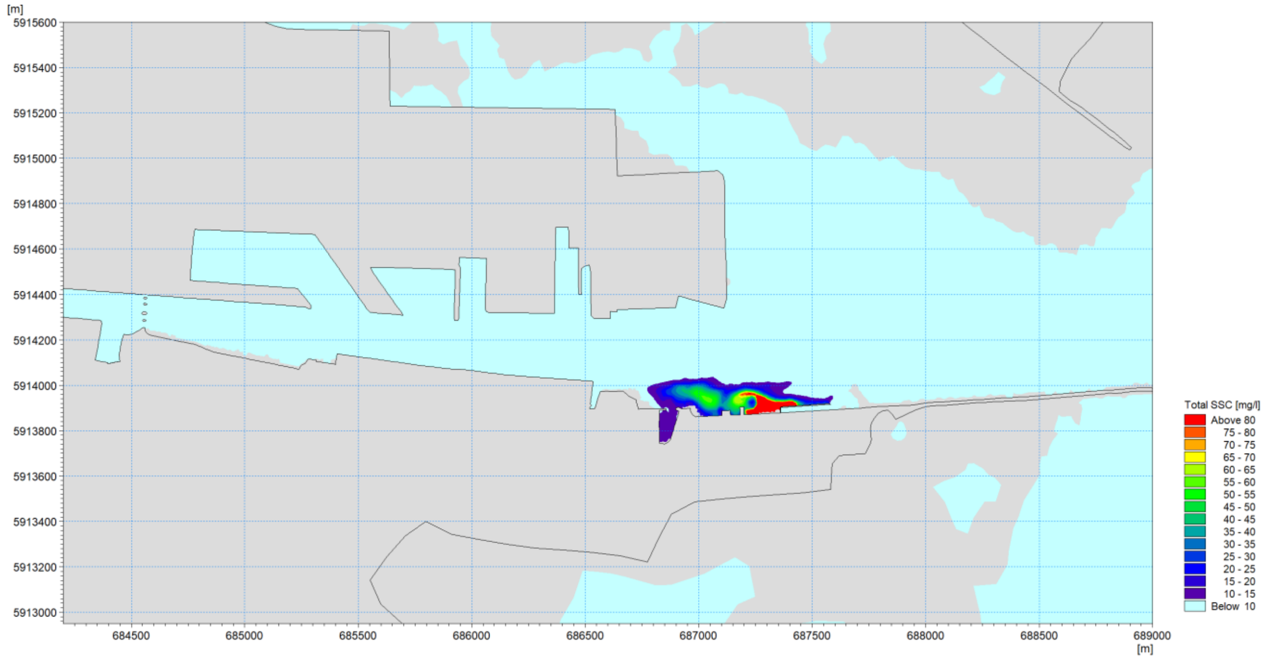

Figure 13.39: Suspended sediment concentration plume in the bottom layer during a typical mid flood phase of a spring tidal cycle whilst dredging construction access at Area N

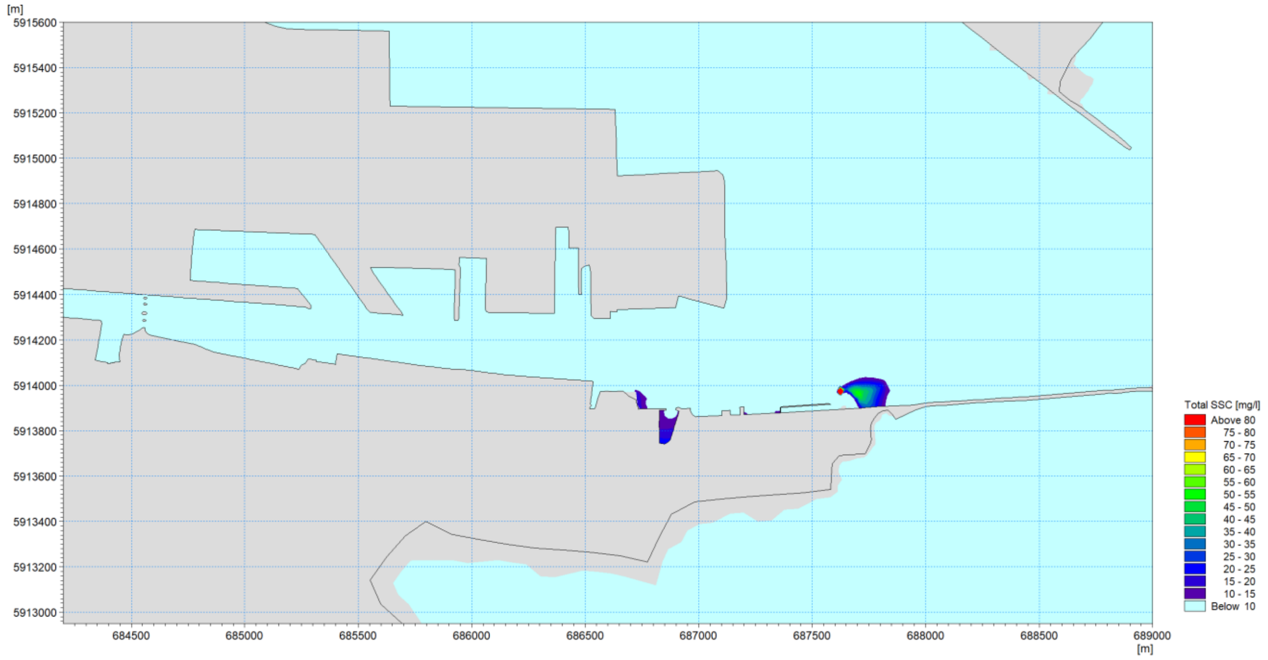

Figure 13.40: Suspended sediment concentration plume in the bottom layer during a typical high water phase of a spring tidal cycle whilst dredging construction access at Area N

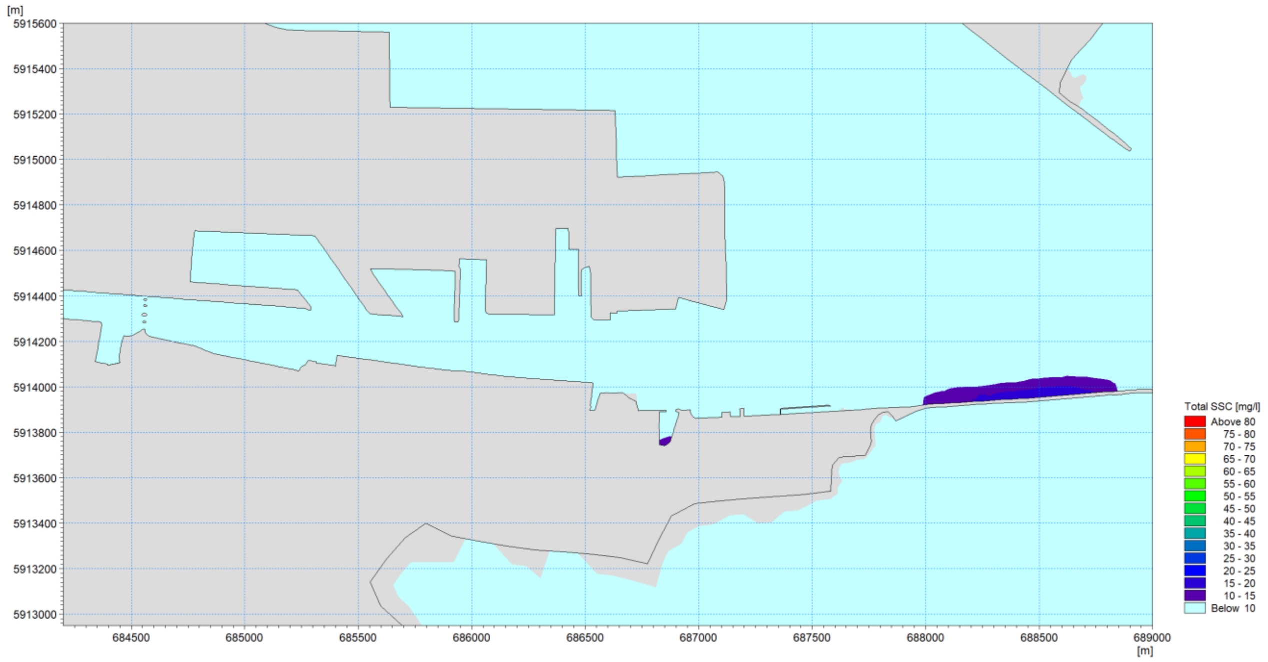

Figure 13.41: Suspended sediment concentration plume in the bottom layer during a typical mid ebb phase of a spring tidal cycle whilst dredging construction access at Area N

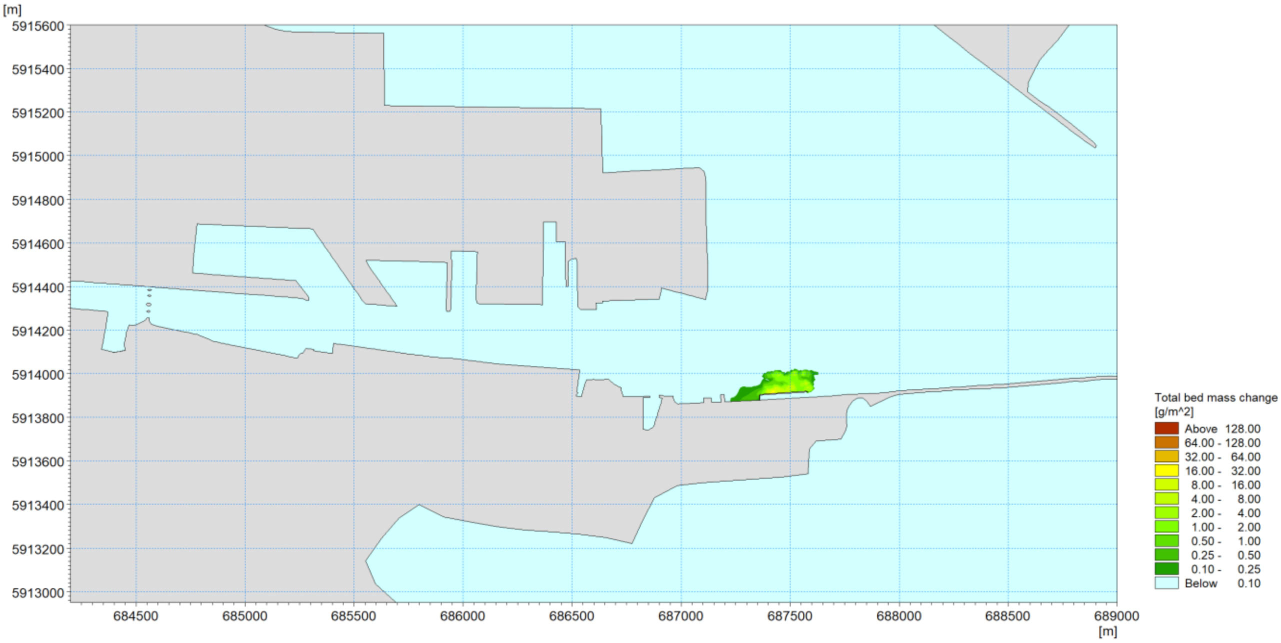

Figure 13.42: Deposition of sediment following the dredging operations for construction access at Area N

Impact of dredging on existing outfalls and power station cooling water systems

Water from the Liffey is abstracted by four power plants within the Dublin Port area: the North Wall Station; Synergen – Dublin Bay Power Plant; Covanta Waste to Energy Plant and Poolbeg Power Station. The water is abstracted as part of the electricity generation process and/or for cooling water components. High levels of suspended solids in cooling water have the potential to impact upon the plants cooling system and may result in an increase in operation and maintenance costs.

The Ringsend Waste Water Treatment Plant is also located on the southern bank of the River Liffey. This plant discharges treated effluent into the Liffey Estuary via a cooling water discharge channel to the north east of Poolbeg Generating Station whilst a storm water overflow is located to the north of the storm tanks about 800m upstream. High levels of suspended solids and the ingress of settling material during periods of low flow may have the potential to impact the operational performance of this outfall. The location of the various power station cooling water intake systems and the Ringsend Waste Water outfall is illustrated in Figure 13.12.

In order to determine whether any of the dredging operations associated with the 3FM Project would impact upon any of these cooling water intake systems or outfalls, RPS analysed the modelling results from the dredging simulations described in the previous four sections to calculate the peak and average suspended sediment concentrations due to dredging at each point of interest illustrated in Figure 13.12. These peak and average suspended sediment concentrations due to additional dredging loads are presented in Table 13.8. Also included in the table for comparison are the peak and average background suspended sediments levels which were derived from monitoring that was undertaken by Dublin City Council and as part of the ABR and MP2 projects between 2017 to 2022.

The results of the simulations show that the increased levels of suspended sediment concentrations at the power station intakes and Ringsend WwTW outfall are generally very small by comparison with background levels in the Liffey Estuary and are unlikely to have any effect on the quality of intake waters at power stations in terms of suspended solids content. The highest instantaneous values occur at the Poolbeg Power Station intake during the construction access dredging. However, the elevated levels occur only for short periods during the flood tides and therefore only comprise *c.*14 events typically peaking at less than 150 mg/l. These activities are also within the distance from the intake for which mitigation measures would be employed.

It is customary practice that DPC notifies the power station operators in advance of each dredging campaign. This allows the operations to temporarily stop abstracting water from the Liffey for a short duration in the event that dredging is required within the immediate vicinity of their intake works. The communication between DPC and the power station operators has enabled previous dredging campaigns, where dredging has taken place closer to the intakes, to be undertaken with minimal disruption.

Table 13.8 Peak and average Suspended Sediment Concentrations at various intakes and outfalls in Dublin Port during 3FM dredging operations

Intake	Dredging Location/Scenario	Peak Concentration (mg/litre)	Average Concentration over 1 month (mg/litre) (*1 week duration)
Poolbeg Power Station	Maritime Village	10.8	4.2
	Area K	3.8	1.3
	Turning Circle	89.3	10.0
	Area N - berthing pocket	34.2	6.4
	Area N – construction access*	385.7	22.3
Synergen – Dublin Bay Power Plant	Maritime Village	29.8	11.4
	Area K	76.9	4.5
	Turning Circle	38.0	8.9
	Area N - berthing pocket	18.7	3.8
	Area N – construction access*	6.3	2.2
North Wall station	Maritime Village	17.9	11.2
	Area K	1.8	1.2
	Turning Circle	11.0	5.8
	Area N - berthing pocket	4.0	2.4
	Area N – construction access*	1.5	1.0
Covanta – Waste to Energy Plant	Maritime Village	36.5	12.8
	Area K	114.6	4.7
	Turning Circle	33.9	9.2
	Area N - berthing pocket	17.8	3.7
	Area N – construction access*	6.4	2.2
SS Monitoring Results (2017 - 2022) *Representing Background Levels*	Liffey Estuary (East Link Bridge)	1,595 (95%'ile = 22.5)	24.5
	Liffey Estuary (Poolbeg jetty)	850	5.8

13.5.1.2 Potential Impacts as a result of disposing dredge material at sea

A programme of sediment quality sampling and analysis within the Tolka Estuary and Dublin Port area (Chapter 8 Land, Solis, Geology and Hydrogeology) has shown that that the sediments to be dredged as part of the 3FM Project are suitable for conventional dumping at sea (subject to the granting of a Dumping at Sea Permit by the EPA). The closest and preferred site is located at the approaches to Dublin Bay to the west of the Burford Bank as presented in Figure 13.43. This disposal option is preferred because it keeps the sand element of the dredge material within the natural Dublin Bay sediment cell.

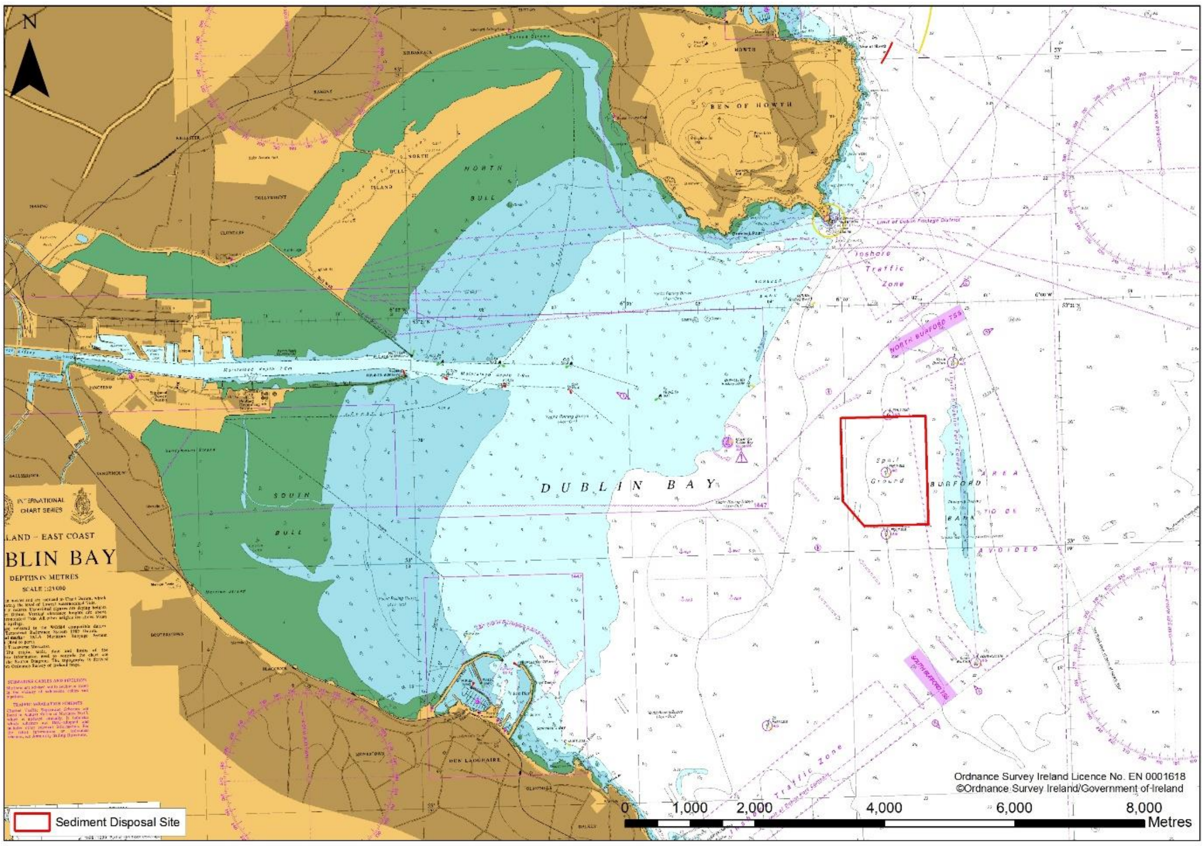

Figure 13.43: Location of the licensed dredged spoil disposal site

The disposal of sediments at sea has the potential to cause a temporary increase in suspended sediments and turbidity levels during the disposal operations and, under certain conditions, could have adverse effects on marine biota (for example, through siltation of benthic communities), changes to sediment structure, or interference with feeding in reduced visibility.

To assess the impact of the 3FM Project disposal operations at the licensed offshore disposal site, a coupled MIKE 21 Hydrodynamic and Sediment Transport model was used to determine the dispersion of the sediment material during the disposal operations.

It was assumed that the Trailer Suction Hopper Dredge would discharge material over the disposal site every *c.* 3 hours and that the equivalent of approximately of 2,030 tonnes (wet weight) would be released per dump. Key parameters relating to the sediment dumping simulations are outlined Table 13.9.

Table 13.9: Disposal simulation input parameters

Parameter	Value
Trailer Suction Hopper Dredger capacity	4,100 m^3
Ratio of sediment/entrained water during loading	0.3
Average density of material inside hopper	1.65 t/m^3
Average Trip Frequency between Dublin Port and Disposal site	3.0 hours
Average Time to Fill Dredger Hopper	1.5 hours
Time to release load	90 seconds

The model simulations were run for the disposal of the dredged material over the course of a complete lunar month, which includes the full range of spring and neap tidal flow conditions. The characteristics of the sediment modelled in this simulation are equivalent to those used in the dredging simulations described in the previous section of this chapter. As such, the sediment material was characterised by three discrete fractions with mean diameters of 200 µm, 20 µm and 3 µm, with each fraction constituting 1/3 of the total volume of silt to be dredged.

The sediment material was introduced into the surface of the model as a point source that moved across the dump site area during the disposal operation. The model then simulated the dispersion, settlement and re-erosion of each fraction of the silt in response to the tidal currents throughout the model area.

The coarser fraction of the sediment, i.e., the sand fraction that had a mean grain size of 200 µm, was found to behave differently relative to the two finer silt fractions that had mean grain diameters of 20 µm and 3 µm. The sand fraction remained on the dump site, whereas the two finer silt fractions were carried away by the tidal currents.

The results of the simulations are given in terms of maximum total suspended sediment concentrations envelope in Figure 13.44, which depicts the maximum level of the suspended sediment concentration which occurs in each cell at any time during the simulation and is thus an envelope covering all the sediment plume excursions. It will be seen from Figure 13.45 that the sediment plume outside the area of the dump site is less than 200 mg/l and does not extend further than 750 m to the north or south of the dump site.

Based on these results, it can be concluded that the disposal operations associated with the 3FM Project will not result in any significant increases to the background level of suspended sediments and will not, therefore, impact the existing water quality in the greater Dublin Bay area.

NOTE - Mean turbidity measured in Dublin Bay (4 monitoring buoys - 3 at dumpsite and 1 background) is 10.25 NTU. Based on the relationship established for fine sands in Dublin Bay this is equivalent to a Total Suspended Solids (TSS) concentration of 16.5 mg/l or based on finer silts/sands of Liffey Estuary to a TSS concentration of 25.6 mg/l (See Chapter 9 Water Quality and Flooding). Note that these measurements cover periods of maintenance and capital dredging.

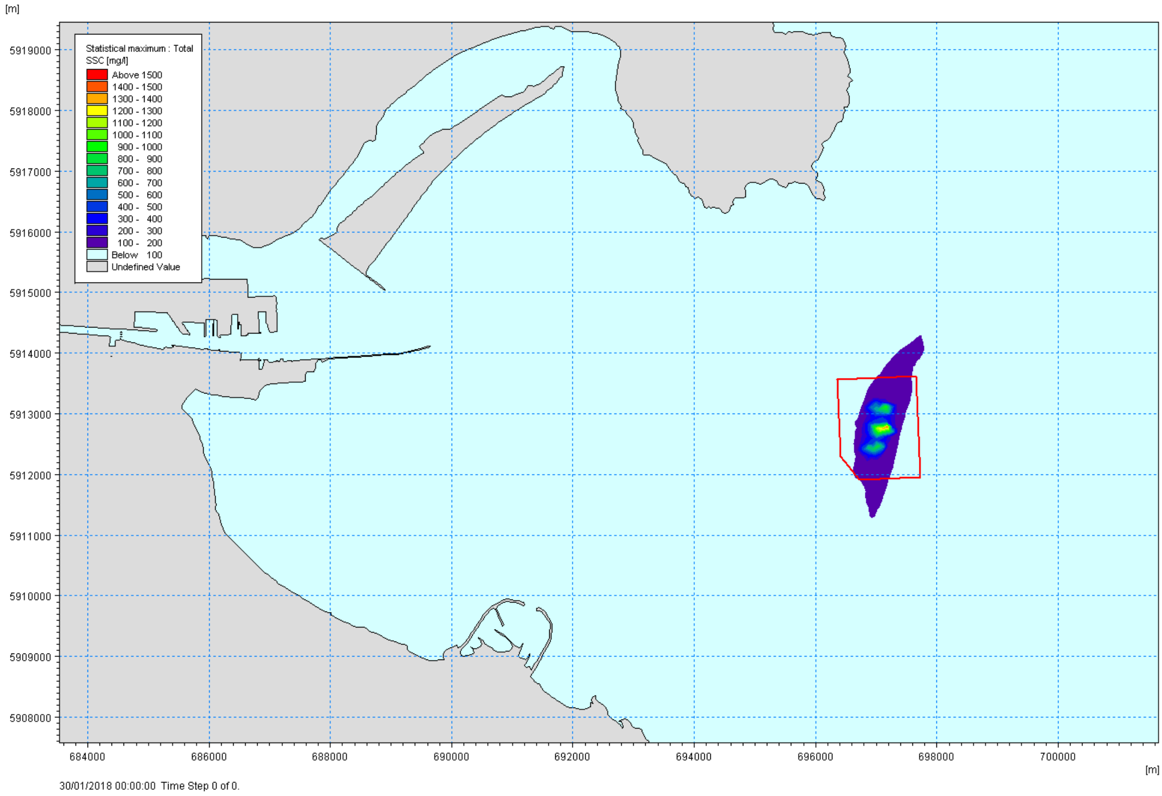

Figure 13.44: Maximum Total Suspended Solids Concentration envelope using a Trailing Suction Hopper Dredger dumping circa 2,030 tonnes wet weight at 3 hourly intervals on average within each winter capital dredging season

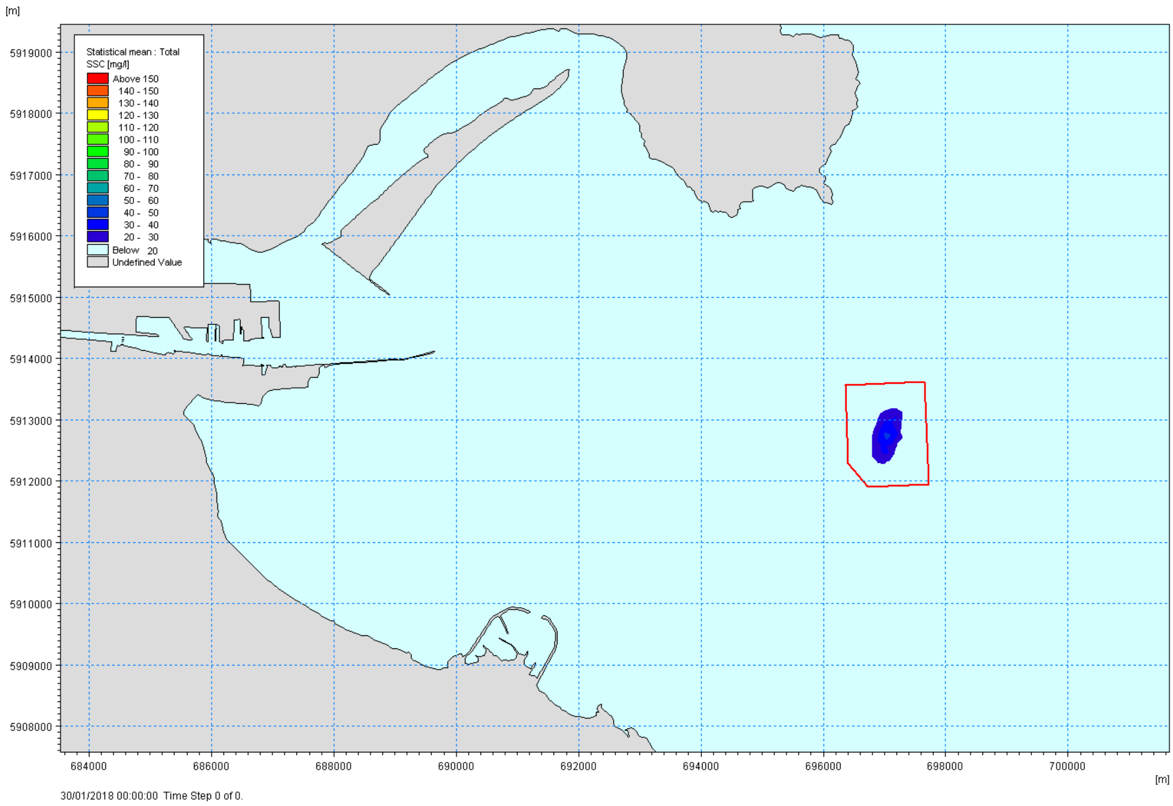

Figure 13.45: Mean Total Suspended Solids Concentration envelope using a Trailing Suction Hopper Dredger dumping circa 2,030 tonnes wet weight at 3 hourly intervals on average within each winter capital dredging season

13.5.1.2.1 Long-term fate of sand material at the dumpsite

As noted in the previous section, the sand fraction of dredge material was found to remain on the dumpsite during the course of the simulation period. To further validate this finding, RPS reviewed site-specific high-resolution bathymetric surveys of the dumpsite to measure changes in seabed elevations and thus derive rates of change. Given that much of the dump site is characterised by well-defined sand waves, the output from this assessment was used as a proxy to determine the long-term potential for sediment erosion and movement. This assessment is described below.

As part of DPC's extensive environmental monitoring programme, Hydromaster Ltd. is contracted to undertake high-resolution bathymetric surveys of the dump site before and after dredging campaigns. Most recently, the dump site was surveyed prior to the first capital dredging campaign under S0024-02 on 13th October 2022 and again on 7th December 2022 upon completion of the campaign. The output from both surveys is illustrated in Figure 13.48.

As illustrated in Figure 13.48, the elevation of the dumpsite ranges between *c.* -24 m along the western boundary and *c.* -11 m along the eastern boundary. Other notable features from this survey include two areas near the centre of the dump site whereby depths are *c.*5 m shallower than the immediately surrounding area. In addition to these shallower areas, distinct sand waves can also be observed in the shallower areas, particularly along the northeast and southern boundaries of the site.

Using a series of Geographical Information System (GIS) tools that were specifically developed for terrain analyses and the assessment of ridge forms, these surveys were analysed to identify key morphological features. The output from this process is presented in Figure 13.49 which illustrates the presence of prominent sand waves common to both surveys and also the deposition of dredge material in the post dredge campaign survey.

Using sand wave features common to both surveys, the spatial movement of morphological features was calculated using more than 40,000 unique vertices as illustrated in Figure 13.50. These differences were then divided by the duration between the two surveys to estimate rates of movement.

The output of this assessment demonstrated that the transport of the coarse material was greatest in shallower water, but that even in these areas the average rate of movement equated to *c.* 0.10 m/day. In deeper waters whereby the seabed is not exposed to the same wave radiation or tidal stresses, the average rate of movement equated to just *c.* 0.05 m/day. The dominant direction of sediment transport was generally from south to north, however, there was variation across the dump site.

Given that the dumpsite is approximately 1.6 km in length, it is estimated that coarse fraction of spoil material disposed of at the centre of the dump site would take between c. 10 – 40 years to move beyond the boundary of the dump site.

It is worth noting that these surveys were undertaken in October and December 2022, during which period the Marine Institute's M2 wave buoy recorded relatively heavy sea conditions as illustrated in Figure 13.47.

Furthermore, since 2012, the Marine Institute, has carried out monitoring to determine macroinvertebrate ecological quality status (EQS) in coastal and transitional waters around the Irish Coast in order to fulfil requirements of the Water Framework Directive (WFD). As part of this programme, sampling must be carried out within each waterbody, including Dublin Bay, at least twice within the 6-year cycle (once every three years).

Based on the sampling and monitoring of 15 individual locations illustrated in Figure 13.46, the seabed material was found to comprise of muddy and fine sand or very fine sands at all stations. Coarse material was found to contribute an insignificant part of the sediment. Furthermore, the benthic communities surveyed in Dublin Bay were characteristic of the shallow muddy fine sand sediments sampled. Taxa common throughout the stations included, amongst others, the polychaetes *Glycera tridactyla, Nephtys hombergii, Spiophanes bombyx* and *Chaetozone christiei.*

The results of the Marine Institute's long-term (since 2012) environmental benthic surveys therefore support conclusion that the movement of coarse material into Dublin Bay as a result of disposing of dredge material at the dump site is extremely limited and highly unlikely to result in a large-scale deposition event in Dublin Bay.

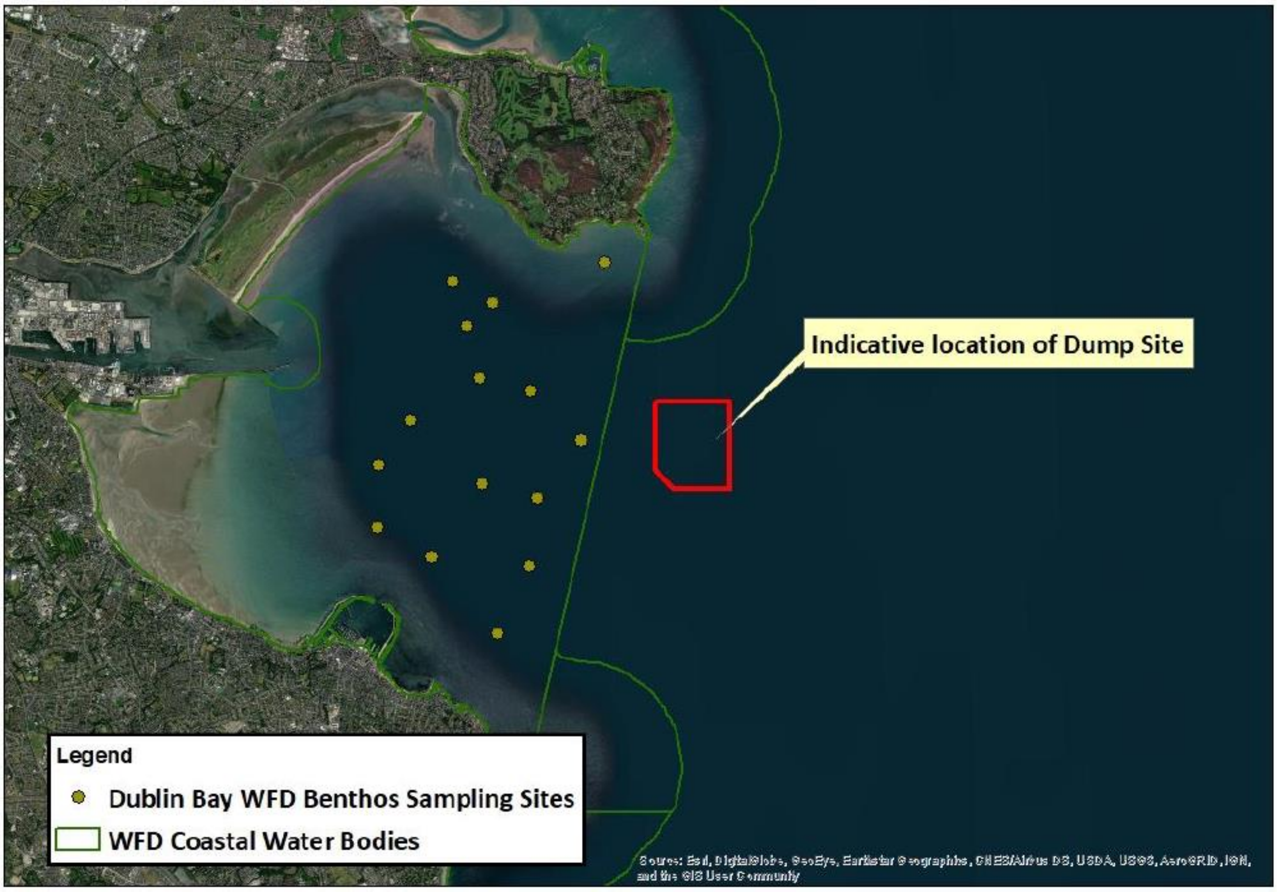

Figure 13.46: Dublin Bay Water Framework Directive benthos macro-invertebrate sampling points (n=15) in relation to the dump site

Table 13.10: Average rate of sediment transport based on a difference assessment of high resolution surveys of the dump site on 13.10.2022 and 07.12.2022

Contour [m]	Average Rate of movement [metres / day]
-24	0.055
-23	0.068
-22	0.053
-21	0.048
-20	0.076
-19	0.084
-18	0.160
-17	0.169
-16	0.123
-15	0.130
-14	0.174
Average	**0.104**

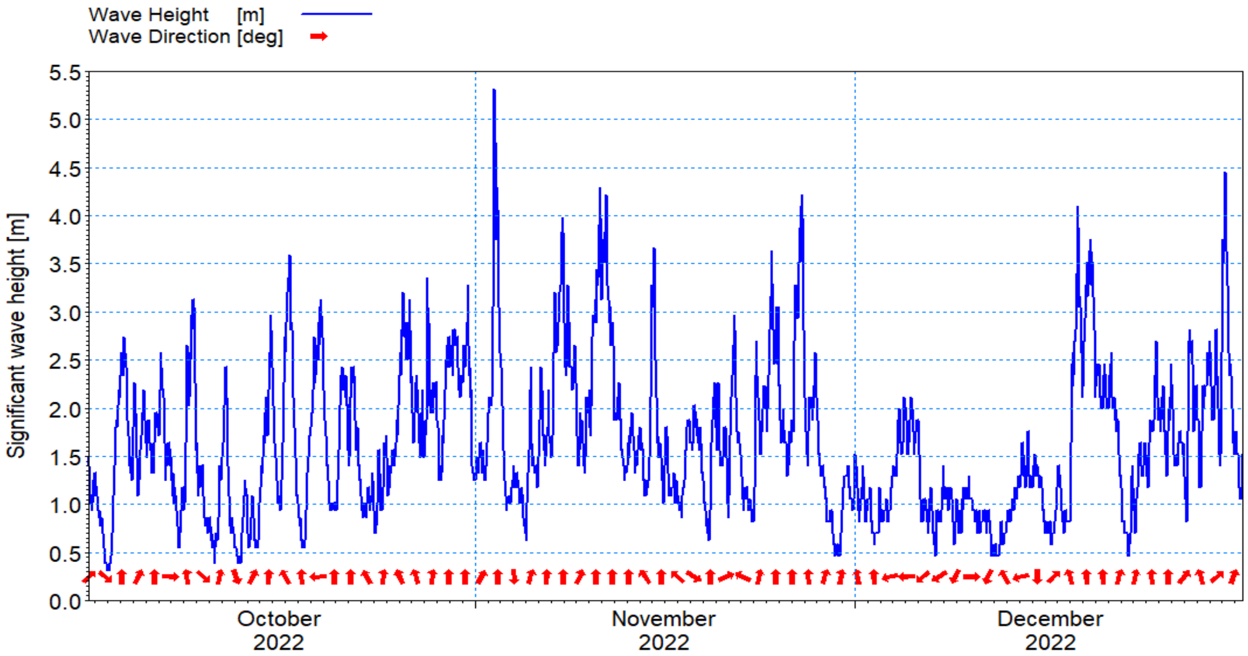

Figure 13.47: Wave climate as recorded by the Marine Institute's M2 wave buoy between October and December 2022.

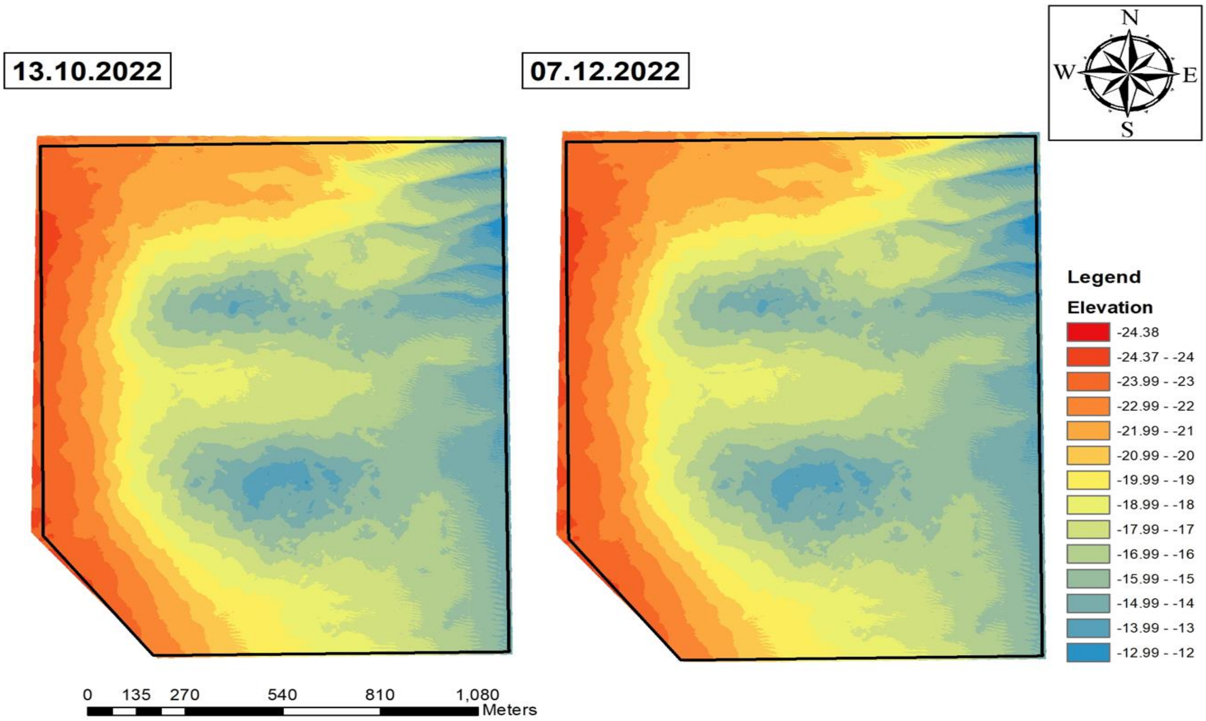

Figure 13.48: Pre and post dredging campaign bathymetric surveys at the licenced offshore dump site at the approaches to Dublin Bay

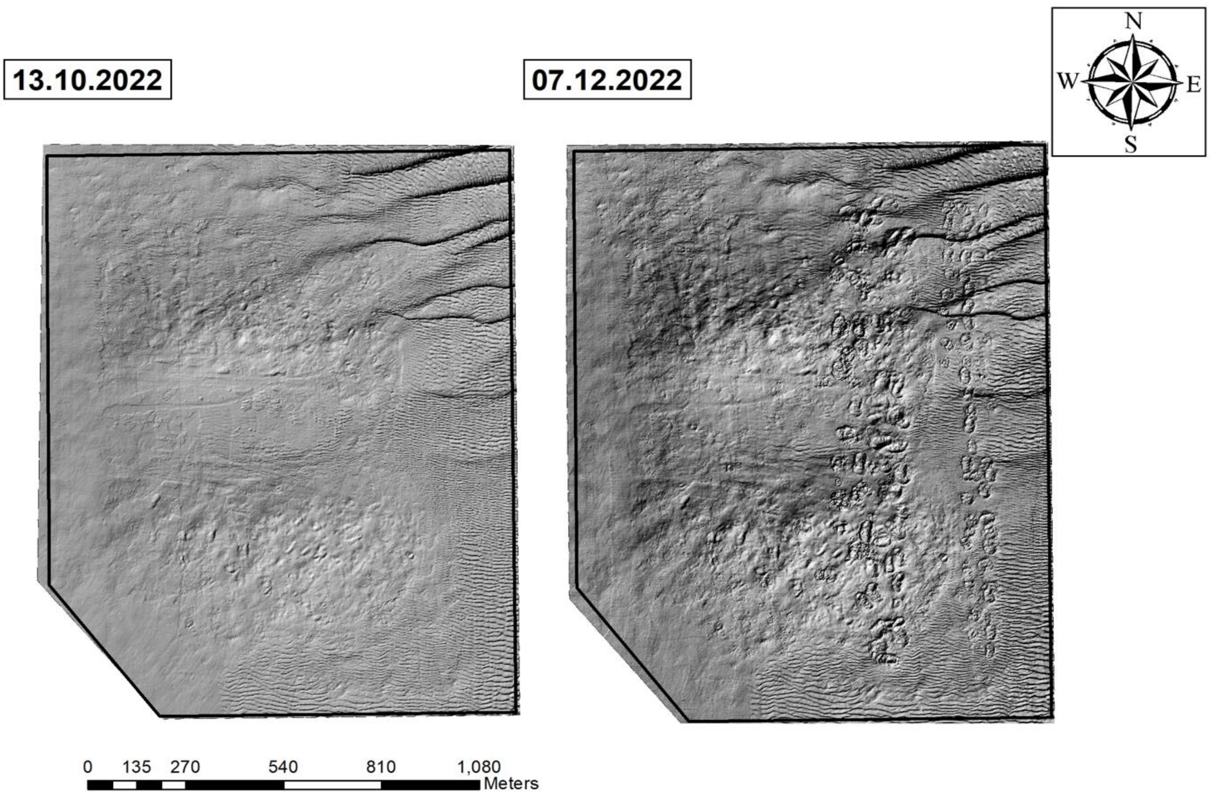

Figure 13.49: Sand wave and other morphological features identified from a terrain analyses of both survey datasets

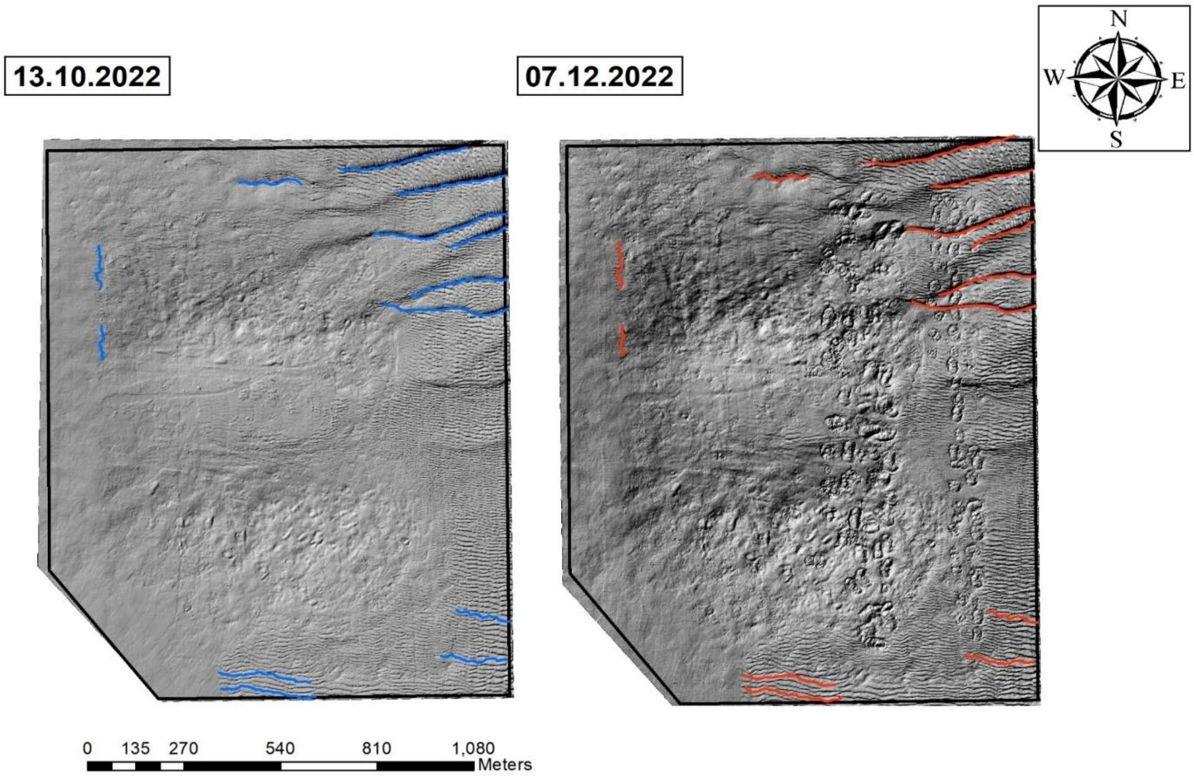

Figure 13.50: Sand wave features common to both surveys identified by blue and red vectors that were used to assess movement of bed material

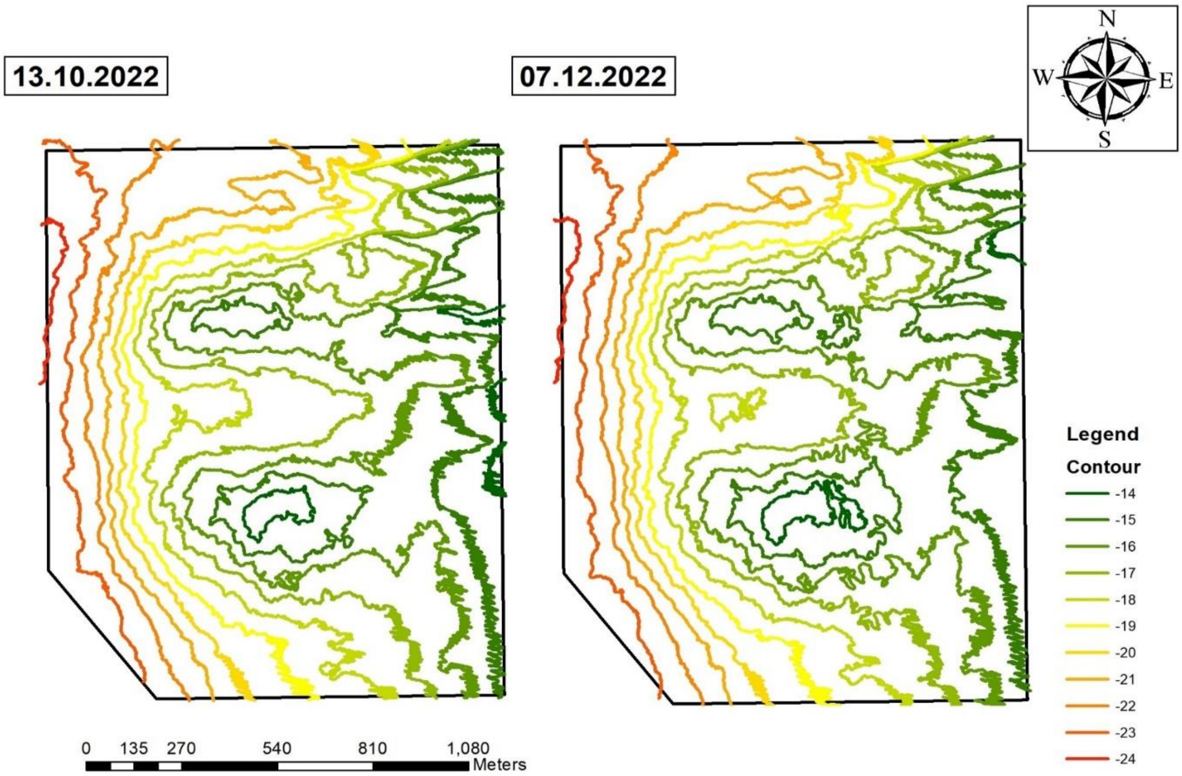

Figure 13.51: Elevation contours of both surveys used to assess the movement of bed material at the dump site

13.5.2 Operational Phase Impacts

13.5.2.1 Potential changes to the existing tidal regime

The potential for changes with the elements of the scheme in place was assessed to consider the potential for operational phase impact. The MIKE 21 Hydrodynamic module described in Section 13.2.3 was used in conjunction with the post-3FM Project scenario (i.e., Dublin Port, including the ABR, MP2 and 3FM Projects) 2D model to simulate the tidal regime in the Dublin Port following the implementation of the 3FM Project. Typical tidal flow patterns for a spring ebb and spring flood tide from the post-3FM Project simulation are presented in Figure 13.52 and Figure 13.53.

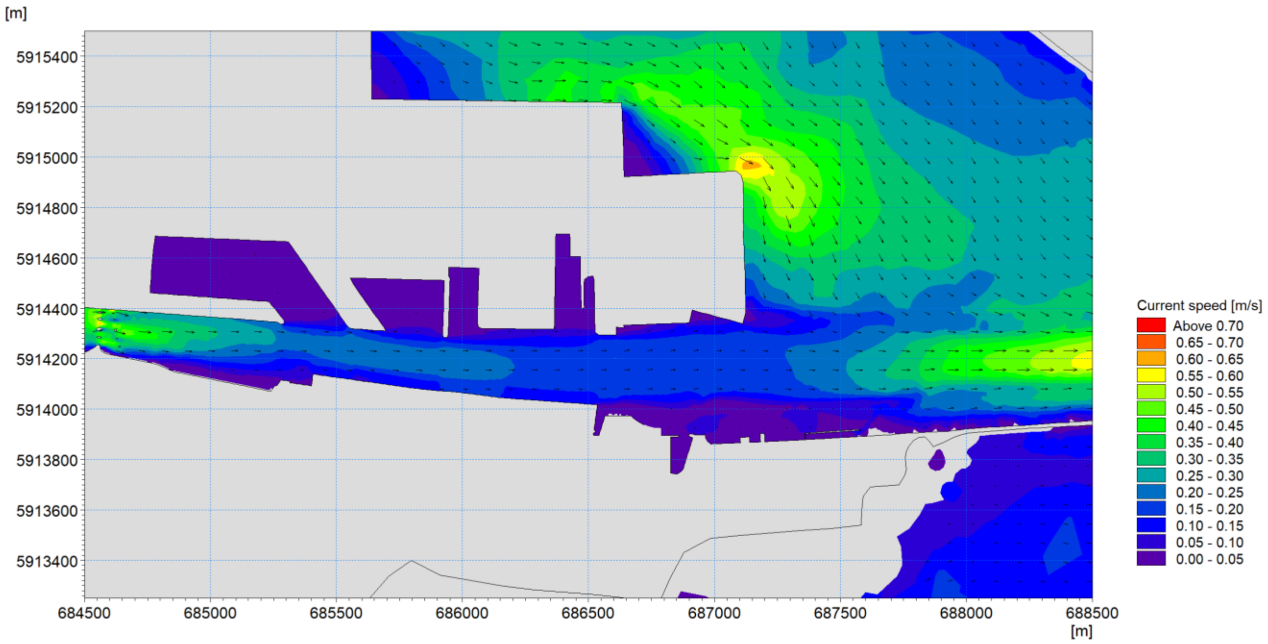

Figure 13.52: Typical spring mid ebb tidal flow patterns – Post 3FM Project

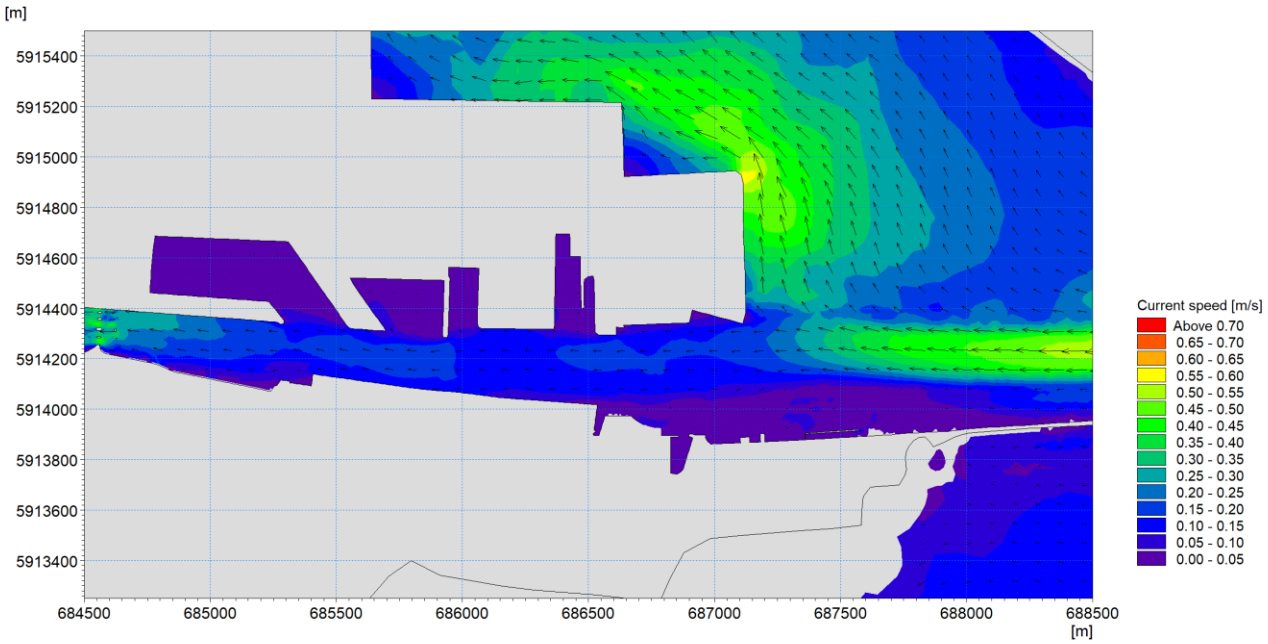

Figure 13.53: Typical spring mid flood tidal flow patterns – Post 3FM Project

The difference in modelled current velocities for the pre and post 3FM Project simulations have been computed for the mid spring ebb and the mid spring flood tides and are presented in Figure 13.54 and Figure 13.55. Spring tides are periods of greatest current velocities.

These figures show that the maximum predicted change to the mid-ebb or flood current speeds is less than ±0.25 m/s throughout the Port area. The greatest changes are generally observed within the vicinity of the SPAR and the Maritime Village where current speeds may change by ±0.20 m/s. This increase in current speeds could result in scouring of the seabed around the proposed SPAR foundations during periods of extreme river flow discharge conditions.

It is important to note that the changes presented in Figure 13.54 and Figure 13.55 relate to mean winter river flow rates (see Table 13.2) and would be considerably less during average or low conditions.

Current speeds along Area K generally increased by up to 0.15 m/s during most phases of the tidal cycle owing to the removal of a nib structure which previously obstructed flows and resulted in sediment accretion within the vicinity of cooling water intakes.

At the Turning Circle, changes to the tidal regime are generally confined to within the footprint of the works. In this area, current speeds are predicted to change by up to ±0.10 m/s because of changes to bathymetry caused by the 3FM Project.

At Area N, the greatest change to the tidal regime is observed within the eastern extent proposed dredge pocket where current speeds are predicted to change by up to ±0.10 m/s. The proposed pile structure required to support Area N did not result in a significant change to tidal currents in this area, changes were limited to reductions in current speeds of less than 0.1 m/s during most phases of the tidal cycle largely attributed to increases in water depth at this location due to dredging activities.

In general, predicted changes in current speed reduce rapidly outside the works areas and changes to mid-ebb or mid-flood current speeds are less than ±0.15 m/s within 50 to 150 m of the works. No notable changes to the tidal regime were detected outside of Dublin Port.

Based on this information, the tidal regime is predicted to remain substantially unchanged post 3FM Project and no notable changes to the tidal regime were detected outside of Dublin Port. Given the localised nature and small absolute magnitude of any predicted changes in tidal current velocity it is unlikely that there will be any significant change in net scouring or deposition of sediments within the Liffey Estuary, Dublin Bay or at any of the intakes illustrated in Figure 13.12 resulting from the 3FM Project.

The risk of impact to the tidal regime is generally determined to be negligible, however increased current speeds as a result of the SPAR development could result in scouring of the seabed around the proposed SPAR foundations during periods of extreme river flow discharge conditions.

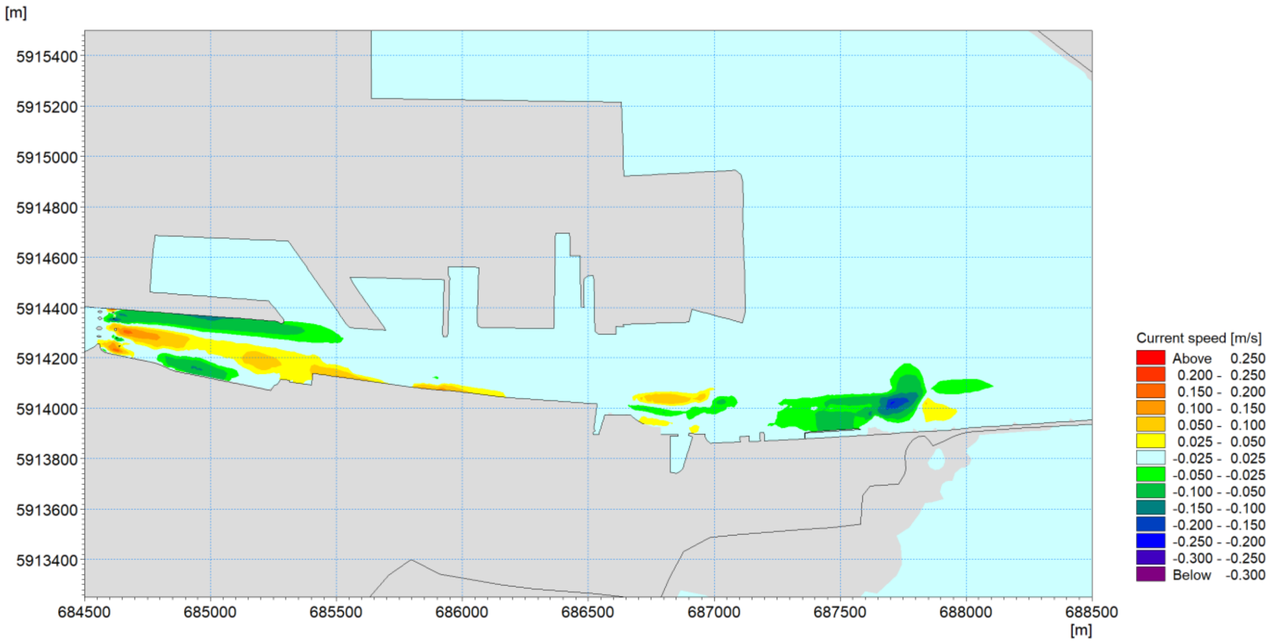

Figure 13.54: Difference in typical spring mid ebb tidal flow patterns as a result of the 3FM Project

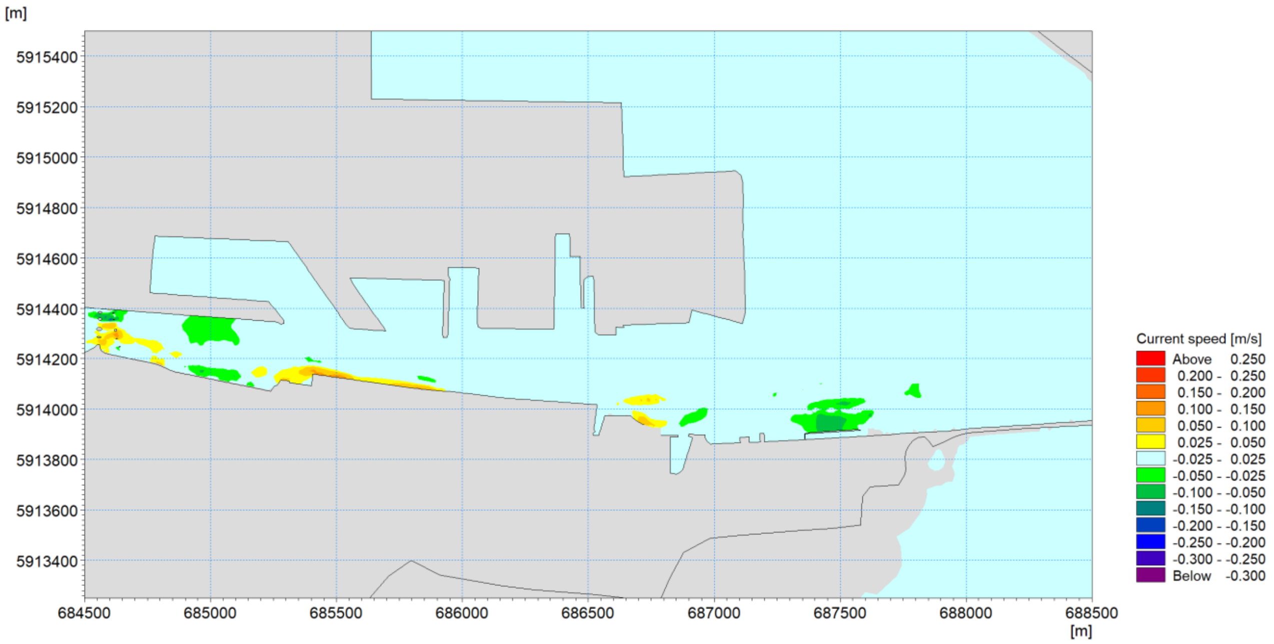

Figure 13.55: Difference in typical spring mid flood tidal flow patterns as a result of the 3FM Project

13.5.2.2 Potential changes to the existing inshore wave climate

Operational phase impacts also considered included potential alteration to wave climate (and its associated possible impact on flood risk). The MIKE 21 Spectral Wave module described in Section 13.2.3 was used in conjunction with the post-3FM Project scenario 2D model to re-run the offshore wave climate simulations in Dublin Bay based on various wave directions as described in Section 13.3.2.

The simulated inshore wave climate in Dublin Port and the adjacent Dublin coastline post 3FM Project is illustrated in Figure 13.56 to Figure 13.58 for north easterly, easterly and south easterly storm events at spring high tide respectively.

Wave height difference plots are presented for the three storm events in Figure 13.59 to Figure 13.61 to highlight the changes to the inshore wave climate because of the 3FM Project. The results show that, during all storm events modelled, only small changes in the wave climate in Dublin Port are predicted and no discernible change in the adjacent coastline areas i.e., Clontarf, Tolka Estuary, Sandymount, i.e., < ±0.01 m.

During easterly storm events, wave heights at the Maritime Village may increase by up to 0.10 m owing to changes in bathymetry in this area. During north easterly and easterly storm events, wave heights are expected to decrease by up to 0.20 m within the vicinity of Area N as a result of the proposed pile structures which will attenuate wave energy.

There are virtually no changes to the wave climate within Dublin Port or beyond during south easterly events. This is because most of the proposed 3FM Project is located on the southern side of the navigation channel which is well sheltered during south easterly events.

Changes in bathymetry due to dredging activities have the potential to alter the energy with which waves break and could conceivably result in wave overtopping of structures and flood defences. However, consideration of changes to the wave climate due to the 3FM Project presented above show no discernible change in relevant proximate areas such as Clontarf, Fairview and Ballybough bordering the Tolka Estuary.

Changes in wave height within the Port beyond the immediate footprint of the 3FM Project works is predicted to be less than ±0.20m during typical storm conditions. These changes are not considered significant and will not impact operations within the Port. Therefore, the risk of potential coastal flooding due to the 3FM Project in these areas is determined to be negligible and no mitigation is required. An assessment of the impact of the 3FM Project on the existing flood risk can be found in in Chapter 9 (Water Quality and Flooding).

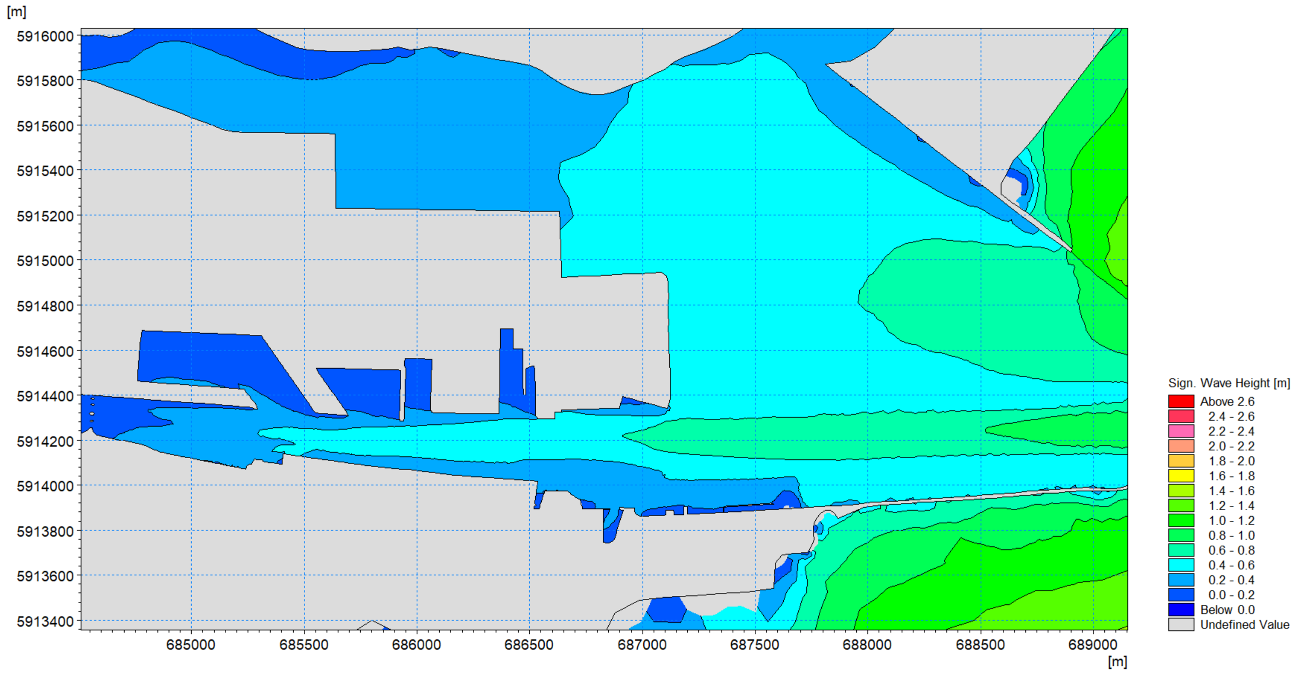

Figure 13.56: North easterly storm wave heights at spring high water – Post 3FM Project

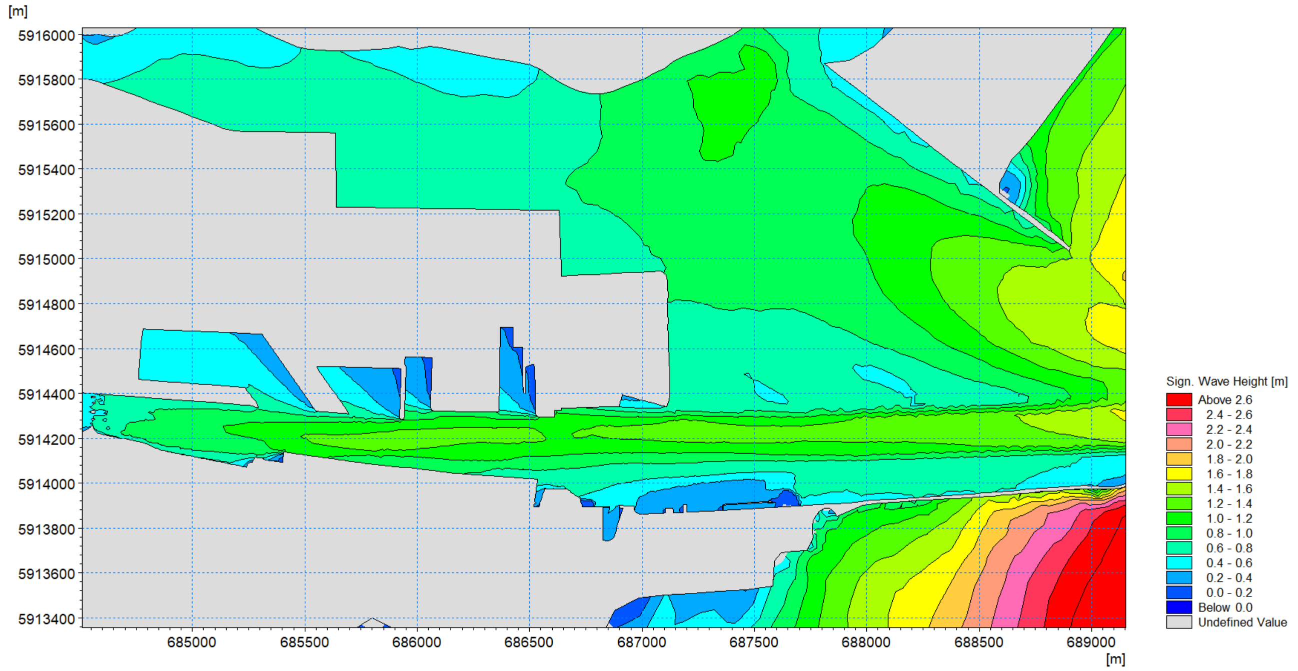

Figure 13.57: Easterly storm wave heights at spring high water – Post 3FM Project

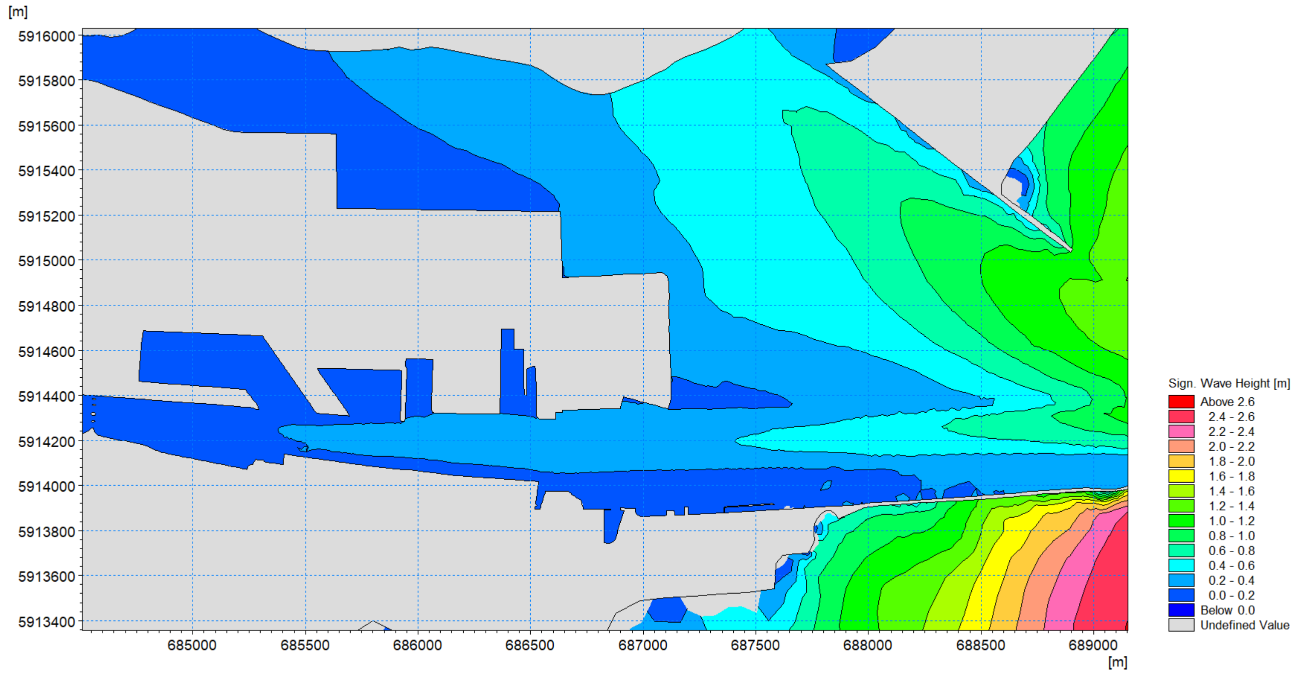

Figure 13.58: South easterly storm wave heights at spring high water – Post 3FM Project

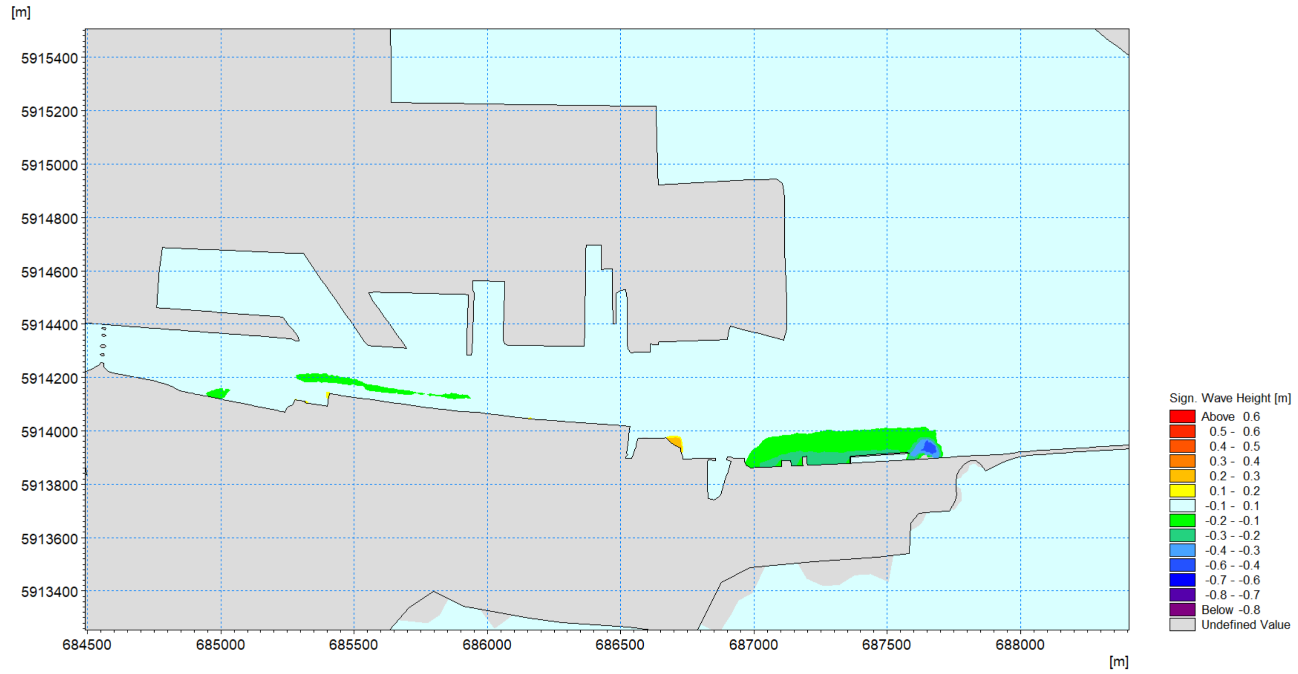

Figure 13.59: Difference in wave heights during a north easterly storm event as a result of the 3FM Project

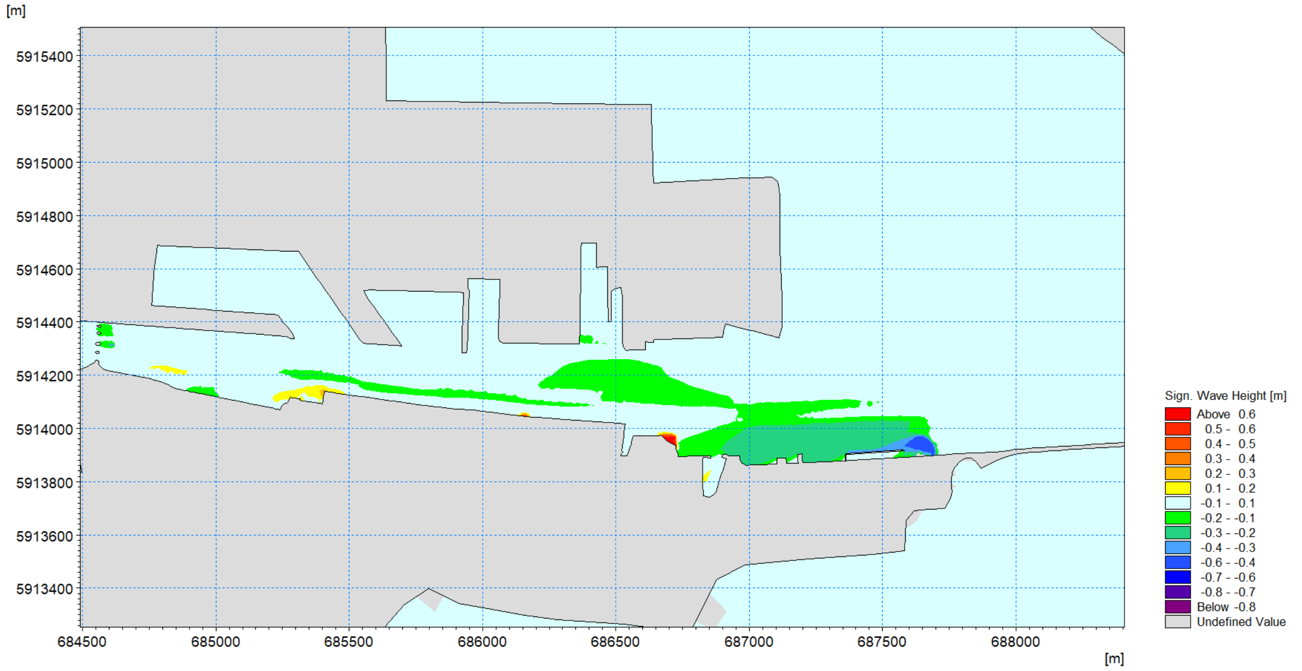

Figure 13.60: Difference in wave heights during a easterly storm event as a result of the 3FM Project

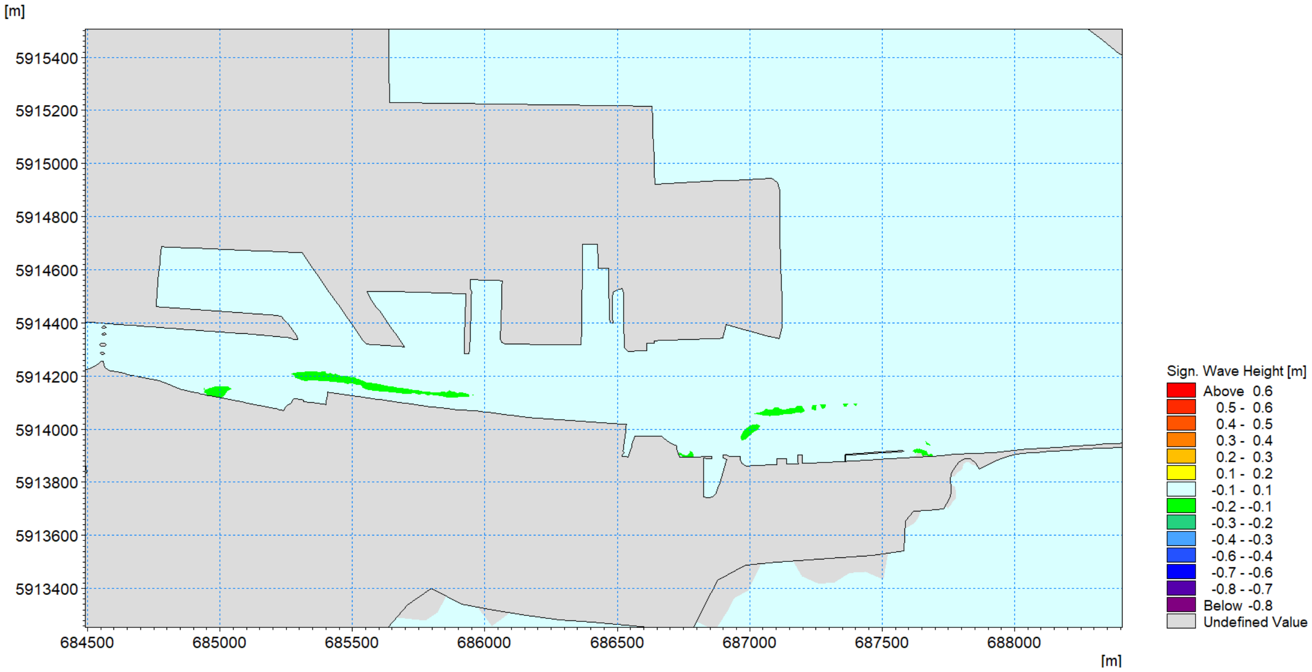

Figure 13.61: Difference in wave heights during a south easterly storm event as a result of the 3FM Project

13.5.2.3 Potential changes to the existing dispersion within Dublin Port

Any change to the thermal properties of the water abstracted from the Liffey has the potential to impact upon the plant's cooling system which may result in environmental or operational impacts. This assessment therefore also considered the operational phase impacts to the dispersion of thermal plumes within Dublin Port. The MIKE 3 Hydrodynamic module described in Section 13.2.3 was used in conjunction with the post-3FM Project scenario 3D model to re-run the thermal dispersion simulations described in Section 13.3.3.

The simulated typical thermal plume patterns for the mid–flood, high water, mid-ebb and low water phases of a typical spring tide with the 3FM Project *in-situ* are presented in Figure 13.62 through to Figure 13.65 respectively.

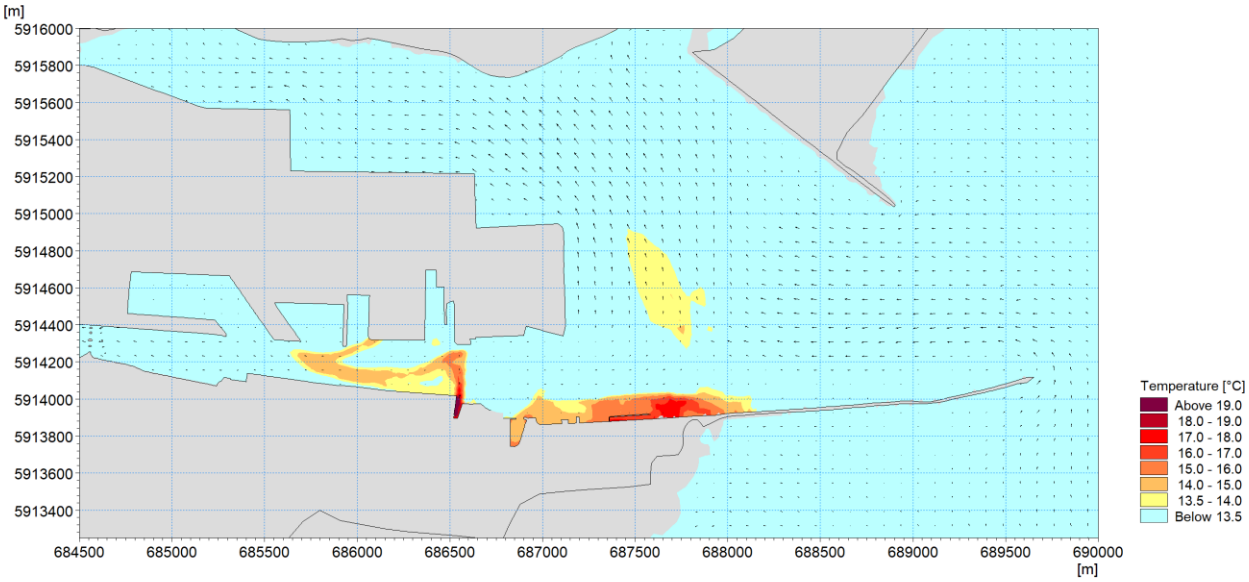

Figure 13.62: Near surface thermal plume envelopes during a typical spring mid flood tide – Post-3FM Project

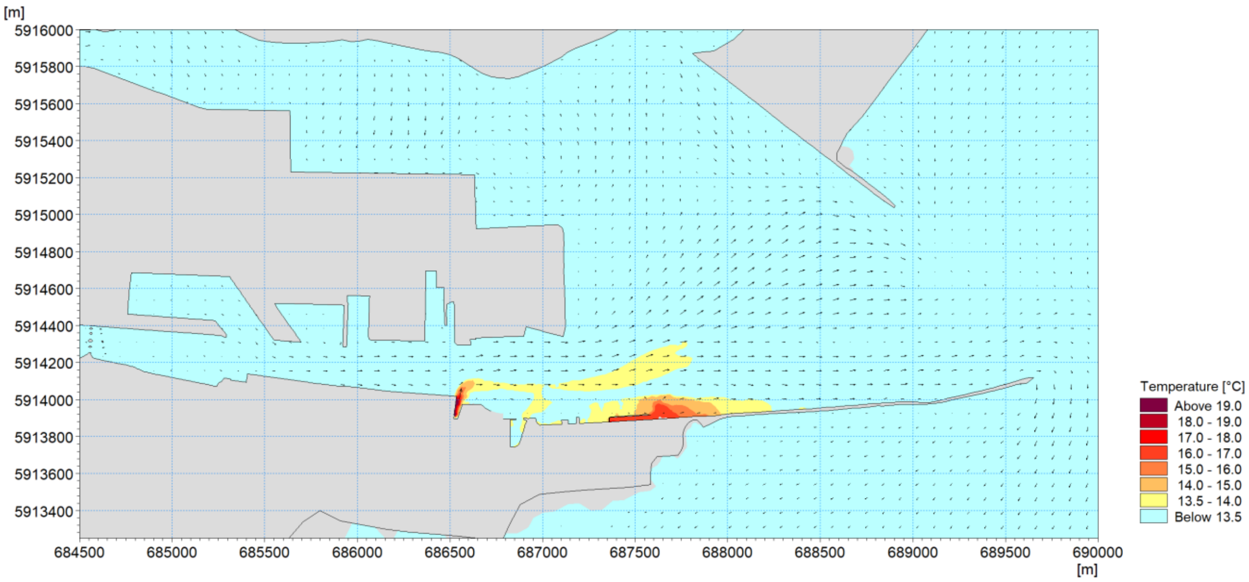

Figure 13.63: Near surface thermal plume envelopes during a typical spring high tide – Post-3FM Project

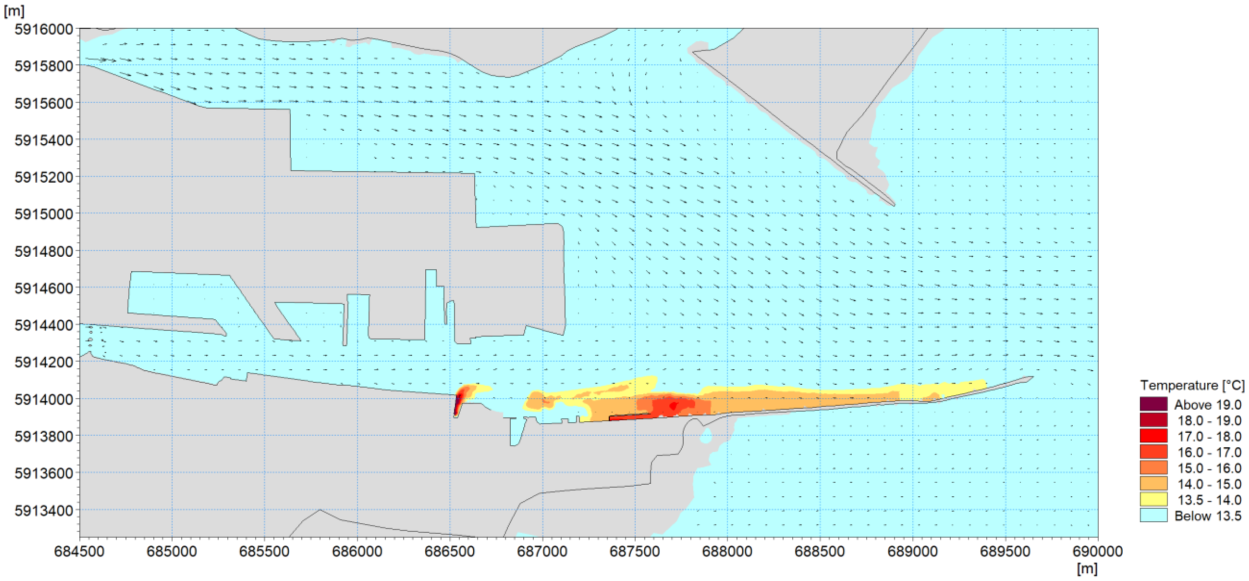

Figure 13.64: Near surface thermal plume envelopes during a typical spring mid ebb tide – Post-3FM Project

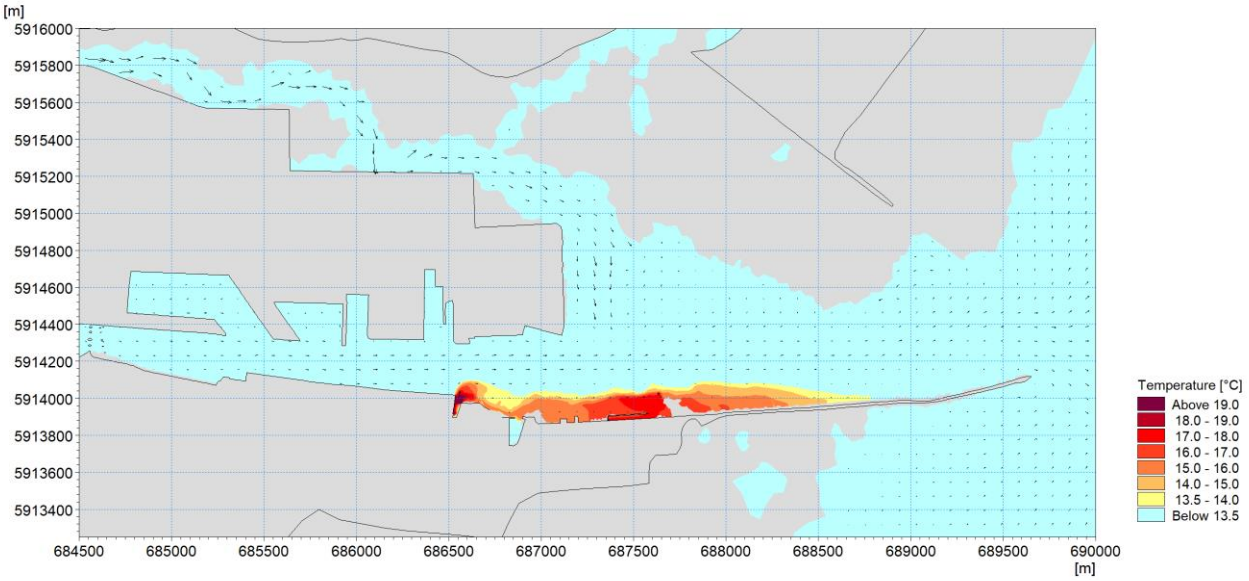

Figure 13.65: Near surface thermal plume envelopes during a typical spring low tide– Post-3FM Project

As outlined in section 13.2.2, the thermal plume modelling was undertaken in three dimensions, with the use of a sigma coordinate transformation approach whereby the vertical layer is divided into a discrete number of layers fixed proportionally to water depth. The relative depth and thickness of the layers varies spatially (i.e. are shallower in shallow water) and also temporally (i.e. with the changing water level associated with tidal flows). This is because the sigma layers used represent a fix percentage of the water column, the depth of which changes with tides and location. Therefore, within the context of undertaking a comparison between baseline and post construction of the 3FM Project, the sigma layer arrangements with respect to thickness will be different between the two scenarios where the bed level has changed, i.e. where either dredging or reclamation has been undertaken.

Due to the buoyant nature of the thermal plumes, the dispersion occurs within top 1 to 2 m of the water surface and therefore differences between sigma layers, which are concentrated towards the surface, will be sensitive to differences in temperature. As a result of this sensitivity calculating arithmetic differences between layers may introduce numerical artifacts which would not be reflected in reality. For this reason, the potential changes in temperature were calculated for a horizontal ‘slice’ through the model at 0.75m below the water surface, i.e. representative of the location of the thermal plume. In the following figures, grey areas shown within the Port and outer Bay indicate locations which are either dry or contain water depths less than 0.75m.

Thermal plume envelope plots relating to a slice 0.75 m below the water surface are presented for the same phases of a typical spring tide as previously in Figure 13.66 to Figure 13.69. Each figure is comprised of three plots; the upper figure relates to the baseline (ABR and MP2), the central figure is post-construction of the 3FM Project, and the lower figure is the difference in temperature between these scenarios.

In general, the greatest changes in water temperatures are observed at the Turning Circle. However, this is an *apparent* change, given that the corner of Pigeon House will be dredged and thus submerged in the Post-3FM scenario. Any change in this area would therefore be considered an increase, even if water temperatures are at a background temperature of 12ºC.

Aside from the Turning Circle, the only other change to the dispersion of thermal plume envelopes is observed within the immediate vicinity of Area N where water temperatures also increase. This can be attributed to two factors. There is a general increase of up to 4ºC which is due to the influence of the proposed piling in this area which results in a very marginal decrease in thermal dispersion in the vicinity. There is a more localised increase adjacent to the south wall at low water which, much like the turning circle, occurs where areas which were previously very shallow or dry become submerged in the Post-3FM scenario.

Importantly, this does not result in a significant change to water temperatures at the Poolbeg Power intake. This is demonstrated in Figure 13.70 which presents the change in water temperatures at the intake and an average value over the water depth as a result of the 3FM Project. Based on this data, the 3FM Project was found to reduce the average temperature at the Poolbeg intake by 0.16ºC whilst overall the depth average values remain unchanged. This is consistent with the marginal decrease in thermal dispersion due to a minor reduction in current speed as a result of the proposed piling.

It can therefore be concluded that there are no significant changes to the dispersion of thermal plumes envelopes within Dublin Port as a result of the 3FM Project and no mitigation is required.

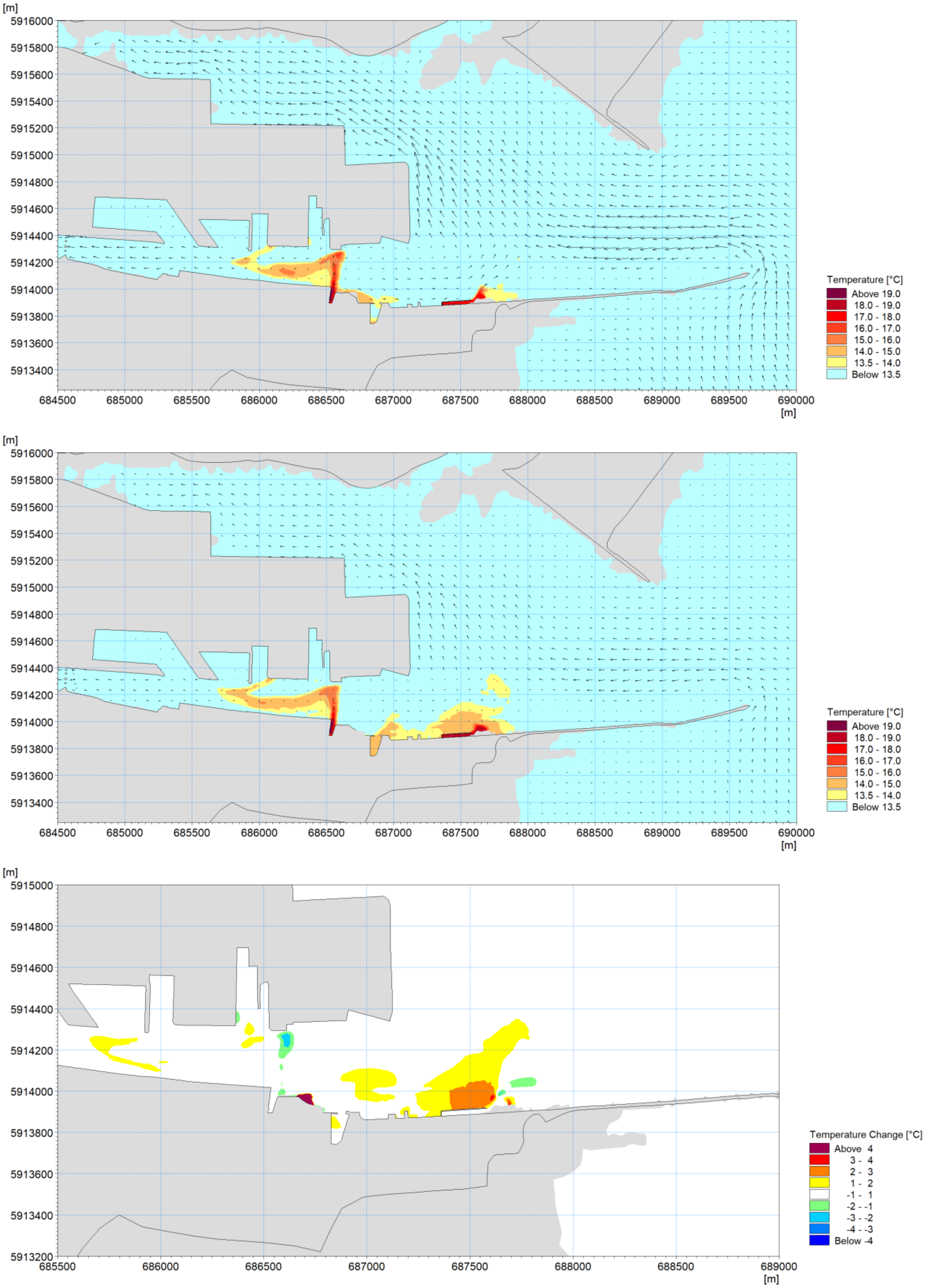

Figure 13.66: Baseline (upper), post 3FM Project (centre) and difference (lower) thermal plume envelopes 0.75 m below the surface during a typical spring mid-flood tide

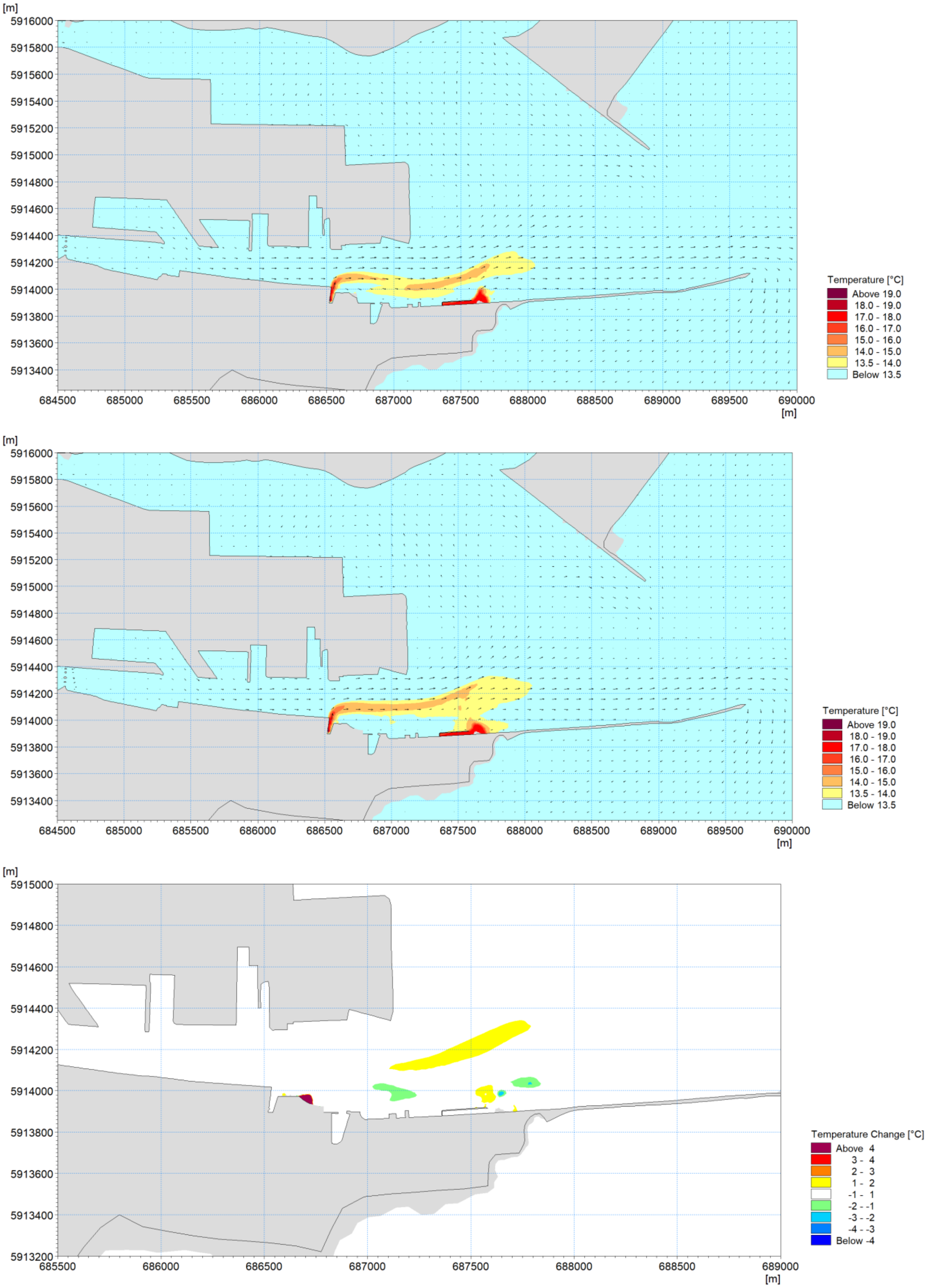

Figure 13.67: Baseline (upper), post 3FM Project (centre) and difference (lower) thermal plume envelopes 0.75 m below the surface during a typical spring high tide

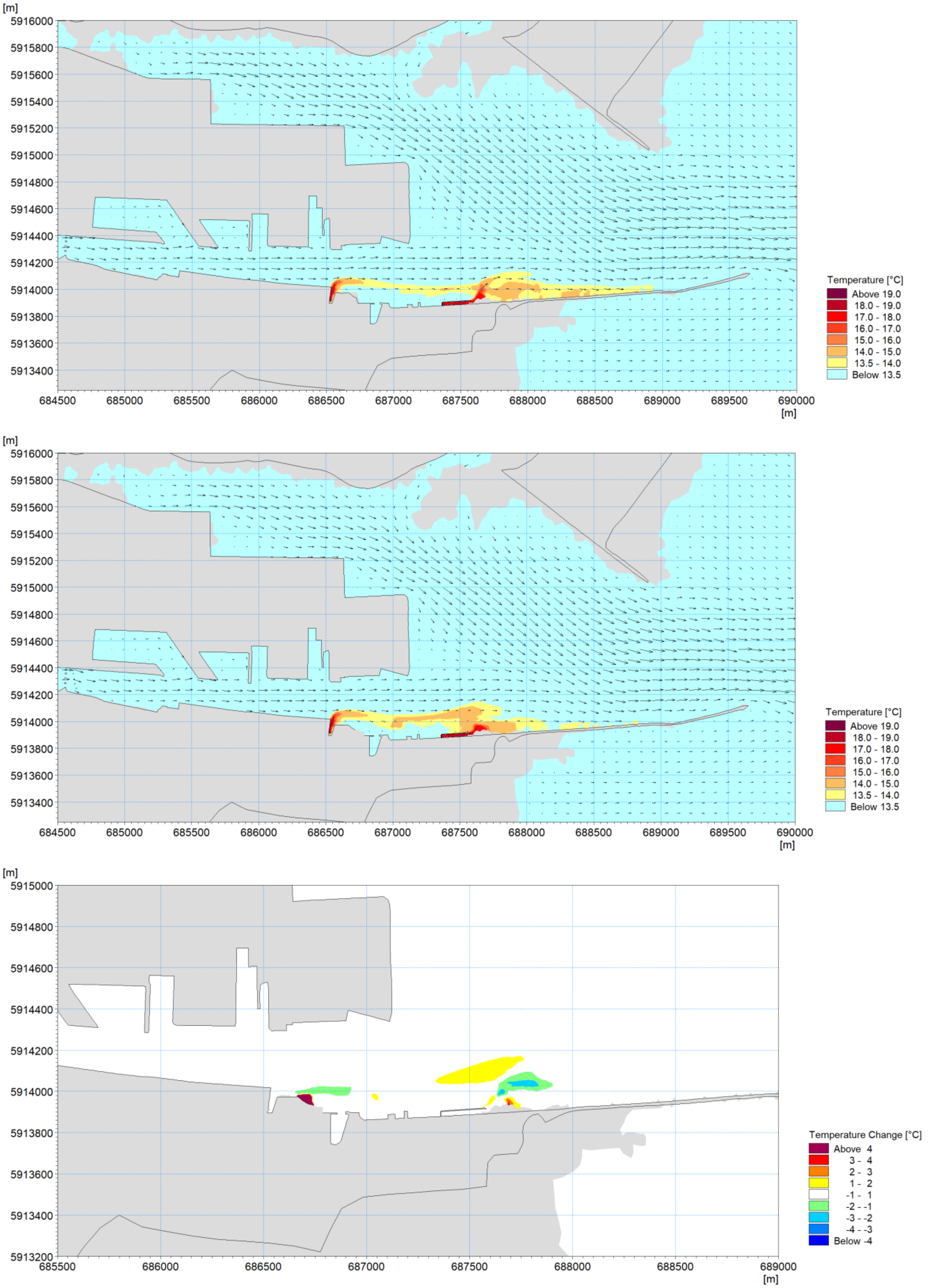

Figure 13.68: Baseline (upper), post 3FM Project (centre) and difference (lower) thermal plume envelopes 0.75 m below the surface during a typical spring mid-ebb tide

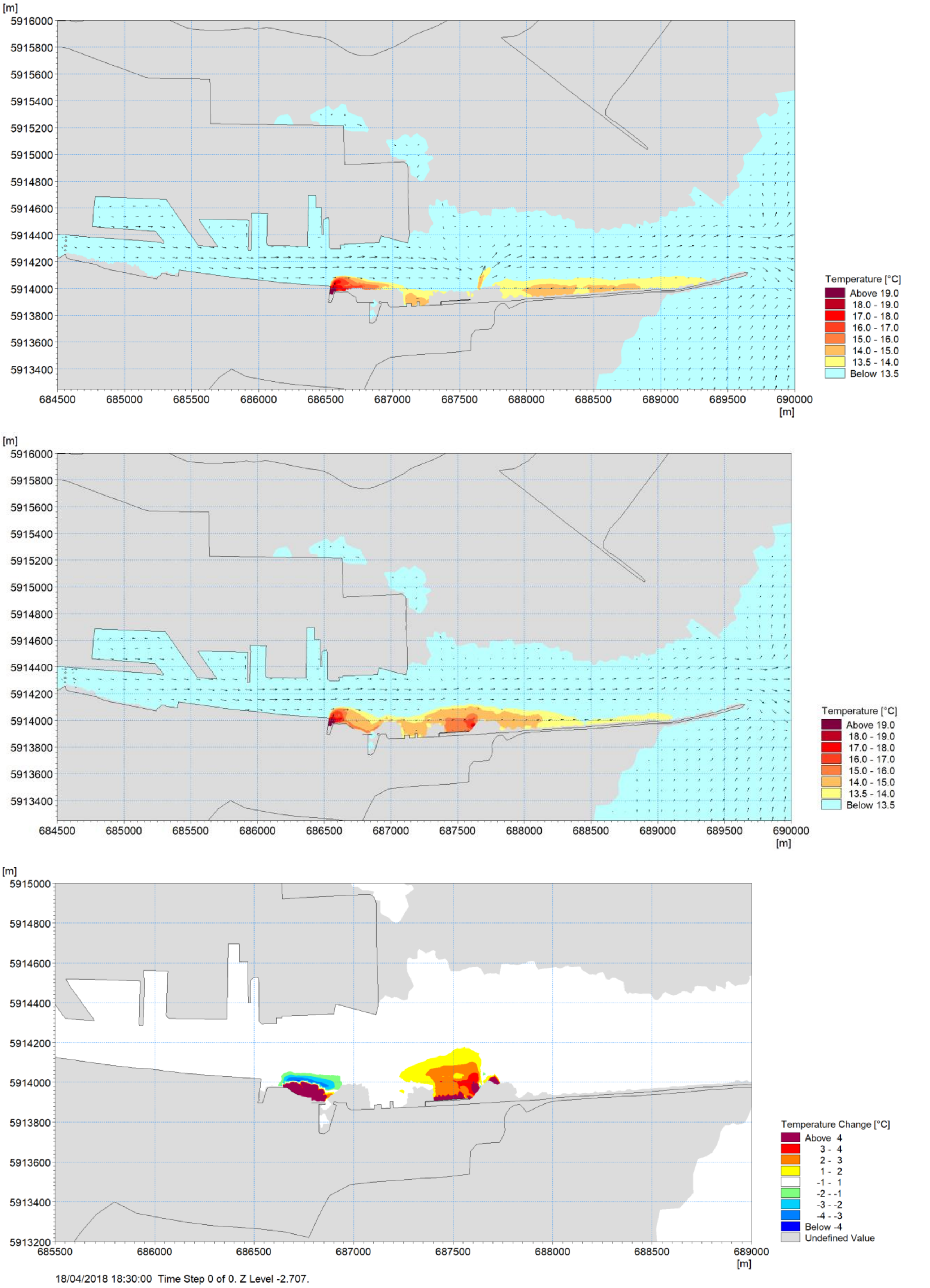

Figure 13.69 Baseline (upper), post 3FM Project (centre) and difference (lower) thermal plume envelopes 0.75 m below the surface during a typical spring low tide

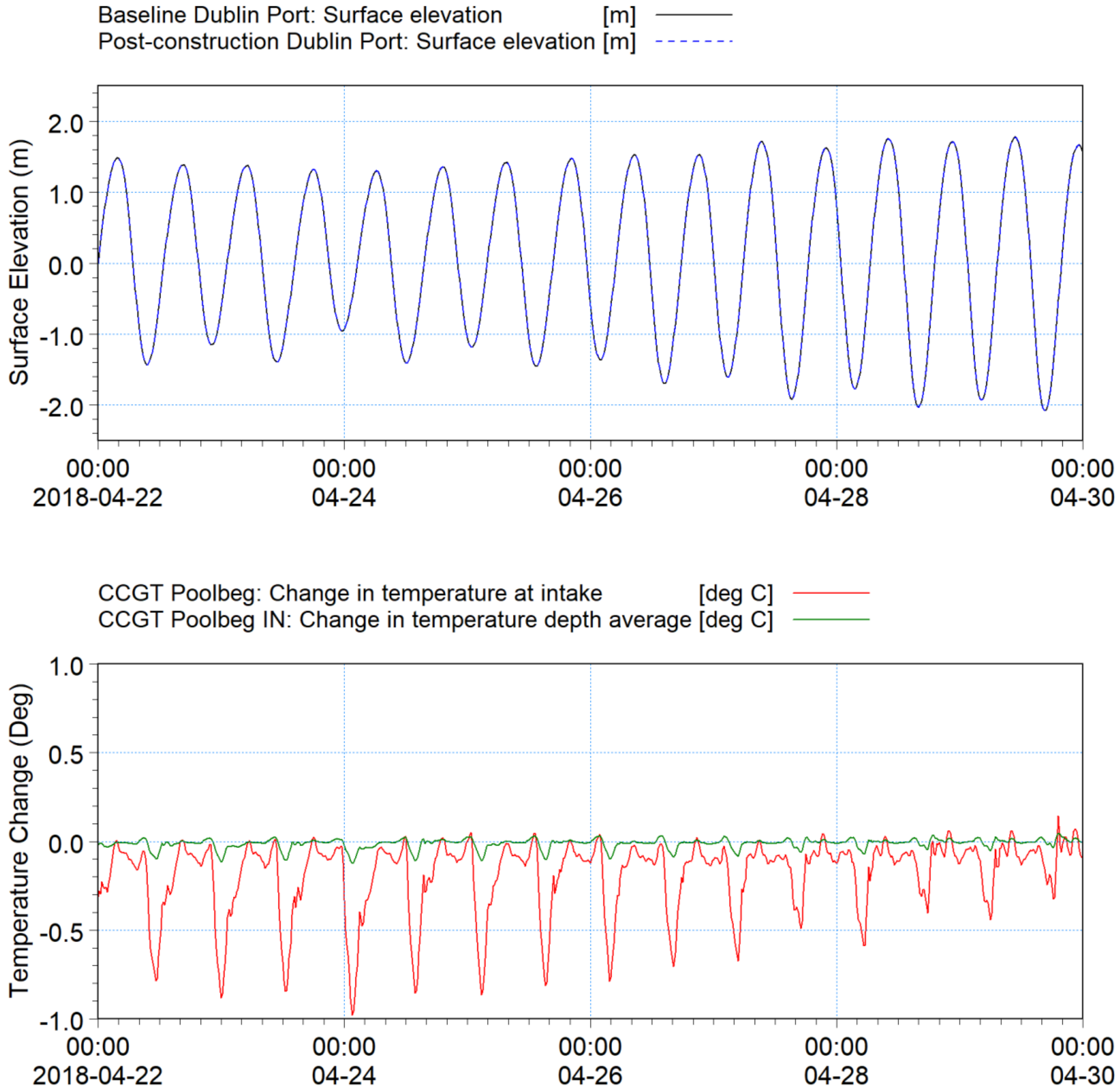

Figure 13.70: Surface elevations (upper) and temperature changes at the Poolbeg intake model layer and average temperature differences across all layers (lower) as a result of the 3FM Project (minus values indicating a temperature decrease relative to baseline conditions and vice versa).

13.5.2.4 Potential changes to the sediment transport regime

As indicated in Chapter 7 (Biodiversity) and shown in Figure 13.71, the 3FM Project site is bounded to the North and East by the South Dublin Bay and Tolka Estuary Special Protection Area (SPA). It was, therefore, important to consider potential changes to the sediment transport regime as a result of the 3FM Project.

Sediment on the seabed is transported when it is exposed to large enough forces, or shear stresses, by the water movements. These movements can be caused by the current or by the wave orbital velocities or a combination of both. The relevant parameters for the description of the sediment transport within a coastal environment are therefore based on the following coastal processes:

1. Wave conditions at the site and the possible variations over a site
2. Current conditions as well as the variations of current over an area
3. Water-level conditions, i.e., tide, storm surge and wave set-up
4. The sediment characteristics over an area
5. The sources and sinks of sediment, such as rivers or tidal inlets.

Given that the previous Sections of this report have demonstrated that the 3FM Project will have no significant impact on these processes, it can be concluded that the 3FM will not result in a significant impact to the sediment transport regime within Dublin Port, at any of the outfall or intake assets, or the wider Dublin Bay area.

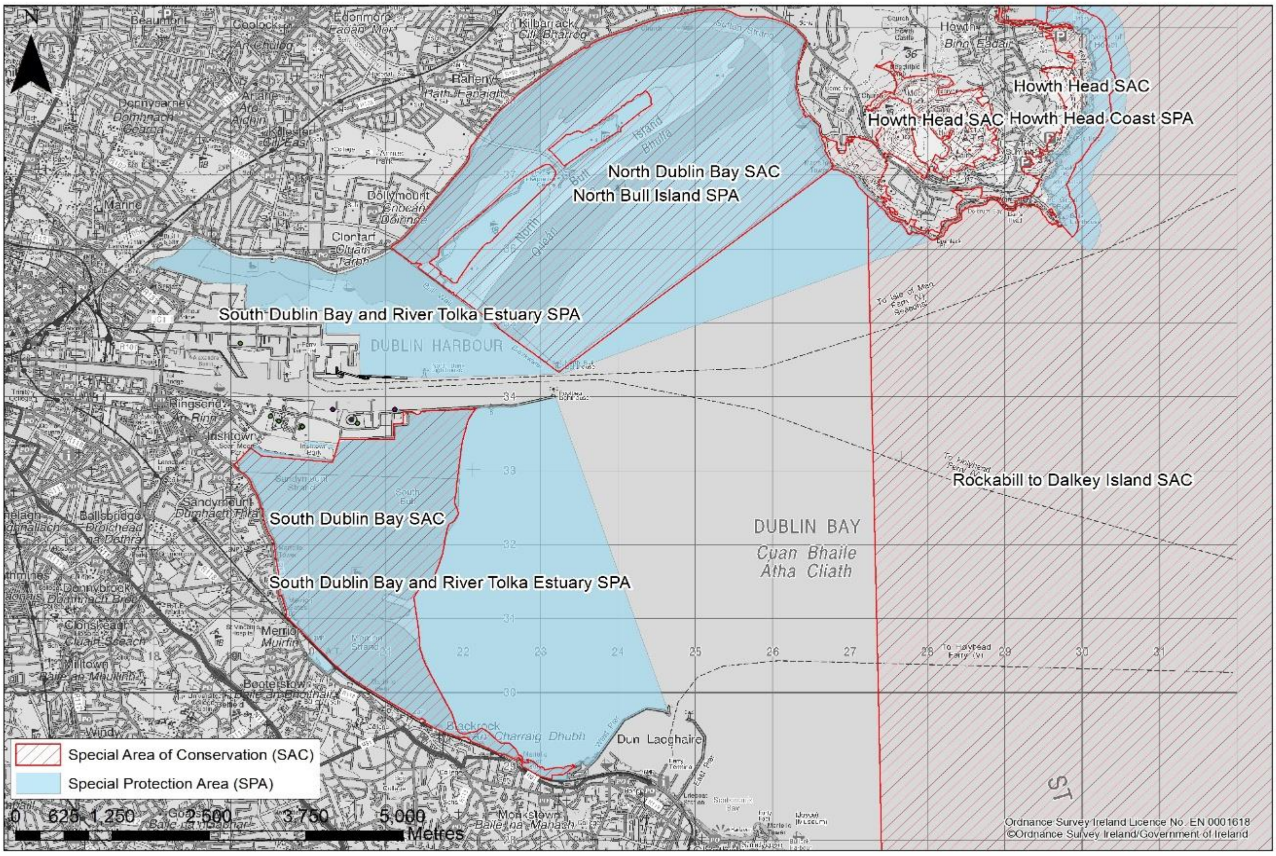

Figure 13.71: Natura 2000 Designated sites surrounding Dublin Port

13.6 Mitigation Measures

13.6.1 Construction Phase Mitigation Measures

As described in Chapter 9, Dublin Port Company completed its first winter dredging season (October 2017 – March 2018) as part of the ABR Project. This dredging campaign was fully compliant with the requirements of the Dumping at Sea, Foreshore and Planning Consents as confirmed by high resolution environmental monitoring results reported in the Annual Environmental Report submitted to the Office of Environmental Enforcement (OEE) in March 2018.

The mitigation for dredging operations in the 3FM Project has been informed by the ABR Project and MP2 Project monitoring and experience working in the same locations.

The following mitigation measures will apply to each dredging campaign in the 3FM Project:

- Loading will be carried out by a backhoe dredger or trailing suction hopper dredger (TSHD).
- The capital dredging activity will be carried out during the winter months (October – March) to negate any potential impact on salmonid migration (particularly smolts) and summer bird feeding, notably terns, in the vicinity of the dredging operations.
- No over-spilling from the vessel will be permitted while the dredging activity is being carried out within the inner Liffey Channel.
- The TSHD pumps will be switched off while the drag head is being lifted and returned to the bottom as the dredger turns between successive lines of dredging to minimise the risk of fish entrainment.
- The dredger's hopper will be filled to a maximum of 4,100 cubic metres (including entrained water) to control suspended solids released at the dumping site. This is equivalent to a maximum quantity per trip of 2,030 tonnes (wet weight).
- Full time monitoring of Marine Mammals within 500 m of loading and dumping operations will be undertaken in accordance with the measures contained in the Guidance to Manage the Risk to Marine Mammals from Man-Made Sound Sources in Irish Waters (NPWS 2014).
- A documented Accident Prevention Procedure will be put in place prior to commencement.
- A documented Emergency Response Procedure will be put in place prior to commencement.
- A full record of loading and dumping tracks and record of the material being dumped will be maintained for each trip.
- Dumping will be carried out through the vessel's hull.
- The dredger will work on one half of the channel at a time within the inner Liffey channel to prevent the formation of a silt curtain across the River Liffey.
- When any dredging is scheduled to take place within a 500 m radius of power station intakes, the relevant stakeholders will be notified so that precautionary measures can be taken if deemed necessary.

Assuming the above mitigation measures are employed during capital dredging and disposal operations, the potential risk to receiving water environment will be negligible thus reducing the significance of environmental impact to Imperceptible.

13.6.2 Operational Phase Mitigation Measures

To mitigate the operational phase impact of the SPAR development as described in Section 13.5.2, suitable scour protection should be developed and implemented within the immediate vicinity of the proposed development.

In circumstances where suitable scour protection is implemented, the operational impacts of the SPAR element of the 3FM Project to coastal processes, in particular, bed morphology and the potential of scouring will be negligible.

13.7 Residual Impact

In circumstances where the mitigation measures are fully implemented during the construction and operational phases as outlined in Section 13.6 the impact of the 3FM Project on the coastal processes within Dublin Port and Dublin Bay will consist of small scale, low magnitude changes in the tidal regime and wave climate.

The 3FM Project is therefore not expected to have a significant effect on coastal processes or make a significant change to the existing morphology.

13.8 Monitoring

As described in this Chapter 9 (Water Quality and Flooding), a water quality monitoring programme will provide additional safeguards to the receiving environment and to confirm the effectiveness of the mitigation measures implemented to address any potential environmental impacts to the receiving environment during the construction phase of the works.

Monitoring will continue during construction to confirm the effectiveness of the mitigation measures identified in this EIAR. Regular, confirmatory visual monitoring and environmental audits will also be undertaken during the construction phase of the works.

In addition, the Port’s existing Environmental Management System (EMS), which is accredited to ISO 14001 standard, will monitor the operational activities to confirm that measures to address operational impacts are effective and provide adequate protection to the sensitive receiving waters.

13.9 Potential Cumulative Impacts

As described in Chapter 20 (Cumulative Impacts), there are several other developments that are proposed within the vicinity of the 3FM Project. Whilst the majority of these relate to terrestrial developments with no pathways to interact with the 3FM Project in context of coastal processes, there are two proposals that could act in combination potentially affect coastal processes in Dublin Port or wider Dublin Bay area. These projects include:

1. The reclamation of a small parcel of land at Pigeon House road which is required by Codling Wind Park Limited (CWPL) to construct a 220 kV substation. This substation is needed to facilitate the transmission of the 900 – 1,500 MW of electricity which would be produced by the proposed Codling Wind Park (CWP) Offshore Wind Farm (OWF) into the existing onshore grid network.
2. In addition to the SPAR which is being proposed as part of the 3FM Project, Dublin City Council also intend to seek permission for an active travel bridge which will span the River Liffey immediately west of the existing Tom Clarke Bridge.

Further to the projects described above, DPC have previously been requested to provide details on the predicted sediment deposition and sediment dispersion from loading and dumping activities, cumulatively from the proposed activities under the 3FM Project and those permitted under (S0004-03 and S0024-02) and any subsequent impacts on the wider environment.

The following sections of this chapter consider the potential cumulative effect between these projects and the 3FM Project on coastal processes, including the potential for cumulative effects associated with dredging with other permitted activities.

13.9.1 CWP Sub-station at Pigeon House

The location, extent and scale of the works proposed by CWP at Pigeon House road is illustrated in Figure 13.72. Whilst the details of this scheme are yet to be finalised, it is understood through extensive consultation with CWP that at a high level, the scheme will involve the demolition and dredging of approximately *c.*170 m^2 of land at the north east of the site (see area hatched orange area in Figure 13.72). As a result, levels in this area will be decreased from between *c.* +3 and +7m to -10 m CD. These levels are commensurate with the dredging required to create Turning Circle as proposed under the 3FM Project. In addition, it is also proposed to reclaim approximately 200 m^2 of land at the south east corner of the Pigeon House site (see area hatch blue in Figure 13.72).

These dredging and reclamation activities associated with this project will be undertaken as part of the 3FM Project, as outlined in the project description detailed in Chapter 5 of this EIAR, independently from the CWP Sub-station project. The 3FM Project coastal processes assessment therefore included any potential impacts from this project and concluded that there will be no cumulative impacts in terms of coastal processes.

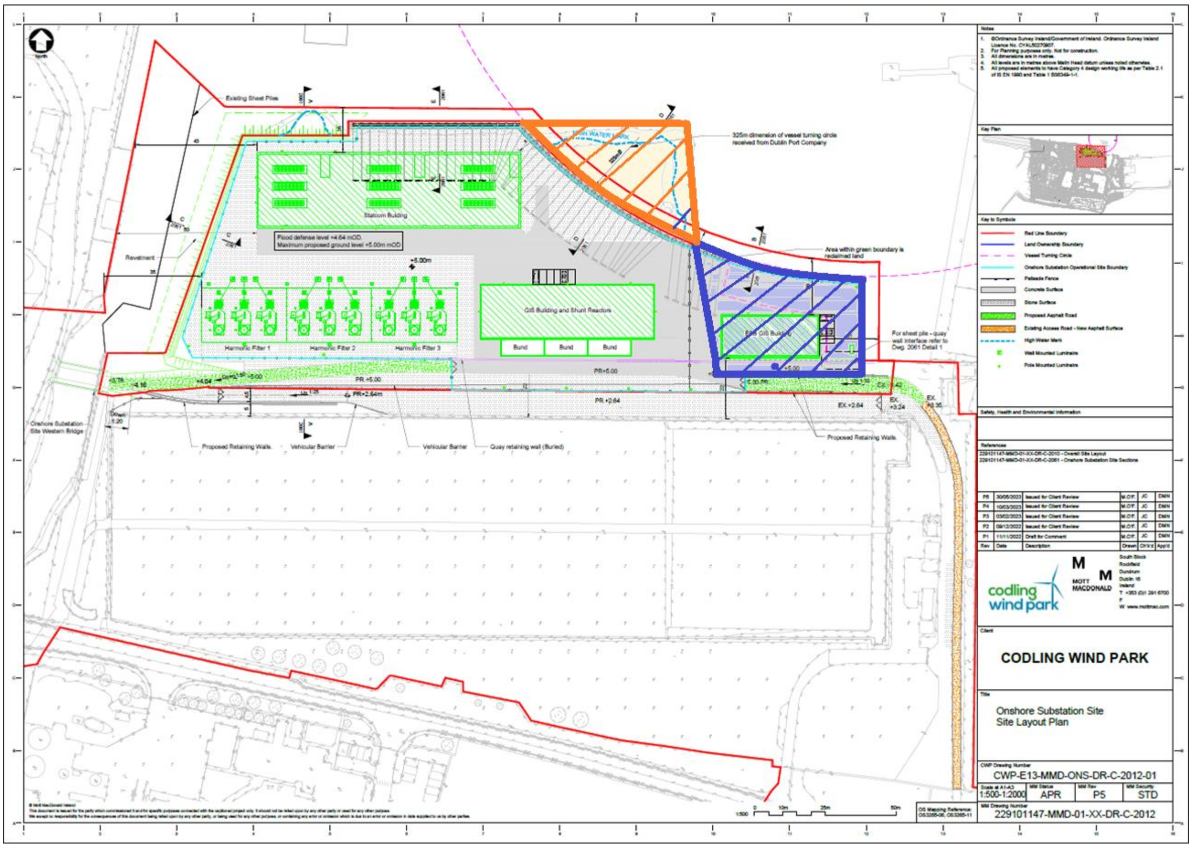

Figure 13.72: Codling Wind Park onshore sub-station site layout plan. Reclamation area hatched blue and demolition/dredge area hatched orange.

13.9.2 Dublin City Council Active travel bridge

Dublin City Council (DCC) intend to seek permission for an active travel bridge which will span the River Liffey immediately west of the existing Tom Clarke Bridge. Whilst details of this scheme are limited, it is understood that an active travel bridge will be designed to accommodate walking, wheeling, cycling and use of non-motorised scooters. Discussions with the designers ROD indicated that based on the preliminary design of the scheme:

- The centreline of this bridge would be located *c.* 20 m west of the existing Tom Clarke bridge.
- The bridge would be supported by one large bascule pier which aligned directly with the existing bascule pier of the Tom Clarke bridge.
- The bridge would be further supported by a series of abutments and landing piers (*c.* 4 in total) which aligned directly with existing supporting structures of the existing Tom Clarke bridge.

Given that the support structures for this bridge will be of similar size and nature and directly aligned with those structures which support the Tom Clark bridge, the change to hydrodynamic streamlines and eddies would be negligible. The preliminary information available at this stage therefore indicates that the potential of any cumulative impacts on coastal processes between the 3FM Project and the Active Travel Bridge would be insignificant.

13.9.3 Cumulative impact of sediment deposition and sediment dispersion

A Section 5(2) Notice was issued to DPC from the EPA on 7th November 2023 requesting additional information so that the Agency may complete a comprehensive assessment of the application. This notice required DPC to

"Provide details on the predicted sediment deposition and sediment dispersion from loading and dumping activities, cumulatively from the proposed activities and those permitted under (S0004-03 and S0024-02) and any subsequent impacts on the wider environment. As a minimum a modelling assessment is required to describe the fate of sediments and the impact on the receiving environment, and address how the activities will be managed to ensure that they will comply with, or will not result in the contravention of the following Directives:

- *The Habitats Directive 82/43/EEC and Birds Directive 2009/147/EEC,*
- *The Water Framework Directive 2000/60/EC,*
- *The Marine Strategy Framework Directive 2008/56/EC."*

The technical document presented in Appendix 13-4 was produced to undertake a cumulative assessment which considered the following permitted loading and dumping activities:

- Dumping at Sea Permit S0004-03 - Dublin Port 2022-2029 Maintenance Dredging Programme
- Dumping at Sea Permit S0024-02 - MP2 Project Capital Dredging

For robustness, this assessment also included for the capital dredging activities required by the 3FM Project.

It should be noted that since the document presented in Appendix 13-4 was issued to the Environmental Protection Agency (EPA) in January of 2024, the maximum anticipated dredge volumes associated with the 3FM Project have increased from 1,117,000 m^3 to 1,189,000 m^3. This represents a volume increase of *c.* 6% in context of the dredge volume associated with the 3FM Project and a *c.* 2% increase in the overall volume considered in the assessment described in Appendix 13-4. Given this immaterial difference, the findings presented in Appendix 13-4 are still considered relevant to this assessment of potential cumulative impacts.

In summary, Appendix 13-4 assessed the potential cumulative impact of all permitted activities and the 3FM Project in context of:

- Sediment deposition from loading activities.
- <u>Silt</u> deposition arising from each dredging project.
- <u>Sand</u> deposition arising from each dredging project.

The findings of these assessments are summarised in the following Sections.

13.9.3.1 Sediment deposition from loading activities

Considering dredging activities, computational modelling studies were undertaken to predict sediment deposition within the Tolka Estuary as a result of loading activity associated with each of the following capital and maintenance dredging programmes:

- Dublin Harbour Capital Dredging Project (subject of current application).
- Dumping at Sea Permit S0004-03 - Dublin Port 2022-2029 Maintenance Dredging Programme.
- Dumping at Sea Permit S0024-02 - MP2 Project Capital Dredging.
- 3FM Project Capital Dredging (application expected Q3/Q4 2024).

The maximum dredge volumes. programme and key mitigation measures as detailed in Section 2 of Appendix 13-4 were used as input to the computational modelling studies. The output of the computational studies is summarised in Table 13.11.

Table 13.11: Predicted Sediment Deposition within the Tolka Estuary for various capital and maintenance dredging activities

Dredging Campaign	Predicted Sediment Deposition	Maximum deposition depth	Reference Document
Dublin Harbour Capital Dredging Project (S0033-01)	<0.30g/m^2	<0.2µm	Dublin Harbour Capital Dredging Project EIAR, Dumping at Sea Permit Application (August 2021)
MP2 Project (S0024-02)	<0.50g/m^2	*c.*0.33µm	RPS Report on Additional Sediment Plume Modelling, Response to Section 5(2) Notice (November 2021)
Dublin Port 2022 - 2029 Maintenance Dredging Programme (S0004-03)	<0.30g/m^2	<0.2µm	RPS Report on Coastal Processes Risk Assessment, Dumping at Sea Permit Application (December 2020)
3FM Project Capital Dredging (application expected Q3/Q4 2024)	<128g/m^2	85 µm	See Section 13.4 and Appendix 13-4
Comparison with Natural Sedimentation	**30,000g/m^2**	***c.*2cm**	**Dublin Port Maintenance Dredging AER (March 2017)**

13.9.3.2 Silt deposition arising from each dredging project.

Numerical modelling work undertaken previously in support of the Alexandra Basin Redevelopment (ABR) Project (RPS, 2014) found that sediment material to be dredged throughout the Port Area could generally be characterised by three discrete fractions with mean diameters of 200µm, 20µm and 3µm with each fraction constituting 1/3 of the total volume of the dredge material. This specification was based on Particle Size Distributions (PSDs) of sediment samples collected from the Harbour area (RPS, 2014) (Dublin Port Company, 2020).

Based on this earlier work, the sand fraction of the dredge material was found to behave differently to silt material in that the sand fraction remained on the dump site whereas the silt material was dispersed by tidal currents.

Recognising the different dispersion and deposition characteristics of these different fractions, the sediment deposition as a result of disposing the silt and sand dredge material at the dump site was considered separately in this Section and Section 13.9.3.3 respectively.

In respect of silt deposition, the cumulative sediment deposition within Dublin Bay as a result of all four dumping at sea activities is presented in Figure 13.73. As demonstrated by this Figure, the cumulative total deposition of silt material beyond the immediate vicinity of the disposal site is generally less than 0.60g/m^2. This magnitude of deposition translates to a maximum change in bed level thickness of *c.* 0.45µm as illustrated in Figure 13.74. This is less than the width of a human hair and is not measurable in the field.

For context, the estimated natural sediment load from the upstream Liffey catchment is estimated at circa 200,000 tonnes per annum (DPC Maintenance Dredge AER 2017, Dumping at Sea Permit S0004-01). If dispersed over the Port area between East Link and Poolbeg Lighthouse and the Tolka Estuary; this is roughly equivalent to a natural sediment load of 30 kg/m^2 in any year (30,000 g/m^2). This is equivalent to an average depth of 2cm (based on a silt material).

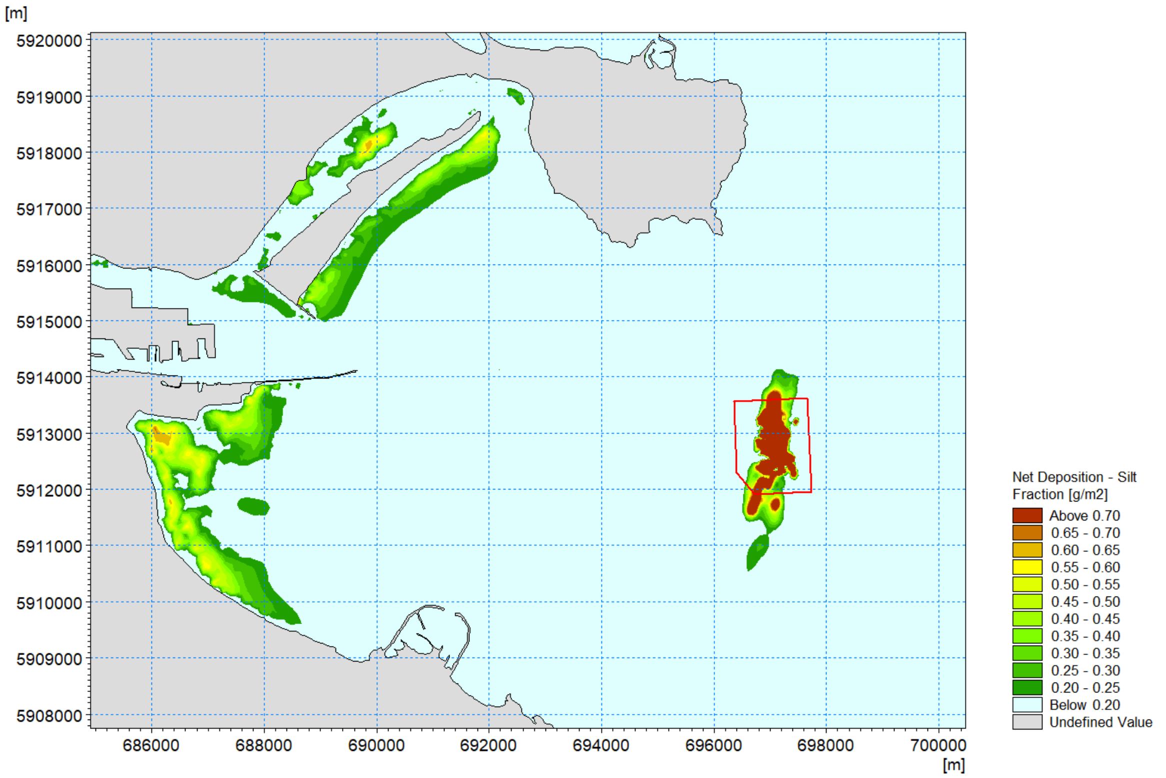

Figure 13.73: Cumulative total deposition of silt material following the dumping at sea activities associated with S0024-02, S0004-03, S0033-01 and the 3FM Project

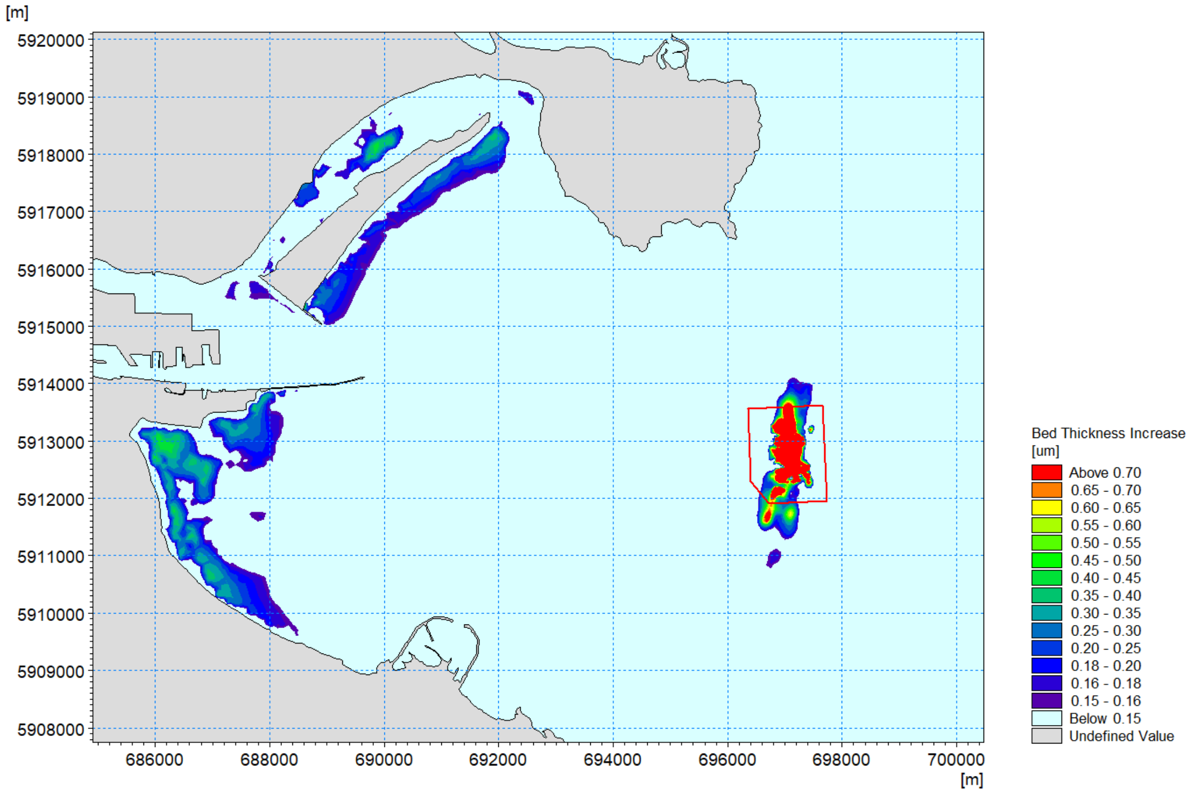

Figure 13.74: Cumulative bed thickness increase as a result of silt deposition from S0024-02, S0004-03, S0033-01 and the 3FM Project

13.9.3.3 Sand deposition arising from each dredging project.

As noted previously, the sand fraction of the dredge material was found to behave differently to silt material in that the sand fraction of dredge material immediately fell and settled on the dump site owing to the high fall velocities associated with this material. This is demonstrated in Figure 13.75 which illustrates the deposition of *c.* 1million cubic metres of sand material across the dump site following the continuous disposal of sand over the course of 6 months.

These findings are in line with other studies which concluded that sand fractions with higher fall velocities and higher critical shear stress parameters (relative to silt material) tend to remain in the locale of the disposal site with minimal re-suspension occurring (CEFAS, 2021).

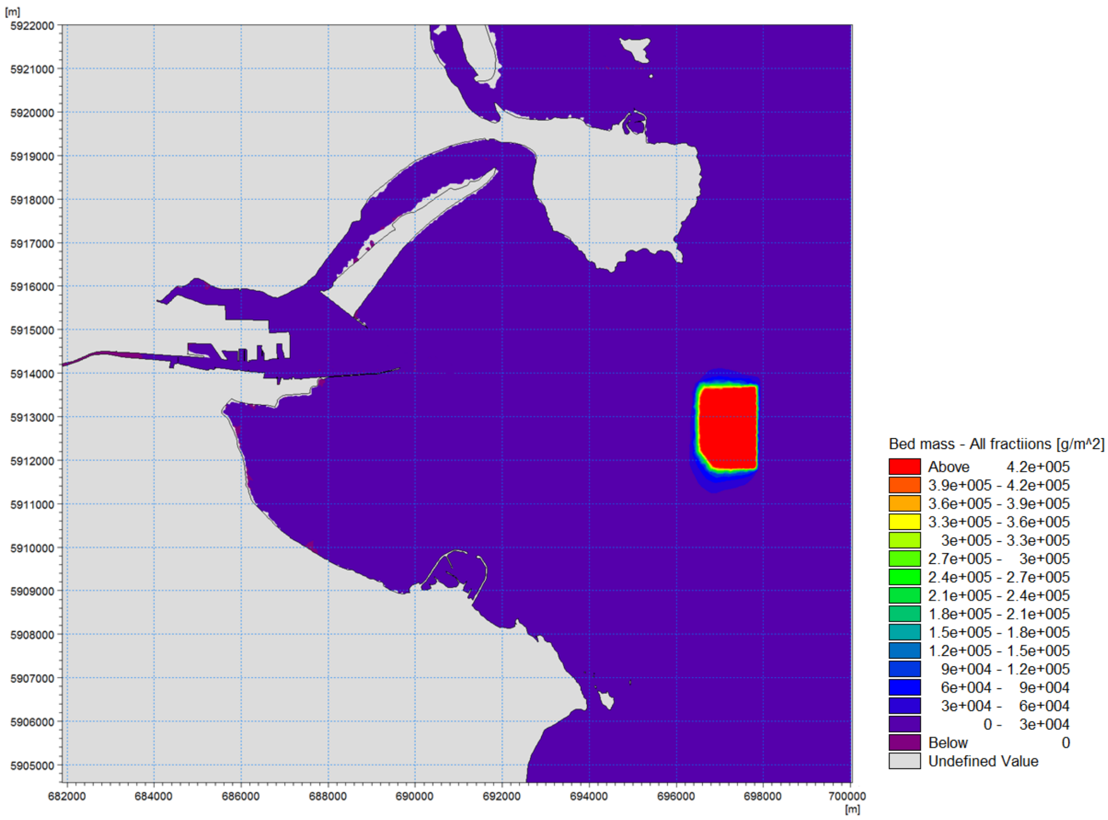

Figure 13.75: Total sand deposition after six months of continuous disposal of sand spoil material

To assess the potential <u>movement</u> of the coarse material on the dump site, RPS utilised a two-stage approach which firstly involved reviewing site-specific high-resolution bathymetric surveys of the dump site to measure changes in seabed elevations and thus derive rates of change. Given that much of the dump site is characterised by well-defined sand waves, the output from this assessment was used as a proxy to determine the long-term potential for sediment erosion and movement. To further support this assessment, RPS undertook a bespoke numerical modelling exercise to quantify the erosion and movement of coarse material based on met-ocean conditions.

This assessment found that sediment transport under tidal conditions alone does not exceed 0.005 m/day regardless of the depth. This further demonstrates that the coarser sand material on the dump site will likely only be mobilised by wave action.

In addition to this assessment, it should be noted that since 2012, the Marine Institute has carried out monitoring to determine macroinvertebrate ecological quality status (EQS) in coastal and transitional waters around the Irish Coast in order to fulfil requirements of the Water Framework Directive (WFD). As part of this programme, sampling must be carried out within each waterbody, including Dublin Bay, at least twice within the 6-year cycle (once every three years).

Based on the sampling and monitoring of 15 individual locations illustrated in Figure 13.46, the seabed material was found to comprise of muddy and fine sand or very fine sands at all stations. Coarse material was found to contribute an insignificant part of the sediment. Furthermore, the benthic communities surveyed in Dublin Bay were characteristic of the shallow muddy fine sand sediments sampled. Taxa common throughout the stations included, amongst others, the polychaetes *Glycera tridactyla, Nephtys hombergii, Spiophanes bombyx* and *Chaetozone christiei.*

The results of the Marine Institute's long-term (since 2012) environmental benthic surveys were therefore found to support the findings of this assessment that the movement of coarse material into Dublin Bay as a result of disposing of dredge material at the dump site is extremely limited and highly unlikely to result in a large-scale deposition event in Dublin Bay.

13.9.3.4 Summary of cumulative impact assessment of sediment deposition and dispersion

As described in Appendix 13-4, when considered in context of natural sedimentation within the Port Area (i.e., 30,000 g/m^2/yr which is equivalent to a deposition rate of *c.*2cm/yr), it is clear that the impact of sediment deposition from all dumping activities is several magnitudes lower than natural sedimentation rates. The impact of predicted sediment deposition from all capital and maintenance dredging dumping activities can therefore be considered to be *de minimis*.

Appendix 13-4 concludes that, the computational modelling studies of the capital and maintenance dredging dumping activities within the licensed dump site located at the approaches to Dublin Bay, west of the Burford Bank, in adherence with the key mitigation measures, will ensure that cumulatively they will comply with, or will not result in the contravention of the following Directives:

- The Habitats Directive 82/43/EEC and Birds Directive 2009/147/EEC,
- The Water Framework Directive 2000/60/EC,
- The Marine Strategy Framework Directive 2008/56/EC.

13.9.4 Inter-related Effects

Effects on coastal processes have the potential to have secondary effects on other receptors and these effects are considered in the topic-specific chapters. The assessment presented therefore informs and is informed by the following technical chapters:

- Chapter 7: Biodiversity including Marine Mammals, Benthic Biodiversity and Fisheries
- Chapter 9: Water Quality and Flooding

During the construction phase increases in suspended sediment concentration as a result of capital dredging works have the potential to impact of marine mammals, fish and shellfish and benthic ecology these are assessed in Chapter 7: Biodiversity. Similarly these activities may impact water quality which is assessed in Chapter 9: Water Quality and Flooding.

During the operation phase potential changes in tidal flow and temperature may impact marine mammals, fish and shellfish and benthic ecology these are assessed in Chapter 7: Biodiversity. The assessment of changes to wave climate and water level has been used to inform the assessment of flood risk, presented in Chapter 9: Water Quality and Flooding.

13.10 Conclusions

The assessment of coastal processes was based on an extensive numerical modelling programme using RPS' in-house suite of MIKE coastal process modelling software developed by the Danish Hydraulic Institute (DHI). Baseline models were calibrated and verified against a range of project specific hydrographic data and subsequently used to assess the construction and operational impacts of the 3FM Project.

The assessment concluded that dredging operations required for the 3FM Project will not result in any significant impact to either water quality in terms of suspend sediments, or the nearby environmentally designated areas in terms of sediment deposition with mitigation measures in place.

In respect to the power station intakes and Ringsend WwTW outfall, any increase in the suspended sediment concentrations was generally very small by comparison with background levels in the Liffey Estuary. The dredging operations are therefore unlikely to have any effect on the quality of intake waters in terms of suspended solids content. However, as customary, DPC will continue to notify the power station operators in advance of each dredging campaign. This will allow operators to temporarily stop abstracting water from the Liffey for a short duration in the event that dredging is required within the immediate vicinity of their intake works.

The assessment of disposal of dredge spoil arising from the 3FM Project at the licenced offshore disposal site located to the west of the Burford Bank at the approaches to Dublin Bay concluded that the disposal operations will not result in any significant increases to the background level of suspended sediments and will not, therefore, impact the existing water quality in the greater Dublin Bay area.

The tidal regime is predicted to remain substantially unchanged post 3FM Project. The risk of impact to the existing tidal regime is therefore determined to be negligible and no mitigation is required.

The assessment of potential changes to the inshore wave climate found that the maximum change in wave heights in Dublin Port during storm events did not exceed ±0.20 m. These changes were confined primarily to the Maritime Village and Area N. There was no discernible change in the wave climate due to the 3FM Project in relevant proximate areas such as Clontarf, Fairview and Ballybough bordering the Tolka Estuary. These changes to the wave climate are not considered significant and will not impact operations within the Port. Furthermore, the change in risk of potential coastal flooding due to the 3FM Project at neighbouring sites is considered to be negligible and no mitigation is required.

Given that there are no significant changes to key coastal processes that govern sediment transport, i.e., tides, waves and water levels, it can be concluded that the 3FM Project will result in no discernible change to the existing sediment transport regime in Dublin Port and the in the greater Dublin Bay area.

The 3FM Project is not expected to act in combination with other nearby developments, including the CWP substation project, Dublin City Council active travel bridge across the River Liffey and other permitted dredging or disposal activities, or to result in any significant impacts to baseline coastal process conditions.

In circumstances where the mitigation measures are fully implemented during the construction and operational phases, the impact of the 3FM Project on the coastal processes within Dublin Port and Dublin Bay will consist of small scale, low magnitude changes in the tidal regime and wave climate. On the basis that the appropriate mitigations measures are fully implemented during the construction and operational phases, the impact of the 3FM Project on coastal processes will be imperceptible.