RPS

COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Alexandra Basin Redevelopment Project

Response to Request for Further Information






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1 INTRODUCTION

Dublin Port Company (DPC) submitted a planning application for the Alexandra Basin Redevelopment Project to An Bord Pleanála in March 2014 under planning reference number 29N.PA0034.

On 7th July, An Bord Pleanála issued by letter a request for further information (RFI), 29N.PA0034 with a request that the information should be submitted to the Board by 18th August 2014.

As the RFI raised matters that have been addressed in the EIS and NIS submitted with the application, RPS has been requested by DPC to prepare a detailed response to the specific queries and points of clarification raised by the Board. This document contains the responses to the Request for Further Information issued by An Bord Pleanála.

The responses to the RFI are provided in Chapter 2. Each query raised by An Bord Pleanála in the RFI is directly addressed sequentially.

2 RESPONSE TO REQUEST FOR FURTHER INFORMATION

A. NOISE AND VIBRATION

1. Construction noise and vibration

1.1 The EIS described the effects of noise and vibration resulting from the proposed works however more information is required to enable the Board to assess the potential adverse effects of construction noise and vibration on the surrounding area. Provide detailed information in relation to the proposal to construct new quay walls and structures over a significant area of Dublin Port referred to in Section 4.1.1 of the EIS with regard to the anticipated duration of overall pile installation activity along with the anticipated duration of piling at Alexandra Basin West and at Berths 52/53. Also, provide further details of the piling techniques that will be used in the construction of the new quay walls and other structures.

Response

Section 7.1.3 of Volume 1 of the ABR EIS contains a detailed appraisal of the predicted construction noise and vibration impacts associated with the proposed development, while Section 7.1.5 of Volume 1 of the EIS contains an outline of mitigation measures for construction noise and vibration. Table 7.1.13 of Volume 1 of the EIS contains the reference plant/equipment inputs into the noise model, including a worst-case reference of tubular steel piling using hydraulic hammer (BS5228:2009, Annex C, Table C3, Reference 3) for piling works. Tables 7.1.14 and 7.1.15 illustrate worst-case predicted construction noise levels during two of the noisiest stages of the construction process and Table 7.1.16 presents this worst-case construction noise levels in the context of commonly used construction noise threshold limits as set out in the National Roads Authority (NRA) *Guidelines for the Treatment of Noise and Vibration in National Road Schemes (2004)* [NRA Guidelines] and *BS5228:2009 Noise and Vibration Control on Construction and Open Sites*.

Table A1 contains specific details relating to the extent of quay wall construction that will require piling works, the number of piles that will be required for each quay and the approximate duration of piling works related to each particular quay. For each quay, two piling rigs will be active simultaneously during the duration of the construction works, albeit there will be a short lag time between the commencement of the first and second rig. As outlined in Table A1 the preliminary programme dates are for piling to commence in October 2015 and continue until January 2019. The number of piling rigs that will be active at any one time will vary over this period of time, with initially only one rig being active (i.e. October 2015) reaching a maximum of 5 in accordance with the programme (e.g. January 2018). In the paragraphs that follow, the discussion on the noise model illustrates that up to 7 piling rigs were included in the noise model as being active at any one time. The logic for this was to create a very robust model that would account for greater levels of construction activity than what is programmed, to allow for potential alterations to the programme and to ensure that a 'worst-case' scenario was appraised.

Table A1: Extent and Duration of Piling Activities during Construction Works (no piling during March – May)

Quay Structure	Approximate Quay Length to be Piled	Number of Piles	Preliminary Programmed Dates	Approximate Duration of Piling Works
Ocean Pier (Berths 32-34)	557m	186	Apr 2016-Feb 2017	10 months
Alexandra Quay West (Berths 29-31)	530m	177	Oct 2015 - Feb 2016 Jan 2017 - Feb 2017 June 2017 - Nov 2017	13 months
Crossberth Quay	256m	86	Nov 2015 - Feb 2016	4 months
North Wall Quay Extension (Berths 21-25)	937m	312	Jan 2018 -Feb 2018 Jul 2018 - Jan 2019	9 months
New Berth 52/53	297m	1433*	Jul 2017 - Jan 2018	7 months
Marina Wall	220m	74	Sept 2017 - Feb 2018	7 months
Ro-Ro Jetty in Alexandra Basin	273m	72	Jan 2017 - June 2017 (Total construction period)	3 months
Ro-Ro Jetty at Berth 49	40m	18	Jul 2017 - Mar 2018 (Total construction period)	1.5 months
Ro-Ro Jetty at Berth 52	75m	18	July 2017 - Mar 2018 (Total construction period)	1.5 months

* New Berth 52/53 quay two forms of construction, 130m steel combi-wall (equating to 45nr 1.6m dia tubes), and 167m formed using cellular cofferdams (equating to 1388nr 0.5m wide straight web piles). The latter is considerably less noisy than the former, so for the purposes of appraising worst-case noise levels, the former has been used in the noise model.

Table 7.1.13 of Volume 1 of the EIS contains the reference for tubular steel piling using hydraulic hammer (BS5228:2009, Annex C, Table C3, Reference 3) which was used in the noise model. This is a particularly noisy form of piling and has been used in the noise model to ensure a worst-case noise appraisal has been completed in the absence of final exact details of the piling technique that will be finalised at the detailed design stage. The two options currently in the submitted proposal for piling are a tubular pile combi wall (diameter approx 1.6m) [tubes at approximately 3m c/c with pair of Arcelor z-section piles between each tube] and a HZM king pile wall [H piles at approximately 2m c/c with pair of Arcelor z-section piles between each tube].

Of the two techniques under consideration, the tubular pile combi wall option is the noisier and hence has been used in the noise model. The proposed piling technique assumes the driving of tubular piles using a combination of vibratory and impact techniques. A temporary steel frame will be erected along the quay edge to form a gate/guide for the installation of the piles. The piles will then be lifted into position. Assuming a maximum pile length of 50m, the piles may be installed in two sections. Based on this assumption, the piles may stand approximately 25m above deck level prior to the commencement of the driving operations. Initially the piles may be driven using a vibratory hammer to penetrate through the softer strata. An impact hammer will then be used to progress the pile through the harder strata to rock. A ramp-up procedure, starting with low impacts and working up to full hammer stroke, will be employed when driving the piles in order to mitigate against potential noise impacts. The noisiest part of this process is assumed in the noise model.

Section 7.1.3 of Volume 1 of the EIS describes the rationale for the noise models that have generated the worst-case predicted construction noise levels included in Tables 7.1.14 - 7.1.16 of Volume 1 of the EIS. There will be many elements of cross-over of construction activities at the various quays during the construction process, so in order to complete a worst-case construction phase noise appraisal two worst-case snapshots of the construction phase were used. These two snapshots are described below:

- Construction Phase Scenario 1: In terms of piling, this scenario assumes that 6 separate piling rigs are active simultaneously at Alexandra Quay West (3 piling rigs), Crossberth Quay (1 piling rig) and Ocean Pier (2 piling rigs).
- Construction Phase Scenario 2: In terms of piling, this scenario assumes that 7 separate piling rigs are active simultaneously at the Marina Wall (1 piling rig), Berth 52 (2 piling rigs), North Wall Quay (2 piling rigs) and Alexandra Quay West (2 piling rigs).

While there will be a certain degree of cross-over between construction activities at the various quays (see Table 1), all of these cross-over events will not take place at the same time and certainly not to the extent that there will be 6-7 separate piling rigs active simultaneously. On this basis, the worst-case construction noise model (which includes piling activities) is very much an overestimation of construction noise from the Port at any one time and it is unlikely that these worst-case construction noise levels on which the EIS assessments have been prepared will be reached at any stage during the construction process.

Even assuming the worst-case assumptions for construction phase activities included in Construction Phase Scenarios 1 and 2 (including piling activities), the worst-case predicted noise levels presented in Tables 7.1.14 - 7.1.16 of Volume 1 of the EIS are within the required noise threshold limits outlined in the NRA Guidelines and BS5228:2009. In the majority of instances, they are also below existing ambient (i.e. L_{Aeq}) noise levels (see Table 7.1.7 of Volume 1 of the EIS) and in many instances, they are also below existing background (i.e. L_{A90}) noise levels at the nearest noise sensitive properties.

A Noise Management Plan will be prepared and form part of the CEMP (see draft High Level CEMP under separate cover).

The impact of piling with respect to underwater noise is presented in Appendix A. This Appendix is also referred to in Section B (Birds), Section C (Marine Mammals), Section D (Benthic Communities) and Section E (Underwater Divers).

B. BIRDS

2. Birds and construction noise

2.1 The NIS and EIS provide information in relation to the potential impacts of the proposed works on bird populations in Dublin Port, the shipping channel and at the dredge disposal site, which were informed by an Avian Impact Assessment. The NIS and EIS concluded that there would be no adverse effects on waterfowl from construction related noise in the port as the birds have become habituated to port related noise and disturbance.

This is a statement of fact and no response is required.

2.2 The proposed works would be located adjacent to the South Dublin Bay and River Tolka Estuary SPA (site code 004024) which is a site of international importance for wintering wildfowl, particularly at low tide when the majority of all birds in Dublin Bay visit the estuary, and in close proximity to the Bull Island SPA (Site code 004006) which is also a site of international importance for wintering bird populations.

This is a statement of fact and no response is required.

2.3 The proposed construction and demolition works at Alexandra Basin West and Berths 52/53 will involve substantial pile installation activity over a prolonged period of time. Section 4.2.3 of the EIS anticipates that the three construction phases will last between 18 to 24 months, overlapping to give overall construction duration of 36 to 47 months. Section 4.2.1 of the EIS indicates that there will be a three month break in marine based piling operations between March and May to mitigate against any potential impact on migrating salmon smolts in the river channel. However no similar consideration has been given to the effects of pile installation noise and vibration or dredging noise on bird populations in the vicinity.

Response

Effects of pile installation noise and vibration on bird populations

The impact of the proposed development on birds has been extensively assessed in Section 5.1.4 and 5.1.5 of Volume 1 of the EIS and the NIS submitted with the application.

Since the application was submitted, there has been an opportunity to further assess the impact of piling on Birds as a consequence of some already permitted works that were being carried out in Alexandra Basin East in May - June 2014. This was at the start of the breeding season for Common and Arctic terns which breed in a large colony on the south side of the Liffey channel at Poolbeg. The two sites within the colony are approximately 1,200m and 1,500m from the pile-driving operations in Alexandra Basin East which took place. The nearest section of the colony is located close to sample station G in Figure B.1.

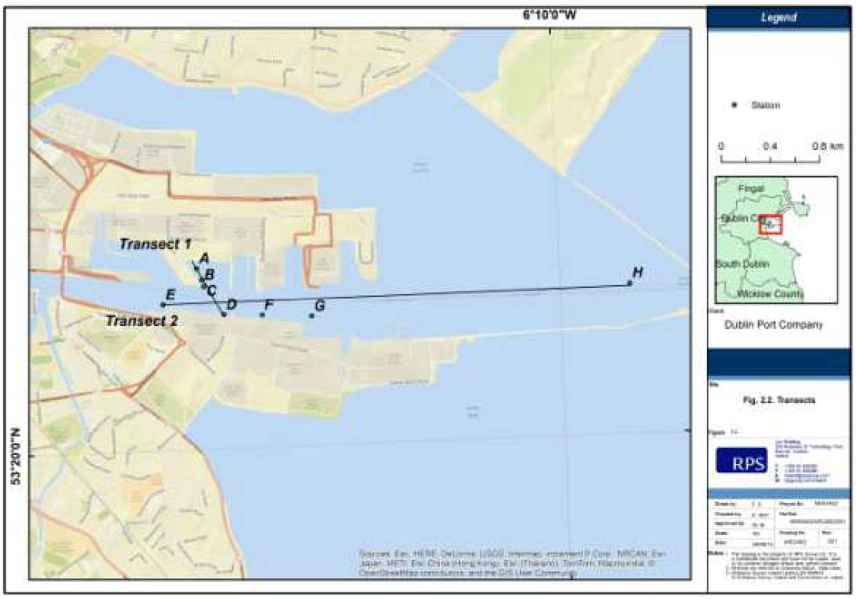

Figure B.1: Measurement locations and transects for RPS monitoring of underwater noise from pile driving in Alexandra Basin, Dublin Port in June 2014.

The tern colony has been carefully monitored in 2014 (and previous years). In 2014, the number of tern nests reached the highest recorded level since 1995 with 487 Common Terns and 91 Arctic Terns (data from BirdWatch Ireland). Average clutch sizes (number of eggs per nest) were in the normal range as measured over the previous two decades (see Merne 2004). Terns were observed throughout the breeding season to be foraging as normal and provisioning the chicks at the colony with fish as normal. This monitoring demonstrates that the tern colony was unaffected by the pile-driving activity in Alexandra Basin East in May-June 2014.

As indicated in Section 5.1.3 of Volume 1 of the EIS, Black Guillemots breed in pipes and cavities in the quays throughout Dublin Port and have been surveyed here in both breeding seasons of 2013 and 2014. Alexandra Basin East contained the highest density of this species in the Port in both years, with 14 birds recorded here in May 2014. The birds continued to use the area in close proximity to the pile-driving activity in May-June 2014. This demonstrates that Black Guillemots are unaffected by pile-driving noise or vibration.

As indicated in Section 5.1.3 of Volume 1 of the EIS, Brent Geese are present in Alexandra Basin West and on Ocean Pier between October and April each year. Here they forage on spilt agricultural products which are unloaded from the ships. They are already habituated to high levels of machinery noise, shipping activity and vehicle noise, so that pile-driving noise is unlikely to have any additional effects. The author has observed that the geese currently tolerate vehicles (and vessels) at a distance of less than 20m so it is likely that they will not be disturbed by construction vehicles.

Noise Levels in the South Dublin Bay and River Tolka Estuary SPA

Piling noise from the ABR Project will not change underwater noise levels in the South Dublin Bayand River Tolka Estuary Special Protection Area (RFI Appendix A). Underwater noise measurements taken in June 2014 at Location G (close to the tern colony at the CDL and ESB mooring dolphins) indicate no piling noise (from the works on Alexandra Basin East) was audible when shipping movements are taking place and is close to background levels at other times. For wading birds generally, underwater noise propagates least at low water, when they are likely to be foraging. While some level of piling noise may be present close to the Alexandra Basin it will have no significant environmental impact on the South Dublin Bay and River Tolka Estuary Special Protection Area.

The Special Conservation Interests of South Dublin Bay and River Tolka Estuary SPA and North Bull Island SPA include Brent Geese, Common and Arctic Terns and 18 additional species (mainly ducks, waders and gulls). The conservation objectives for the SPA are to maintain (or restore) the favourable conservation condition of the bird species listed as Special Conservation Interests for these SPAs. There will be no significant impacts of pile-driving noise or vibration from the proposed development on any of these species or on the Conservation Objectives of either Special Protection Area. The proposed development will not therefore adversely affect the integrity of any SPA, in view of the sites' Conservation Objectives.

Effects of dredging noise on bird populations

This matter has been dealt with in Section 5.1.4 and 5.1.5 of the EIS and the NIS. The technology to be used in the dredging of largest part of the main channel will be a trailer suction hopper dredger (TSHD) where the material is pumped aboard a 'hopper' vessel which carries it out to the licensed spoil ground. In addition an excavator-mounted clamshell bucket adopted for environmental dredging will be used for dredging Alexandra Basin West (and the area of the main channel adjacent to the North Wall Quay Extension where slight to moderate levels of contaminated sediment have been found to minimise disturbance and escape of contaminated material. Dredging of the shipping channel will generate some minor noise from the vessel engines and the dredging work. Underwater noise from dredging will be at similar levels to the noise generated existing shipping. Shipping noise (as measured by Dr Eugene McKeown, RPS, in Dublin Port – Appendix A) does not propagate more than 200 metres from the source and dredging noise will be approximately the same. Birds that use the port are familiar with the existing shipping activity and dredging will be similar in nature but over longer periods and (much) slower moving. Habituation by the birds is very likely. It is possible that dredging activity will generate some new foraging opportunities for birds by bringing prey items to the surface. The author has personally observed terns and Kittiwakes feeding in the wake of ships entering and leaving Dublin Port and has observed Cormorants foraging close to an active dredger in Wicklow Harbour. Underwater noise will not impact waders as it cannot propagate in water less than 1.0m deep. The largest species of wader, Curlew, has legs that are a maximum of 0.1m in length and they do not normally swim in deeper water.

Noise Levels due to Proposed Dredging for Alexandra Basin West

Underwater noise levels from dredging activity will be significantly lower than those arising during piling. A Manu-Pekka is a relatively noisy backhoe dredger. At 500m the noise level from such dredging operations is around 50 dBA. A modern TSHD is noticeably quieter in operation. In context 60dB to 65dB is regarded as normal conversation level, 50 dB is a typical (not noisy) office environment level. Dredging noise is thus unlikely to disturb birds.

From the modelling carried out (Appendix A), the underwater noise transmission loss is significant due to the shallow water and the sediment/sand based seabed in Dublin Bay. Proposed dredging activity will be limited to the navigation channel and the Alexandra Basin. The navigation channel is close to the North Bank and some dredging noise will arise at low tide in this area which is part of the South Dublin Bay and River Tolka Estuary SPA. Due to the extremely shallow water depths at low tide, transmission loss will be far greater than that outlined in the model. Underwater noise propagating in this area will be at background levels and will not have any significant environmental impact. Underwater noise arising from dredging the navigation channel inside the North Bull Wall will not propagate to the North Bull Island. Dredging in the navigation channel east of the Bull Wall is located 1,500mfrom North Bull Island from which it is separated by very shallow water. Noise from dredging will not cause any significant environmental impact at North Bull Island SPA.

Maintenance dredging was carried out in the Liffey channel in 2012 and no significant changes in bird populations in the Dublin Port breeding tern colony or Tolka Estuary area in winter 2012/13 were recorded that could be connected with the dredging activity. All birds using the channel and approaches are habituated to high levels of shipping activity. A single, slow-moving dredging vessel, involved in the proposed capital dredging for this project, would not cause any significant additional disturbance affecting wintering waterbirds or seabirds within the channel.

2.4 Further detailed information is required to enable the Board to assess the impact of pile installation noise and vibration and dredging noise on the bird populations that use the adjacent and nearby European sites in Dublin Bay. A comprehensive analysis should be carried out by a suitably qualified bird ecologist. The analysis should be based on international research as well as information currently available in Ireland.

Response

Direct effects of pile-driving noise on birds

The effects of construction noise on wild birds are poorly studied in general with most emphasis on terrestrial species. Lackey *et al.* (2012) examined behavioural responses, territory placement and reproductive success in the federally endangered Golden-cheeked Warbler *(Setophaga chrysoparia)* in a field experiment that used playback of construction noise. Their results suggest that this species alters neither its territory placement nor its behavioural response to noise playback. Reproductive success also appears to be unaffected by construction noise. These findings suggest that intermittent construction noise is not among the threats to this species.

Waders using a high tide roost on Mutton Island in Galway Bay were surveyed before, during and after the construction of a major sewage treatment plant situated between 150m and 200m from the main roost site (Nairn 2005). At the start of this five-year period the island was linked to the mainland by a causeway and the roosting birds became more concentrated on the undeveloped part of the island but otherwise showed no negative effects of construction noise or disturbance. Numbers of waders using the roost were highest in the last two of the construction years.

The construction work for Mutton Island treatment plant included trench excavation for the outfall in rock and was excavated using drill and blast techniques. The maximum charge for the blasting was adjusted to ensure that the sound waves were maintained in the range 150dB to 160dB when measured 250m from the epicentre (Edger and Murdock 2003). The author carried out observations of foraging waders during the blasting, at ranges of 250m and 500m from the location of the blasting and no visible response was observed in any of the birds, which continued to forage normally.

Leopold and Camphuysen(2009) studied possible effects of underwater noise levels on sensitive seabirds during construction of the first Dutch offshore wind farm in North Sea waters. This was the OWEZ project that consisted of 36 turbines on monopoles. It is located north-west of Ijmuiden harbour, some 8 NM off the mainland coast of the Netherlands. Erecting the 36 mono-piles was done by pile-driving, from a large ship using a hydro-hammer. This technique generated considerable noise that might be detrimental for local wildlife. The action of the hydrohammer on the large steel pipes, that need to be driven into the seabed, could produce underwater sound levels in excess of 200 dB and this could be detrimental to vertebrates swimming in the vicinity (within several hundreds of meters).

Bird species most likely to be vulnerable to underwater sound were those that forage by diving after fish or shellfish. Diving birds that may occur in relatively high densities at the OWEZ location include auks, and possibly divers and seaduck. Terns, that feed by shallow dives are considered less vulnerable and mostly occur closer to the mainland coast. Several gull species may occur in the area in high densities, but they feed at the surface only, and are considered the least vulnerable. Pile driving took place from 17 April to 28 July 2006. The potentially vulnerable divers, seaduck and auks had largely left the area by the time the pile driving started. Migration commenced early in 2006 and any birds still left in the area by mid-April would have been scared away by the shipping activities long before actual pile driving started. Further mitigation of possible effects on sensitive seabirds included a ramp-up procedure that ensured that full hammering power was only administered after a period of low-energy blows that were unlikely to cause negative effects on any birds still present. Furthermore, an underwater pinger, aimed at scaring off marine mammals, was put into operation 3-4 hours before pile driving started. Visual observations before and during three pile driving sessions failed to detect any of the seabirds deemed sensitive to pile driving noise in the vicinity of the construction work. Birds that did fly by the construction site (mainly gulls and terns) did not show a noticeable reaction to the activities. It is therefore concluded that effects of underwater noise on seabirds, though potentially detrimental, were negligible during construction of OWEZ. This was due to fortunate timing of the work and to appropriate mitigation measures(Leopold and Camphuysen 2009).

The U.S. Department of the Interior (2004) briefly mentioned effects of underwater sound(seismic surveys) briefly In their extensive Environmental Impact Assessment of exploration activities in the Gulf of Mexico, as follows:

"Generally, noise produced from activities associated with seismic surveys might impact only those offshore species of birds that spend large quantities of time underwater, either swimming or plunge diving while foraging for food. Offshore birds that may be classified as underwater swimmers include certain waterfowl (some diving ducks) and seabirds (loons and cormorants). Generally, these species are limited to waters of the inner continental shelf. Waterfowl and loons are both seasonal migrants (winter), whereas cormorants areresident species. Plunge diving birds include only certain seabirds (primarily brown pelicans, gannets, and boobies). Gannets are seasonal migrants that may range throughout the Gulf of Mexico. Noise from seismic surveys could adversely affect surface feeding and diving seabirds near air gun arrays. However, there are no data indicating such impacts exist. Stemp (1985) found no effect of seismic survey activity on thedistribution and abundance of seabird populations in arctic Canadian environment. Parsons (in Stemp, 1985) reported that shearwaters with their heads underwater were observed within 30 m of seismic sources (explosives) and did not respond. Because seismic pulses are directed downward and highly attenuated near the surface, birds feeding on the surface or diving just below it are unlikely to be exposed to sound levels sufficient to cause temporary or permanent hearing impairment. In any case, sound pressure levels would not be sufficient to cause death or life-threatening injury."

Neither of the above studies found any impacts of pile-driving noise or vibration on birds in the marine environment. Birds flying or swimming close to the sources of noise showed no response to the noises. This is supportive of the conclusions reached in Section 5.1.7 of Volume 1 of the EIS and the NIS.

Indirect effects of pile-driving noise on fish prey of birds

Inger*et al*.(2009) have reviewed the potential ecological impacts of underwater noise. While there is evidence of impacts of underwater noise on marine mammals, less information is available regarding effects on fish populations, although estimates suggest fish can detect pile-driving noise over large distances, and that the noise may affect intra-specific communication, or cause injury or mortality at close range(Popper *et al.*2003; Thomsen *et al.*2006).

Mueller-Blenkle*et al.*(2010) undertook experiments on the effects of pile-driving on behaviour of marine fish. Pile-driving noise during construction is of particular concern as the very high sound pressure levels could potentially prevent fish from reaching breeding or spawning sites, finding food, and acoustically locating mates. This could result in long-term effects on reproduction and population parameters. Further, avoidance reactions might result in displacement away from potential fishing grounds and lead to reduced catches. However, reaction thresholds and therefore the impacts of pile-driving on the behaviour of fish are completely unknown.

They played back pile-driving noise to cod and sole held in two large (40 m) net pens located in a quiet bay in West Scotland. (Neither of these fish species is a significant food item for seabirds in Irish waters as they are both primarily bottom dwelling). Movements of the fish were analysed using a novel acoustic tracking system. Received sound pressure level and particle motion were measured during the experiments. There was a significant movement response to the pile-driving stimulus in both species at relatively low received sound pressure levels (sole: 144 – 156 dB re 1μPa Peak; cod: 140 – 161 dB re 1 μPa Peak, particle motion between $6.51x10^{-3}$ and 8.62x10-4 m/s^2 peak). Sole showed a significant increase in swimming speed during the playback period compared to before and after playback. Cod exhibited a similar reaction, yet results were not significant. Cod showed a significant freezing response at onset and cessation of playback. There were indications of directional movements away from the sound source in both species. The results further showed a high variability in behavioural reactions across individuals and a decrease of response with multiple exposures. This study was the first to document behavioural response of marine fish due to playbacks of pile-driving sounds. The results indicate that a range of received sound pressure and particle motion levels will trigger behavioural responses in sole and cod. The results further imply a relatively large zone of behavioural response to pile-driving sounds in marine fish. Yet, the exact nature and extent of the behavioural response needs to be investigated further. Some of the results point toward habituation to the sound.

Slabbekoorn*et al.* (2010) reviewed the effects of underwater noise on fish and other organisms. In addition to an impact on growth or reproduction related to noise-determined physiological stress, anthropogenic noise may also affect populations in a more indirect way. Data on birds has shown that individuals that vary in reproductive abilities, related to age, experience, or size, may not be evenly distributed over noisy and quiet areas of otherwise suitable habitat (Reijnenand Foppen 1994, Habib*et al.*2006).The relative absence of more experienced and typically more productive males in noisy territories means that habitat productivity for these species diminished beyond the effect of a reduction in number of territory holders.

This review confirms the conclusions in Section 5.1 and 5.4 of the EIS and the NIS that there may be some localised negative impacts of pile-driving on fish species in the immediate vicinity of the construction site. However, the Alexandra Basin West is not generally used for foraging by fish-eating birds (terns, Cormorants, Black Guillemots) so no indirect effects are predicted. Underwater noise from the pile-driving propagating beyond 200m from the source will be at background levels and is not expected to have any negative impacts on fish or on fish-eating birds.

Effects of dredging noise on birds

A review of the impacts of capital and maintenance dredging in the Tamar estuary, in south-west England, was published by Widdows *et al.* (2007). This estuary is a Special Protection Area under the EU Birds Directive which requires annual maintenance dredging as well as occasional capital dredging for new installations. Maintenance dredging here involves annual removal of between 5,000 and 200,000 tonnes of dry sediment per year. During two periods of capital dredging in the Tamar, the amount of sediment dredged was between 500,000 and 700,000 tonnes per year. Annual estimates for ten species of wildfowl and waders were analysed over several decades in the Tamar Estuary. There were no significant correlations between overwintering bird numbers and dredging activity. Declines in Teal and Wigeon over 30 years were related to milder winters which changed the migratory patterns of these species. An assessment of the ecological impacts of maintenance dredging noise in the Plymouth Sound and Estuaries European Marine Site reached similar conclusions (Debut Services 2011)

In summary, the international research in this area is supportive of the conclusions reached in the EIS and the NIS that noise generated during the proposed development from pile driving or dredging will not adversely affect the integrity of any designated site having regard to the conservation objectives of that site.

Statement of Competency of the Bird Ecologist

Richard Nairn is a professional ornithologist and ecologist with a comprehensive knowledge of bird ecology and survey methodology as well as nature conservation and environmental assessment in Ireland. He holds a Master's Degree in Natural Sciences from Trinity College Dublin (1979). He has extensive field experience in the survey of habitats, birds and mammals in all habitat types. In the 1970s he worked as a nature reserve warden with the National Trust (Northern Ireland) and in the 1980s he was National Director of IWC (now BirdWatch Ireland). Since 1990 he has worked as an environmental consultant, managing a team of ecologists in Natura Environmental Consultants. He specialises in bird surveys and Environmental Impact Assessment for a variety of developments including windfarms, roads, pipelines, port developments, sewage treatment works, water supply schemes and industrial developments. Since 2009, he has advised Dublin Port Company on nature conservation issues, especially regarding birds. This included four years of field surveys of birds in the Tolka Estuary, one year survey of seabirds in the Liffey Channel and the supervision of BirdWatch Ireland in carrying out a three-year bird monitoring project covering the entire area of Dublin Bay. He was also the principal ecologist advising Dublin City Council in relation to the extension of Ringsend

Wastewater Treatment Works, especially in relation to the impacts on birds in Dublin Bay. During the period 2012-2014, he managed a team of ornithologists, surveying bird populations on over 175 potential windfarm sites in seven counties in the midlands of Ireland. He has recently undertaken part-time post-graduate research with University College Cork, studying the interactions between wind turbines and birds.

He has provided expert witness services on ecology for 27 Oral Hearings conducted by An Bord Pleanala. He was the editor of the publication Status of EU Protected Habitats and Species in Ireland (National Parks and Wildlife Service 2008). He also prepared the Guidelines for Assessment of the Ecological Impacts of National Road Schemes for the Irish National Roads Authority and Ecology Guidelines for Transmission Powerlines for EirGrid. He is an experienced writer and has published extensively in the scientific literature (over 20 peer-reviewed papers on birds and mammals). He is the author of two books: Wild Wicklow (1998) and Ireland's Coastline (2005) and co-editor, with Professor John O'Halloran, of a book entitled Bird Habitats in Ireland (2012). He is a Chartered Environmentalist and Fellow of the Chartered Institute of Ecology and Environmental Management.

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C. MARINE MAMMALS

3. Marine mammals, noise and disturbance

3.1 The NIS and EIS provide information in relation to the potential impacts of the proposed works on marine mammals in Dublin Bay which were informed by a Marine Mammals Impact Assessment. It was concluded that there would be no long term significant adverse effects on marine mammals as a result of the proposed demolition, construction, pile installation activity, channel dredging and dredge disposal works subject to the full implementation of mitigation measures.

This is a statement of fact and no response is required.

3.2 The proposed works would be located within Dublin Bay and partly inside the Dublin Bay and Rockabill to Dalkey Island cSAC (site code 003000). The harbour porpoise, grey seal and harbour seal forage in the shipping channel and the dredge disposal site, populations of grey seal and harbour seal have haul out sites in on the Bull Island and all three species are sensitive to noise.

This is a statement of fact and no response is required.

4. Harbour seals, grey seals and haul out sites

4.1 Given the nature of the proposed development and the importance of the area for harbour seal and grey seal populations, which are known to use the Bull Island as a haul out site, more information is required to assess the potential effects of the proposed works on these Annex II species and on their ability to continue using the Bull Island during the channel dredging works which may take between 6 to 10 years to complete. A comprehensive analysis should be carried out by a suitably qualified seal ecologist which should be based on international research as well as information currently available in Ireland. A site visit to the NE section of the Bull Island should be undertaken.

Response

The main potential impacts on seals at haul out sites adjacent to the proposed construction site are outlined in Section 5.2.5 of Volume 1 of the EIS. These include:

1. Physical injury or death of individuals resulting from collisions with operator vessels.

2. Physical injury or death of individuals resulting from close-range exposure to pile driving noise.

3. Chronic hearing damage or disturbance/displacement as a result of piling or dredging noise.

4. Consumption of contaminated prey items resulting from contaminants entering the food chain (this is only a problem where contaminated substrates are disturbed).

5. Temporary impact on marine mammals' visibility should they intersect the sediment plume during the dumping of dredged material.

6. Changes in prey availability due to local changes in benthic ecology caused by accumulation of dredge spoil on the seabed.

The likelihood and scale of each of these effects has been estimated in the EIS and where required appropriate precautionary mitigation measures have been identified to reduce the estimated effects.

In the context of the specific information sought by ABP on Bull Island, the author contacted the Irish Seal sanctuary and Pat Corrigan, Dublin City Council Wildlife Ranger for Bull Island. Pat Corrigan estimated up to 30 seals regularly use the island to haul out, and has recorded “white coats” (pups) on a number of occasions. On 31 July 2014 Carolyn O'Laoire reported 21 common seals on the stretch of sand near the tip of Bull Island on the Dublin Road at Sutton including adults and young to the Irish Seal Sanctuary who passed this record on.

Following the RFI by ABP, a second site visit for and land-based observations of the haul out sites was carried out by Dr. Joanne O’Brien on 15th August 2014. Watches were carried out from a vantage point (the highest point available on this side of the island) on the NE section of Bull Island across the bay from the vantage points as described by Cronin and Jessop (see Figure 2 of Appendix B of the NIS). Two four hour watches were carried out, one watch for a duration of 2 hours before and after low water and the second two hours before and after high water (same methods as those used by Cronin and Jessop (NIS)). Scans were completed using Swarovski 8 X 32 binoculars as well as an Opticron ES 80 spotting scope.

Table C1. Details of watches carried out of potential seal haul out sites from the NE section of Bull Island on the 15th August.

Watch no	Time	Weather conditions	Tidal state	No. of seals	Behaviour
1	07:15 – 11:15 (4 hrs)	Sea state 1-3, Wind:F1-3, Visibility:10-15km	LW: 09:08	2-4	2-4 harbour seals observed hauled out adjacent to Sutton Creek between Bull Island and Sutton Dinghy club, returned to water after a time. 3 other individuals were observed in water over the duration of the watch. Total=5
2	14:00-18:00	Sea state 1-3, Wind:F1-3, Visibility:15-20km	HW: 15:57	16	4 seals observer from 14:00-17:00 around the NE part of Sutton Creek. At 17:30, more individuals began to haul out on a shallow sandbank in the middle of Sutton Creek, NW of the Dinghy club, by the end of the watch 16 harbour seals were hauled out at the site. Total = 16

Harbour seals were recorded continuously at the site between 07:15 and 11:15 and again from 14:00 to 18:00. The abundance of seals present at the site varied across the day but it was clear that smaller numbers were present from the period of low to high tide. Once the tide started to fall the abundance increased to 16 individuals at 18:00. A variety of behaviours were recorded throughout the day showing individuals used the site for socialising, foraging and resting. It was also evident that seals used different parts of the creek depending on tidal state (Figure C1).

Figure C1: Location of vantage point on the NE side of the island as well as the different areas used over the course of the tidal cycle.

The figures produced in Section 5.2.3 of the EIS as further supported by additional fieldwork carried out above affirm that there are only a relatively small number of seals that regularly use Bull Island as a haul out sitei. The portion of Dublin Bay incorporating the main approach channel to Dublin Port is a disturbed site; it is a busy port with considerable boat traffic and already subjected to annual dredging. Consequently seals using Bull Island for hauling area are likely to have a tolerance for this disturbance, which to the extent that there is any disruption arising from the construction activities can be further supported by any necessary mitigation measures to minimise impacts.

Published literature where estimates of disturbance distance for harbour and grey seals have been estimated are presented in Table C2 from Bailey et al. (2010). This suggests that major disturbance from pile-driving may be restricted to within 200-300m while minor disturbance may occur over a much wider area up to 15km.

Table C2. Noise exposure criteria from Bailey et al. (2010) for behavioural disturbance for the marine mammal species most commonly found in the Moray Firth and the maximum distance from the pile-driving within which this sound level was exceeded based on our recordings. In cases where the response is highly variable, minor disturbance has been used to indicate some animals may be sensitive to this level whereas major disturbance is likely to elicit a strong reaction.

Species	Threshold for behavioural disturbance (peak to peak broadband level)	Max. distance from pile-driving	Reference for threshold
Bottlenose dolphin (mid-frequency cetacean)	140 dB re 1 µPa	50 km (43 km)	(Southall et al., 2007)
Harbour porpoise (high-frequency cetacean)	Minor disturbance: 90 dB re 1 µPa Major disturbance: 155 dB re 1 µPa	Minor: 70 km (70 km) Major: 20 km (21 km)	(Southall et al., 2007)
Minke whale (low-frequency cetacean)	143 dB re 1 µPa	40 km (38 km)	(Gordon et al., 2003)
Harbour and grey seal (pinnipeds in water)	Minor disturbance: 160 dB re 1 µPa Major disturbance: 200 dB re 1 µPa	Minor: 14 km (15 km) Major: 215 m (300 m)	(Harris et al., 2001)

Effectiveness of Mitigation Measures

In Section 5.2.9 of the EIS proposed mitigation measures to reduce the impact of piling and dredging on seals are set out to include the implementation of the recommended NPWS (2014) guidelines (the NPWS 2013 guidelines where updated in 2014) which requires a Marine Mammal Observer (MMO) to ensure the area is clear of marine mammals before construction activity begins or dumping is carried out and a soft start procedure where the equipment is ramped up slowly to full power.

The nearest well documented harbour seal haul out to the proposed works is Lambay Island, while Grey seals have been recorded hauled out on Bull Island. With regards dredging activities and seal presence, NPWS (2014) requests that sound from the attendant vessels be considered as well as the actual dumping of dredged material. Under the NPWS guidelines, once dredging has commenced, following the effective visual monitoring by a qualified MMO, the operation should be able to continue if dredging and/or dumping or either activity is underway. Once dredging is underway "there is no need to halt operations at night time or if weather conditions deteriorate" unless there is a break in sound output of >30 minutes (NPWS, 2014). These guidelines also apply to seals at haul out sites, once they are outside of the mitigation zone then work can proceed. Monitoring of a mitigation zone of 1000m for piling will be effective in mitigating the potential effects of piling and dredging. Marine mammals are highly mobile. Grey seals have been shown to move around 5km per day during foraging trips off the west coast of Ireland which may last up to 80-90 days (Cronin et al. 2013) and grey seals from Lambay Island have been recorded in west Wales (Kiely et al. 2000).

These guidelines do not avoid circumstances whereby such operations could prevent seals from returning to haul out sites, especially given the duration of the proposed project. Therefore a greater understanding of the number and behaviour of seals using the Bull Island site is important as this is the closest haul out site. In order to assess the impact and effectiveness of mitigation measures it is recommended that monthly monitoring of seal haul out sites be carried out at Bull Island and adjacent areas pre-construction, during construction and for a minimum of two years post-construction in line with best international practice.

5. <u>Harbour porpoise, marine mammals and noise</u>

5.1 The harbour porpoise has been identified as being particularly sensitive to noise from demolition, pile installation activity, dredging and dumping operations and the proposed mitigation measures are broadly in line with the Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters which was published by the Department of Arts, Heritage and the Gaeltacht in 2014. The mitigation measures set out in Section 5.2.9 of the EIS require the presence of a trained and experienced Marine Observer (MMO) and the use of "ramp up" procedures for noise and vibration emitting operations.

5.2 The harbour porpoise has been described as Europe's smallest cetacean species which is difficult to detect because of its small size and erratic surfacing behaviour. Given the nature of the proposed development and the importance of the area for harbour porpoise, and having regard to the characteristics and behaviour of this species, which makes it difficult to detect, more information is required to enable the Board to assess the potential effects of noise and disturbance on this Annex II species and to examine the likely effectiveness of the proposed mitigation measures in relation to:

- Exposure to prolonged pile installation noise and vibration throughout the course of the construction works which could last up to 4 years.

- Exposure to prolonged dredging and dumping noise throughout the course of the works which could last up to 10 years.

- The effectiveness of other additional mitigation measures including the deployment of acoustic deterrence and harassment devices prior to commencement of pile installation or dredging operations, and other measures that would result in a reduction of sound pressure levels radiated into the water column, including the use of alternative pile installation techniques.

5.3 A comprehensive analysis should be carried out by a suitably qualified marine mammal ecologist and the analysis should be based on international research as well as information currently available in Ireland.

5.4 The NIS and EIS should also contain separate sections which deal with the potential effects of, and mitigation measures for, (a) pile installation activity and construction noise and vibration, and (b) noise from dredging and dredge disposal operations, on harbour porpoise and other noise sensitive marine mammals.

Response to 5.1 – 5.4

Harbour porpoise, marine mammals and noise

This matter has been dealt with in Section 5.2 of Volume 1 of the EIS and the NIS. ABP require further information on the impacts of the proposed development outlined in the EIS and NIS, especially of the potential effects of noise and disturbance on harbour porpoise. This is required to examine the likely effectiveness of proposed mitigation measures. The Board has sought further information on exposure to prolonged pile installation and dredging and dumping. In addition the Board wishes for an exploration of additional mitigation measures including acoustic deterrents and other measures to reduce sound pressure levels radiated into the water column. ABP requested that the response (5.4) should be presented as:

a) Pile installation activity and construction noise

b) Noise from dredging and dredge disposal operations

<u>Ambient Noise</u>

Ambient, or background noise, is defined as any sound other than the sound being monitored (primary sound) and, in the marine environment, is a combination of naturally occurring biologically and physical sound sources including sediment transfer, waves and rain and that of a biological origin including fish, crustaceans and from marine mammals. The impact of noise created by human activity is strongly influenced by background or ambient noise, the impact is less in a noisy environment compared to a quiet environment and it's the intensity and frequency of this increased noise compared to the ambient levels at a site which defines its impact. As ambient noise levels increase, the ability to detect a biologically important sound decreases. The point at which a sound is no longer detectable over ambient noise is known as acoustic masking. The range at which an animal is able to detect these signals reduces with increasing levels of ambient noise (Richardson et al. 1995). This is important when considering the impact of sound sources on marine mammals by the proposed works.

Ambient noise levels worldwide have been on the rise in recent decades with developments in industry and, in particular, in commercial shipping. In the North Pacific, low frequency background noise has approximately doubled in each of the past four decades (Andrew et al. 2002), resulting in at least a 15- to 20-dB increase in ambient noise. In recent years, interest has grown in the effects of anthropogenic noise on marine life. Ambient noise in Dublin Bay has been estimated at around 113 db by Beck et al. (2013) and by McKeown (2014). This level is higher than that reported from Galway Bay and the Shannon Estuary and reflects the greater vessel traffic at this site.

Marine mammals are often seen in close proximity to human activity and exhibit some tolerance to anthropogenic noise and other stimuli (Richardson et al. 1995). Baleen whales use shipping lanes and feed in rich fishing grounds occupied by large fishing vessels. Odontocetes are often even more tolerant, being repeatedly exposed to many vessels, small and large. Pinnipeds also exhibit much tolerance and often haul out on man-made structures where there is considerable human activity.

This exposure may lead to some chronic exposure to man-made noise, with which they tolerate. Ecological or physiological requirements may leave some marine mammals with no choice but to remain in these areas and continue to become chronically exposed to the effects of noise. In areas with repeated exposure, mammals may become habituated with a decline in avoidance responses and thus become less sensitive to noise and disturbance (Richardson et al. 1995).

Pile Installation and Construction noise

As indicated on the Project Programme in Appendix 4 of Volume 2 of the EIS piling is proposed to take place in three phases. In phase 1 piling is in the area to the west of Berth 29 and will continue for four months at three consecutive sites starting November 2015 until May 2016. A second phase of piling will commence at the end of phase 1 from May 2016 until February 2017 at Berths 32-34 and Ocean Pier. In phase 2a piling will continue at berths 29-31 from around February 2017 to end 2017. In phase 3 piling of the North Wall Quay Extension will be ongoing from January 2018 until January 2019. Piling of the Marina Wall will be ongoing from September 2017 until April 2018.

Thus piling will be fairly continuous at the development site for a period of 38 months. During this period a total of approx 990 piles will be driven. Piling will potentially be simultaneous at three sites, namely, Berths 32-34, berths 29-31 and the Marina Wall. As indicated in the EIS, the main impact of piling is from sound generated and the transmission of this sound into the marine environment.

Impacts of piling on marine mammals

If a marine mammal's received sound exposures, irrespective of the anthropogenic source (pulse or nonpulse), exceed the relevant criterion, auditory injury (PTS) is assumed to be likely. Pile driving is classed as a multi pulse source of impulsive sound. Its measured effects on marine mammals are largely based on work by Southall et al. (2007), who proposed a dual criterion based on peak sound pressure level (SPL) and sound exposure level (SEL), where the level that is exceeded first is what should be used as the working injury criterion (i.e. the precautionary of the two measures). The potential impacts on marine mammals from piling activity include Permanent Threshold Shift (PTS), Temporary Threshold Shift (TTS) and behavioural disturbance; each of which have varying degrees of severity for exposed individuals.

As all marine mammals do not hear equally across all frequencies, the use of frequency weightings is applied to compensate for differential frequency responses of their sensory systems (Table C3). The M-weighting (for marine mammals) is similar to the C-weighting for measuring high amplitude sounds in humans. At present there are no data available to represent the onset of PTS in marine mammals but Southall et al. (2007) estimated it as 6 dB above the SPL (unweighted) and 15 dB above the SEL (M-weighted according to the relevant marine mammal functional group, see Figure 1) based on the onset of TTS. Therefore, Southall et al. (2007) proposed SPL criteria of 230 dB re 1 µPa (peak broadband level) for PTS onset in cetaceans and 218 dB re 1 µPa for pinnipeds. They also recommended TTS can occur at 224 dB re 1 µPa (peak broadband level) for cetaceans and 212 dB re 1 µPa for pinnipeds (Southall et al. 2007; Bailey et al. 2010) (Table 2). While, the SEL criteria proposed by Southall et al. (2007) include TTS onset at 183 dB re 1 µPa2 -s for cetaceans and 171 dB re 1 µPa2 -s for pinnipeds, and PTS onset is expected at 15 dB additional exposure (Bailey et al. 2010) (Table C4).

Table C3. Functional marine mammal hearing groups, and group specific (m) frequency weightings (from Southall et al., 2007)

Functional hearing group	Estimated auditory bandwidth	Genera represented (Number species/subspecies)	Frequency-weighting network
Low-frequency cetaceans	7 Hz to 22 kHz	*Balaena, Caperea, Eschrichtius, Megaptera, Balaenoptera* (13 species/subspecies)	M_{lf} (lf: low-frequency cetacean)
Mid-frequency cetaceans	150 Hz to 160 kHz	*Steno, Sousa, Sotalia, Tursiops, Stenella, Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Grampus, Peponocephala, Feresa, Pseudorca, Orcinus, Globicephala, Orcaella, Physeter, Delphinapterus, Monodon, Ziphius, Berardius, Tasmacetus, Hyperoodon, Mesoplodon* (57 species/subspecies)	M_{mf} (mf: mid-frequency cetaceans)
High-frequency cetaceans	200 Hz to 180 kHz	*Phocoena, Neophocaena, Phocoenoides, Platanista, Inia, Kogia, Lipotes, Pontoporia, Cephalorhynchus* (20 species/subspecies)	M_{hf} (hf: high-frequency cetaceans)
Pinnipeds in water	75 Hz to 75 kHz	*Arctocephalus, Callorhinus, Zalophus, Eumetopias, Neophoca, Phocarctos, Otaria, Erignathus, Phoca, Pusa, Halichoerus, Histriophoca, Pagophilus, Cystophora, Monachus, Mirounga, Leptonychotes, Ommatophoca, Lobodon, Hydrurga,* and *Odobenus* (41 species/subspecies)	M_{pw} (pw: pinnipeds in water)
Pinnipeds in air	75 Hz to 30 kHz	Same species as pinnipeds in water (41 species/subspecies)	M_{pa} (pa: pinnipeds in air)

Table C4. Proposed injury criteria for individual marine mammals from Southall et al. (2007)

	Sound type		
Marine mammal group	Single pulses	Multiple pulses	Nonpulses
Low-frequency cetaceans	Cell 1	Cell 2	Cell 3
Sound pressure level	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)
Sound exposure level	198 dB re: 1 μPa^2-s (M_{lf})	198 dB re: 1 μPa^2-s (M_{lf})	215 dB re: 1 μPa^2-s (M_{lf})
Mid-frequency cetaceans	Cell 4	Cell 5	Cell 6
Sound pressure level	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)
Sound exposure level	198 dB re: 1 μPa^2-s (M_{mf})	198 dB re: 1 μPa^2-s (M_{mf})	215 dB re: 1 μPa^2-s (M_{mf})
High-frequency cetaceans	Cell 7	Cell 8	Cell 9
Sound pressure level	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)	230 dB re: 1 µPa (peak) (flat)
Sound exposure level	198 dB re: 1 μPa^2-s (M_{hf})	198 dB re: 1 μPa^2-s (M_{hf})	215 dB re: 1 μPa^2-s (M_{hf})
Pinnipeds (in water)	Cell 10	Cell 11	Cell 12
Sound pressure level	218 dB re: 1 µPa (peak) (flat)	218 dB re: 1 µPa (peak) (flat)	218 dB re: 1 µPa (peak) (flat)
Sound exposure level	186 dB re: 1 μPa^2-s (M_{pw})	186 dB re: 1 μPa^2-s (M_{pw})	203 dB re: 1 μPa^2-s (M_{pw})
Pinnipeds (in air)	Cell 13	Cell 14	Cell 15
Sound pressure level	149 dB re: 20 µPa (peak) (flat)	149 dB re: 20 µPa (peak) (flat)	149 dB re: 20 µPa (peak) (flat)
Sound exposure level	144 dB re: $(20\ \mu Pa)^2$-s (M_{pa})	144 dB re: $(20\ \mu Pa)^2$-s (M_{pa})	144.5 dB re: $(20\ \mu Pa)^2$-s (M_{pa})

Bailey et al. (2010) estimated the effect of pile driving on coastal cetaceans in the Moray Firth (42m water depth), within 25km from the sound source. They found that based on the broadband peak to peak sound level, PTS onset would have occurred within 5m of the pile-driving operation for cetaceans and within 20m for pinnipeds. The level for TTS onset would have been exceeded within 10m and 40m of the pile-driving for cetaceans and pinnipeds respectively. They found that the closest measurement of the pile-driving noise recorded at 100m, had an M-weighted SEL of 166 dB re 1 µPa2 –s which was less than the PTS and TTS SEL criteria for cetaceans and pinnipeds. They suggest that this indicated that no form of injury or hearing impairment should have occurred at ranges greater than 100m from the pile-driving operation.

Table C5. Proposed behavioral response criteria for individual marine mammals exposed to various sound types

Marine mammal group	Sound type: Single pulses	Multiple pulses	Nonpulses
Low-frequency cetaceans	Cell 1	Cell 2[1]	Cell 3[6]
Sound pressure level	224 dB re: 1 µPa (peak) (flat)	Tables 6 & 7	Tables 14 & 15
Sound exposure level	183 dB re: 1 µPa²-s (M_{lf})	Not applicable	Not applicable
Mid-frequency cetaceans	Cell 4	Cell 5[2]	Cell 6[7]
Sound pressure level	224 dB re: 1 µPa (peak) (flat)	Tables 8 & 9	Tables 16 & 17
Sound exposure level	183 dB re: 1 µPa²-s (M_{mf})	Not applicable	Not applicable
High-frequency cetaceans	Cell 7	Cell 8[3]	Cell 9[8]
Sound pressure level	224 dB re: 1 µPa (peak) (flat)	[Tables 18 & 19]	Tables 18 & 19
Sound exposure level	183 dB re: 1 µPa²-s (M_{hf})	Not applicable	Not applicable
Pinnipeds (in water)	Cell 10	Cell 11[4]	Cell 12[9]
Sound pressure level	212 dB re: 1 µPa (peak) (flat)	Tables 10 & 11	Tables 20 & 21
Sound exposure level	171 dB re: 1 µPa²-s (M_{pw})	Not applicable	Not applicable
Pinnipeds (in air)	Cell 13	Cell 14[5]	Cell 15[10]
Sound pressure level	109 dB re: 20 µPa (peak) (flat)	Tables 12 & 13	Tables 22 & 23
Sound exposure level	100 dB re: (20 µPa)²-s (M_{pa})	Not applicable	Not applicable

Based on work by Southall et al. (2007), it is possible that harbour porpoise can experience behavioural disturbance up to 70km from the pile-driving, while Bailey et al. (2010) presented results which indicated that strong avoidance behaviour would only be expected within 20km of the sound source. They also suggested that bottlenose dolphins and minke whales may exhibit behavioural disturbance within 50km and 40km from the source respectively (Bailey et al. 2010). Regarding pinnipeds, this zone is smaller, estimated within 14km of the source.

In the German North Sea, 12 wind turbines were installed 45km from the German coast. Visual monitoring of harbour porpoises was conducted prior to, as well as during construction and operation, using distance sampling during 15 aerial line transect surveys. During aerial surveys, 18,600 km of transect lines were covered with 1,392 harbour porpoise sightings were recorded. Results showed lowest densities were recorded during the construction period in 2009. Static Acoustic Monitoring (SAM) using C-PODs at 12 locations was also carried out. SAM devices were deployed between 1 and 50 km from the centre of the wind farm (a gradient experimental design). The spatial distribution pattern before and during pile-driving showed a strong avoidance response within a 20km distance of the sound source. Generalized Additive Modelling of SAM data showed a negative impact of pile-driving on relative porpoise detection rates at eight positions at distances less than 10.8 km.

Based on this literature and as indicated in the EIS and NIS, pile driving as part of the ABR project has the potential to impact on harbour porpoise, minke whale, common and bottlenose dolphin as well as common and grey seals.

Effectiveness of Mitigation Measures

Recommended mitigation measures were proposed in the EIS following consultation with the NPWS to reduce the impact of piling on marine mammals and are focused on the implementation of the NPWS (2014) guidelines which requires a Marine Mammal Observer (MMO) to ensure the area is clear of marine mammals and a soft start procedure where the equipment is ramped up slowly to full power. Visual mitigation measures require daylight and favourable sea conditions in order to be implemented effectively. Harbour porpoise are elusive and can be extremely difficult to detect unless conditions are very favourable. They do however have very distinctive echolocation characteristics (high frequency – narrow bandwidth), which facilitates acoustic monitoring techniques. Additionally, based on information from other sites in Ireland (O'Brien et al. 2013), harbour porpoises can be more active during night-time hours and thus would not be detected visually.

To enhance the mitigation measure, we propose that a real-time passive acoustic monitoring (PAM) system is installed at the approaches to Dublin Port to provide information on the presence of marine mammals during these periods when visual mitigation is not possible. This technique is to compliment and not replace visual techniques.

We propose a PAM supplied by LIDO (www.listentothedeep.com) is deployed which can acquire high and low frequency data and stream these data ashore through the internet. This system is provided by LAB UPC at the University of Barcelona and has been used throughout the world as an ocean basin wide acoustic monitoring tool. Additionally it allows for real time monitoring. Hardware and technical support is provided by UPC. PAM will allow monitoring of harbour porpoises and other odontocetes (bottlenose dolphins) within a range of 250 – 800m and will also detect mid and low frequency seal vocalisations during both day and night-time and in all weather conditions. We recommend two hydrophone system will achieve monitoring of the minimum 1000m exclusion zone for piling.

We propose PAMwill be used to provide additional assurance that any disturbance is temporary and will not lead to significant impacts on marine mammals in the long term nor adversely affect the integrity of any designated site having regard to the conservation objectives of each site. This method will allow for the on going assessment of disturbance as well the effectiveness of mitigation measures.

Most recent piling projects which may impact on marine mammals involved offshore wind farm construction. International best practice to reduce the sound pressure levels penetrating the marine environment involves the deployment of bubble curtains around the sound source. A stream of bubbles is emitted as a curtain around the sound source and the technique dampening the sound pressure created and bubble curtains have been used successfully at other construction sites. This technique was first developed used to protect marine mammals from piling operations (Wursig et al. 1999) and has been used extensively in the North Sea during construction of offshore wind farms (REF). In field tests carried out sound reductions from pile driving have been recorded out to 1km with decreases in sound pressure levels achieved by bubble curtains of by up to 90 percent (Reyff 2003). Given the extended duration and size of the piling proposed this measure could be used to ensure the zone affected by noise production will be reduced minimizing any potential TTS in cetaceans and pinnipeds. Recent trials to determine the attenuation of sound pressure from piling at the proposed construction site (McKeown, 2014) have reported rapid attenuation within 500m of the sound source due to the topography, seabed substrate and the shallow water and the sound pressure was undetectable above ambient noise at 3,570m from the sound source. Although these trials were carried out during piling on smaller diameter piling activity than proposed for Alexandra Basin, this suggests that piling will not cause TTL in marine mammals within 500m of the site (McKeown, 2014).

If this is the case then standard mitigation measures outlined in the NPWS (2014) recommendations would be sufficient to ensure there are no significant impacts on marine mammals and therefore there is no requirement for bubble curtains or other sound mitigating measures to be used.

Dredging and Dumping

The potential effect of dredging works associated with the proposed development is significant and referred to in Chapter 9 of the EIS. During the proposed construction an estimated 1 million m3 will be dredged from the navigation channel and dumped at Burford Bank on the boundary of the Rockabill to Dalkey Island SAC per annum over a six year period during a six month winter dredging campaign, day and night for seven days per week. Dredge spoil would have been dumped in this general area going back 100 years or more as this is the closest point where a north-south current is encountered to take dredged silts away to the open sea. The site itself was first licensed in 1996 after the previous dumpsite nearby closed. The area has been subjected to regular dredge spoil disposal since it was first licensed. Table 5.4.6 in the EIS outlines the dredge spoil tonnages licensed for disposal at the site since 1996. Although this may not indicate the amounts actually disposed at the site under those permits, it highlights the active nature of the dumpsite on a continual basis. The average annual licensed tonnage is circa 550,000 m3 and dredging and dumping is to be confined to a six month period during October to March each year.

The receiving environment includes the area being dredged and the area in which the dredged material is disposed or dumped. The route between the dredge and the dump site could also be impacted through increased noise associated with the movement of the dredger as it transits to and from the dump site. Here we are only considering the risk to marine mammals from the dredging operations and especially at the dump site and during transit between the dredge and dump site.

The ecological effects on marine mammals of the dumping dredge material have been the subject of very limited international studies and provide little additional perspective on the assessments carried out in the EIS/NIS. Widdows et al. (2007) carried out an assessment of the likely effects of annual maintenance dredging on the Tamar Estuary, SW England as it is a Special Area of Conservation (SAC). The study concluded that there was no evidence of ecological changes related to the dredging activity in the Tamar and any significant changes to fish catches, and the number of over-wintering ducks appeared to be related to large scale climatic events rather than anthropogenic factors within the Tamar estuary. They did not consider the effects on marine mammals as they did not occur in the estuary. Messiaeh et al. (1991) considered the greatest impact of dumping on marine fish and mammals in continental shelf waters of eastern Canada was the re-suspension of contaminants that had become fixed in the sediment.

Impacts of dredging and dumping on marine mammals

Richardson et al. (1995) identified only two studies on the effects of dredging on marine mammals and both were on large baleen whales (bowhead and northern right whales). There have been no further studies on the effects of marine dredging (Thomsen et al. 2006; Nowacek et al. 2007). Belugas, which are toothed odontocetes, showed less reaction to stationary dredges than moving barges in the Mackenzie estuary, Canada and it was concluded that passage of belugas along a shoreline was temporarily blocked by a dredging operation involving frequent barge traffic but not by a dredging operation with little barge traffic (cited in Richardson et al. 1995). During a controlled exposure experiment on Bowhead whales received broadband levels of <113 – 131 dB re 1 µPa (<11 – 30 dB above ambient) from a suction dredge were created leading to weak and inconspicuous avoidance, however the low frequency components were under-represented. Off the southeast coast of the US Northern Right whales exposed to intensive dredging by noisy hopper dredges apparently show some tolerance of this noise (cited in Richardson et al. 1995). The best documented case of long-term change by baleen whales is from Baja California where Gray whales breeding in lagoons subjected to industrial activities, including dredging were virtually absent during years with shipping which led to the suggestion that the constant dredging may have been the main source of disturbance (cited in Richardson et al. 1995). More recently, Diederichs et al. (2010) through the use of acoustic monitoring with click detectors, showed that harbor porpoises in the North Sea temporarily avoided an area where sand extraction took place off the Island of Sylt in Germany. The authors found that when the dredging vessel was closer than 600m to the monitoring location, it took three times longer before a porpoise was again detected compared with times without sand extraction. However, all of these studies only considered dredging and not the dumping of dredged material.

Thus dredging seems to have less effect on marine mammals than moving sound sources although avoidance behaviour of whales exposed to high levels of activity have been documented. Reactions, when measured have only occurred when received sound levels are well above ambient levels. Although there are fewer studies on pinnipeds or odontocetes these animals do tolerate considerable noise from such sources (Richardson et al. 1995).

Despite these references to the potential effects of dredging on marine mammals the international research contains little consideration of the impact of the actual dumping of dredge material as opposed to removal of material from the site to be dredged. This is either an oversight, or more likely reflects the extremely low impact of the dumping of dredged material on marine mammals, compared to the effects of dredging, which are considered low down the spectrum of impacts of coastal activities on marine mammals. OSPAR (2008) suggested that the dumping of dredge materials is largely irrelevant with respect to environmental impact and the issue is confined to disturbance due to underwater noise emission during the dumping process and during the transport (ship noise).

Dublin Bay generally (the site of the proposed dumping) is a foraging area for harbour porpoise throughout the year and perhaps also bottlenose dolphins and minke whales seasonally. Common and grey seals are known to occasionally occur in small numbers in Dublin Bay and may forage at Burford Bank. However harbour porpoises are highly mobile and have been shown to travel up to 23km per day in the North Sea (Sveegaard et al. 2011). Bottlenose dolphins recorded in Dublin Bay are also highly mobile (O'Brien et al. 2009) and thus any local impacts if they occur should be considered in the overall range of the species.

Dredging

The potential for disturbance to marine mammals is greatest when elevated levels of underwater noise are considered. Marine mammals, especially cetaceans, have well developed acoustic capabilities and are sensitive to sound at much higher frequencies than humans (Richardson et al. 1995). They are less sensitive to the lower frequencies but there is still great uncertainty over the effects of sound pressure levels on marine mammals and thus the assessment of its impact. Sources of noise include that generated by the vessel during dredging and transiting to and from the dump site, the noise generated by dredging and that generated during dumping.

Received levels of dredging noise by marine mammals can exceed ambient levels to considerable distances depending on the type of dredger used (Richardson et al. 1995). Hopper dredges produced broadband sound between 20-1000 Hz and the highest levels occurred during loading. Evans (2000) suggested dredging activities produce sounds varying from 172-185 db re 1 ųPa at 1 metre over the broadband range 45 Hz to 7 kHz but there have been no studies examining the reaction of odontocetes to this activity. Audiograms for bottlenose dolphins show peak sensitivity between 50-60 kHz and no sensitivity below 2 kHz and above around 130 Khz (Richardson et al. 1995). Because of rapid attenuation of low frequencies in shallow water dredge noise normally is undetectable underwater at ranges beyond 20-25km (Richardson et al. 1995). The effects of low frequency (4-8 kHz) noise level and duration in causing threshold shifts in bottlenose dolphins were predicted by Mooney et al. (2009). They found that if the Sound Exposure Level was kept constant significant shifts were induced by longer duration exposures but not for shorter exposures. They found that short duration exposures require greater sound energy to induce Temporary Threshold Shift (TTS) but predicting TTS in odontocetes is complicated however a logarithmic algorithm was suggested for inducing TTS and also for recovery. The broadband sound generated by hopper dredges (20-1000 Hz) are generally below the frequencies detectible by dolphins thus disturbance from the noise generated will not exist or at worse be very minimal. A recent guidance document generated by the World Organisation of Dredging Associations acknowledges that the management of risks related to dredging sound is not an easy task, but that it is clear that sound produced from dredging has the potential to impact on aquatic life and it is assumed that most of these impacts would concern disruption of communication due to masking or alteration of behaviour patterns. However, cumulative and long-term exposure leading to TTS has to be considered for marine mammals (Kastelein et al. 2012), but PTS or other auditory injuries are unlikely. Previous studies on sound production by Trailer Suction Hopper Dredger (TSHDs) in silt/mud substrates have found that maximum source levels from different activities associated with TSHD dredging (including the dredging process, transit to dump site, placement, pumping and rainbowing) were very similar with dredging itself not producing louder sounds than those produced by the dredger during transit (De Jong et al. 2010). Therefore marine mammals occurring at the site over the durations of the works will be exposed to sound equivalent to an additional ship in the area. Given that the dump site is adjacent to one of the busiest shipping lanes in coastal Irish waters (Beck et al. 2013), marine mammals frequenting the site will be well accustomed to shipping noise.

NPWS (2014) identify increased sound pressure levels above ambient do occur due to dredging which could be detected up to 10km from shore. These levels are thought to potentially cause masking or behavioural effects but are not thought to cause injury to a marine mammal. There is no guidance from international research on the effects of noise generated by dumping of dredge material on marine mammals, In the current proposal the proposed dump site for the uncontaminated dredge spoil is already a pre-existing licence dump site. As indicated in the NIS it is not expected that the dumping of dredge spoil on the proposed site will adversely impact on marine mammals within the designated area.

As indicated in Section 11.2.4, dredging of contaminated material from Alexandra Basin West will be excavated from a floating pontoon with an excavator mounted clamshell bucket which has been adapted for environmental dredging. A silt curtain will be used around the dredger to minimize silt escaping from the site. The type of dredger to be used to in the navigation channel will depend on the project programme, but the dredging operations will generally be undertaken starting at the outer area of the channel and progressing inwards towards the harbour channel using a trailer suction dredger or equivalent. The dredged material will be loaded into barges and transported directly to an established licensed sea disposal site located at the entrance to Dublin Bay.

Effectiveness of Mitigation Measures

Recommended mitigation measures in the EIS to reduce the impact of dredging and dumping on marine mammals involve the implementation of the NPWS (2014) guidelines which requires a Marine Mammal Observer (MMO) to ensure the area is clear of marine mammals and before dredging commences and before dumping is carried out. These measures should be sufficient given that dredging, and especially dumping, has not be shown to have a significant impact of marine mammals. Visual monitoring is not effective at night but as dredging and dumping is continuous over a six month period any marine mammals in the immediate area will be either temporarily displaced or accommodated to this disturbance.

Acoustic harassment devices (AHD) have been used at fish farms to deter seals from the nets and during construction of offshore windfams. This technique has been suggested as a mitigation measure during other coastal activities to deter marine mammals in order to prevent any significant impacts. Whereas this technique may be vindicated for short duration, high impact activities such as blasting it is not best practice for low impact, long duration activities such as that proposed. AHD involve putting additional sound energy into the marine environment and this is to avoided if possible. Marine mammals have been shown to accommodate to AHD if used over extended periods and thus there effectiveness diminishes with time. The use of these devices would require an additional license from the DAHG for the use of active devices, designed to deliberately disturb marine mammals and is not recommended for the current proposal.

As an additional mitigation measure for harbour porpoises it is proposed to establish a static acoustic monitoring (SAM) programme using CPODS. CPODs are self-contained click detectors which log the echolocation clicks of dolphins and porpoises. They can be deployed on a mooring for 4-6 months before recovery and downloading of data. These data can be analysed as detection positive minutes (DPM) to generate an acoustic index of activity. This technique provides large datasets to enable changes in activity to be identified at high resolutions. CPODs are spatially constrained having detection distances of around 250m for harbour porpoise and 800m for bottlenose dolphins (O'Brien et al. 2013). O'Brien et al. (2013) recommended a minimum of four units should be deployed in small inshore study areas to ensure that statistically robust data can be collected. The number of PODs required should reflect the parameters or factors to be tested (e.g. fine scale diel or larger scales such as seasonal trends). Using an even number design for replication purposes can allow for parameters such as inshore and offshore trends to be explored in larger areas. The more units that can be deployed in an area, the more an informed evaluation of a site and successful monitoring indices will be generated. Hence we recommend four stations are established for SAM.

Four stations will be monitored including two at the dumping site on Burford Bank and two within Dublin Bay. These stations will be monitored pre-construction, during construction and for a minimum of two years post-construction in line with best international practice.

Noise associated with shipping

Shipping produces low broadband and "tonal" narrowband sounds. The primary sources are propeller cavitation and singing and propulsion of other machinery (Richardson et al. 1995). For large and medium vessels tones dominate up to around 50Hz and broadband components may extend to 100Hz. Source levels for ships up to 85m are around 170-180 dB re 1 µPa (Richardson et al. 1995). For TSHD there will be additional higher frequency sounds associated with the opening and closing of the doors during dredge disposal but this will be low intensity and of short duration.

Many odontocetes show considerable tolerance to vessel traffic. Sini et al. (2005) showed bottlenose dolphins resident in the Moray Firth generally exhibited a positive reaction to medium (16-30m) and large vessels (>30m) and showed some evidence of habituation. Buckstaff (2004) suggested an exposure level of 110-120 dB from vessel noise solicited no observable effect on bottlenose dolphins. A similar exposure level solicited minor changes in orientation behaviour and locomotion changes in minke whales, a small baleen whale (Palka and Hammond 2001). Fin whales are thought to avoid ships by slight changes in heading or by increasing the duration and speed of underwater travel but continued to call in the presence of vessel noise (Richardson et al. 1995). Harbour porpoise are frequently observed near vessels but tend to change behaviour and move away and this avoidance may occur up to 1-1.5km from a ship but is stronger with 400m (cited from Richardson et al. 1995). Seals show considerable tolerance to vessel activity but this does not exclude the possibility that it has an effect.

Dublin Port and its approaches are some of the busiest shipping lanes in Irish coastal waters and yet marine mammals regularly occur in Dublin Bay throughout the year and for harbour porpoise at high densities. Habituation occurs when there is a gradual waning of the responses to a stimulus until it lacks any significant effect on the animal. Seals provide many examples of habituation (Richardson et al. 1995) and cetaceans, especially coastal species, can also become habituated within an area.

Impact of suspended material and contaminants

There is likely to be an impact of dumping dredged material on benthic and demersal fish species but as this site has been subjected to dumping for many years it is not pristine and it is likely the fish community has responded to this regular disturbance. The diet of porpoises in Ireland is not well known but it is thought to be a mixture of pelagic and benthic fish including sandeels, gobies as well as crustaceans (Rogan 2008) . Disturbance to this site for porpoise if it occurs will only be of very short duration and have no long term effect. As indicated in Section 5.4 of Volume 1 of the EIS shallow sand banks are highly dynamic systems responding to changes in tide and wind and the benthic community are adapted to this regime.

Re-suspension of contaminants, especially heavy metals into the food chain that were fixed in sediments, may have a long-term detrimental impact on higher predators. As indicated in Section 11.2.4 of Volume 1 of the EIS the dredge material to be dumped at Burford Bank is considered not heavily contaminated and suitable for dumping in the marine environment.

Statement of Competency of the Marine Mammal Ecologists

Dr Simon Berrow is one of the most experienced marine mammal biologists in Ireland having worked extensively on whales, dolphins and porpoises as well as seals, seabirds, basking sharks and marine turtles. He has carried out primary research from Ireland to the Antarctic and to the Cape Verde Islands including surveying inshore and offshore waters of the Atlantic Ocean. He worked and lived on South Georgia for 2.5 years with the British Antarctic Survey where he carried out primary research and monitoring on albatrosses, penguins and fur seals. Simon is currently a full-time Lecturer at the Galway-Mayo Institute of Technology contributing to the Applied Freshwater and

Marine Biology Honours Degree. He is involved in delivering modules in the Biology and Culture of Aquatic Organisms, Biology of Aquatic Organisms and Environmental Legislation. He also contributes to the Ecology of Top Predators and Stakeholder Engagement modules on the EMBC+ Masters course. He is currently supervising three PhD students at GMIT, on topics such as social behaviour of bottlenose dolphins, ecosystem approach to fisheries management and ecosystem services. As well as supervision of undergraduates and post-graduates and research projects he is an active member of the Marine and Freshwater Research Centre

He has founded and is still a key figure in two Irish NGOs: Irish Whale and Dolphin Group (www.iwdg.ie) and the Shannon Dolphin and Wildlife Foundation (www.shannondolphins.ie) which are both involved in research and conservation of cetaceans. This work has led to involvement in a range of management groups and positions. He is a former full council member of the Heritage Council and on the board of the European Cetacean Society. Simon has an extensive publication record with 80 papers in peer-reviewed journals, 20 book chapters or conference proceedings and 50 short communications. Most publications are on marine mammals but also on seabird ecology and foraging behaviour and on fur basking sharks, fur seals and turtles.

Dr Joanne O'Brien is Conservation Officer with the Irish Whale and Dolphin Group (IWDG) and is currently lecturing at the Galway-Mayo Institute of Technology (GMIT) on the Marine and Freshwater undergraduate course and is supervising four postgraduate students focusing on the acoustic and behavioural repertoire of Arctic charr and Atlantic salmon, seal haul-out behaviour in Galway Bay and the foraging ecology of bottlenose dolphins in the Shannon Estuary. She also delivers a module entitled "Acoustic Monitoring as a Marine Conservation tool" on the International Master of Science programme in Marine Biodiversity and Conservation (EMBC+). Joanne completed her BSc in Marine Science at NUI Galway in 2003 and worked for 18 months with the Shannon Dolphin and Wildlife Foundation. Here she carried out tour boat monitoring, photo-identification of bottlenose dolphins, static acoustic monitoring using hydrophones and was MMO on numerous occasions during dredge operations in the Shannon Estuary. She completed her PhD on small cetaceans in Galway Bay and Clew Bay at GMIT in 2009, primarily focusing on visual and acoustic monitoring techniques. Since 2004, she has carried out numerous offshore and inshore cetacean distribution and abundance surveys on-board the state research vessels, the R.V Celtic Explorer and Celtic Voyager and additionally on foreign research vessels surveying in Irish waters. She also has experience with other marine mammals in Irish waters and internationally, having spent 4 weeks researching fur seals in South Georgia in 2008. Joanne has also carried out dedicated cetacean abundance surveys as part of NPWS contracts between 2007 and 2014, and has completed training courses in the use of DISTANCE and MARK abundance generation software. She was work-package leader on the PReCAST project (Policy and Recommendations from Cetacean Acoustics, Surveying and Tracking) which was a partnership between the IWDG and the GMIT worth in excess of €500,000. Here she was responsible for developing Static and Passive acoustic monitoring techniques and assessing how such datasets could be used for meeting Irelands' monitoring requirements under the EU Habitats Directive. She has participated in six "Cetacean on the Frontier" cruises onboard the state research vessel, R.V. Celtic Explorer from 2009 – 2014, where she acted as Chief Scientist in 2012 and 2014. She was Principal Investigator on an EPA funded project assessing Ocean Noise in Irish waters 2011-2013 and as a result takes part in EU workshops to guide the MSFD process. She is a council member of the European Cetacean Society and has published in national and internal journals.

Adequacy of the EIS and NIS with respect to Marine Mammals

The marine mammal response to the RFI was prepared by Dr Simon Berrow and Dr Joanne O'Brien, from the Marine and Freshwater Research Centre at the Galway-Mayo Institute of Technology.

Dr Berrow and Dr O'Brien based their findings on international research, information currently available in Ireland, their own extensive experience in the field of marine mammal ecology and also from the scientific data already provided on marine mammals in Chapter 5 of Volume 1 of the EIS & the Marine Mammals Impact Assessment Report prepared by the Coastal and Marine Research Centre of University College, Cork to support the NIS (reproduced in Appendix C of this Report).

Dr Berrow and Dr O'Brien have reviewed the adequacy of the EIS and NIS with respect to marine mammals and agree with the findings contained therein. The response to the RFI provides further information which supplements and further supports the EIS and NIS.

Correction to Appendix B of the NIS

Since the submission of the planning application, it has come to the attention of the Applicant that an incorrect version of the Marine Mammals Impact Assessment Report (MMIAR - appended to the Natura Impact Statement [NIS] as Appendix B) was inadvertently submitted with the application. An original MMIAR was prepared by the Coastal and Marine Research Centre of University College, Cork and is now attached. The version that had been originally appended to the NIS differs from the attached original as a consequence of a lapse in editing protocols on the part of RPS when compiling the final documentation for submission to the Board.

Accordingly we wish to substitute the enclosed Marine Mammals Impact Assessment report (Appendix C of this document) for the version of that report submitted with the application. This is the original version of the MMIAR prepared by UCC.

It is important to note that the NIS submitted with the application was based on and only references the attached MMIAR rather than the version that was inadvertently submitted. In particular, it should be noted that there are no changes whatsoever to the content of the NIS itself and no additional information is contained in the Marine Mammals Impact Assessment report now enclosed.

Please note that subject to the Board's direction, the application website will need to be amended so as to substitute the original version of the report for the subsequent (incorrect) version of that report.

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D. BENTHIC COMMUNITIES

6. Benthos recovery times

6.1 The EIS and NIS anticipate that, because dredging and dredge disposal operations will be limited to 6 month periods in each of the 6 consecutive years, the benthic communities will have time to recover prior to each period of dredging and dredge disposal. However research to date (Hill et al, 2011 for defra.uk) has shown that impacts and recovery at dredge sites are highly variable, depending on a range of environmental and biological factors and that it is difficult to accurately predict impact and recovery rates. This study concluded that it could take up to 12 months for signs of recovery to occur under high tidal energy conditions and several years under low to moderate energy conditions.

6.2 Further detailed information is required to enable the Board to assess the potential adverse impacts of the dredging and dredge disposal operations on the various benthic communities, their anticipated recovery times and the effects of a prolonged recovery time might have on waterfowl populations and marine mammals who forage for food in the area.

Response 6.1 and 6.2

Benthos - Dredge Area

This matter has been dealt with in Section 5.4 of Volume 1 of the EIS. As indicated in the EIS the proposed 6-year dredging campaign will be undertaken in the winter period (October to March), and the dredge area will be divided into 6 different sections, with one section being dredged to -10m CD annually. This significantly reduces the footprint of the disturbance occurring annually and would allow for more rapid recolonisation from lateral migration of fauna to the dredged areas from non-dredged sites. In addition, to limiting the dredging to the winter months, it facilitates recovery from larval settlement in the area during the spring/summer reproductive bloom.

As indicated in the EIS, the sediment present in the shipping channel consists primarily of muds and sands. Muds dominate the berths and inner sites and sands and muddy sands dominate the outer sections of the dredge area (Table 5.4.3 and Fig. 5.4.3, EIS Vol. 1). Hill *et al.* (2011) in their report for DEFRA look at the impacts of dredging at aggregate extraction sites. These sites generally tend to be coarser in nature, with sands and gravels being the primary resource extracted. The findings of Hill *et al.* (2011) correspond to the findings in the EIS in relation to the dredging activities in Dublin Bay. Hill presents a summary of typical conditions for impact and recovery (Key Facts VIII in Hill *et al.*, 2011). These include rapid recovery (months to 1 year) at sites which contain some or all of the following characteristics;

- High tidal energy
  - o Dublin Bay is a shallow coastal embayment, with sediments subjected to movement from hydrodynamic and riverine inputs. This is characterised by the presence of sands across large parts of the outer sections of Dublin Bay including the outer parts of the shipping channel.
- Fine sediments including sands
  - o The area to be dredged consists of fine sands and muds. There is an evident change in fauna and sediment from muds along the inner parts of the dredge area (by the mouth of the River Liffey) and sands dominant along the outer stretches of the survey area.

- Disturbed community type
  - o Dublin Bay is a shallow, coastal embayment, with a large river flowing into it on its western border. The area is subjected to episodic increases in water flow from the River Liffey, resulting in increased sediment movement along the channel. In addition, the shallow nature of the Bay allows for large amounts of sediment movement in times of strong wind and wave activity.
  - o The shipping channel is subjected to regular maintenance dredging. These episodic disturbance events result in the presence of community types which are more adapted to such events, and as such, will recover more rapidly after dredging.
- R-selected species dominant
  - o Opportunistic fauna dominate the inner sites. These fauna will rapidly recolonise similar benthos, and are adapted for such rapid recolonisation (e.g. short life span, rapid growth rate, small body size, early and frequent reproduction).
  - o Rapidly reproducing species are also present along the outer sections of the dredge area (e.g. Capitella capitata and Chaetozone christiei along the inner sites and Magelona spp. and Abra spp. from the outer sites). Although it is expected that recovery in the sandier sites will be marginally slower than the inner sites, recovery is expected to commence immediately on cessation of dredging, with recolonisation taking place from larval settlement and lateral migration of mobile species from adjacent un-dredged areas.
- Sediment remaining unchanged
  - o It is expected that the sediment which remains in-situ following dredging will be similar in nature to the sediment which has been removed (pers comm, RPS).
- Small dredge area
  - o Dredging at the site will be limited to a relatively small area each year. This reduces the footprint of the impact area and allows for more rapid recovery to pre-dredge levels from lateral migration and larval settlement from established areas in close proximity to the dredge area.

Maintenance dredging was undertaken along large parts of the shipping channel in 2012 (see Fig. 5.4.19 in the EIS), results from the present survey indicate that there were no differences in community structure between areas which were subject to maintenance dredging and those which weren't, pointing to the ability of the site to rapidly recover following dredge events. In addition, there is a long history of dredging of the shipping channel in Dublin Bay. Surveys of the benthos in Dublin Bay referred to in the EIS indicate that there is no long term impact associated with this dredging activity. Surveys undertaken throughout Dublin Bay highlight the stable nature of the benthos in the bay (Kennedy, 2008; Dublin City Council, 2012 & Walker & Rees, 1980).

Benthos - Disposal Area

The proposed development requires the deposition of approximately 1 million m3 per year for 6 years of sands and muds at the licensed dumpsite at the Burford Bank. This equates to an average of 177,000 m3 of sediment deposited monthly over a six month period each year. The disposal will be undertaken between October and March each year, which will allow a six month non-dredge window (April to September) prior to the next annual dredging, during which partial recovery of the benthos will occur. As indicated in Section 5.4.3 and 5.4.4 of the EIS there are several features of the Burford Bank dumpsite which will facilitate rapid recovery of the benthos. These include the hydrodynamics at the site, history of the site for sediment disposal and the nature of the dredge spoil to be disposed. Recovery can also be facilitated by appropriate management of the operation. These are discussed in the EIS and below.

The Burford Bank disposal site is dispersive in nature with a peak tidal flow of 1.59 knots and this is reflected in the sediment identified at the site. As stated in section 5.4.4 of the EIS, the dominant sediment present consists of fine to medium sands with pockets of coarser material (Infomar, 2010). Benthic communities in high dispersal areas contain infauna which are subjected to natural stresses from both wind and wave activity in the area. Surveys at a highly dispersive site in the UK (e.g. Rame Head) recorded 'minimal' impacts and no station within the dredge spoil disposal area exhibited 'impoverished biological community at any time' (Bolam et al, 2011). This is also reported from other dispersive coastal sites (Bolam & Rees, 2003; Simonini et al., 2005; Smith & Rule, 2001).

The dumpsite has been subjected to regular disposal activities since it was initially designated as a disposal area in 1996, with nearly 9 ½ million tonnes of spoil licensed to be deposited at the site from 1996 to 2012 (EIS Vol. 1, Section 5.4.3 & Table 5.4.6). Work undertaken by Kennedy (2008) in November 2007 assessed the levels of recovery at the site from previous disposal events. In the six years prior to the survey, the site had been licensed to receive >4 million tonnes of dredge spoil. Results from this survey reported a classification of High for the benthos with reference to the Water Framework Directive and his conclusions indicated that the site had recovered well from previous disposal events. In addition, an Aquafact survey in 2011 (Dublin City Council 2012) in the immediate vicinity of the disposal site, identified faunal communities which were similar to those identified in 1971 and 1972 by Walker & Rees (1980) indicating the stable nature of the benthos over time in the vicinity of the Burford Bank dumpsite and within Dublin Bay in general.

The sediment to be deposited at the site consists of sands and muds from the shipping channel (EIS Vol. 1, Table 5.4.3 and Fig. 5.4.3 of the EIS). Previous studies have shown that similar sediment types occur in and adjacent to the dumpsite (Kennedy, 2008); Dublin City Council, 2012). Peer-reviewed studies at several dumpsites internationally have indicated that recovery of the benthos is more rapid at sites where the grainsize composition of the deposited material is similar to that at the disposal site (Wilber et al., 2008). In the case of the current proposal, the sediments to be disposed of consist of medium and fine sands from the outer portions of the dredge channel. This will facilitate recovery during the years in which this material is deposited. The disposal of the muddier sediments from the inner portions of the dredge channel, towards the latter end of the 6 year campaign may result in a slower rate of recovery for that year at the dumpsite. However, the higher organic content of this material is likely to facilitate the rapid growth of opportunistic species (e.g. small polychaete worms) in the first few months following deposition. These will provide a food source for juvenile fish feeding at the site (see Bolam and Rees, 2003).

Management of the disposal operations in terms of sediment deposition depth and the timing of the deposition can influence the rate of recovery at the site. Depth of sediment deposition is an important factor determining in the recovery of benthic communities. Infaunal species have varying abilities to vertically migrate through layers of deposited sediment (Maurer et al., 1981a & b & Maurer et al., 1982). Essink (1999) indicated that the majority of benthos can migrate vertically through 20-30cm of deposited sediment. This is reflected in several studies highlighting that thin layer deposition following disposal of sediment allows for a more rapid recovery through vertical migration (Wilber et al, 2007; Maurer et al, 1986; Smith & Rule, 2001). It is important to note, however, that many benthic species are less adapted to migrating through mud (see Essink, 1999). For the current proposal, it has been recommended that dredge spoil is spread evenly throughout the disposal site to facilitate vertical migration of the resident benthos thereby facilitating more rapid recovery at the site (EIS Vol. 1 Section 5.4.7, Page 5-108)

Dumping in the Autumn/Winter period is more beneficial in aiding recovery (Bolam & Rees, 2003; Essink, 1999). This allows for the settlement of new recruits to the infauna from planktonic larvae during the Spring/Summer reproductive period.

Full recovery at the Burford Bank disposal site is not expected to occur until cessation of all dredging activities at the site (EIS Volume 1, Section 5.4.8; Dumping). However, as demonstrated above, the likelihood is that with correct management, partial recovery can take place between each six month disposal period. This concurs with a large body of work at disposal sites in the UK and elsewhere, where substantial recovery occurs quickly (often <12 months) following cessation of dredging (for a review, see Bolam & Rees, 2003). As such, it is expected that the benthos within the licensed disposal area will undergo an annual cycle of impact and partial recovery over the 6-year campaign but full recovery will not occur until after cessation of all disposal activities at the site.

It is important to note in relation to dredge spoil deposition that '*dredged material disposal in the coastal environment does not result in large areas of seabed devoid of life. In many instances, one or more attributes within the disposal site appeared to indicate a 'healthier' situation relative to the reference site*'. (Bolam *et al,* 2006)

Indirect Impacts on Waterfowl and Marine Mammals

Ecological Function

Recovery of the benthic community at dredging and dredge spoil disposal sites has and continues to be assessed using a combination of univariate metrics (e.g. species richness, diversity indices, dominance indices, densities etc.) and multivariate metrics (e.g. Primer and MDS). Changes in these parameters are used to decide the degree to which sites have been impacted and the degree to which they can be said to have recovered. This is usually measured by comparison to pre-dredge or pre-disposal communities at the site or at reference sites depending on the question being answered and the history of the site. Although the changes in species diversity, numerical density and biomass are all important measures of the state and structure of a benthic community, the ecological functioning of the benthic community may be more important when one is attempting to assess the implications of man-made disturbance of the benthos for higher levels on the food chain e.g. fish, birds and marine mammals. In this context, the importance of benthos as a source of energy for epibenthic predators (e.g. fish and mobile crustaceans such as shrimp and crab) is likely to be more important than community structure measures alone. However, far fewer studies on the impact of dredging and dredge spoil disposal in the peer-reviewed scientific literature have looked at their effect on ecological functioning (Bolam et al., 2011). Those that have (Bolam et al., 2011; Bolam, 2012) to date have covered insufficient numbers of dredge and dredge spoil disposal sites to provide definitive answers across a wide range of dredging and dumping site types. What this work does suggest is that secondary production is more likely to show significant reductions at disposal sites receiving larger amounts of dredge spoil more frequently, when compared to reference sites (Bolam 2012). However, at the cessation of dredge spoil disposal these sites would be expected to recovery normally.

Assessing Fisheries Impacts and Indirect Impacts on Waterfowl and Marine Mammals

Potential nutritional / feeding impacts on marine mammals and waterfowl due to dredging and dredge-spoil disposal within the study area will largely be mediated through changes in fish density and biomass. Few studies have attempted to directly assess the impacts of channel dredging or dredge disposal on fisheries. One study on the impacts of dredge-spoil disposal which took fisheries into account (Wilber and Clarke, 1998) compared the benthic secondary production in dredge spoil placement and non-placement sites in Galveston Bay (USA) with the total estimated benthic consumption requirements of fish and shellfish populations in the Bay. The study concluded that spoil placement had no long-term adverse impact on secondary production and 2 years post placement, production levels (of the benthos) were higher at placement sites than in non-placement sites. The study also showed that in all but one year of the 5-year study that benthic production exceeded total estimated food requirements of fish and shellfish (shrimp and crab) in the Bay, and on the one occasion where that was not the case it was attributed to natural inter-annual variation which saw a reduction in overall benthic production levels throughout the Bay i.e. in both placement and non-placement sites alike.

There are very few published studies that have dealt with the impacts of channel dredging on fisheries. Although some work has being undertaken in marine aggregate extraction sites in the UK, that isn't readily transferable to channel dredge sites because the aggregate extraction sites tend to have coarser sediments, are located in offshore areas where dredging tends to be carried out over several years, often at high intensity and over large areas. Nevertheless, in the EIS (Vol 1, Section

5.4.6, Pages 5-97 to 5-99), the potential for impacts on fisheries resources are discussed and the main conclusion drawn is that the principal impact will be on small bottom-dwelling species such as gobies, juvenile flat fish and crustaceans (shrimp and crab) and that the impact will be confined to a limited area each year. Furthermore, in the context of the wider Dublin Bay, where all of the same species are very common, it is concluded that the impact will be minor. This impact will also be temporary because fish are likely to begin foraging within the dredged area as soon as dredging has finished. In support of this hypothesis is the fact that most of the species recorded in beam trawl collections in non-dredged areas in the May 2013 survey for the EIS were also taken in the shipping channel (Figure 5.4.17, page 5-82 and Table 5.4.10, page 5-86, EIS Vol 1) even though the channel had be dredged the previous autumn (Figure 5.4.19, page 5-93, EIS Vol 1). This is also supported by an unpublished study in Cork Harbour that examined the impact of channel dredging on benthos and fisheries for the Port of Cork (ASU, 2013). This work found that all the same fish and mobile invertebrate species (crabs and shrimps) which were present in beam trawls collected in the shipping channel within 7-9 months after cessation of dredging had been recorded in pre-dredge surveys in the same areas despite an observed reduction in benthic biomass in the same period. This supports the observation that functional recovery (i.e. in terms recovering secondary production) may proceed faster than community structure (i.e. in terms of species diversity, density and biomass) and furthermore that this may be to the benefit fish that can take advantage of the species present (Millner et al, 1977 quoted in Desprez, 2000). In this regard, it is worth noting that many of the commoner benthic fish species present in Dublin Bay e.g. gobies, juvenile flat fish, juvenile cod family etc., can eat a wide variety of benthic invertebrates and can therefore shift their diet preferences depending on the availability of particular prey items following community disturbance due to dredging. It is important to note, as well, that pelagic species such as sprat, herring, pipefish and sandsmelt, which are either exclusively or substantially more dependent on food within the water column will be unaffected by dredging (or dredge spoil disposal), apart from localised and temporary displacement due to dredging plumes. Intuitively, one would expect that while benthic production in the form of invertebrate growth and biomass is supressed in the short-term due to dredging, that fish density within the dredge channels will be reduced. However it is clear that they are unlikely to be absent and more than likely will be present in substantial numbers within months of cessation of annual dredging (ASU, 2013). This means that they will be available to be preyed on by both birds and marine mammals, although surveys would suggest that key bird species within Dublin Bay will either be entirely absent from dredge channel during the October – March dredging period (common tern) or present in reduced numbers with a much greater presence in the wider bay (black guillemot) (see EIS Volume 1, 5.1.4, P5-14 to 5-16). Some fish-eating birds such as Cormorants are present in the shipping channel in winter. However, Cormorants have been observed foraging close to an active dredger in Wicklow Harbour, suggesting that their prey species may be brought to the surface by the works.

A similar trend is anticipated to occur at the dredge spoil disposal site, i.e. the potential for reduced fish density and production following a predicted decline in benthic invertebrate biomass within the dumpsite. However, after dumping ceases each year at the end of March, the site will be used by benthic and demersal species, although possibly at reduced densities. Indeed it is likely that fish will continue to be present at the dumpsite throughout the disposal period even if their distribution will be patchy depending on dredging activity. Again, pelagic species are not expected to be impacted to the same degree as bottom-associated species, as they are either exclusively or substantially dependent on the water column and not the benthos for prey items including plankton and other fish.

The dump disposal site is used by a typical range of foraging seabirds as indicated in the Natura Impact Statement (section 3.4). Common Guillemot was the predominant species recorded in the dredge disposal site in January 2014. These species mainly feed on shoaling pelagic fish which will move away from the dredge disposal site temporarily during the operations. It is important to point out however, that (i) the site will still contain bottom or near-bottom dwelling fish species but also that the areas surrounding the site will contain a mix of all the same species, so that at worst foraging will either be reduced within the dumpsite or temporarily displaced to adjoining areas.

The same can be said for harbour porpoises that may forage in the area. If porpoise forage for bottom dwelling fish in the dumpsite, then that source of food may be reduced both temporally and spatially within the site, reducing the potential food energy available to the animals from the site. This may mean that any animals that would forage there may do so less often or not at all. The diet of porpoises in Ireland is not well known but it is thought to be a mixture of pelagic and benthic fish including sandeels, gobies as well as crustaceans (Rogan 2008). Disturbance to this site for porpoise if it occurs will only be of very short duration and have no long term effect. In assessing the possible impacts of potentially reduced fish densities at the dumpsite during the 6-year dredging programme, it is important to take account of the size of the dump site in relation to the size of the Rockabill to Dalkey Island SAC.

The dumpsite constitutes less than 0.5% of the area of the whole SAC, and for this reason, changes in benthic fish densities at the dumpsite during the proposed dredging campaign are expected to have no adverse impact on the harbour porpoise population in the SAC because they are likely to forage over a much wider area than the dumpsite (see also EIS Volume 1, Section 5.2.1 page 5-31). This is supported by the fact that harbour porpoise is known to be a wide ranging species with a large home range (Read and Westgate, 1997). Sveengnard et al., 2011 also noted that immature animals had much larger home ranges that adults.

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E. UNDERWATER DIVERS

7. Noise and Turbidity

7.1 The Irish Underwater Council has raised concerns that the EIS does not contain any information in relation to diver safety with regards to works that could cause disturbance for divers by way of noise disturbance and reduced visibility. Please comment on this matter.

Response

In accordance with established practice and guidance the approach adopted in preparing the EIS is to firstly provide a description of the aspects of the environment which have the potential to be significantly affected by the proposed ABR Project. A description of the environmental impact appraisals undertaken is next presented which establishes the likely or probable significant effects of the proposed development on the environment. This is followed by a description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment. The impact of residual effects is then assessed. This step-wise nature of the EIS allows for a transparent 'paper trail' enabling the competent authority, in this case ABP, to conduct the required Environmental Impact Assessment (EIA). This approach is consistent with the provisions of the Codified EIA Directive, Irish national law in relation to EIA and EPA guidelines.

Consultations formed a key role in formulating the scope of the EIS. Building on the extensive consultation carried out the process to develop the Masterplan, further consultation on the ABR project was carried out in the course of developing the current proposal. The extent of the consultations is presented in Section 2.3 of Volume 1 of the EIS.

The scope of the EIS is presented in Section 1.5 of Volume 1 of the EIS.

The potential impact on diver safety did not form part of the scope of the EIS for the following reasons:

- The issue of diver safety was not raised at all throughout the consultation phase associated with either the Masterplan or the scoping exercise carried out for the ABR Project;
- The issue of diver safety was not raised by any statutory body, including the Health and Safety Authority, which was a notified consultees;
- The Irish Underwater Council was not on the list of consultees that DPC was requested to contact by the Board;
- There are no records of any complaint having ever been received by DPC with respect to diver safety during any previous annual maintenance dredging campaign.
- The areas of the development, including the main approach channel are not areas of recreational diving activity given that they are busy port operational areas.

The Irish Underwater Council first made contact with DPC via a letter of concern following submission of the Planning Application in March 2014. A meeting between the Underwater Council and DPC took place on 14 April 2014 to discuss the concerns raised.

Potential disturbance due to Underwater Noise

RPS was requested by DPC to determine the environmental impact of piling and dredging works with respect to the ensonification of the underwater environment (i.e. acoustic noise) within the Alexandra Basin and the wider Dublin Bay.

The results of the study are presented in Appendix A of this Report.

The study, based on both site measurements and computational modelling, shows that underwater noise levels at recognised recreational diving sites will not be impacted by piling noise from the Alexandra Basin. This has been confirmed with measurements taken at Locations S1 and S2 as shown in Figure 2.1 of Appendix A. These are the two nearest dive sites to the Alexandra Basin. In both cases the underwater noise level was determined by the presence of vessels in the area. Noise modelling for pile driving indicates that the Transmission Loss between the Alexandra Basin and these sites is such that no noise from pile driving will arise.

Noise from piling in the Alexandra Basin area of Dublin Port has an impact on an area confined to the Basin in which piling takes place, and a short distance upstream and downstream of that point. No piling noise is detectable at the North Bull Lighthouse or the outer Dublin Bay area.

Dredging of the navigation channel and dumping of the dredging spoil at the Spoil Ground will cause short term localised increases in underwater noise levels. These changes will have no environmental impact at the recognised recreational dive sites in Dublin Bay.

Potential disturbance due to reduced visibility

This matter is addressed in Section 9.9 of Volume 1 of the EIS. The dredged material from the ABR Project comprises two different types of material, a silt material confined to the inner harbour channel area and relatively fine sand which is found in the outer approach channel. The dispersion of these two types of material has been modelled separately as their dispersion characteristics are quite different.

During disposal under normal tidal conditions the sand material settles quickly onto the bed of the sea within the disposal area and does not produce a significant plume beyond the area of the licensed dumpsite (concentrations of 0.002 mg/l or less). With the exception of the disposal site itself (where diving operations are not permitted during disposal operations) the increase in suspended solids values is so low that it will not affect diving operations in Dublin Bay.

The disposal of the silt material is quite different from that of the sand in that the silt stays in suspension and is dispersed away into the main body of the Irish Sea. The waters around the licensed disposal site are well mixed and material which stays in suspension will be relatively quickly dispersed thoughout the depth of the water column. Again the increase in suspended solids values, outside the footprint of the disposal site, is so low that it will not affect diving operations in Dublin Bay.

The proposed capital dredging campaigns are restricted to the winter months (October to March) outside the normal recreational season for sailing, bathing and diving. A notice to mariners is provided to increase awareness of the dredging campaign and to provide details of the dredging programme. This information will be extended to the Irish Underwater Council.

F. COASTAL PROCESSES

8. General

8.1 Compare previously completed Coastal Processes Studies in the Dublin Bay and Liffey Estuary (including the Tolka and Ringsend Areas) either published as technical papers or performed in support of other marine and estuarine projects with the current ABR study for hydrodynamic (2D and 3D modelling including thermal, water quality and salinity studies), tidal surge, wave climate and sediment transport (dredging and morphology) analysis.

Response

RPS reviewed the following three relevant studies relating to coastal processes within Dublin Bay during the preparation of the EIS:

1. A Three-Dimensional Hydro-Environmental Model of Dublin Bay. Bedri *et al*. (2011).

2. Ringsend Waste Water Treatment Plant, Long Sea Outfall, Dublin Bay. DHI (2010).

3. Dublin Waste to Energy. DHI (2006).

Bedri's et al Study, 2011.

A 3D hydro-environmental study of Dublin Bay conducted by Bedri *et al*. (2011) investigated the impact of emissions from a sewage treatment plant on the water quality of Dublin Bay. The study utilised TELEMAC modelling software to simulate the hydrodynamic conditions within Dublin Bay, before using the hydrodynamic results to model the transport and fate of *Escherichia coli (E. Coli)* in the bay and generate distribution and concentration maps of *E.coli* throughout the bay.

The modelling approach used by Bedri *et al.* is similar to that used by RPS in that hydrodynamic conditions were first simulated using a two dimensional flexible mesh model which was constructed, calibrated and run in order to provide basic hydrodynamic variables including water surface elevations, current directions and velocities. Analogous to the MIKE package software used by RPS, the TELEMAC software solves the full set of the Navier-Stokes equations for free surface flow environments, including coastal waters, seas and estuaries.

As can be seen from Figure F1 and Figure F2 which show the extent and structure of the models produced by RPS and Bedri's *et al*., the general extent of both models are similar, however, the RPS model has a higher resolution with over 50% more mesh nodes.

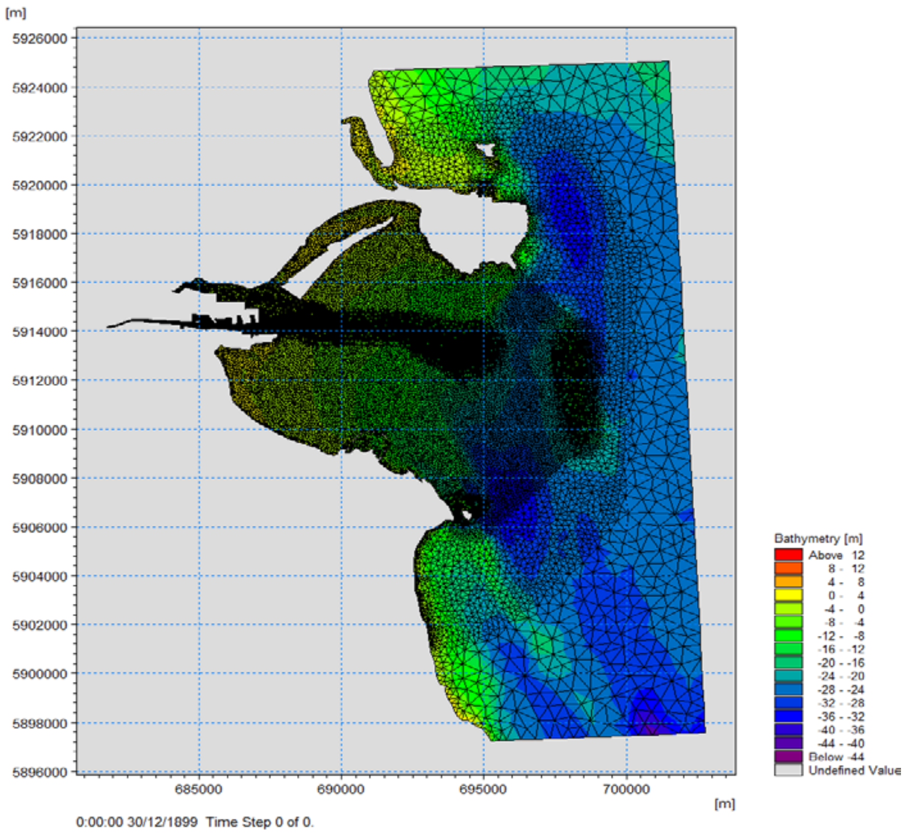


Figure F1: Extent and resolution of RPS' Dublin Bay Model

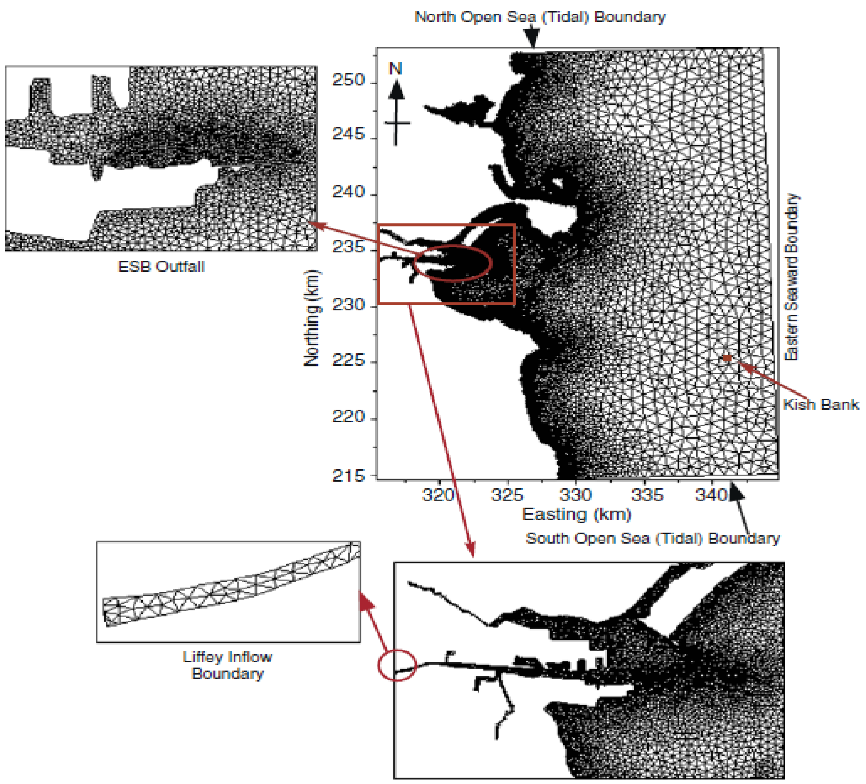


Figure F2: Extent and resolution of Bedri's *et al*. Dublin Bay Model

Other comparisons between the two models are presented in Table F1.

Table F1: Comparison of RPS' and Bedri's *et al*., model.

	Model Resolution				Model Extent		
	Mesh elements	No. of node	Largest mesh size	Smallest mesh size	Layers in 3D model	East-West direction	North-West direction
Bedri's *et al*. 2D model	43,742	23,503	750 m	12.5 m	5	29.5 km	38.5 km
RPS 2D model	66,624	34,753	500 m	15 m	5	22.5 km	20 km

Regarding inflow boundaries, Bedri *et al*., accounted for the discharge from the river Liffey and the ESB outfall at Poolbeg only and did not account for either the river Dodder or the Tolka estuary. For the river Liffey, Bedri *et al.,* assumed a constant discharge of 12.4 $m^3 s^{-1}$, whereas RPS assumed a discharge value of 15.6 $m^3 s^{-1}$ for the Liffey river, 2.3 $m^3 s^{-1}$ for the Dodder and 1.4 $m^3 s^{-1}$ for the Tolka estuary.

The model used by Bedri *et al*., was calibrated against measurements recorded at eight different stations located throughout Dublin Bay. The report produced by Bedri *et al* presents the calibration data for two of these stations; station H2 and H5. As can be seen in Figure 2.3, station H2 is situated in close proximity to the designated dump which is just north of Burford bank, whilst H5 is situated in close proximity to the head of Howth.

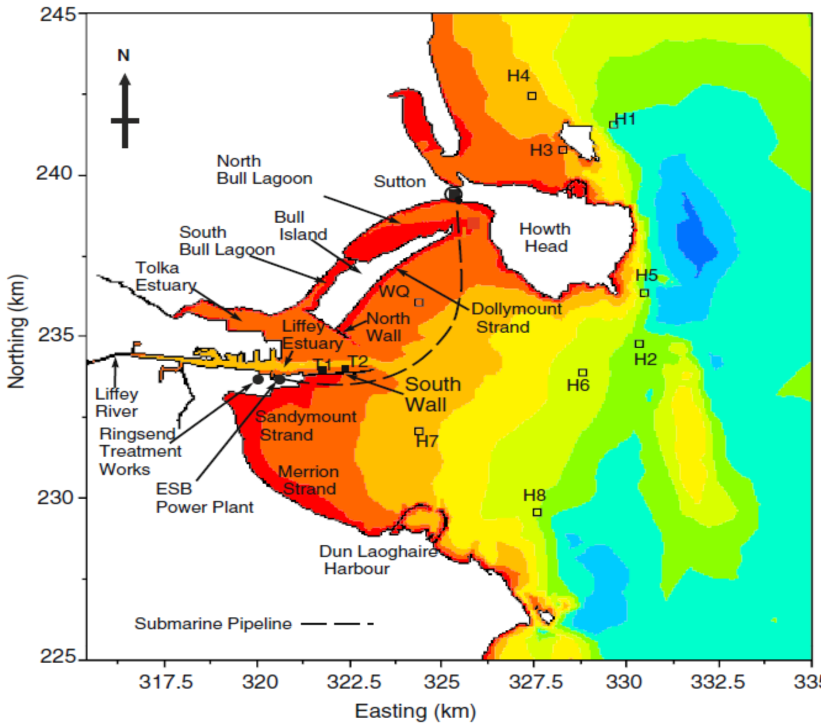


Figure F3: H1 - H8 denote points of hydrographic measurement stations taken for Bedri's *et al.* study

Unfortunately only a hard copy of the data collected by Bedri *et* al. was available for this study. However, it is possible to visually compare the measured and recorded current directions and velocities at stations H2 and H5 presented by Bedri *et al*., with the results simulated by RPS.

As can be seen in Figure F4 and Figure F5, the measured data at the two stations compare very well with the conditions simulated by the RPS model. It should be noted that only the results from RPS' 2D hydrodynamic model were compared with the findings of Bedri *et al*. This is because the 3D model produced by RPS only extends as far as Drumleck Point, past which the water column becomes well mixed and fully represented by a 2D model.

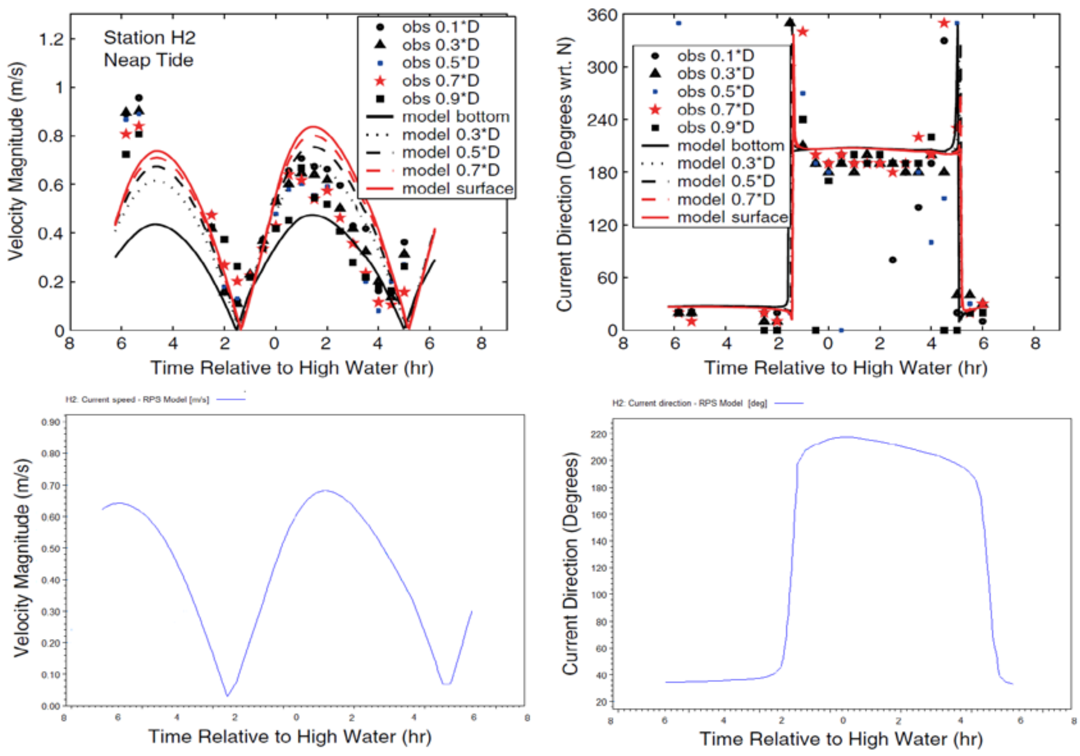


Figure F4: Comparison of Bedri's calibration data (upper) with RPS' current speed calibration data (lower)- Station H2

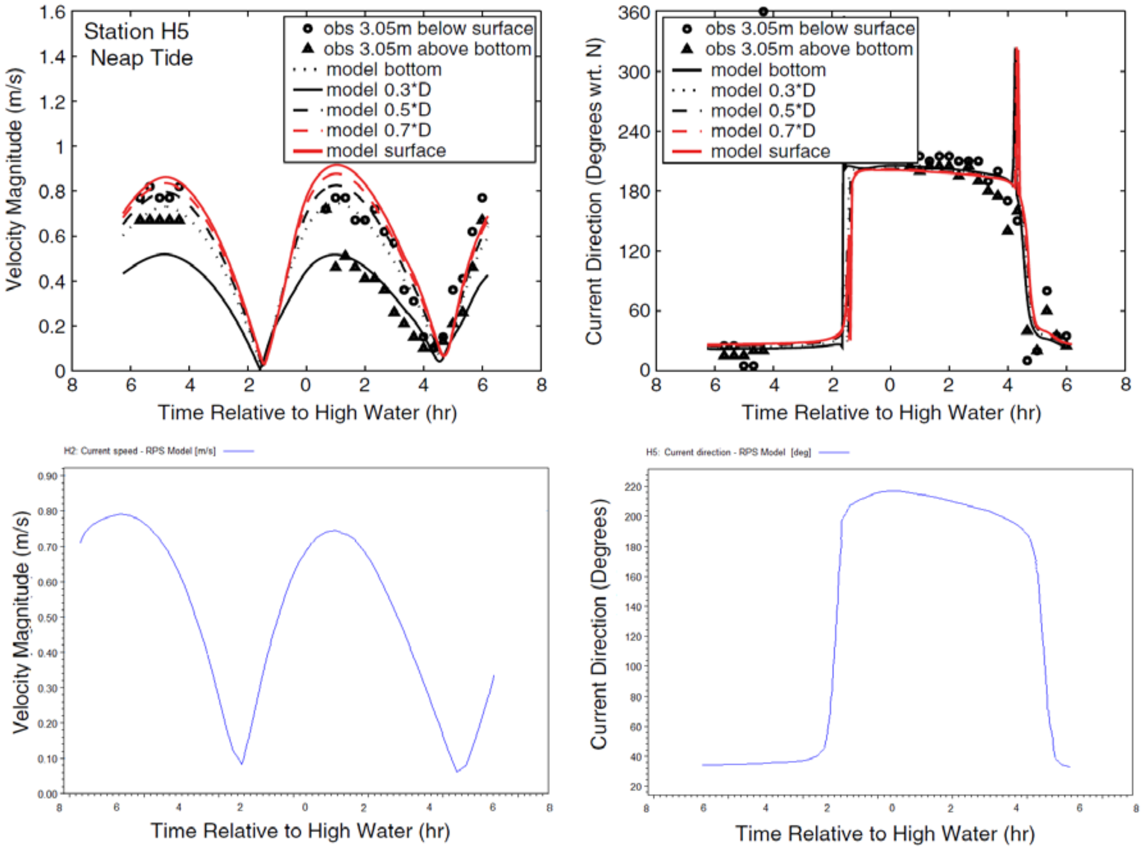


Figure F5: Comparison of Bedri's calibration data (upper) with RPS' current speed calibration data (lower)- Station H5

DHI's Study, 2010

DHI were subcontracted in 2010 by CDM (Ireland) Ltd to conduct a study on behalf of Dublin City Council to assess and quantify the effluent dispersion and plume trajectories resulting from a proposed expansion of the Ringsend Wastewater Treatment Works (WwTW).

For this study, DHI developed an existing model of Dublin Port which was established for the Dublin Waste to Energy study in 2006. Like the 3D model used by RPS, the model employed by DHI was based on a MIKE 3 flexible mesh structure and consisted of five layers. The 3D model utilised by DHI for this study comprised of 3,100 mesh elements as opposed to RPS' 3D model which was comprised of 7,662 mesh elements. Analogous to the method used by RPS, DHI took the boundaries for their 3D model from an extended 2D model. As can be seen from Figure F6, the extent of DHI's 2D model is similar to the model developed by RPS.

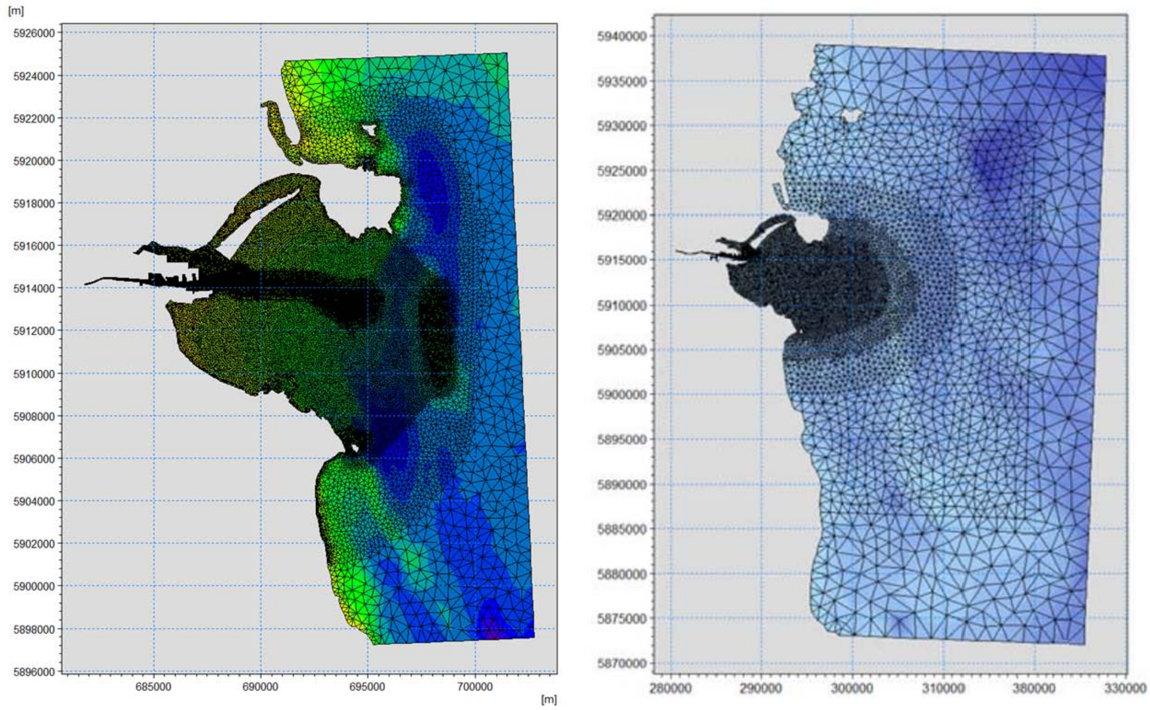


Figure F6: Comparision of RPS's 2D model (left) and DHI's 2d model (Right)

As part of the model development for the Ringsend WwTW EIS, two current current measurement campaigns in Dublin Bay were undertaken by the DHI in 2010 with the purpose of providing data for calibration and verification of a numerical model:

- The first of these campaigns comprised of vessel-based mapping of the spatial current distribution in Dublin Bay and also the deployment of two bottom-mounted Acoustic Doppler Current Profilers (ADCPs).

- The second of these campaigns comprised of mapping the spatial current distribution as well as float trackings.

The hydrographic data collected in the first of these campaigns were used to develop and calibrate the hydrodynamic model used by RPS in the EIS. As can be seen by comparing Figure 2.7 and

Figure F8, which presents the velocity and direction of the flow at station 2 simulated by the RPS' model and those measured by the ADCPs deployed by DHI respectfully shows that the current velocities and directions are very well represented by the RPS model. It should be noted that the date of the time-series presented in these figures are not in sync as the data from the DHI study was only available in a hardcopy, however both figures show similar tidal conditions during an average neap to spring transition.

The calibration process is outlined in Appendix 9, Volume 2 of EIS.

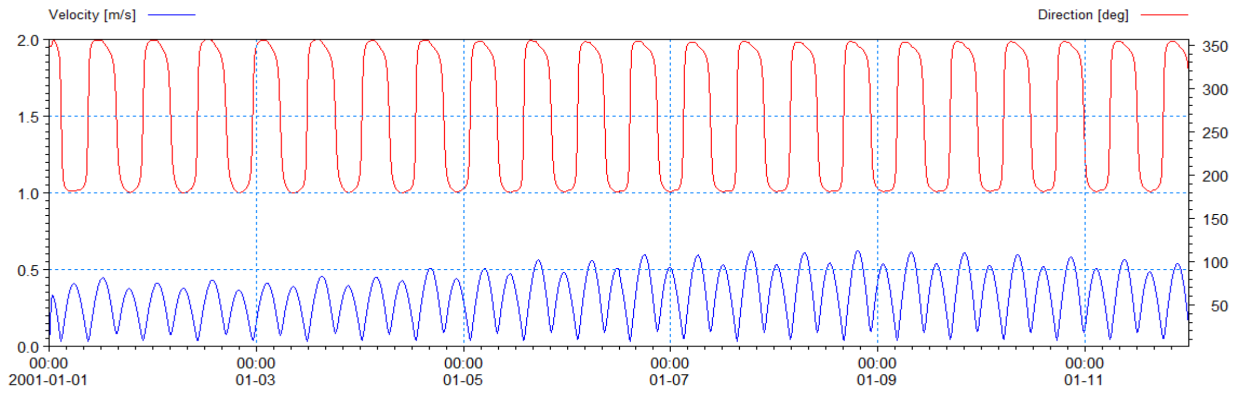


Figure F.7: RPS model results of the current direction and velocity at station 1

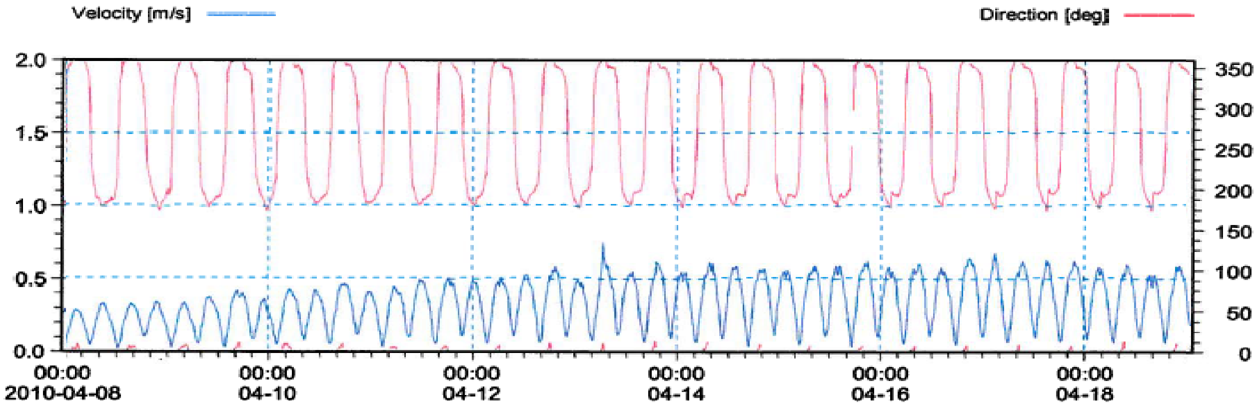


Figure F8: ADCP results of the current direction and velocity at station 1 collected by DHI.

<u>DHI's Study, 2006</u>

In 2006 as part of the Dublin Waste to Energy project EIS, DHI undertook a 3D model thermal plume study. In summary, DHI applied MIKE 3 to the Liffey tidal estuary and Dublin Port to simulate the thermal plume and dispersion of biocides. These simulations were then assessed by DHI before being input to the EIS of the Dublin Waste to Energy Project.

Like the model employed by RPS, the 3D model used by DHI to simulate the coastal processes within Dublin Bay also had five layers and solved the vertical turbulence across these layers using a standard k-epsilon model ($k - \varepsilon$) with a buoyancy extension, whilst the horizontal turbulence was solved using a Smagorinsky formulation.

A comparison of Figure F9 with Figure F1 shows that the overall extent of the 3D model used by RPS in the coastal processes study of Dublin Port is much greater than the extent of the 3D model used by DHI. DHI's model comprised of 3,560 mesh elements compared with 7,662 mesh elements in the RPS' 3D model of Dublin. Similar to the method adopted by RPS, DHI took the boundaries for their 3D model from an extended 2D model

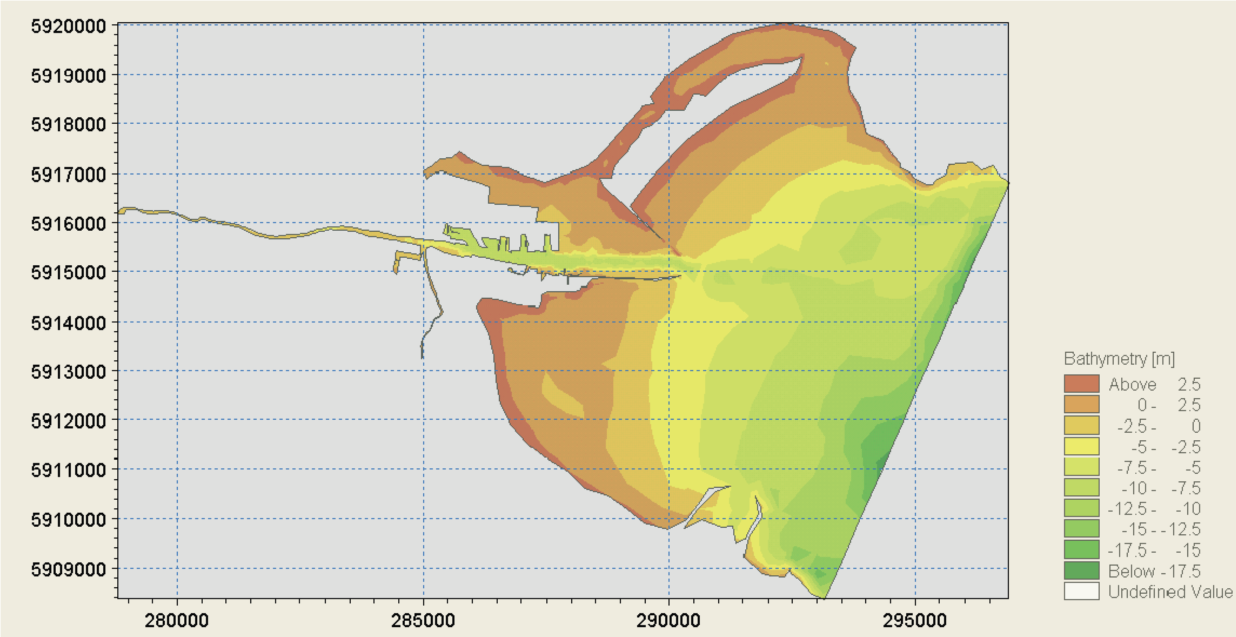


Figure F9: Extent and bathymetry of DHI's 3D model used for the Waste to Energy EIS.

8.2 There is little information provided in the coastal modelling studies in relation to the model capabilities and limitations and their justification for use in respect to the ABR project and further clarity is required with respect to boundary conditions, bed roughness, turbulence model and specific boundary inputs for tides and freshwater flows for the calibration runs.

Response

There are a range of well established computational modelling systems that were considered by RPS for the simulation of the coastal process for the ABR project, including:

- the French Telemac system;
- the Dutch Delft system;
- the Danish MIKE system; and
- several models developed by the US Army Corps.

All the well established modelling systems include 2 and 3 flow models as well as wave transformation and sediment transport models.

In RPS's view the MIKE modelling system is the most suitable for the ABR project as it includes both rectangular and flexible mesh models, a greater range of wave models and a full morphological coupled model including flow, wave and sediment transport models with automatic feedback of the morphological change in bathymetry into the flow and wave model calculations throughout the simulation. This morphological modelling capability is not as well developed in many of the other modelling systems.

Within the MIKE modelling system, the 2D flexible mesh models were used for areas where the water column was well mixed. However in the Liffey Estuary where there are stratified flows due to the impact of salinity and temperature a 3D layer flow model was utilised to simulate the coastal processes in and around these waters.

The wave transformation from offshore and in and around Dublin Bay was simulated using a Spectral WAM type model based on flexible mesh technology. This type of model was considered to be the most appropriate wave model as it contains all the relevant processes except reflected wave to wave interference. Consideration was given to the use of Boussinesq wave disturbance modelling for the investigations of the wave climate in the Liffey channel and Tolka estuary. The use of such a wave model could be justified if the project included significant changes to the boundary of the river or estuary boundaries. The down side of the use of the Boussinesq wave model is that it does not include wind wave generation within the model area which is most significant in the determination of the wave climate within the Liffey and Tolka Estuary. In view of the fact that ABR does not include any significant changes to the boundaries of the Tolka estuary and the wave climate is greatly influenced by local wind wave generation, the use of a Boussinesq type wave model was considered to be inappropriate for assessing the impact of the ABR project on the wave climate within the Tolka and Liffey estuaries.

Details of the various models used in the assessment of the coastal processes are given below.

1: MIKE21 FM flexible mesh modelling system

The tidal flow simulations which formed the basis of the study were undertaken using the MIKE21 FM flexible mesh modelling system. The FM Module is a 2-dimensional, depth averaged hydrodynamic model which simulates the water level variations and flows in response to a variety of forcing functions in lakes, estuaries and coastal areas. The water levels and flows are resolved on a mesh covering the area of interest when provided with bathymetry, bed resistance coefficient, wind field, hydrodynamic boundary conditions, etc.

The system solves the full time-dependent non-linear equations of continuity and conservation of momentum using an implicit ADI finite difference scheme of second-order accuracy.

The effects and facilities incorporated within the model include:

- Convective and cross momentum;
- Bottom shear stress;
- Wind shear stress at the surface;
- Barometric pressure gradients;
- Coriollis forces;
- Momentum dispersion (e.g. through the Smagorinsky formulation);
- Wave-induced currents;
- Sources and sinks (mass and momentum);
- Evaporation;
- Flooding and drying.

2: Mud Transport (MT) module modelling system

The Mud Transport (MT) module of MIKE 21 Flow Model FM describes erosion, transport and deposition of mud or sand/mud mixtures under the action of currents and waves. The hydrodynamic basis for the MT Module is calculated using the Hydrodynamic Module of the MIKE 21 Flow Model FM modelling system and the MT is implemented as a couple model with the two running concurrently. The MT module is applicable for mud fractions and also sand/mud mixtures.

The following processes may be included in the simulation.

- Forcing by waves
- Salt-flocculation
- Detailed description of the settling process
- Layered description of the bed, and
- Morphological update of the bed

In the MT-module, the settling velocity varies, according to the salinity and the concentration taking into account flocculation in the water column. Bed erosion can be either non-uniform, i.e. the erosion of soft and partly consolidated bed, or uniform, i.e. the erosion of a dense and consolidated bed. The bed is described as layered and is characterised by the density and shear strength.

3: Transport module modelling system

The hydrodynamic basis for the Transport Module is calculated using the Hydrodynamic Module of the MIKE 21 Flow Model FM modelling system. The transport module calculates the resulting transport of material based on these flow conditions coupled with the other appropriate aforementioned modules. A number of components may be specified with each component defining a separate transport equation. The time integration of the transport (advection-dispersion) equations is then performed using an explicit scheme to calculate the resulting sediment transport.

4: MIKE21 FM flexible mesh Spectral Wave modelling system

Modelling the wave transformation from the offshore boundary of the Dublin Bay model to the sites of interest was undertaken using the MIKE 21 Spectral Wave (SW) model which is a new generation spectral wind-wave model based on unstructured meshes. The model simulates the growth, decay and transformation of wind-generated waves and swell in offshore and coastal areas.

MIKE 21 SW accounts for the following physical phenomena:

- Wave growth by wind action
- Non-linear wave-wave interaction
- Dissipation due to white-capping
- Dissipation due to bottom friction
- Dissipation due to depth-induced wave breaking
- Refraction and shoaling due to depth variations
- Diffraction
- Wave-current interaction
- Effect of time-varying depth and flooding and drying

The discretisation of the governing equation in geographical and spectral is performed using a cell-centred finite volume method. In the geographical domain, an unstructured mesh technique is used. The time integration is performed using a fractional step approach where a multi-sequence explicit method is applied for the propagation of wave action.

The MIKE 21 SW includes two different formulations:

- Directional decoupled parametric formulation
- Fully spectral formulation

The directional decoupled parametric formulation is based on a parameterization of the wave action conservation equation. The parameterization is made in the frequency domain by introducing the zeroth and first moment of the wave action spectrum as dependent variables following Holthuijsen (1989).

5: Boundary Conditions

The tidal boundary conditions for the Dublin Bay model were taken from RPS' Irish Sea Tidal and Storm Surge model which was developed for the Irish Coastal Protection Strategy Study (ICPSSS). This model was developed using flexible mesh technology with the mesh size (model resolution) varying from circa 24km along the offshore Atlantic boundary to circa 200m around the Irish coastline. RPS also utilised their 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 open sea boundaries were applied to the model as Flather boundaries in which the water level and velocities are specified along the boundary. The format of these boundaries are such that they vary temporally and also spatially along the length of the boundary. The Flather condition was chosen as it is one of the most efficient open boundary conditions as in downscaling coarse model simulations to higher resolution areas. The instabilities, which are often observed when imposing stratified density at a water level boundary, can be avoided using Flather conditions.

At the coastline where the water level intersects the bathymetry, a zero velocity condition was applied, which assumes the no slip condition is assumed to hold, that is, both the normal and tangential velocity components are zero.

For the calibration process the open sea boundaries were applied as Flather boundaries, whilst at the coastline a zero velocity boundary was applied. The open sea boundaries were taken from RPS' ICPSS tidal surge model during what was considered an average lunar month that experience a full range of spring and neap tidal conditions. For the calibration process mean annual discharge rates for the Liffey, Dodder and Tolka were taken from the OPW's Catchment Flood Risk Assessment and Management (CFRAM) studies - the values of which are presented in Table F2

Table F2: Mean annual discharge rates from the Liffey, Dodder and Tolka used in the calibration process

Source	**Mean annual discharge rate (m^3/s)**
Liffey	15.6
Dodder	2.3
Tolka	1.4

6:Bed roughness

When using the two-dimensional hydrodynamic models, the bed resistance was specified using the Manning number. In the MIKE 21 manual, the relationship between the Manning number, M, and the Nikuradse roughness length, k_s is estimated using

$$M = \frac{25.4}{k_s^{1/6}}$$

Using one of the several relationships recommended by Soulsby (1997), over flat beds of sediment, k_s is related to the median grain diameter (D_{50}) as approximately

$$k_s = 2.5\, D_{50}$$

For the three-dimensional models, the bed resistance was specified using the bed roughness height of the sea bed which is dependent on the von Karman constant.

It was therefore possible to impose a uniform bed resistance coefficient at the seabed for both the two and three dimensional models based on the median grain diameter which was determined through the Particle Size Analyses as detailed in Chapter 11 Volume 1 of the EIS.

Turbulence module

The turbulence model used by MIKE software is based on a standard k-epsilon model ($k - \varepsilon$) with a buoyancy extension. The model uses transport equations for the turbulent kinetic energy (TKE), k, and the dissipation of TKE, ε, to describe the turbulence.

8.3 There is a high reliance on relatively poor resolution colour contour/tonal plots to demonstrate magnitude of impact in the EIS (for example Figure 9.7 to 9.23). Provide zoomed in plots in addition to time series plots at relevant reference locations and also where appropriate provide tabular comparisons.

Response

The majority of the plots presented in the coastal processes chapter in Volume 1 of the EIS including Figures 9.7 to 9.23 were compiled in a style to demonstrate any far field impacts of the proposed capital dredging scheme and were produced from a range of high resolution models which had a mesh grid size varying from *c.*15m in the area of interest ranging to *c.*500m at the model boundary, as reported in Chapter 9 Volume 1 of the EIS.

The original digital images produced by RPS for the EIS clearly demonstrate the magnitude and extent of any impacts of the proposed dredging scheme within Dublin Bay - it is therefore important to ensure that when viewing this document that it has not been compressed to an extent that the quality of the images are compromised.

In order to increase the clarity of Figures 9.7 to 9.10, the Figures have been reproduced with isolines to represent changes in values, the number of vector arrows representing the magnitude and direction of the current flow in the X and Y axes has also been reduced. Figures 9.11 to 9.14 and 9.21 to 9.23 have been reproduced with zoomed inlays of relevant locations. Each of the inlays also has isolines representing changes in values to increase the clarity of the image.

Throughout the Chapter 9 Volume 1 of the EIS, where possible RPS have utilised difference plots instead of additional time series plots and tabular comparisons to indicate any impacts stemming from the redevelopment of Dublin Port as this shows the impact of the proposed scheme on the coastal processes over the entire area rather than at a number of isolated points.

All plots presented in this section have been made digitally available in a separate PDF document.

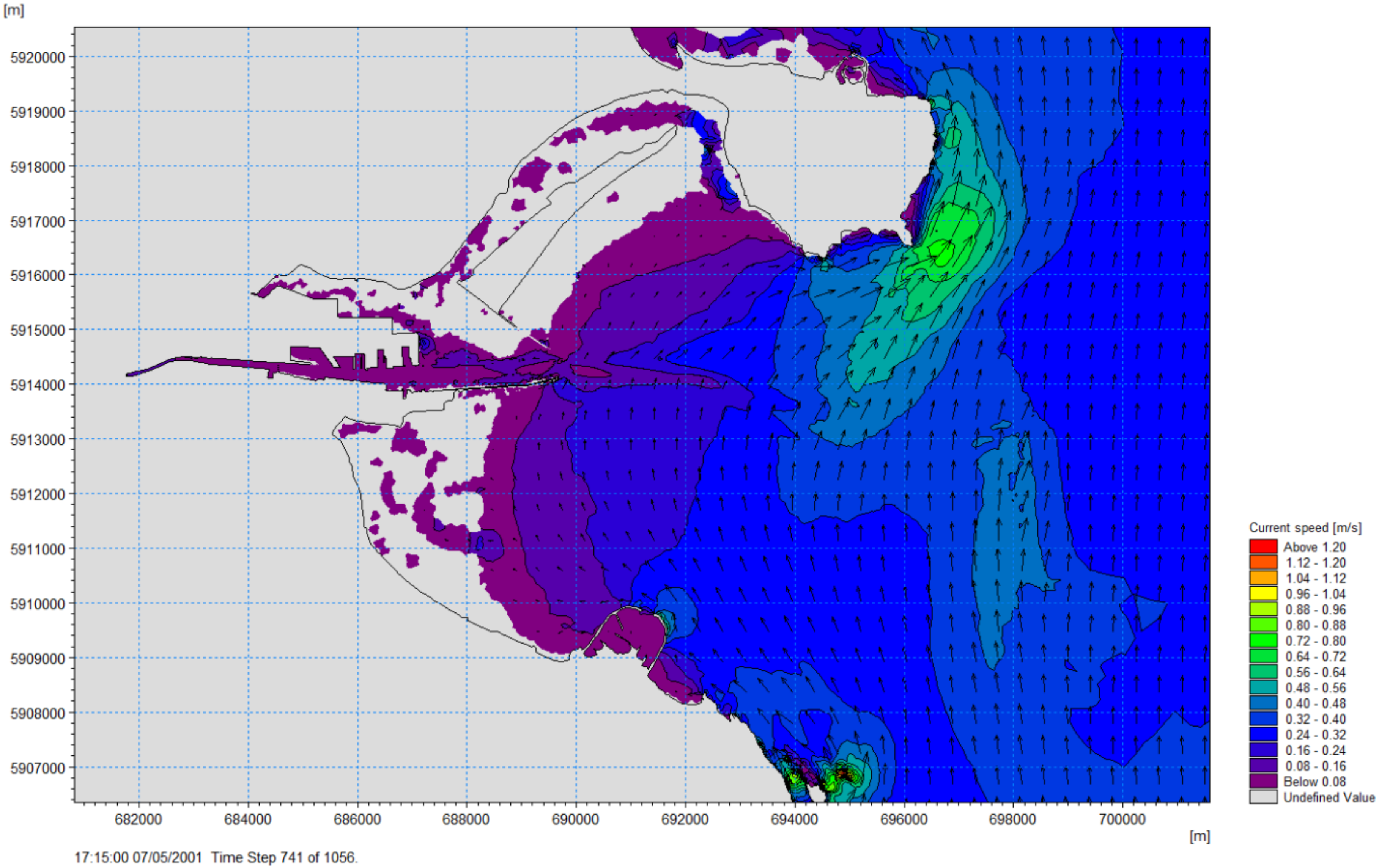


Figure F10: Typical spring ebb flow pattern w/contours - Existing Port Channel

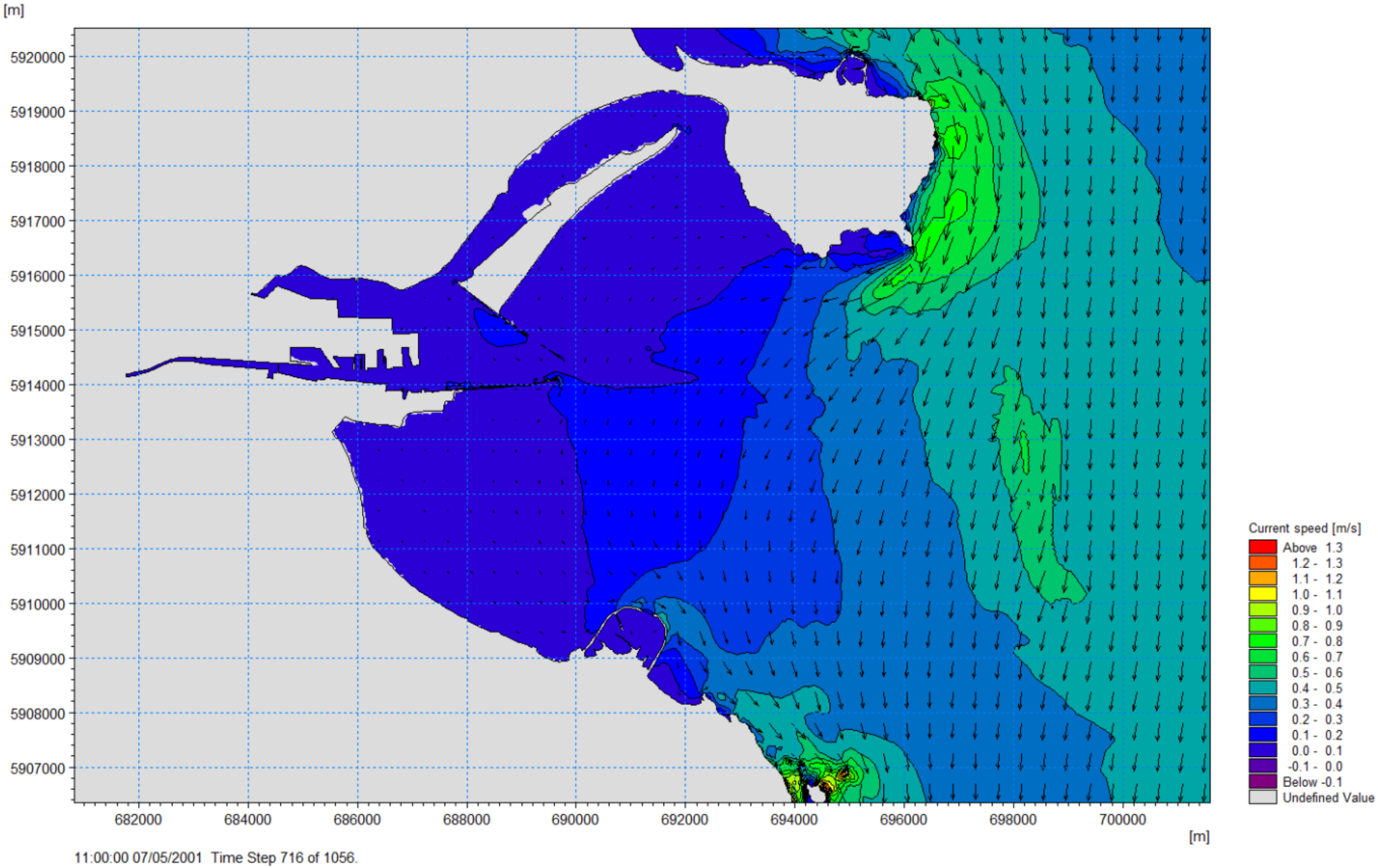


Figure F11: Typical spring ebb flood pattern w/contours - Existing Port Channel

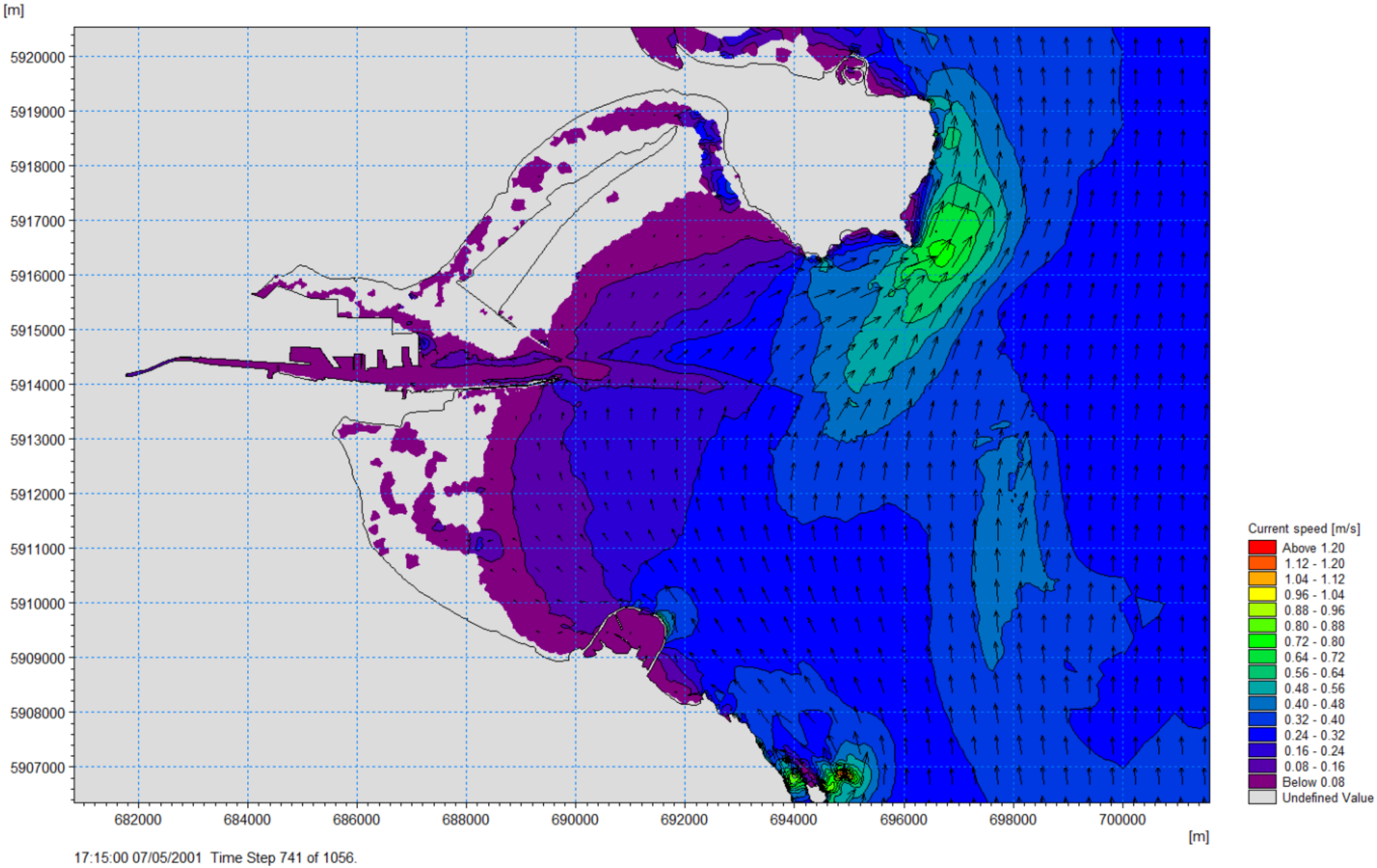


Figure F12: Typical spring ebb flow pattern w/contours - Post Capital Dredging

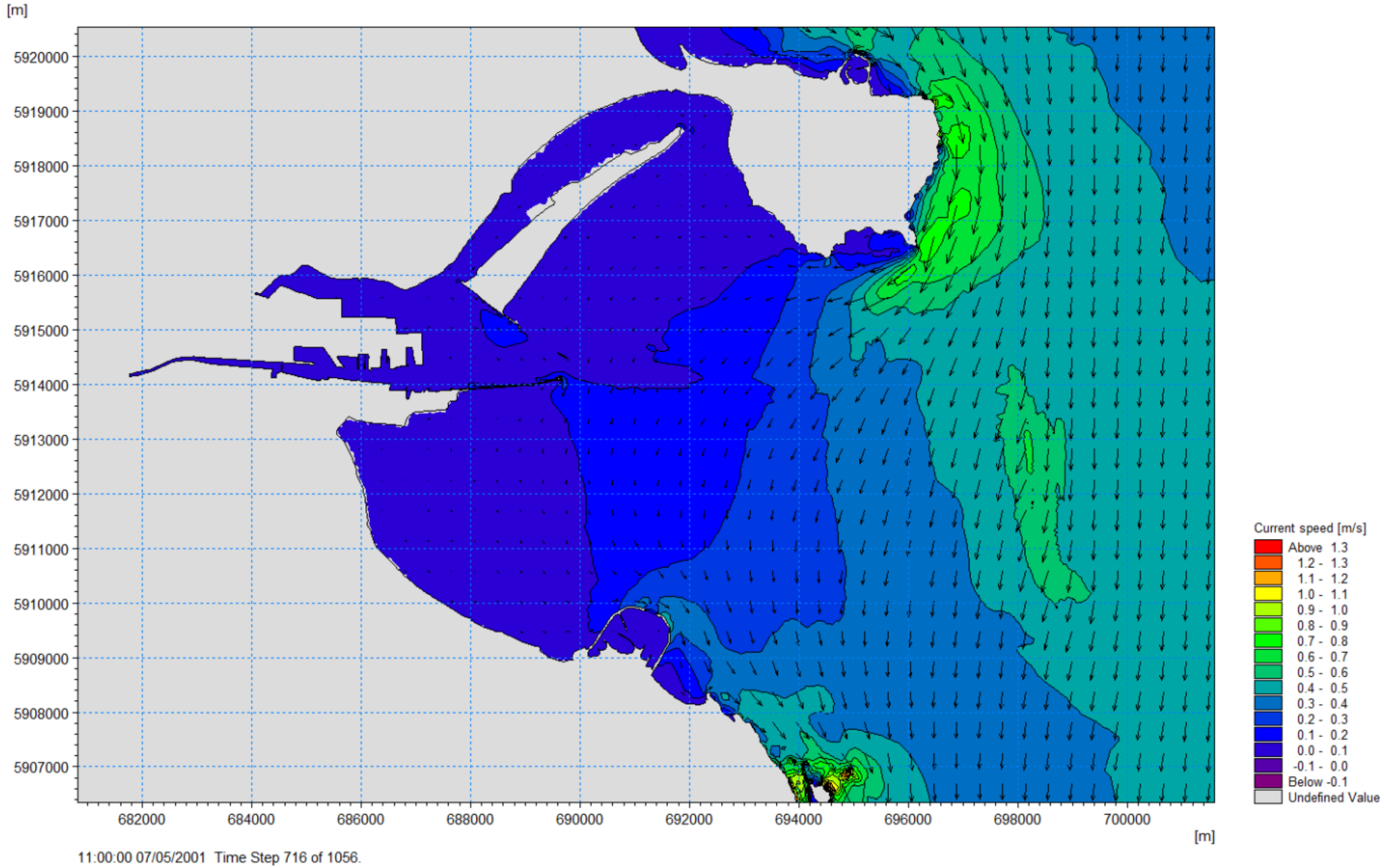


Figure F13: Typical spring flood flow pattern w/contours - Post Capital Dredging

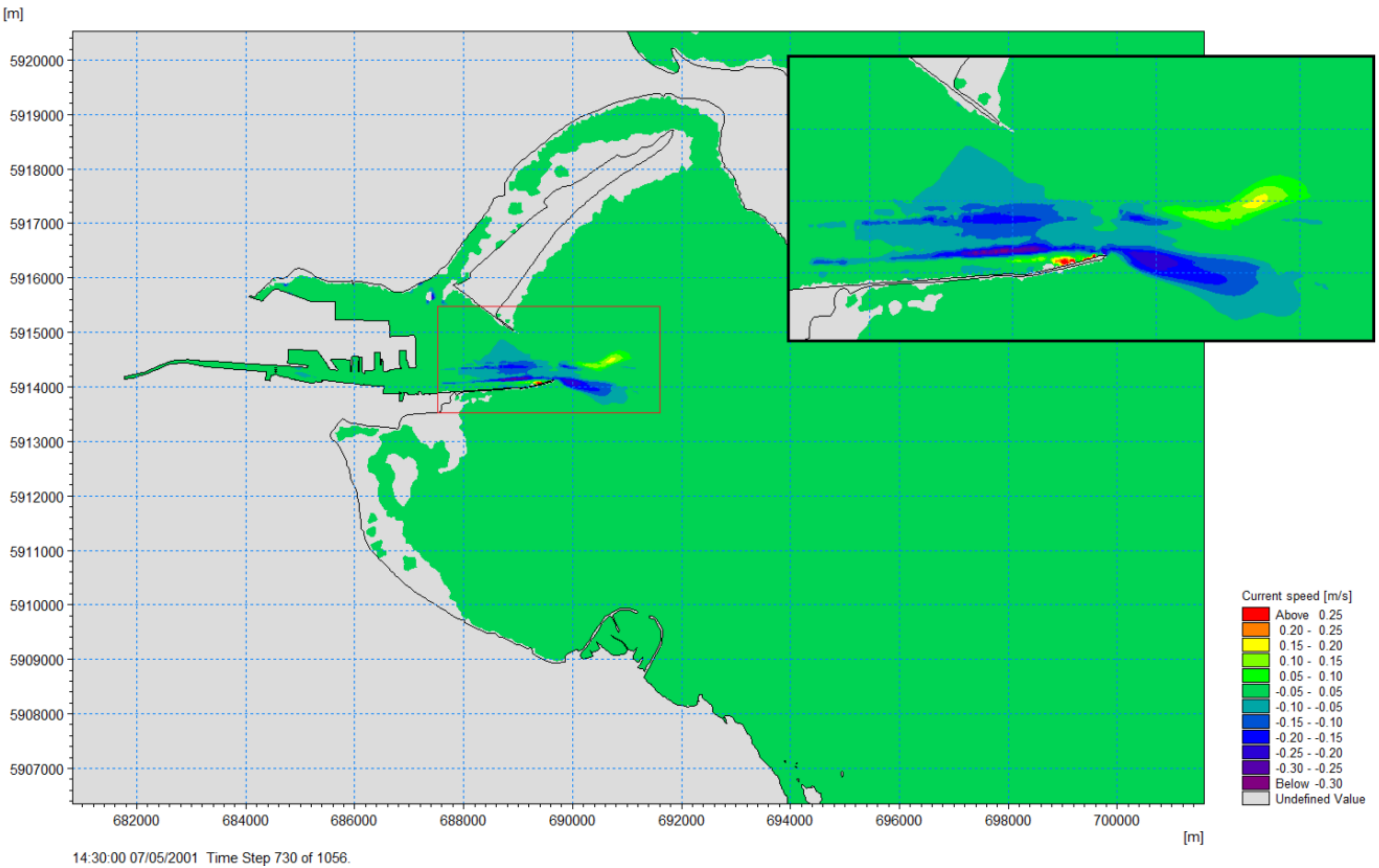


Figure F14: Difference in mid spring ebb current velocity as a result of the proposed capital dredging - Inlay area highlight by red box

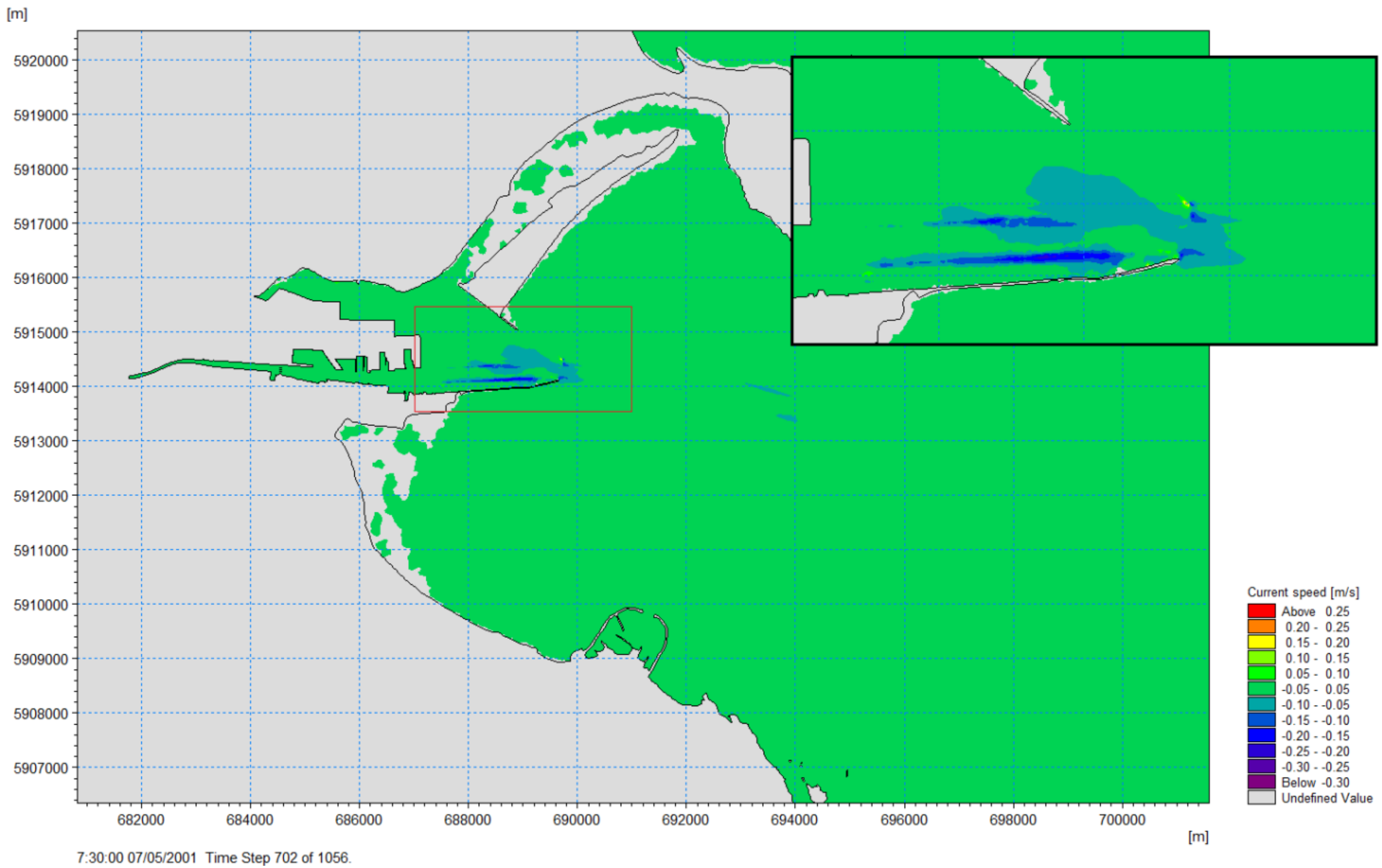


Figure F15: Difference in <u>mid spring flood</u> current velocity as a result of the proposed capital dredging - Inlay area highlight by red box

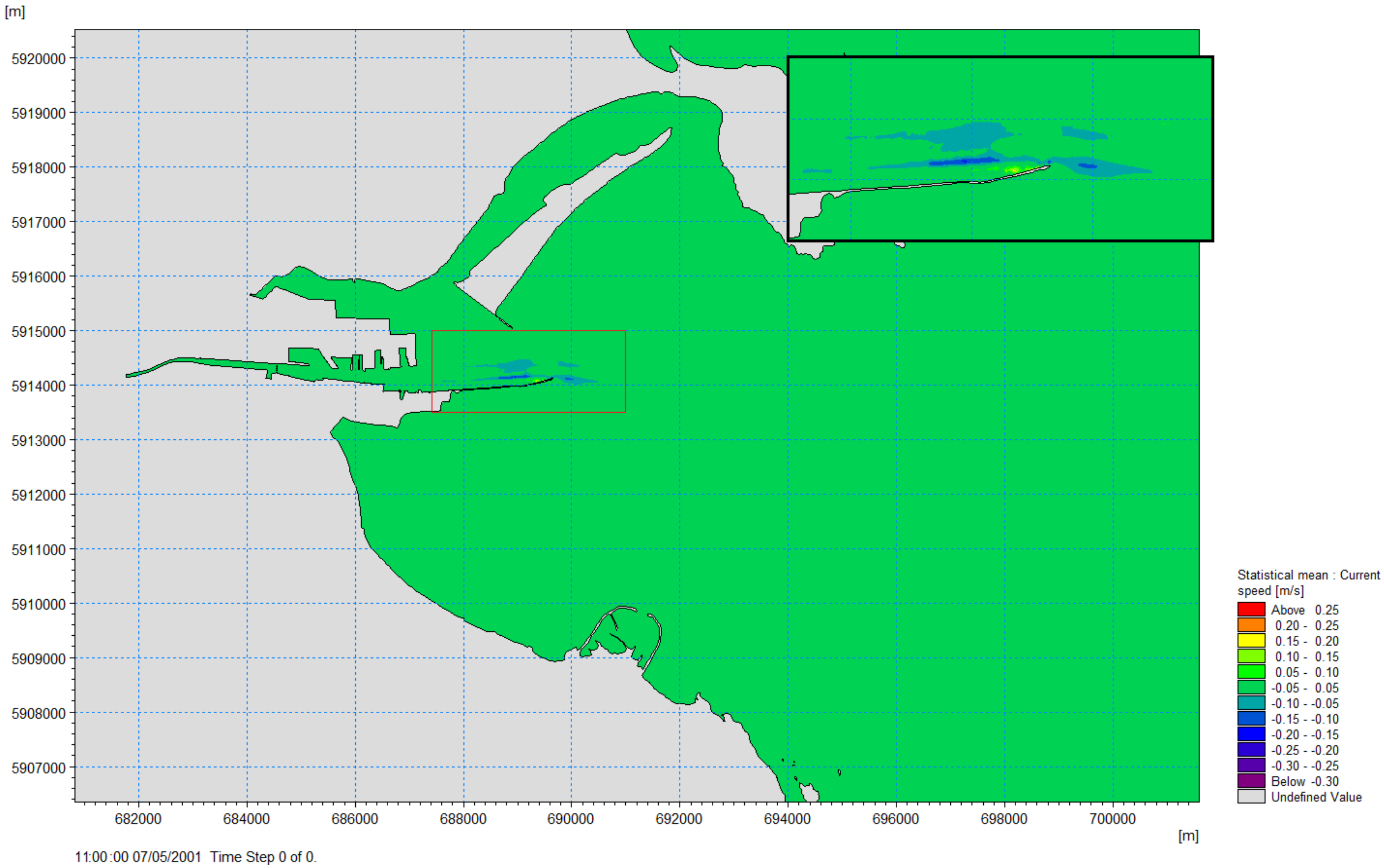


Figure F16: Difference in mean spring ebb current velocity as a result of the proposed capital dredging - Inlay area highlight by red box

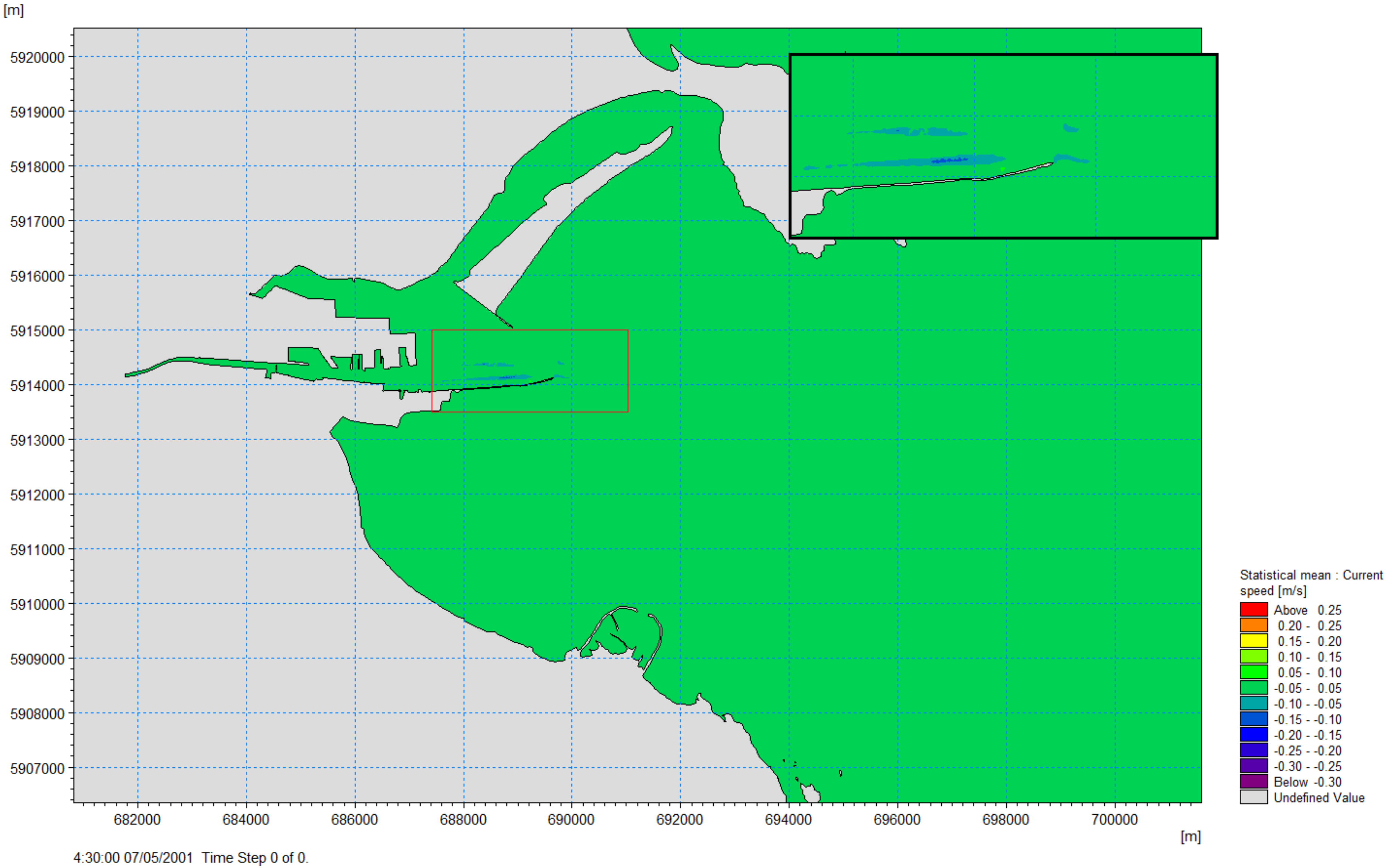


Figure F17: Difference in <u>mean spring flood</u> current velocity as a result of the proposed capital dredging - Inlay area highlight by red box

As requested time series plots have also been produced from the 2D hydrodynamic model to show the impact of the proposed channel on the current speed and horizontal current directions at four different stations. The location of the four stations is presented in Figure F18, whilst the time series plots for these stations are presented in Figure F19 to Figure F22.

As demonstrated by these time series plots, the proposed redevelopment of the Dublin Port channel does not have a significant impact on neither the current speeds nor the horizontal current directions at any of the four stations. It should be noted that the time series plots were taken during spring tidal conditions, which is when the impact of the proposed channel on the existing hydrodynamic regime would be greatest.

Further time series plots have also been produced to show the impact of the proposed channel on the hydrodynamics at the four stations identified above in the top, middle and bottom layers of the 3D hydrodynamic model. These figures can be found in Appendix F1 of this document.

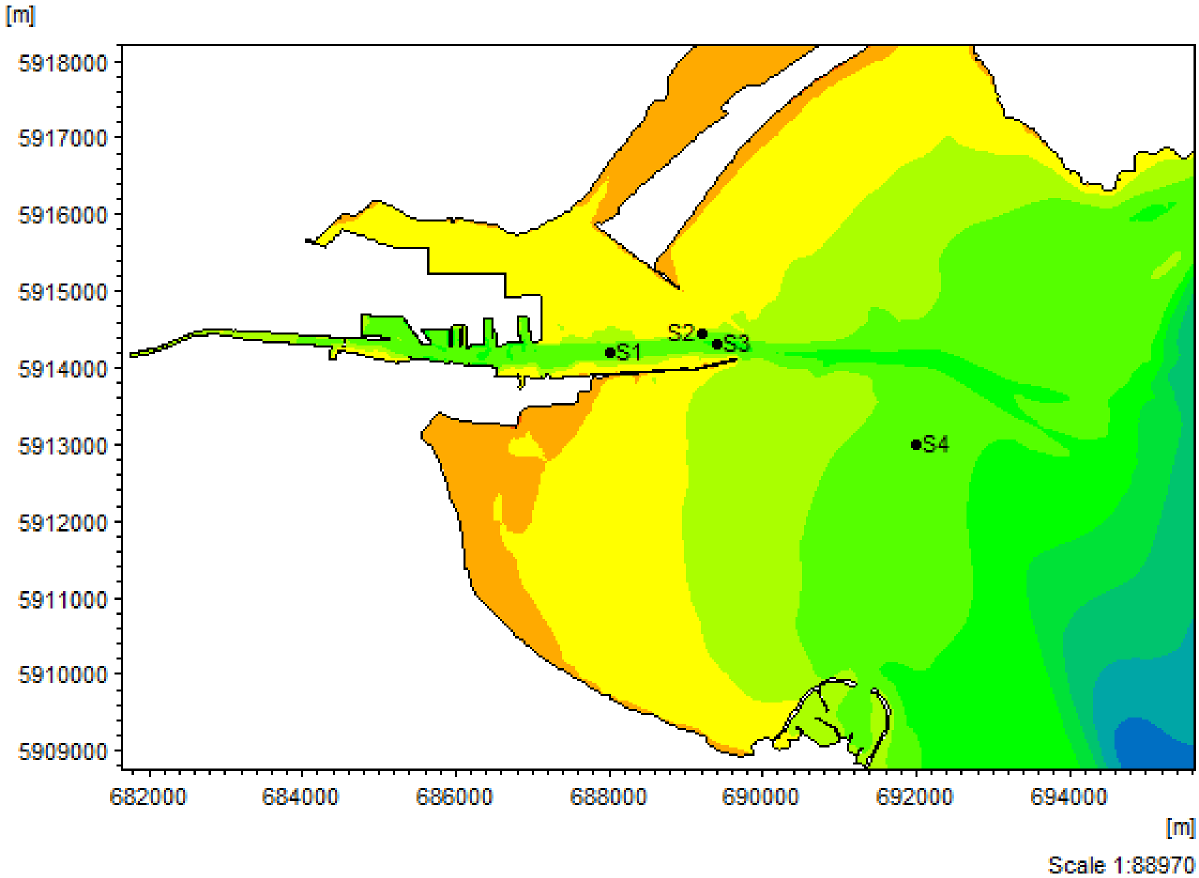
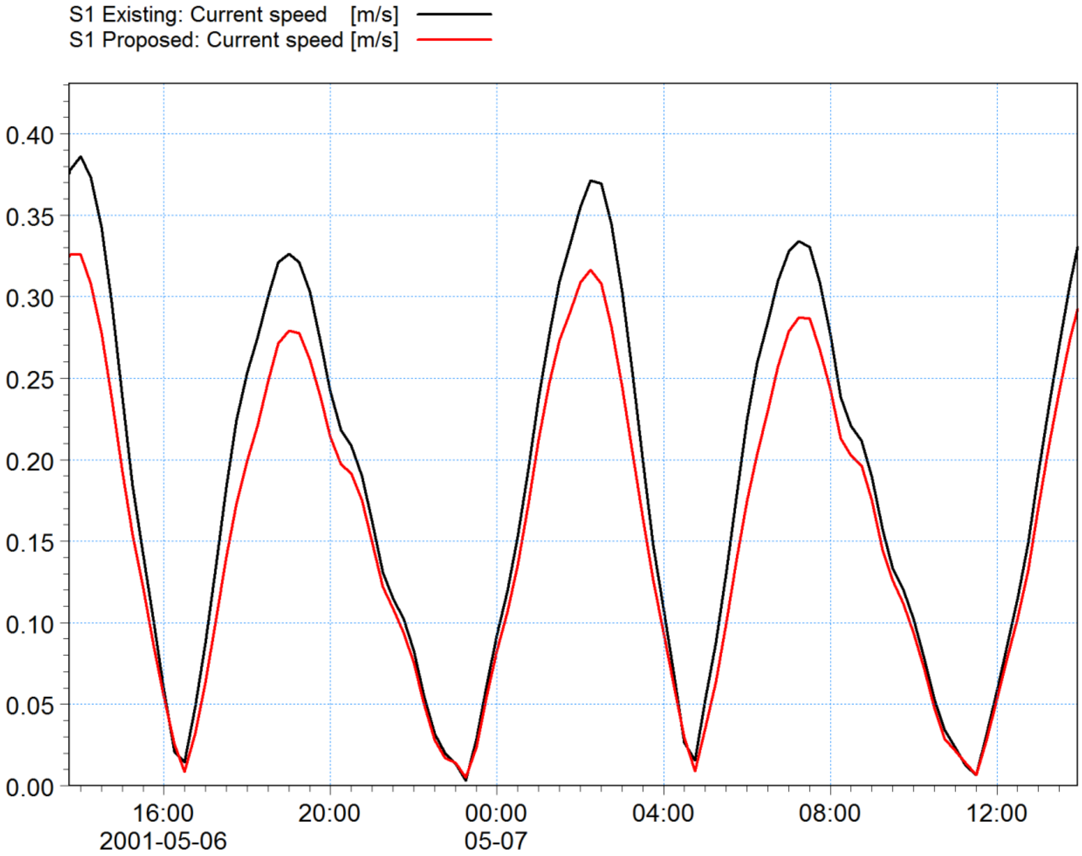


Figure F18: Location of the four hydrodynamic sampling stations in Dublin Bay.



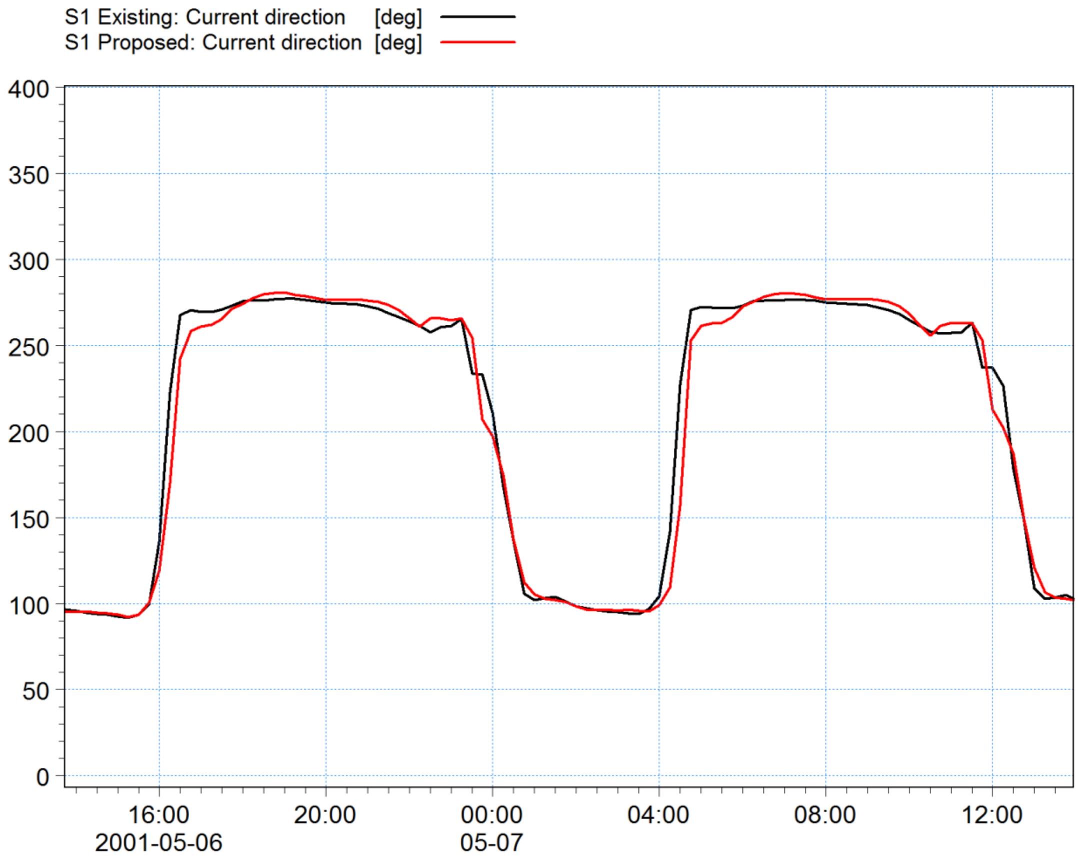
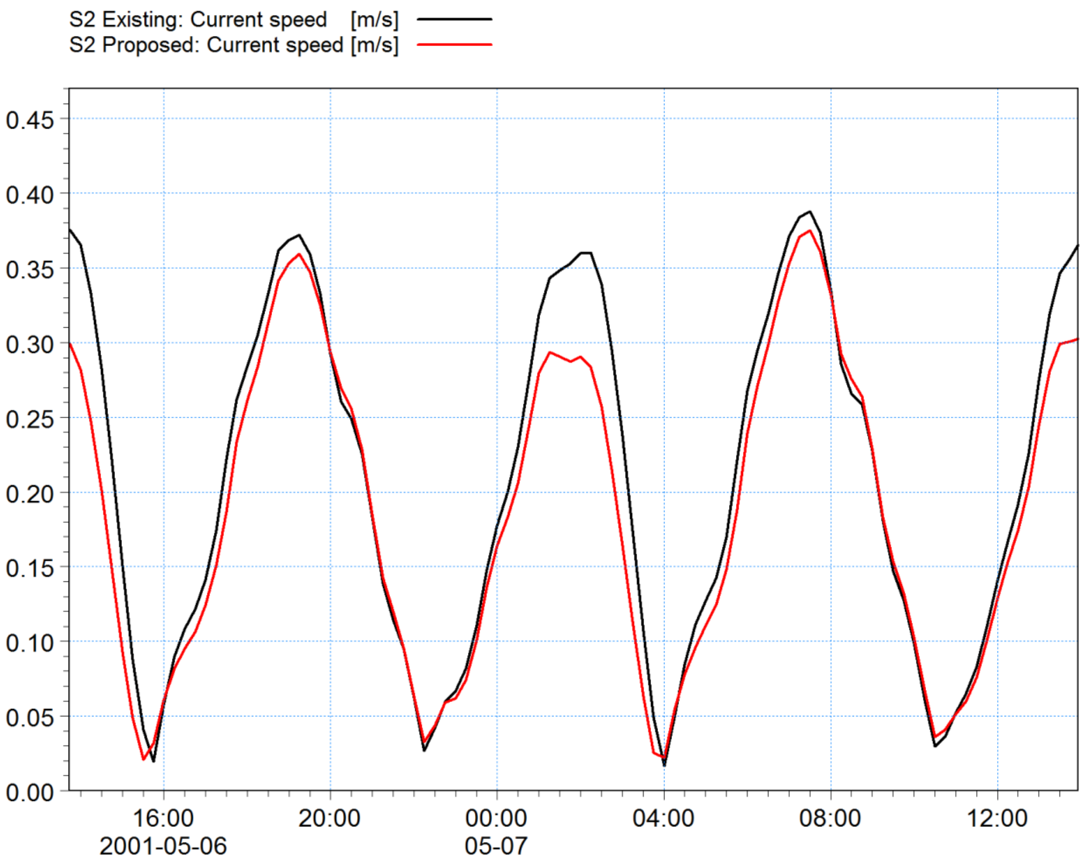


Figure F.19: Existing and proposed current speeds (upper) and current directions (lower) - Sampling station S1



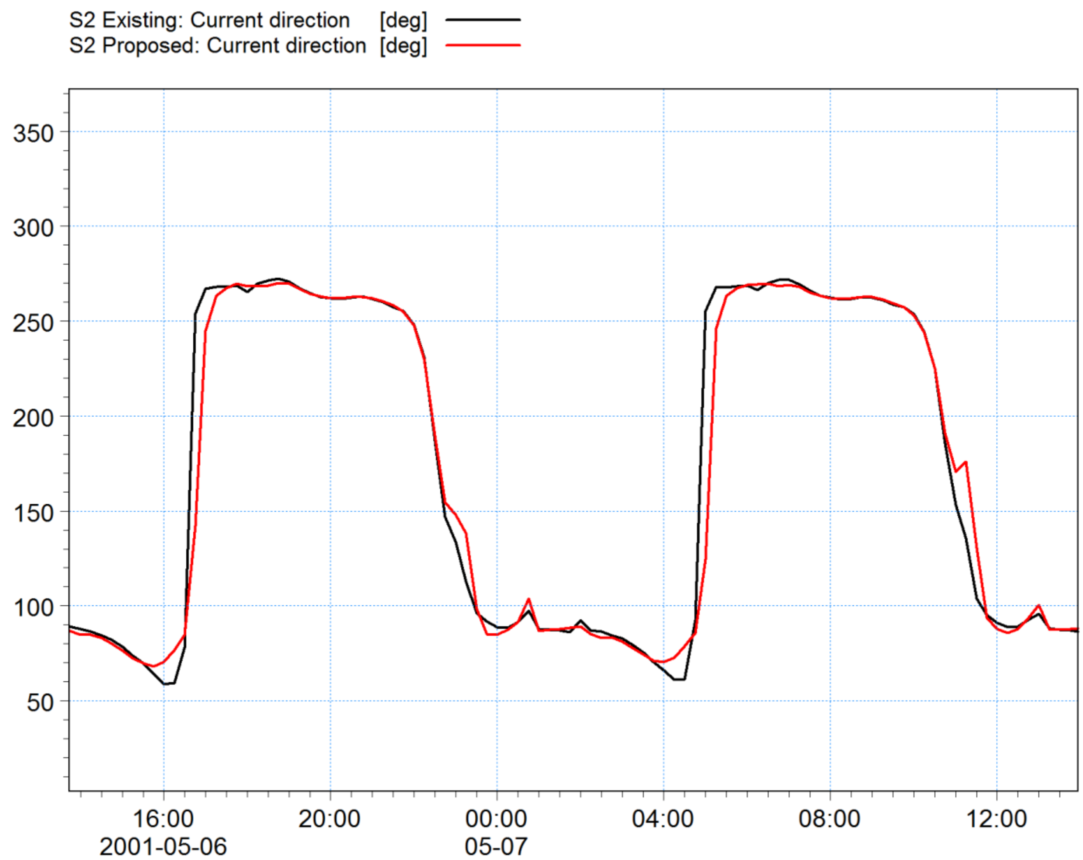
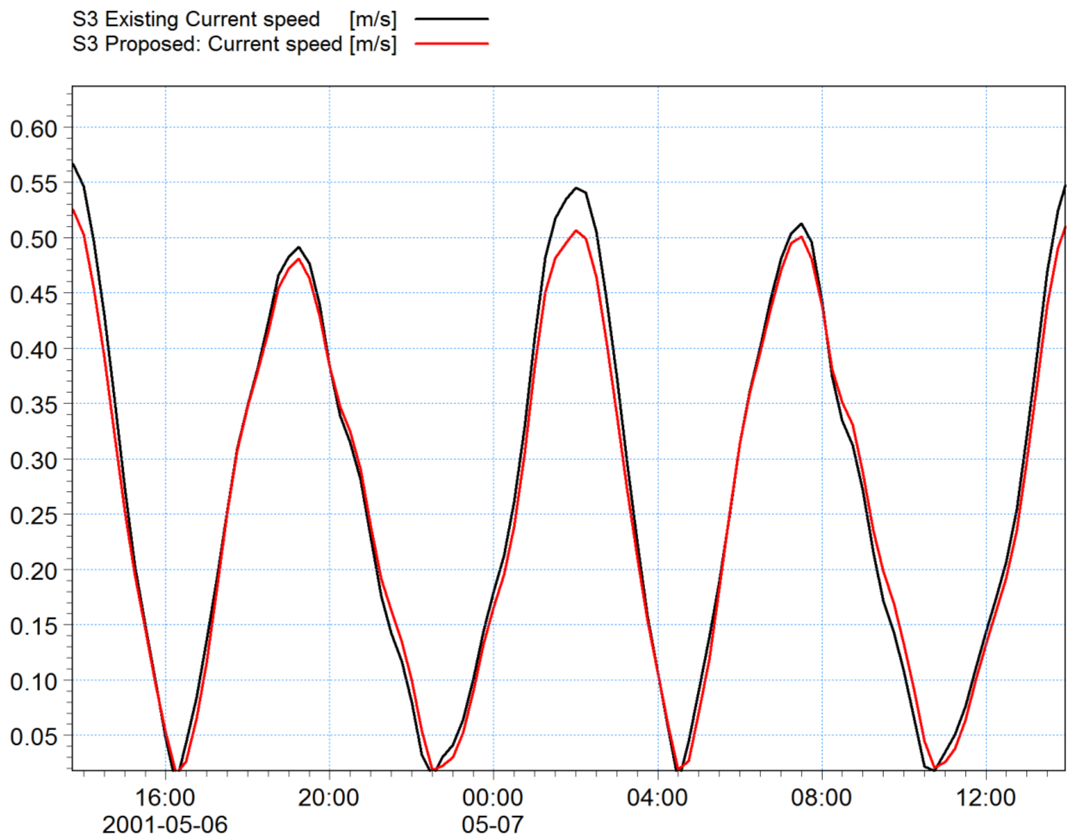


Figure F20: Existing and proposed current speeds (upper) and current directions (lower) - Sampling station S2



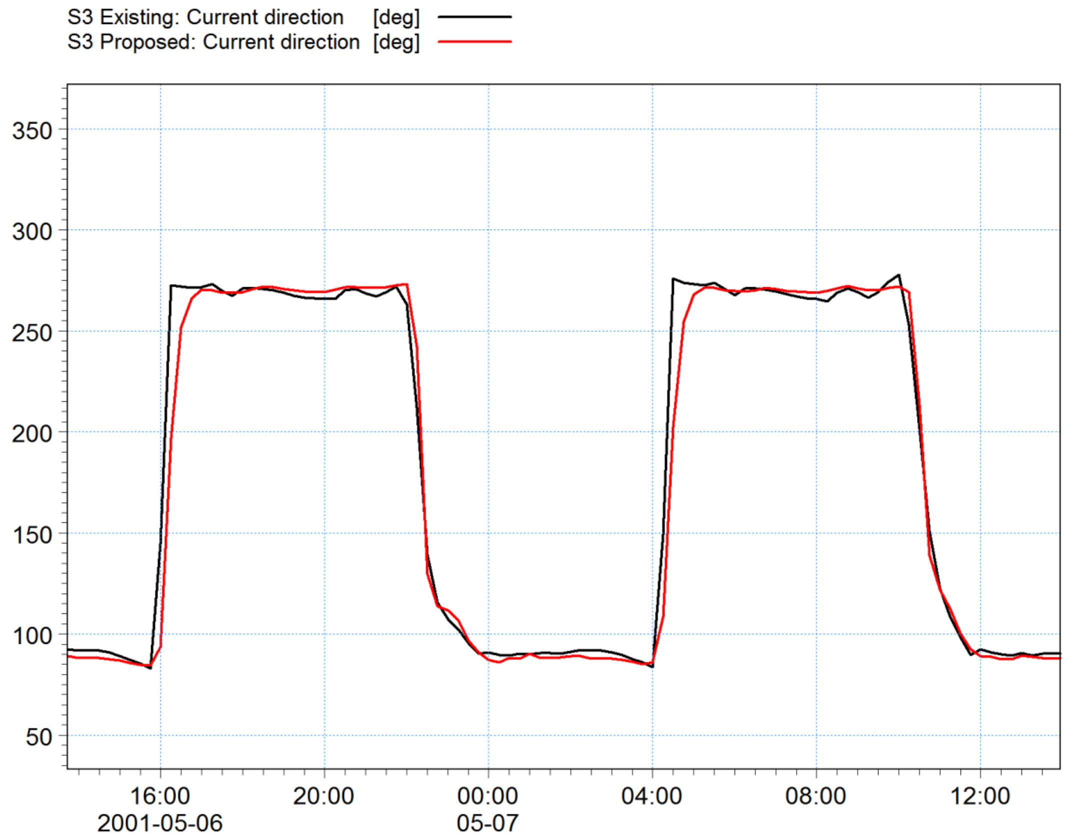
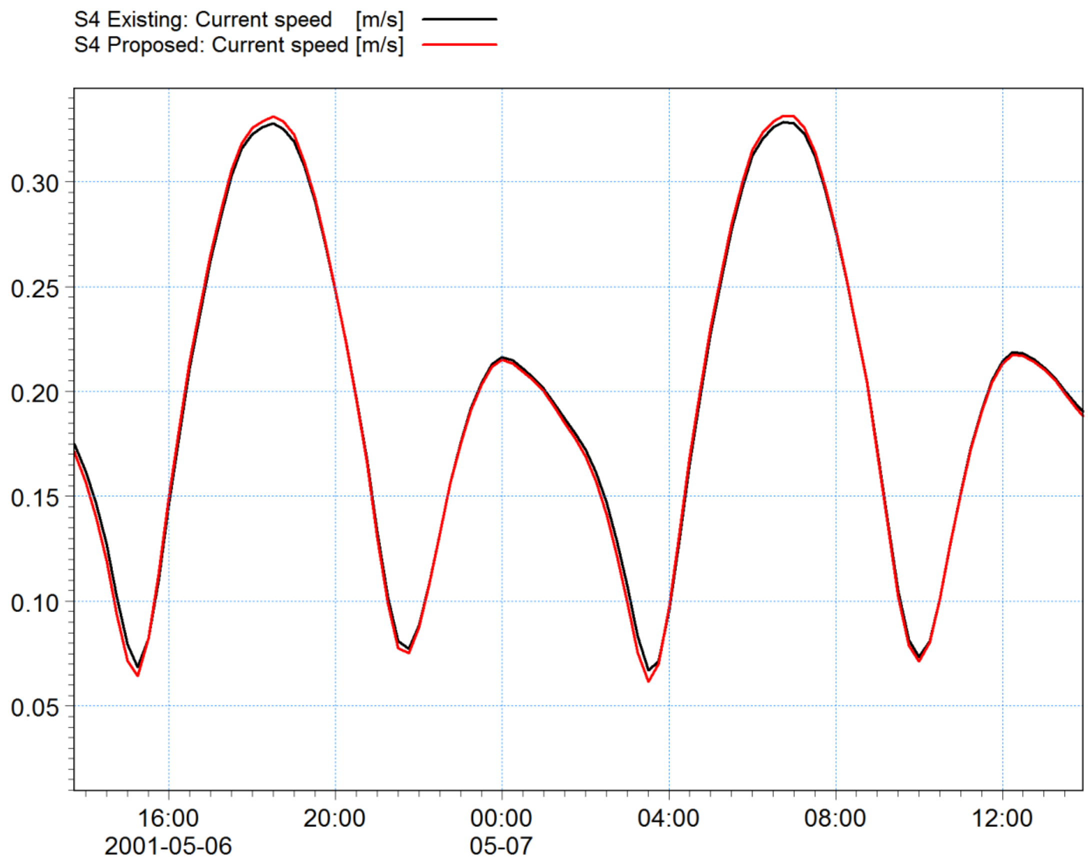


Figure F21 Existing and proposed current speeds (upper) and current directions (lower) - Sampling station S3



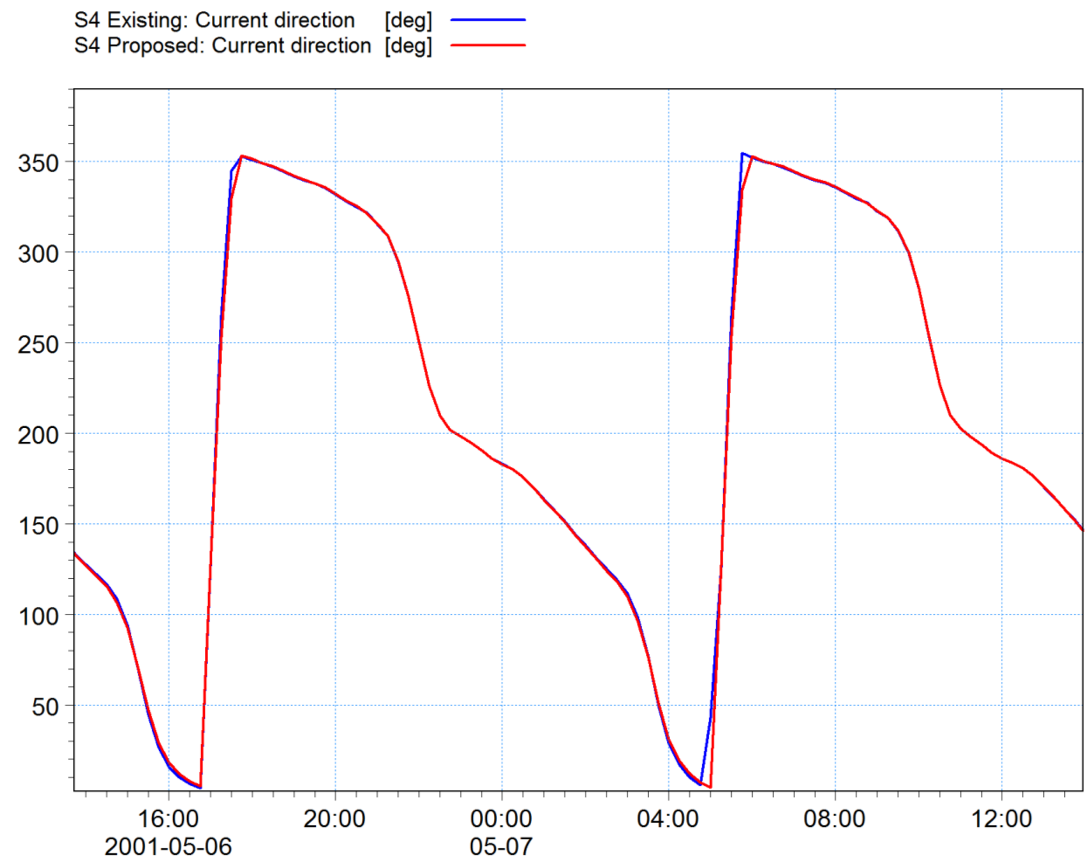


Figure F22: Existing and proposed current speeds (upper) and current directions (lower) - Sampling station S4

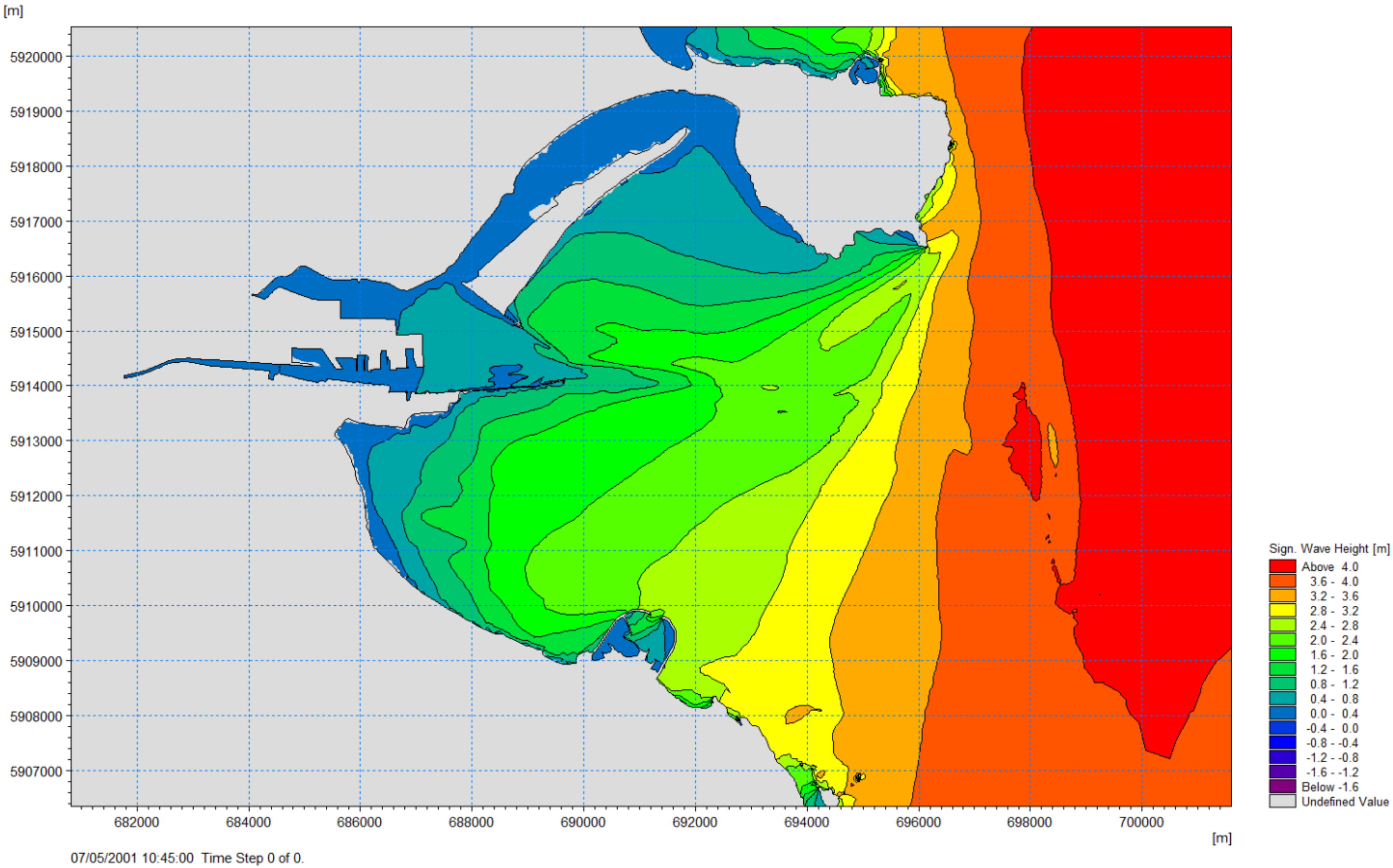


Figure F23: North Easterly storm wave heights at spring high water w/contours- Existing Port Channel

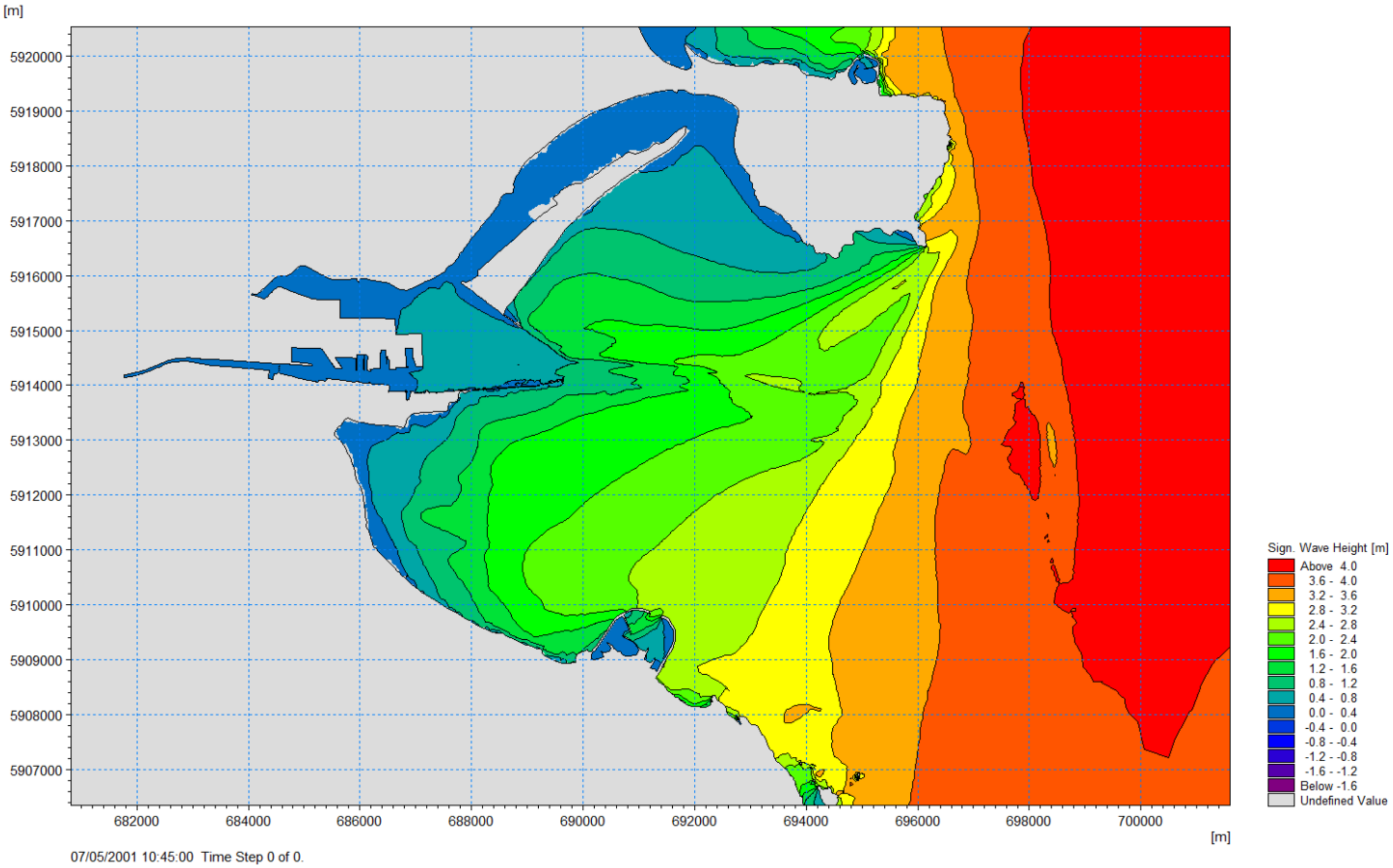


Figure F24: North Easterly storm wave heights at spring high water w/contours- Post Capital Dredging Scheme

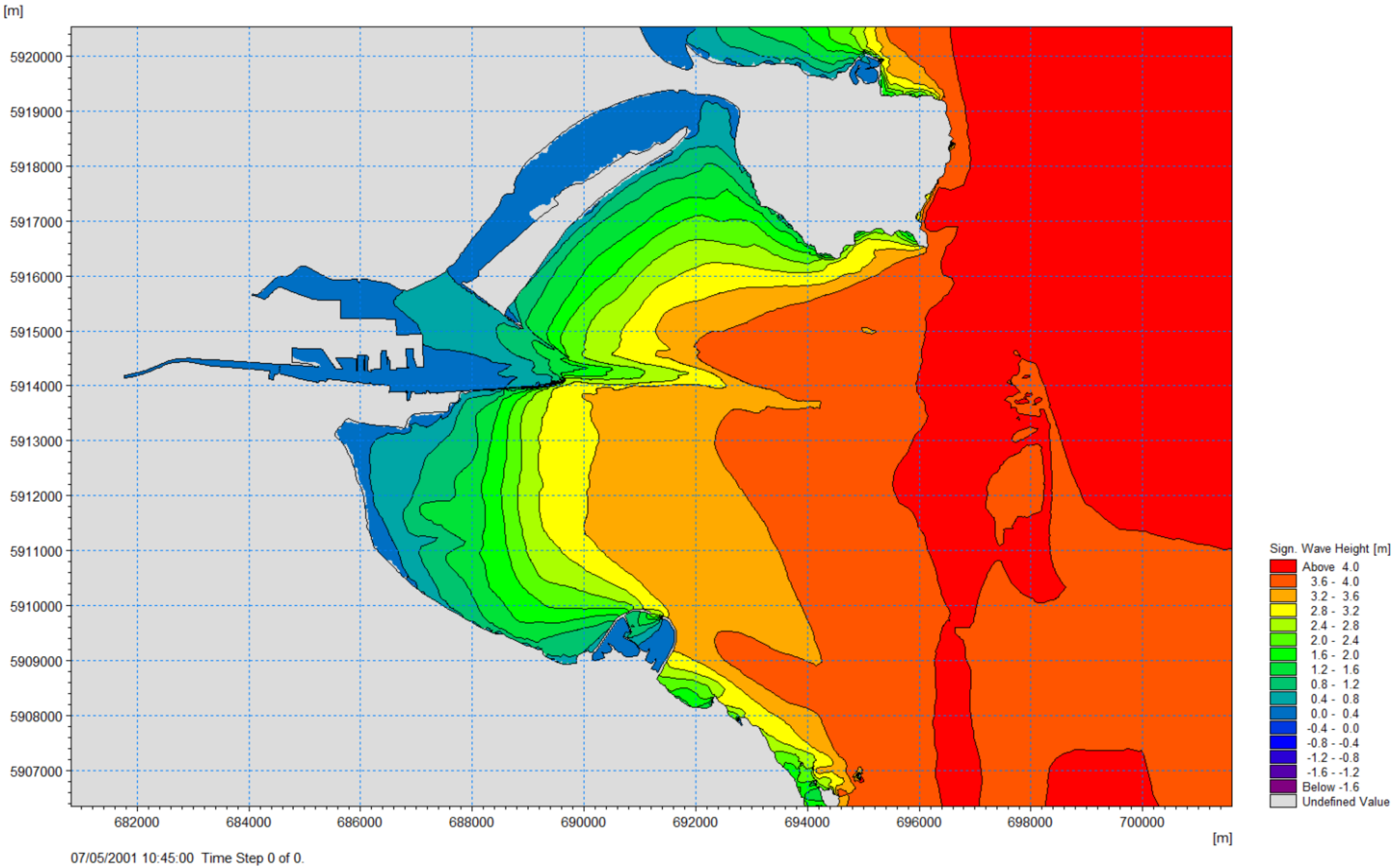


Figure F25: Easterly storm wave heights at spring high water w/contours- Existing Port Channel

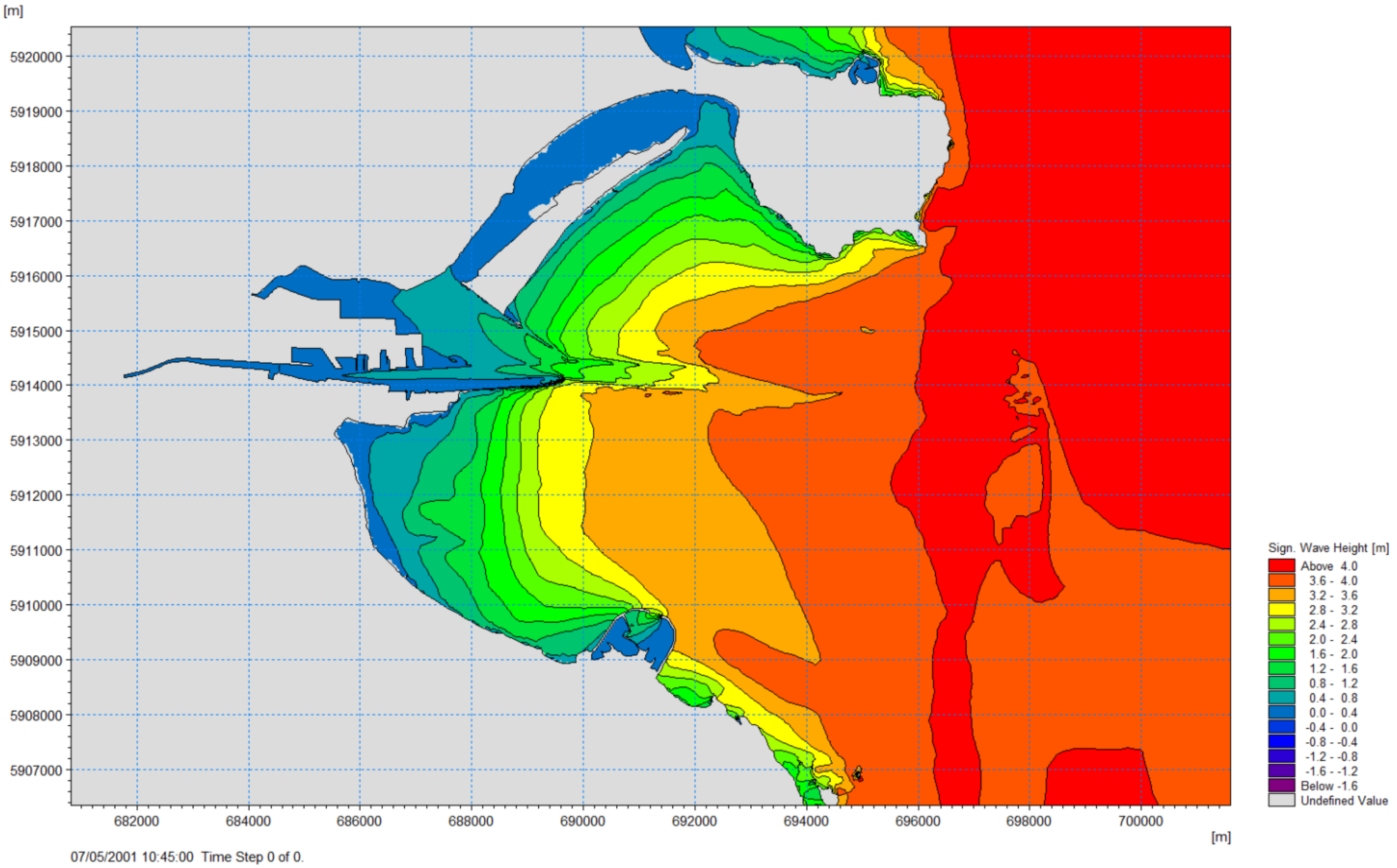


Figure F26: Easterly storm wave heights at spring high water w/contours- Post Capital Dredging Scheme

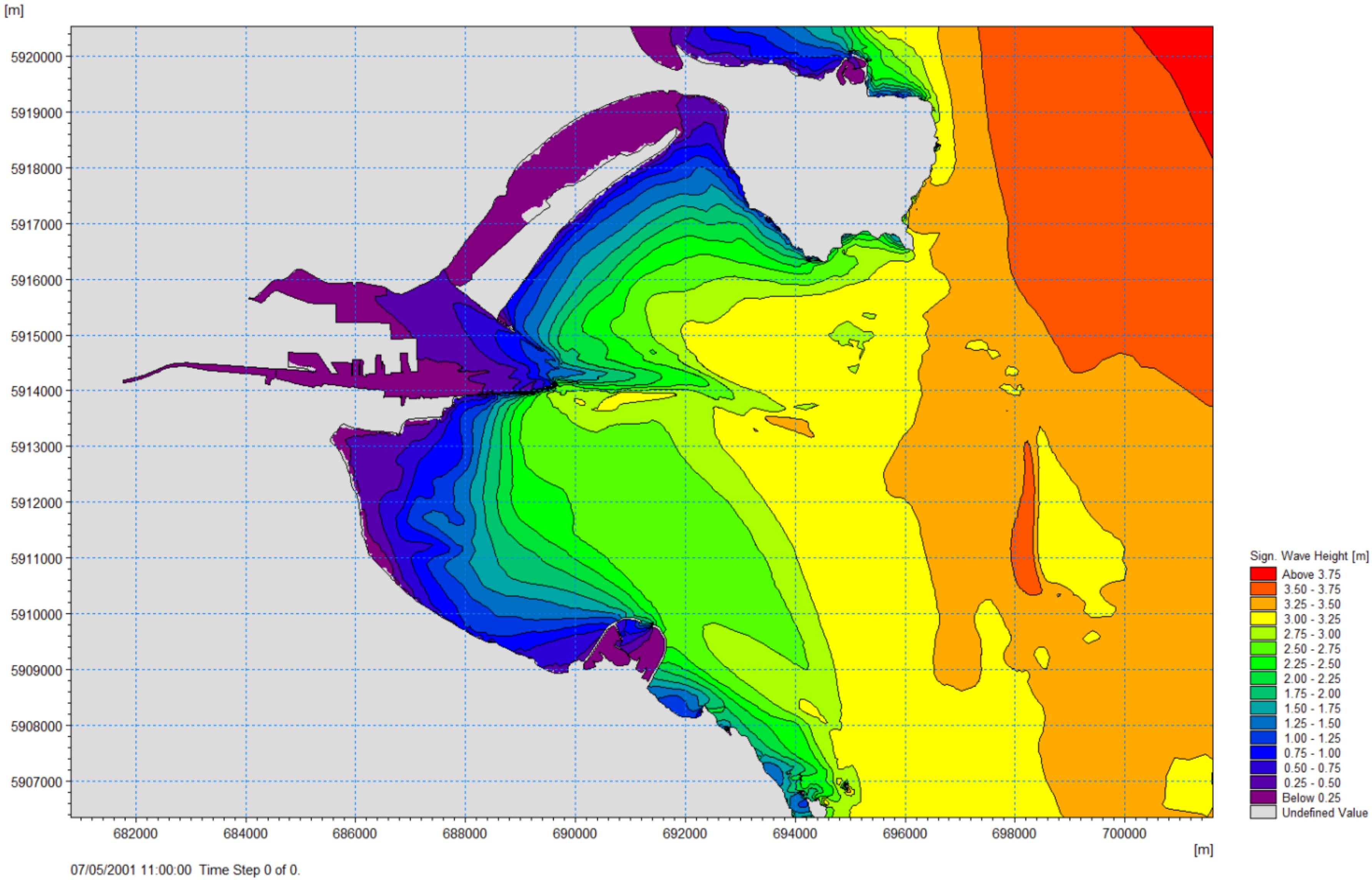


Figure F27: South Easterly storm wave heights at spring high water w/contours- Existing Port Channel

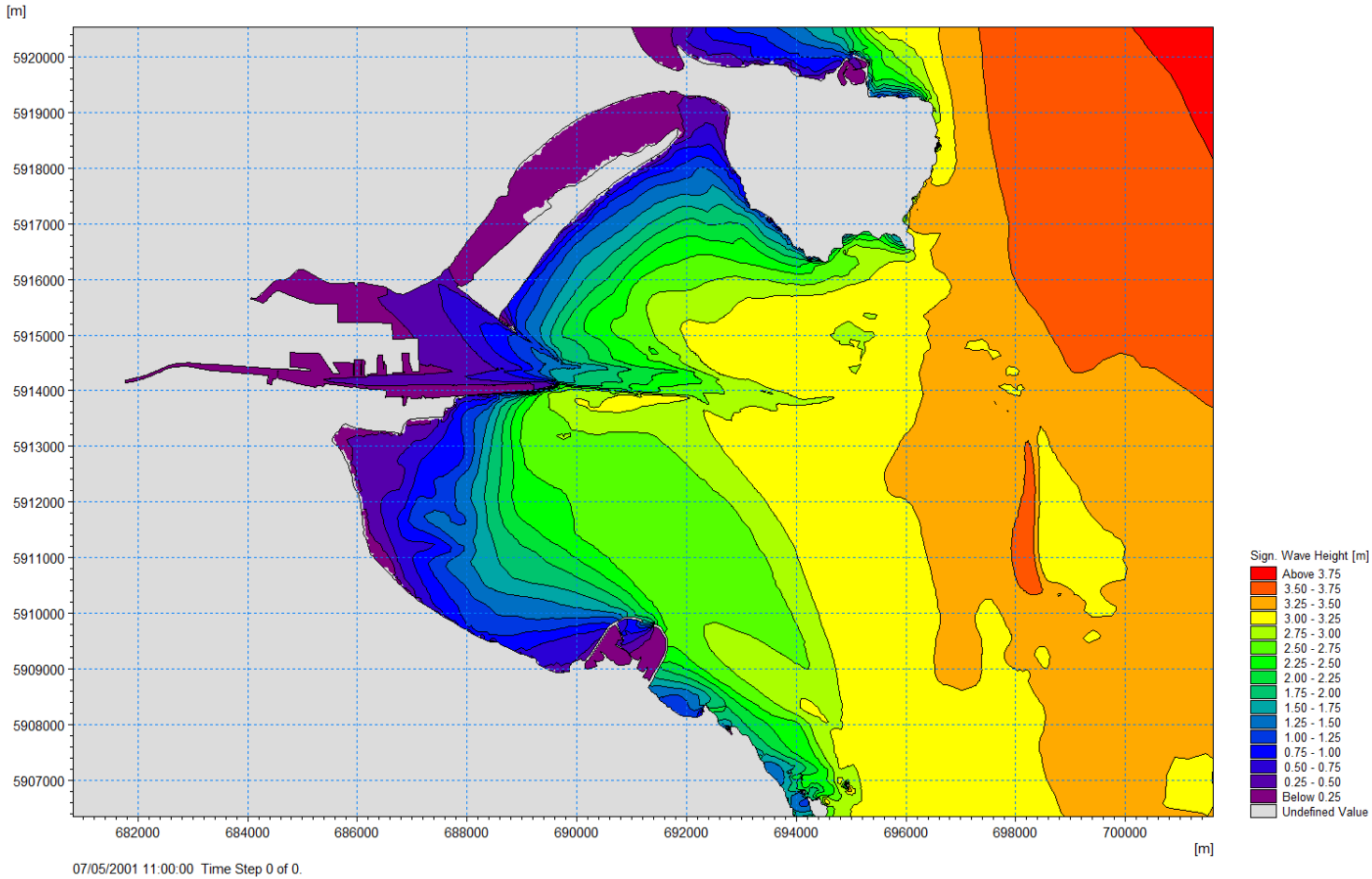


Figure F28: South Easterly storm wave heights at spring high water w/contours- Post Capital Dredging Scheme

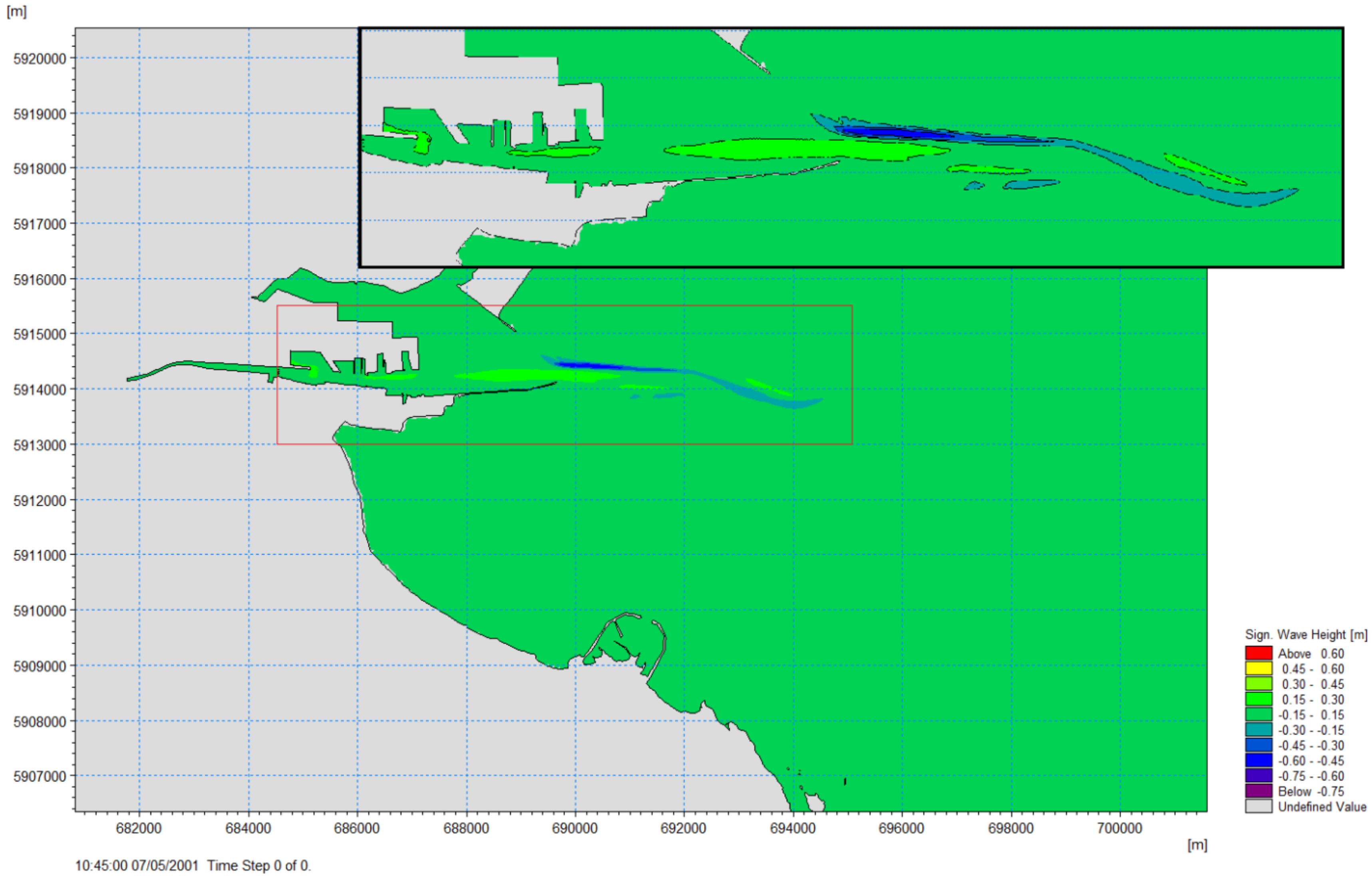


Figure F29: North Easterly Storm - Difference in significant wave heights at spring high water as a result of the proposed capital dredging scheme - Inlay area highlight by red box

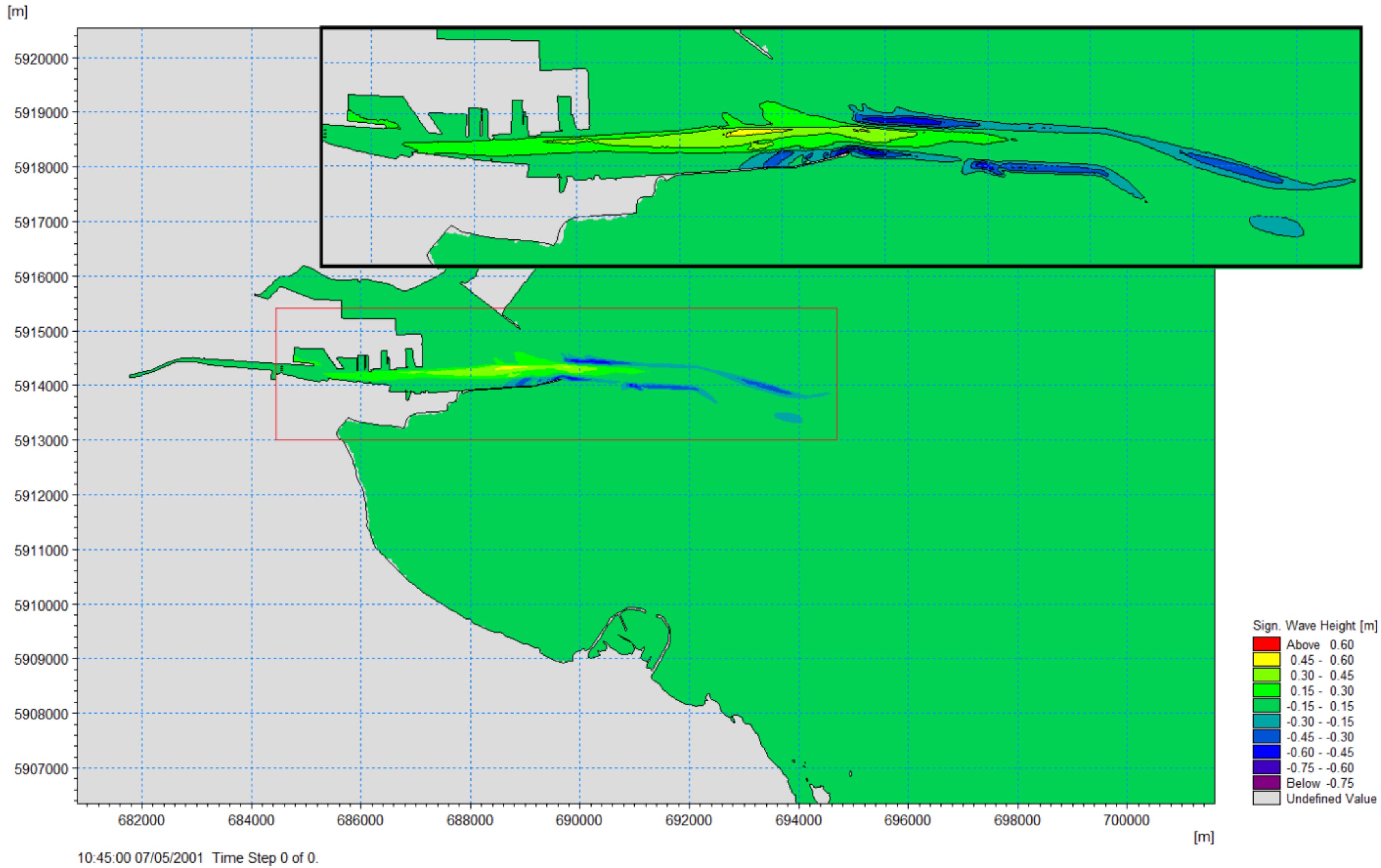


Figure F30:Easterly Storm - Difference in significant wave heights at spring high water as a result of the proposed capital dredging scheme - Inlay area highlight by red box

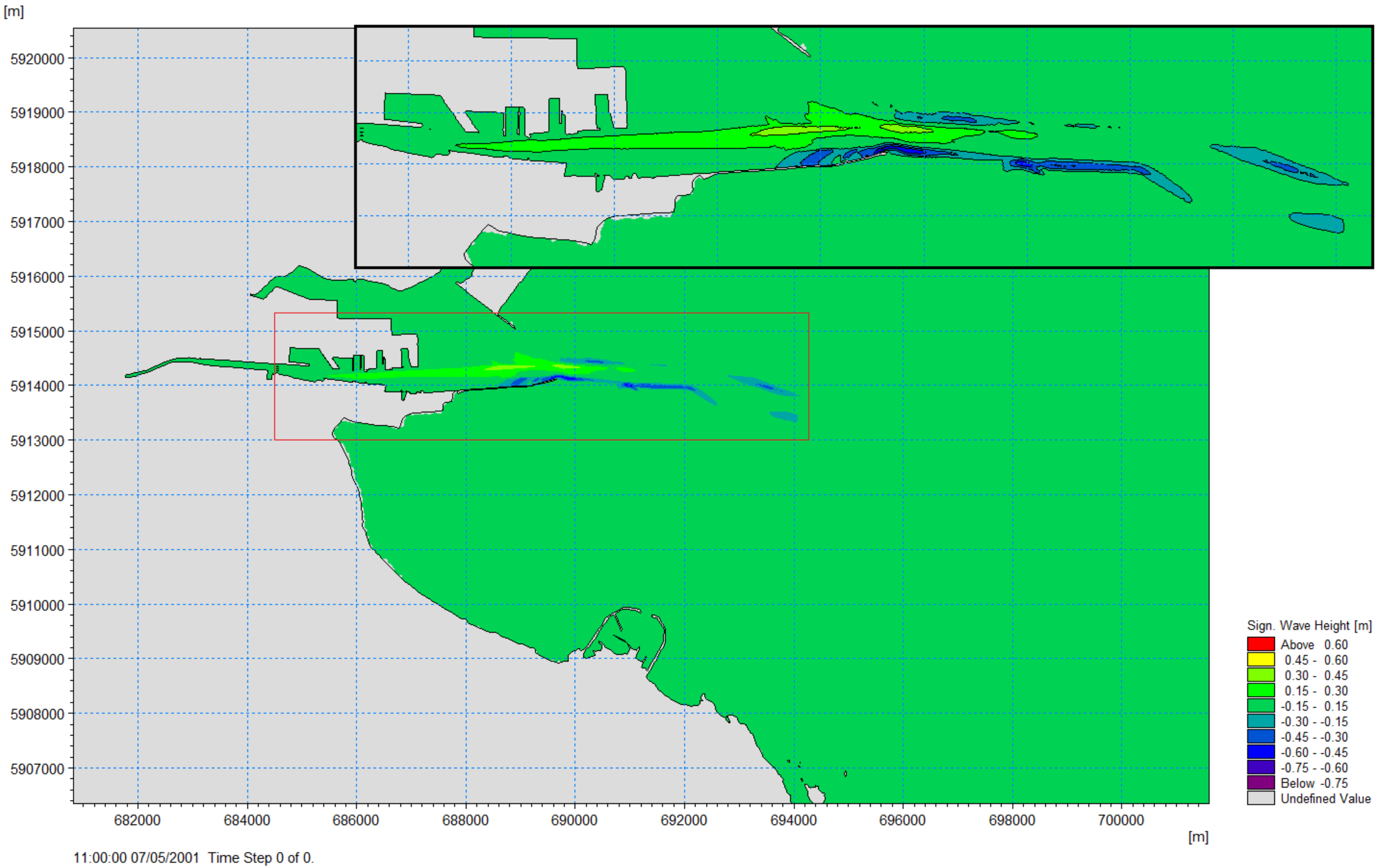


Figure F31: South Easterly Storm - Difference in significant wave heights at spring high water as a result of the proposed capital dredging scheme - Inlay area highlight by red box

9. Wave Climate

9.1 Clarify the accuracy of the wave climate model as it is not clear from the EIS to what degree the wave climate modelling has been verified against measured Wave Climate in Dublin Bay or compared with other Wave Climate studies.

Response

Suitable detailed wave measurements of the inshore wave climate of Dublin Bay were not available thus RPS' wave model simulations were undertaken as a comparative study. The inshore wave climate for assessing the impact of the proposed scheme was therefore derived by transforming offshore wave data for individual past storm events into the Dublin Bay area using state of the numerical modelling tools and techniques.

The techniques used in the EIS to transform the offshore wave climate into the inshore region have also been extensively and successfully used in numerous other studies including the Irish Coastal Protection Strategy Study and the Irish Coastal Wave and Water level modelling study both conducted on behalf of the Office of Public Works (OPW).

It is also important to clarify that this aspect of the EIS is a comparative study which is primarily interested in the impact of the change to the bathymetry as a result of the proposed dredging rather than the establishment of the inshore wave climate for a specific range of extreme storm events. It is the view of RPS that this is a sufficiently accurate and robust approach to assess and quantify the impacts of the ABR project on the inshore wave climate of Dublin Bay and the surrounding areas.

9.2 Please clarify whether wave-breaking and wave-current interaction has been included and to what extent wave reflection and diffraction processes have been modelled to predict the Wave Climate in the Liffey and Tolka estuaries. Comment on the effectiveness of the North and South Bull Walls in protecting the Estuarine waters.

Response

The inshore wave climate was transformed using the MIKE 21 Spectral Wave (SW) module which is a 3rd generation wind-wave model that simulated the growth, decay and transformation of wind-generated waves and swells in offshore and coastal areas. The SW model accounts for the following phenomena:

- Wave growth by action of wind;
- Wave breaking;
- Dissipation by white-capping;
- Dissipation due to bottom friction;
- Refraction due to depth variations;
- Diffraction at structures; and
- Wave-energy reflection along boundaries.

Wave-current interactions have not been accounted for in the model as RPS's experience shows that this type of interaction makes little difference to the inshore wave climate in this part of the east coast of Ireland for comparative studies.

It should be noted that the SW model is not a wave disturbance model in that it does not account for wave-wave interactions as a Boussinesq model would. Unlike the previous Gateway Project, there are no intentions of changing the boundary conditions within the Tolka Estuary.

The model used by RPS was chosen in preference to the Boussinesq wave harbour disturbance model because the Boussinesq wave model does not include wind wave generation within the model area which is extremely important for the wave climate along the Clontarf frontage.

By examining Figure F23 to Figure F28, it will be seen that the Bull Walls successfully attenuate the incident offshore waves and afford Dublin Port significant protection against arduous storm events. This is because both of the walls act as effective breakwaters. The South Bull Wall is a surface breaking breakwater, whilst the part of the North Wall is submerged at high water. In addition to the surface piercing structures, the model includes the partially submerged section of the North Bull wall which has been well defined in all of the coastal processes models using a fine triangular grid system as can be seen in Figure F32.

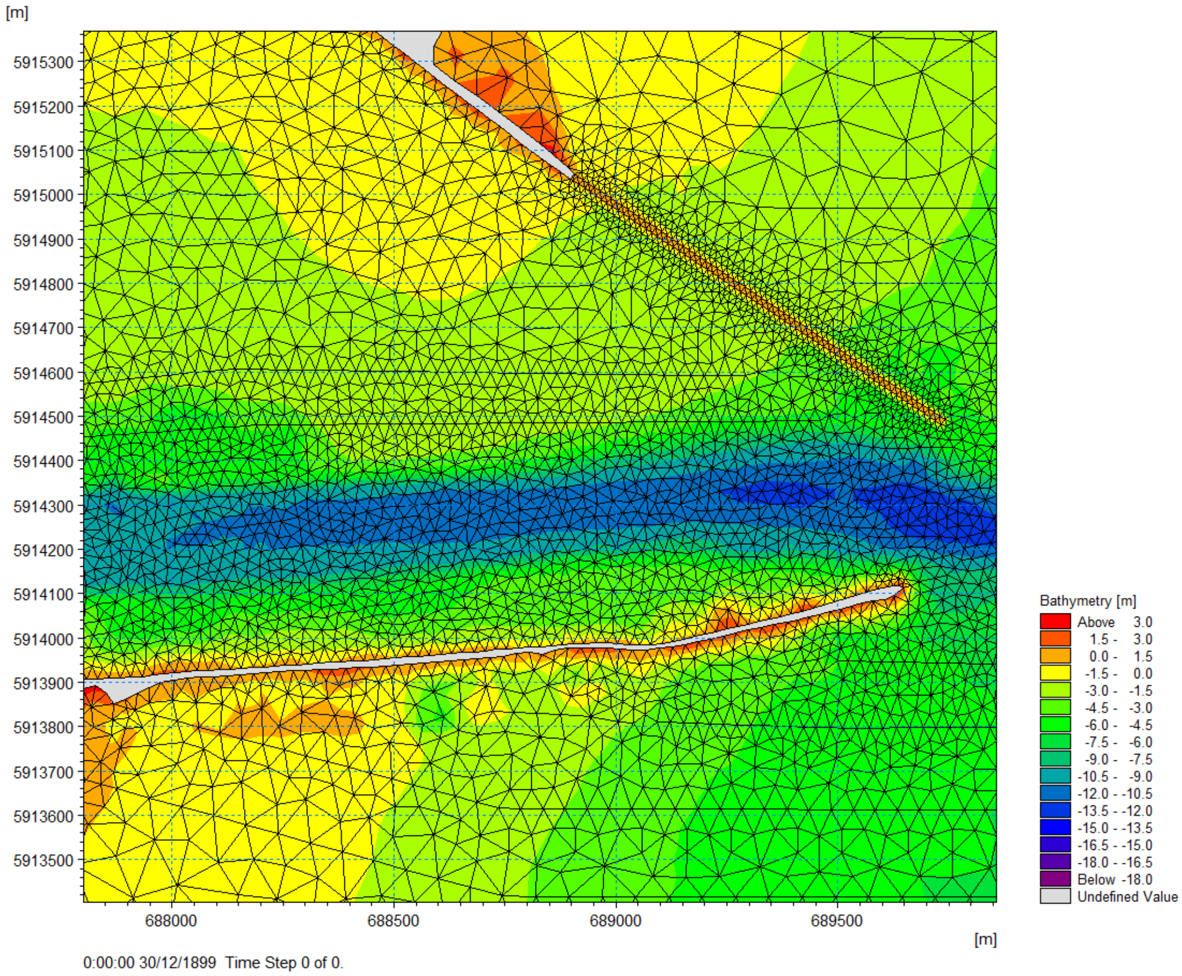


Figure F32: The fine mesh structure of the North and South Bull Walls.

9.3 Comment on the predicted increase in wave heights up along the Liffey Channel, and clarify the magnitude of wave heights in this area and along the adjacent Liffey and Tolka Estuary Shoreline areas with and without the proposed development. Comment on the implications for navigation, mooring and flood risk caused by the wave climate.

Response

As can be seen from Figure F33 which shows the wave height differences in Dublin Bay for an extreme south easterly storm event, the change in the wave heights at the entrance to the harbour channel does not exceed 0.20m. There is also a small increase in wave at the entrance to the Tolka Estuary, the extent of which depends upon the tidal levels. The details of this impact on the wave climate in the Tolka Estuary are already provided in Chapter 10 Volume 1 of the EIS.

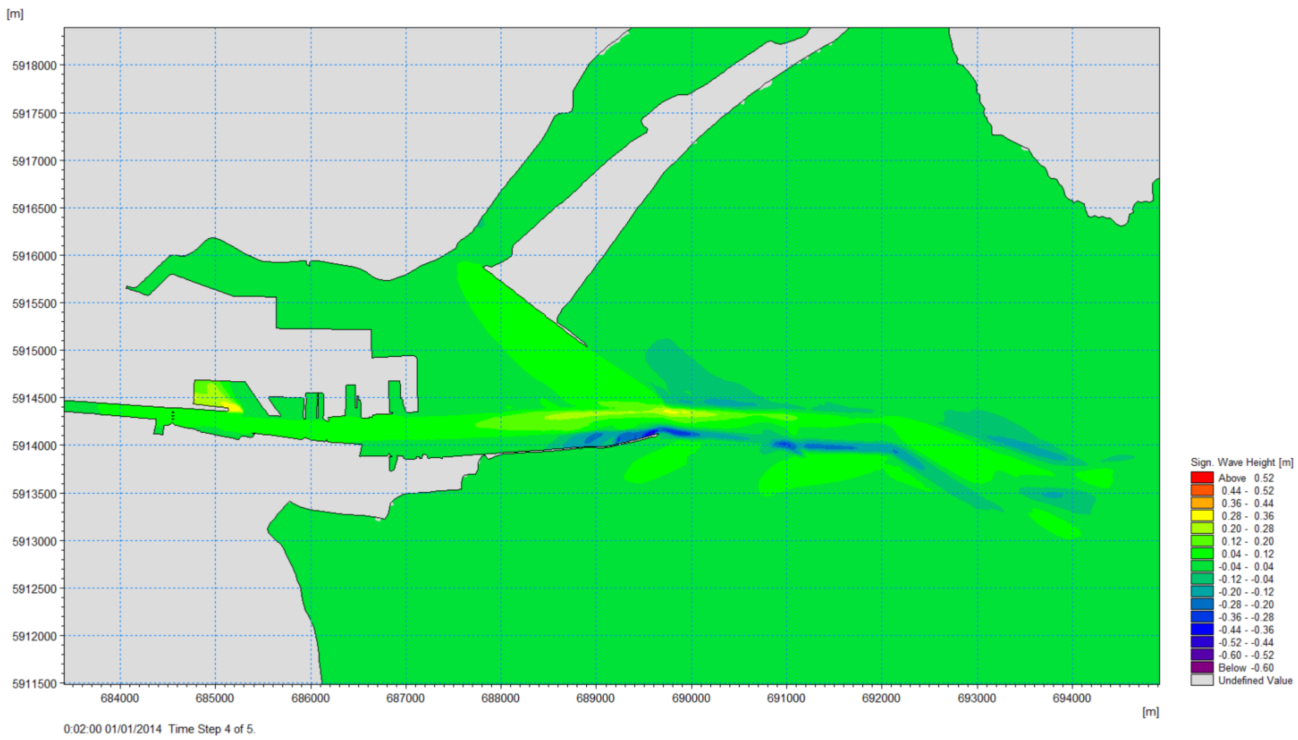


Figure F33: Plot of wave height differences (proposed minus existing channel) for an extreme south easterly storm event.

Navigation

In RPS's opinion neither the relatively insignificant increase of +0.20m to the wave climate at the entrance of the harbour channel nor the +0.12m increase along the entrance of the Tolka estuary will have any impacts on navigation within Dublin Harbour or the Greater Dublin Bay area.

Mooring

As can be seen in Figure 2.33, which shows the wave height differences in Dublin Bay for the worst case scenario, it was found that the maximum change to the inshore wave climate within the channel during an extreme storm did not exceed +0.20 metres. Given this, it is evident that there would be no significant impact to the mooring loads within Dublin Port as a result of the ABR project.

Flood Risk

As detailed in Chapter 10 Volume 1 of the EIS, a Flood Risk Assessment (FRA) of the ABR Project was undertaken as part of the EIS and was performed in accordance with The Planning System and Flood Risk Management Planning Guidelines (2009).

The FRA identified that there was a small increase in wave height to the south of the North Bull Bridge in the Clontarf area of Dublin as a result of ABR project; this difference can be seen in Figure F34. The potential impact was examined further using a Spectral Wave model and it was found that the post dredging situation will increase the height of the waves approaching the sea defences by 0.12m.

As concluded in Chapter 10 Volume 1 of the EIS, the increase in wave height will have no perceptible impact in terms of the volume of water breaching the sea defences from overtopping waves and that there will be no net increase to the existing flood risk to this area of Clontarf as a consequence of the ABR Project.

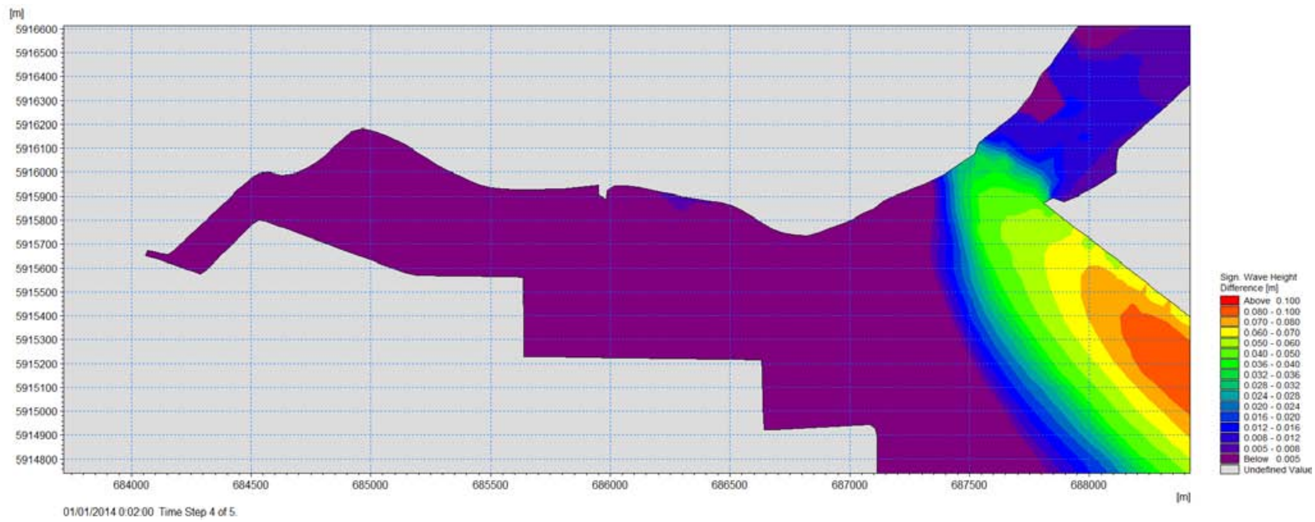


Figure F34: Wave height difference plot (proposed minus existing) for water level 2.92m OD. (Figure 10.18 taken from Chapter 10 Volume 1 of the EIS)

10. Hydrodynamics

10.1 Comment on the effectiveness of a 3D model with 5 layers to model salinity and the effect that salinity and temperature stratification will have on the dredge plume dispersion from the dredging works in the Liffey Channel.

Response

RPS' method of constructing a three-dimensional model of Dublin Bay by repeating the horizontal mesh five times over the vertical to produce a five layer model is an approach that has also been successfully adopted by the following studies:

1. A Three-Dimensional Hydro-Environmental Model of Dublin Bay. Bedri *et al*. (2011).

2. Ringsend Waste Water Treatment Plant, Long Sea Outfall, Dublin Bay. DHI (2010).

3. Dublin Waste to Energy. DHI (2006).

As such, the five layer model developed and used by RPS is a very effective balance between accuracy and computational efficiency that models salinity, temperature and the dispersion of sediment material resulting from dredging operations very well.

10.2 In the hydrodynamic calibration at Station 1 the time/date scales on horizontal axis are significantly different. Please review and overlay these plots similar to the presentation for stations 2 and 3 in Appendix 9 Volume 2 of the EIS.

Response

As specified in Appendix 9 Volume 1 of the EIS, the ADCP data at station 1 was acquired by the Danish Hydraulic Institute in 2010, however only a hardcopy of the data was available for this study. As such, it was only possible to visually compare the observed spring current directions and speeds at station 1 with a simulated period which experienced similar tidal conditions. As can be seen in and Figure F35 below, conditions measured at station 1 by DHI are very well represented by the tidal conditions simulated by RPS at station 1.

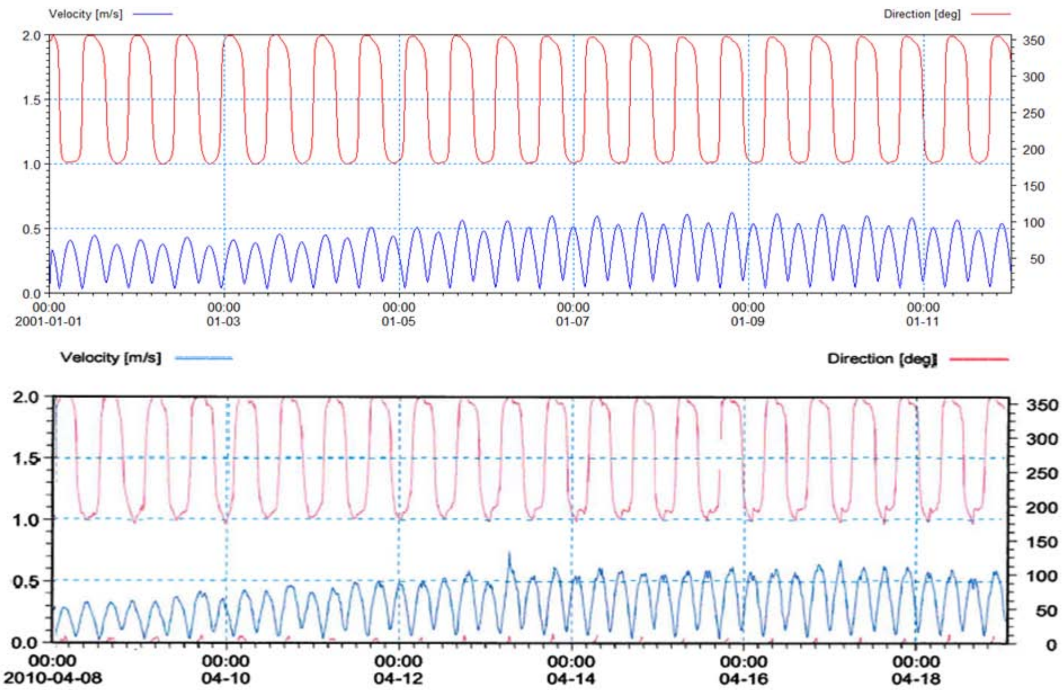


Figure F35: Comparison of tidal conditions modelled by RPS (upper) and tidal conditions recorded by DHI (lower) at station 1. (Figure 4 taken from Appendix 9 of Volume 1 of the EIS)

10.3 In respect to the offshore sediment disposal site please review and comment on why the provision of ADCP measurement data was not carried out in the dredge disposal site. Previous hydrographic measurements may have been carried out at this disposal site for previous dumping at sea licences and such data should be included in the model verification.

Response

The model developed by RPS was well calibrated with the three hydrographic stations shown in Figure F36, which indicates that hydrodynamics throughout the greater Dublin Bay area was also be accurately simulated by the model.

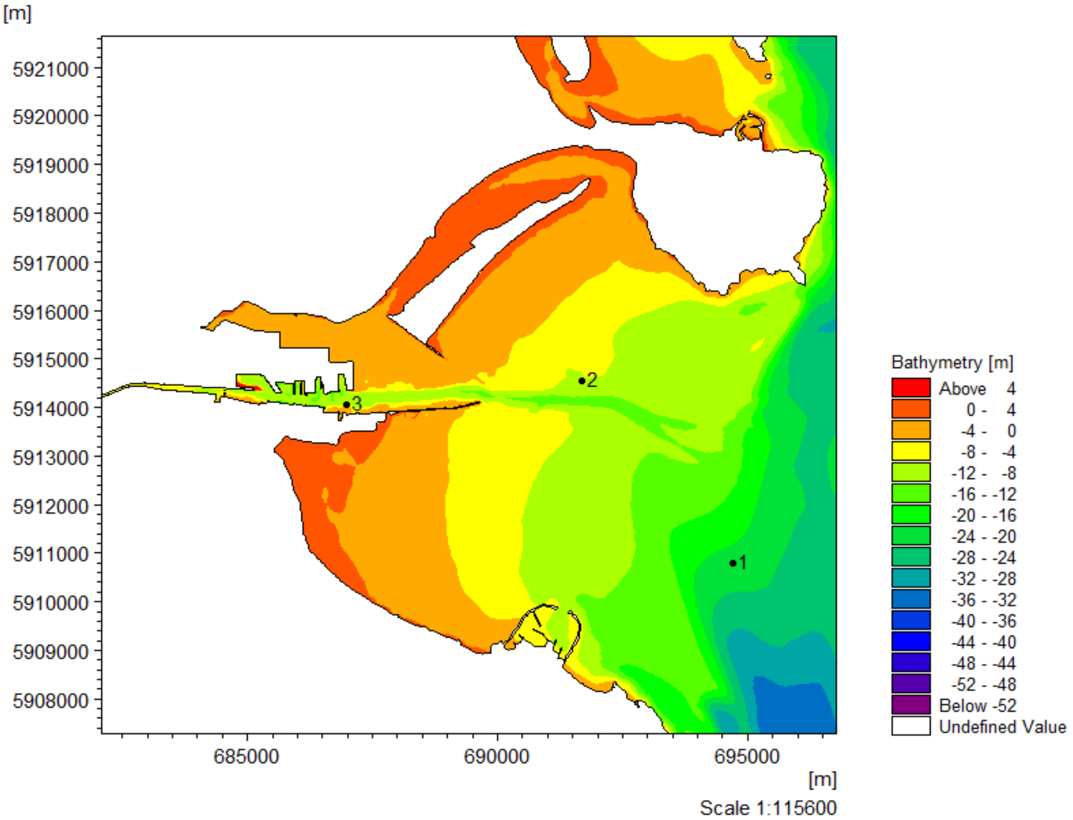


Figure F36: ADCP Current Measurement Locations

Furthermore, the calibration data presented by Bedri *et al*., for hydrographic sampling station H2 (see Figure F3) which is situated in close proximity to the designated dredge disposal compared very well with the conditions simulated by the RPS model as can be seen from Figure F37 below.

Given the close proximity of the hydrographic sampling station H2 to the designated dredge disposal site, it is valid to assume that the conditions recorded at station H2 would be representative of those that would be observed at the dredge disposal site.

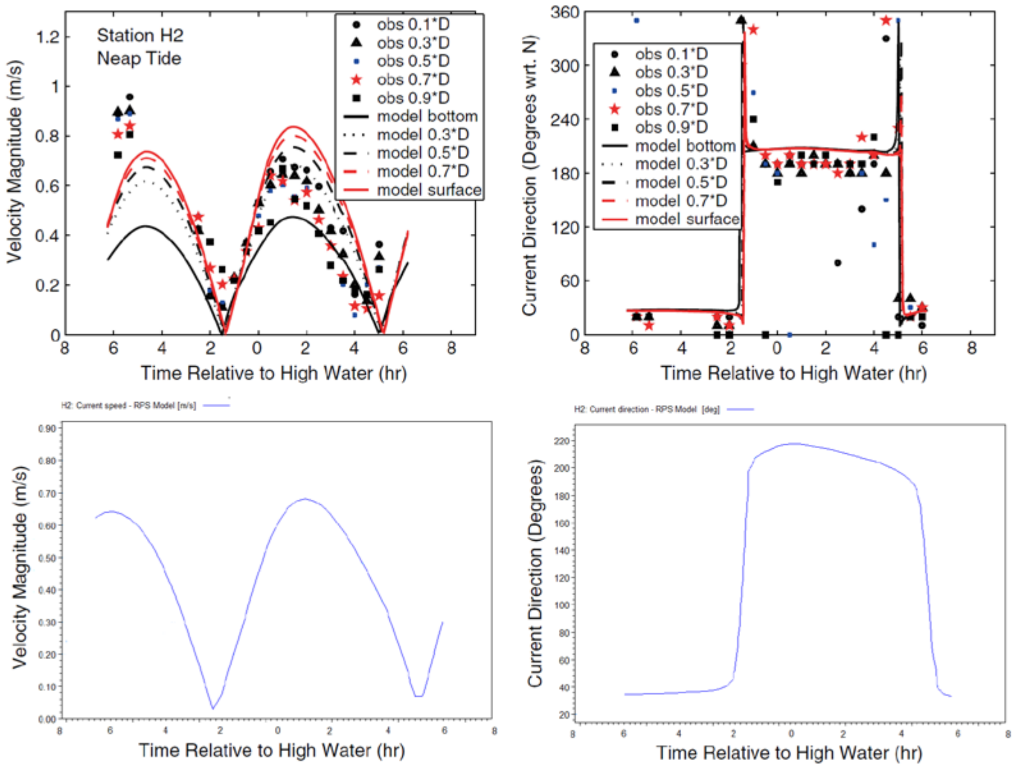


Figure F37: Comparison of Bedri's calibration data (upper) with RPS' current speed calibration data (lower) - Station H2

10.4 Review and comment on the implications of the proposed development on the Dublin Sewage Outfall discharge plume.

Response

The impact of the proposed Dublin Sewage Outfall was considered by RPS. Figure F38 shows a maximum concentration plot of the discharge from the proposed outfall which was produced by DHI as part of the Ringsend Wastewater Treatment Works Extension EIS. As can be seen the dispersion envelope covers an area in which the hydrodynamic regime remains unchanged as a result of the ABR project thus there can be no change to the dispersion plume as a result of the proposed scheme. It was therefore concluded that the ABR project would have no impact on the fate of the discharge from the outfall.

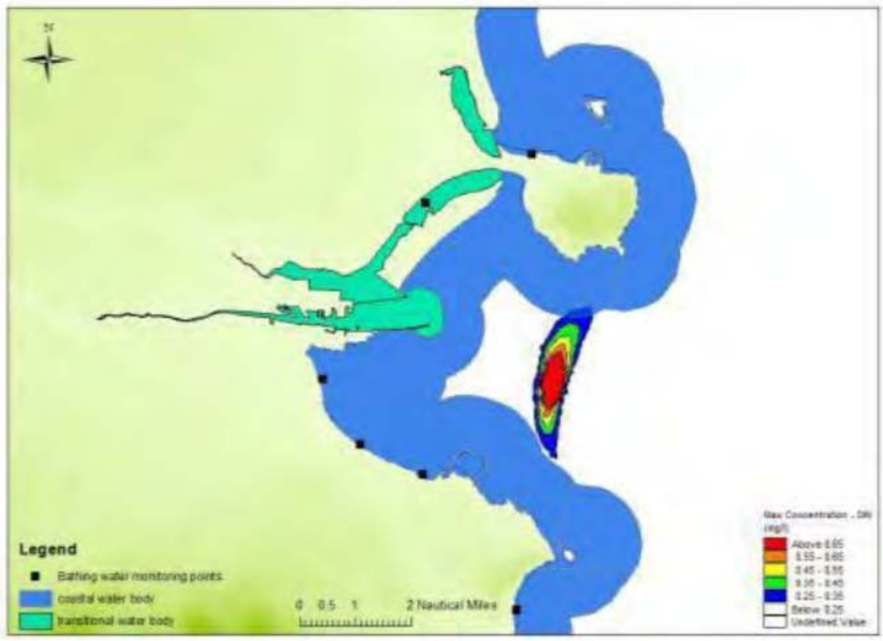


Figure F38: Maximum concentration of Dissolved Inorganic Nitrogen (DIN) in Dublin Bay. (Taken from Figure 6.45 of the Ringsend Wastewater Treatment Works Extension EIS, Volume 2)

It has also been noted that the construction of the 9km long sea outfall, bored through rock underlying Dublin Bay, was considered to have the potential of in-combination affects with the ABR Project, particularly the proposed disposal of limestone rock at the licensed offshore disposal site at the Burford Bank, limestone being uncharacteristic of the sediments which make up the seabed within Dublin Bay. As part of the ABR project a meeting was held with the EPA to discuss this issue at which the EPA confirmed that potential in-combination effects could be screened out (meeting held on 10/12/2013 and attended by representatives from Dublin Port Company, RPS and EPA).

Subsequently, Irish Water released a statement on 12 May 2014 to confirm that the proposed Ringsend long sea outfall was cancelled. An article published in the Irish Times on 12th May 2014 is presented in Appendix F2 of this document confirming this fact.

11. Sediment Disposal Site

11.1 Please clarify the accuracy of the Bathymetric surveys at the Disposal Site that provided an estimate of 15% of the deposited waste between 2008 and 2013 to have remained within the disposal site. Please also clarify the conclusion that the contaminated sediments overlain/capped by placed sand and gravel remain in-situ.

Response

As part of the Dublin Port Company's license requirements hydrographic surveys are conducted at the designated disposal site before and after every maintenance dredge operation. These hydrographic surveys are undertaken by the same company using the same high end echosounder swath systems. The accuracy of any survey data depends on the water depth and beam footprint size which is a direct function of the transmitting and receiving bandwidths, as the water depth increase so does the beam footprint size, but generally multi beam survey data can be expected to be accurate within the order of centimetres

The data collected from each of these surveys is then used to generate a full digital terrain models (DTMs), which are in turn used to conduct volume computations. As the accuracy of the original survey data is within the order of centimetres, volumetric computations can be expected to be within approximately the same degree of accuracy.

As specified in Chapter 9 Volume 1 of EIS the volume of material dumped during the 2012 dredging maintenance dredging campaign was approximately 0.650 million m3, an assessment of the 2008 and 2013 hydrographic indicated that the change in sea bed level equated to only an additional 0.075million m^3 of sediment at this segment of the spoil site, whilst the change in sea bed level over the entire spoil site equated to an additional 0.094million m^3 of sediment. The 15% referred to the estimated percentage of sand fraction in the maintenance dredge material.

The mounds of the capped material were clearly visible in the 2013 hydrographic surveys. The conclusion that the contaminated sediments overlain by the capping of granular material remained in-situ was based on volumetric difference calculations of the results of the hydrographic surveys.

11.2 The models appear to indicate that the dumping is evenly distributed across the entire disposal area, comment on how this would be achieved and what are the implications of recurring disposal in a localised section of the site.

Response

The models indicates that the dumping is evenly distributed evenly across the entire disposal area because the MIKE21 Sediment Transport model which was used to simulate the fate of the silt released from the barges over the dump site had a moving sediment source that spilled sediment at a constant rate of 108kg s^{-1} along a track that transverses the entire dump site area over the course of one lunar month. The track over which the sediment dumping was simulated is presented in Figure F39.

All dumping operations will be undertaken according to industry standards and will be conducted in accordance with any restrictions imposed by the Dumping at Sea Permit which is issued by the EPA. Furthermore, all dredgers will have GPS track plotters fitted to ensure that they remain on course throughout the entire dredging/dumping operation.

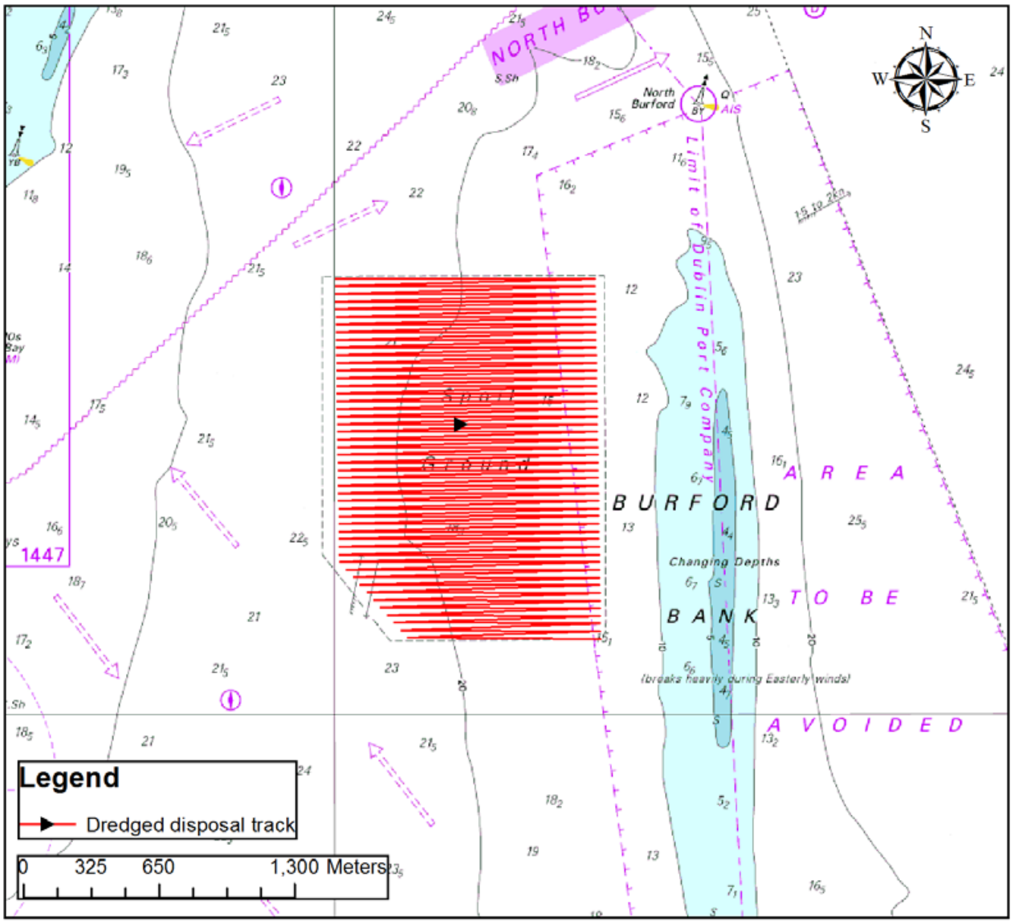


Figure F39: Track of disposal route over the designated dredge disposal site.

12. Sediment Transport

12.1 Review and comment on the spillage risk from the proposed use of silt curtains to contain dredge sediment within the Alexandra Basin and whether a spillage input has been included in the dredging plume analysis.

Response

A spillage input was not included in the dredging plume analysis as it was not deemed necessary. The spillage risk from the dredging of Alexandra Basin West is assessed in the Dredging Risk Assessment document which is included as an Appendix of the Draft High Level Construction Environmental Management Plan.

12.2 Provide scientific backup for the use of 1% sediment loss rates at the Suction Dredger head and for the overspill at the surface and comment on the potential deviation in such rates and the resultant impact on Liffey Channel.

Response

The losses from the dredgers were assessed based on site measurements made during the construction of the Denmark - Sweden fixed link tunnel and bridge and by reference to data contained in "*Scoping the Assessment of Sediment Plumes from Dredging"* CIRIA 547. The analysis of these data sources indicated that for normal dredging operations the total losses to the water column should be taken as 3% of the dredged material. This is represented by a 1% source at one metre above the bed and 2% at the surface.

In the case of dredging the partially contaminated material, loses due to overspill will be restricted so that loses at the surface will be no more than 1% (see response to Query 12.3 below).

Suspended sediment measurements can be undertaken to control the dredging operations if excessive overspill becomes a problem during the dredging of the inner channel.

12.3 Provide more details in respect to the dredge plume modelling (for example how the dredging activity was specified in the model runs including the location of the dredging activity) that gives rise to the plume plots presented in the EIS.

Response

As specified in Chapter 9 Volume 1 of the EIS, the dredging of the inner harbour channel will be undertaken over three separate six month winter periods. The modelling was therefore undertaken for dredging operations in the outer, middle and inner sections of the harbour channel with the middle and inner sections being undertaken by a pontoon mounted excavator fitted with a clam-shell bucket.

It was determined from Particle Size Analyses described in Chapter 11 Volume 1 of the EIS that the material to be dredged from each section of the harbour channel was predominantly silt and was characterised by three discrete fractions with mean diameters of 200µm, 20µm and 3µm. In the channel adjacent to Alexandra Basin West each fraction constituted 1/3 of the total volume of silt to be dredged. In the outer parts of the Liffey channel in the harbour the sand fraction consisted about half of the total volume to be dredged. The coarser fraction of the silt, i.e. the sand fraction that had a mean grain size of 200µm was found to behave differently relative to the two finer fractions that had mean grain diameters of 20µm and 3µm. The sand fraction remained in the area of the dredging and produced virtually no plume, whereas the two finer silt fractions were carried away by the tidal currents.

It should be noted that for these simulations the plume modelling was undertaken for the silt fractions with the silt losses being taken as 1% at the dredger head and 1% at the surface as opposed to the 2% spill rate which was assumed for the dredging of the outer channel. The reason for this difference is that the material in the inner harbour has been shown to be moderately contaminated as discussed in Chapter 9 Volume 1 of the EIS. The use of the clam-shell bucket with no over-wash from the barges reduces the loss of moderately contaminated sediment to the surrounding waters.

12.4 Comment on the implications for the intake waters to the Power Plants at Poolbeg from the proposed dredging activities.

Response

As already specified in Chapter 9 Volume 1 of the EIS, the suspended sediment concentration at the various power station cooling inlets was assessed and quantified for each of the three dredging operations specified below:

- Dredging of outer section of the Liffey channel in the harbour
- Dredging of middle section of the Liffey channel in the harbour
- Dredging of inner section of the Liffey channel in the harbour

The peak and mean increase in the suspended sediment concentrations predicted by the 3D model simulations are given in Figure F3 below.

Table F3: Peak and mean suspended sediment concentrations at various power station cooling inlets. (Table 9.4 taken from Chapter 9 Volume 1 of the EIS)

Cooling water intake	Dredging Location	Peak Concentration (mg/litre)	Average Concentration (mg/litre)
Poolbeg power station	Inner channel	30	18
	Middle channel	23	14
	Outer	16	8
Synergen power station	Inner channel	35	23
	Middle channel	27	15
	Outer	14	7
North Wall station	Inner channel	50	30
	Middle channel	20	13
	Outer	10	5

It will be seen from the results of the simulations that the levels of additional suspended sediment concentrations at the power station intakes is relatively small and is unlikely to have a significant effect on the power station operations. In addition, numerous past maintenance dredging campaigns with similar a dredging rate have been completed at Dublin Port without any significant impact on the on the power station intakes within the Port.

12.5 In the sediment transport study please indicate the sediment composition of the sea bed used throughout the model domain (i.e. whether it was variable based on sediment sampling or constant).

Response

The composition of the sea bed used throughout the models was based on the particle size distribution analyses of the sediment samples as detailed in Appendix 11 of Volume 1 of the EIS. It was found from these analyses that the material comprising the sea bed was mainly a fine sand.

Given this, the model domain was comprised of a constant fine sand which had a mean grain diameter of 0.14mm. This fine sand fraction had a sigma value of 1.1 meaning that 68% of the grains had a diameter within a factor of $2^{1.1}$ of the median diameter of 0.14mm.

12.6 The resolution of the morphology plots for the navigation channel and adjacent Bay area presented in the EIS are of a very coarse scale and consequently difficult to distinguish the sediment pattern from the modelled storm events. Please provide more zoomed in plots at the areas of interest and explain the pattern of erosion and accretion predicted in respect to the role of wave climate and tidal dynamics.

Response

To increase the clarity of the images representing the sediment transport in Dublin Bay under various storm conditions, Figure F40 to Figure F48 have been reproduced with isolines to represent changes in values and were were compiled in a style to demonstrate any far field impacts of the proposed capital dredging scheme. The plots were generated from a range of high resolution models which had a mesh size varying from 15m in the area of interest ranging to 500m at the model boundary.

As can be seen from these plots, the morphological simulations of the existing and proposed approach channel show that the proposed channel will perform in a similar manner to the existing channel. As with the existing channel there will be a tendency for the northern bank of the approach channel, seaward of the North Bull Wall, to migrate south under storm conditions. Similarly it is expected that there will be siltation along the banks of the approach channel landward of the Bull Walls with a tendency for these banks to migrate in towards the channel. It is expected that the new channel will require maintenance dredging of a similar magnitude to that required with the existing channel.

It should be noted that the apparent significant change in bed levels behind the south Bull Wall which can be seen in Figure F48 is the exacerbated by the partial wetting and drying of the model in this area and is therefore unlikely to represent the actual change in bed levels in this region. Furthermore, the apparent change in the bed levels at the harbour entrance presented in Figure F42, Figure F45 and Figure F47 is a direct result of the position of the channel banks being moved, not because of a change in the hydrodynamic or sediment transport regime.

Overall, the results show that there will be no significant impact on the sediment transport regime within the River Liffey Channel, Tolka Estuary or Dublin Bay as a result of the capital dredging scheme.

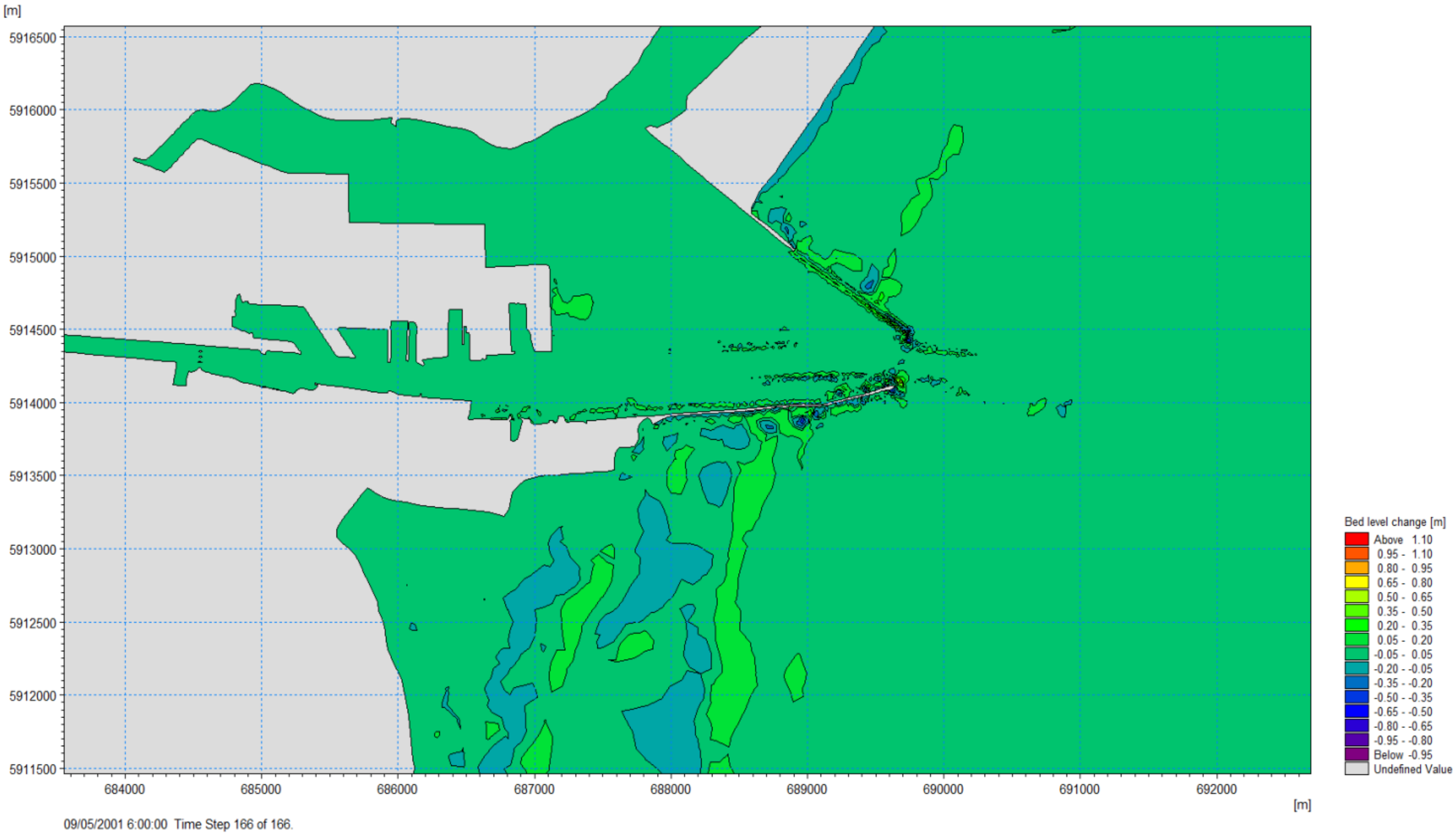


Figure F40: Change in bed levels after a North Easterly storm event with contours – Existing Port Channel

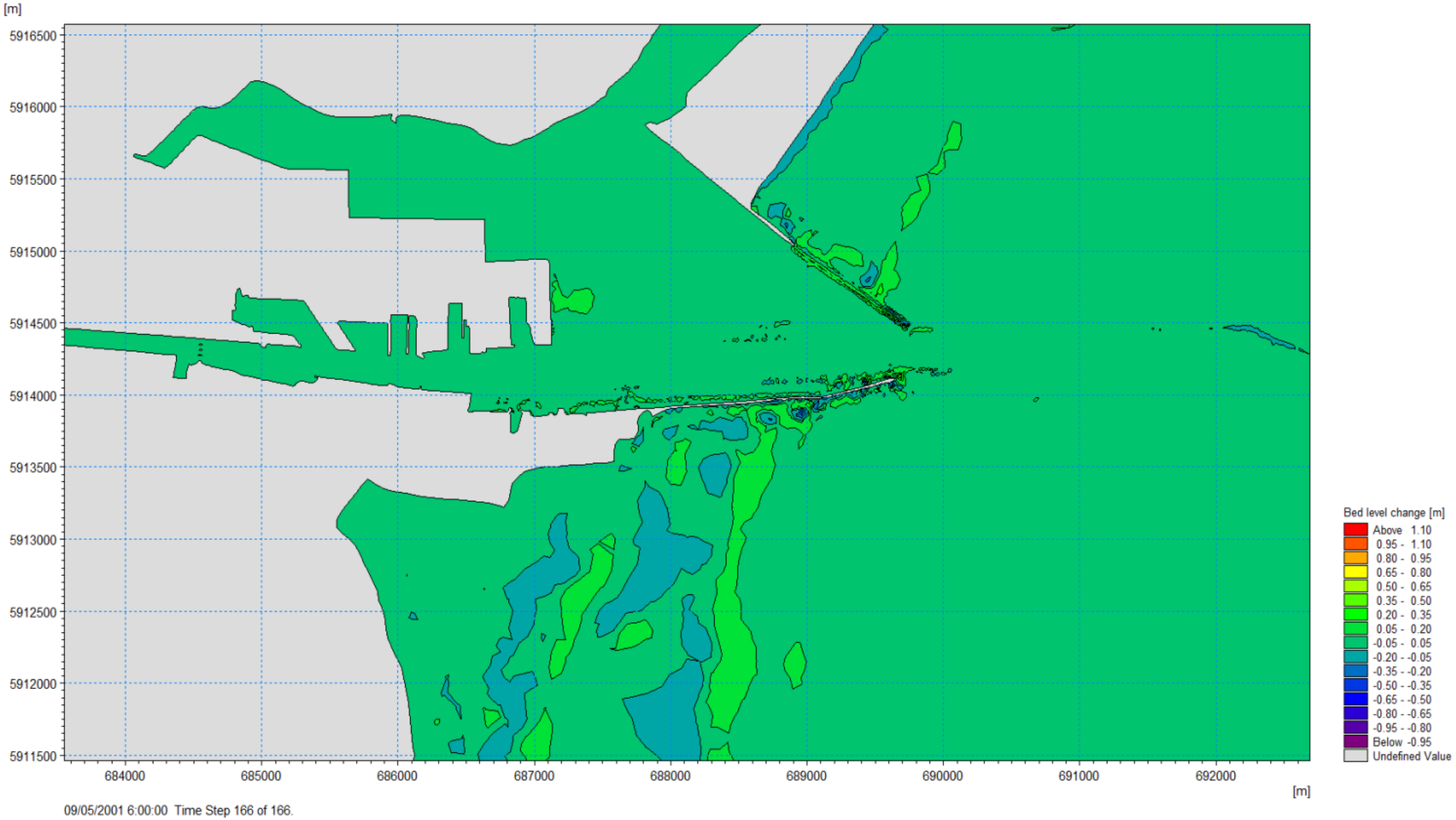


Figure F41: Change in bed levels after a North Easterly storm event with contours - Post Capital Dredging Scheme

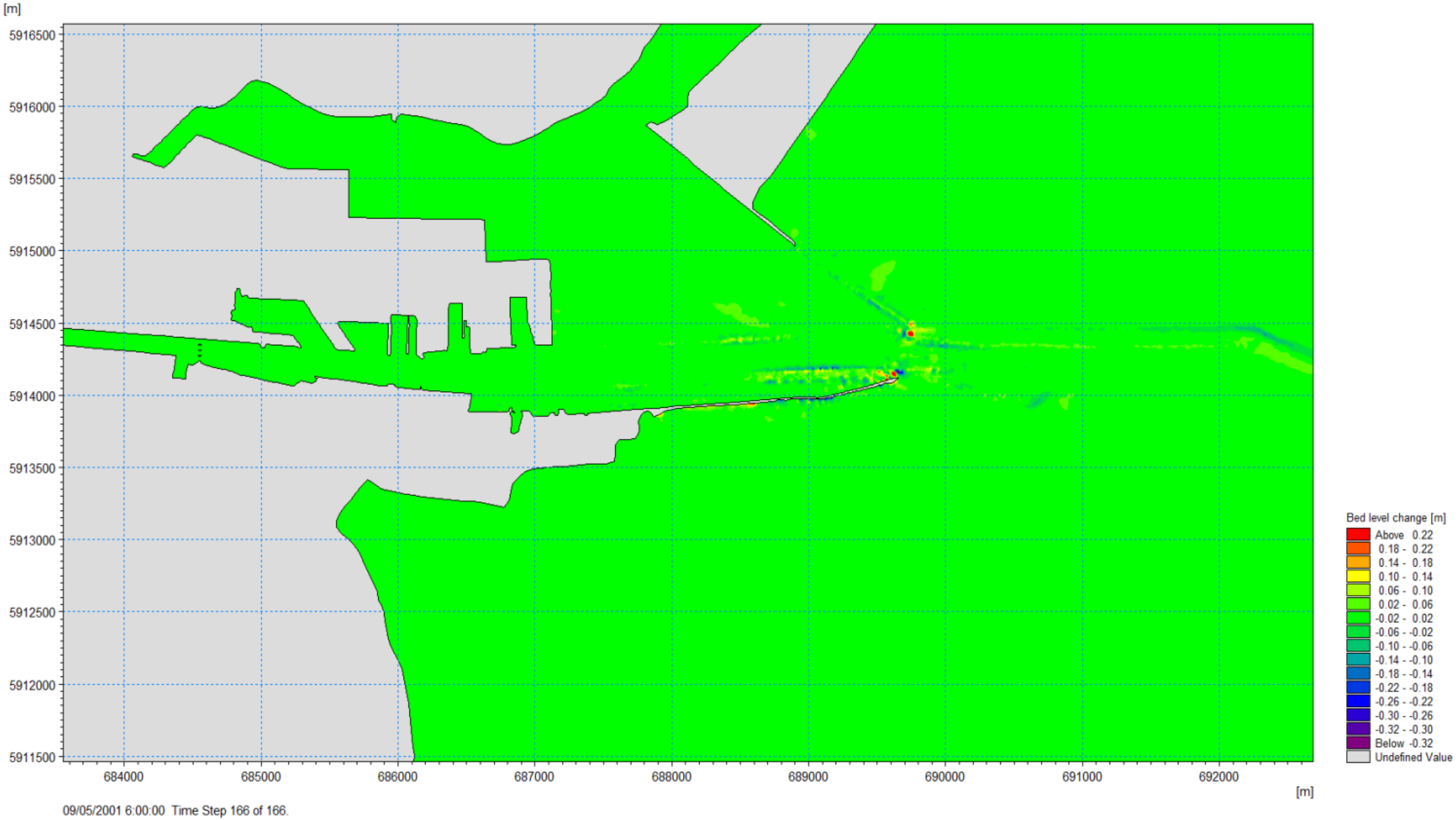


Figure F42: Difference in bed level change as a result of the proposed capital dredging scheme - North Easterly storm event

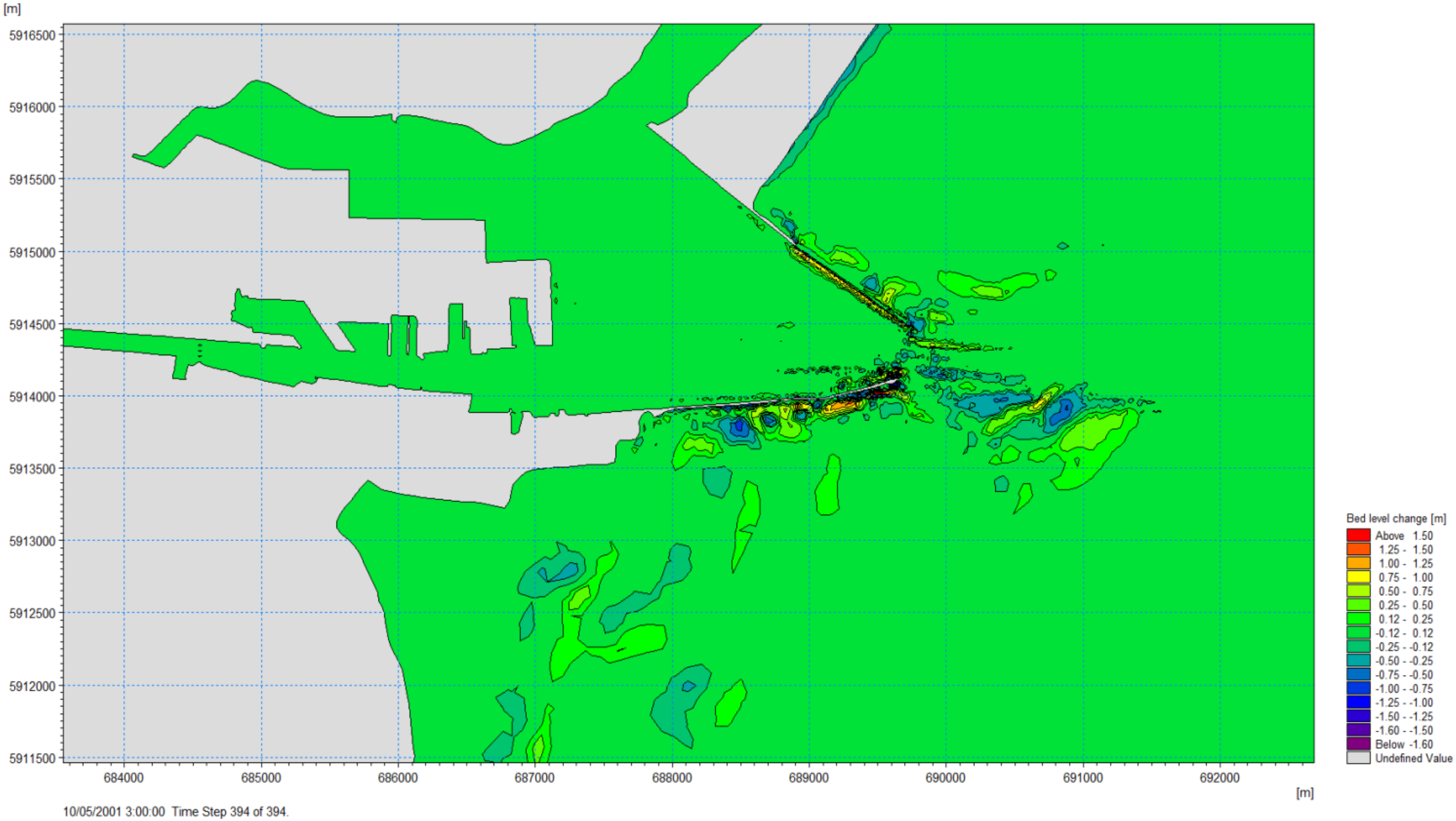


Figure F43: Change in bed levels after an Easterly storm event with contours – Existing Port Channel

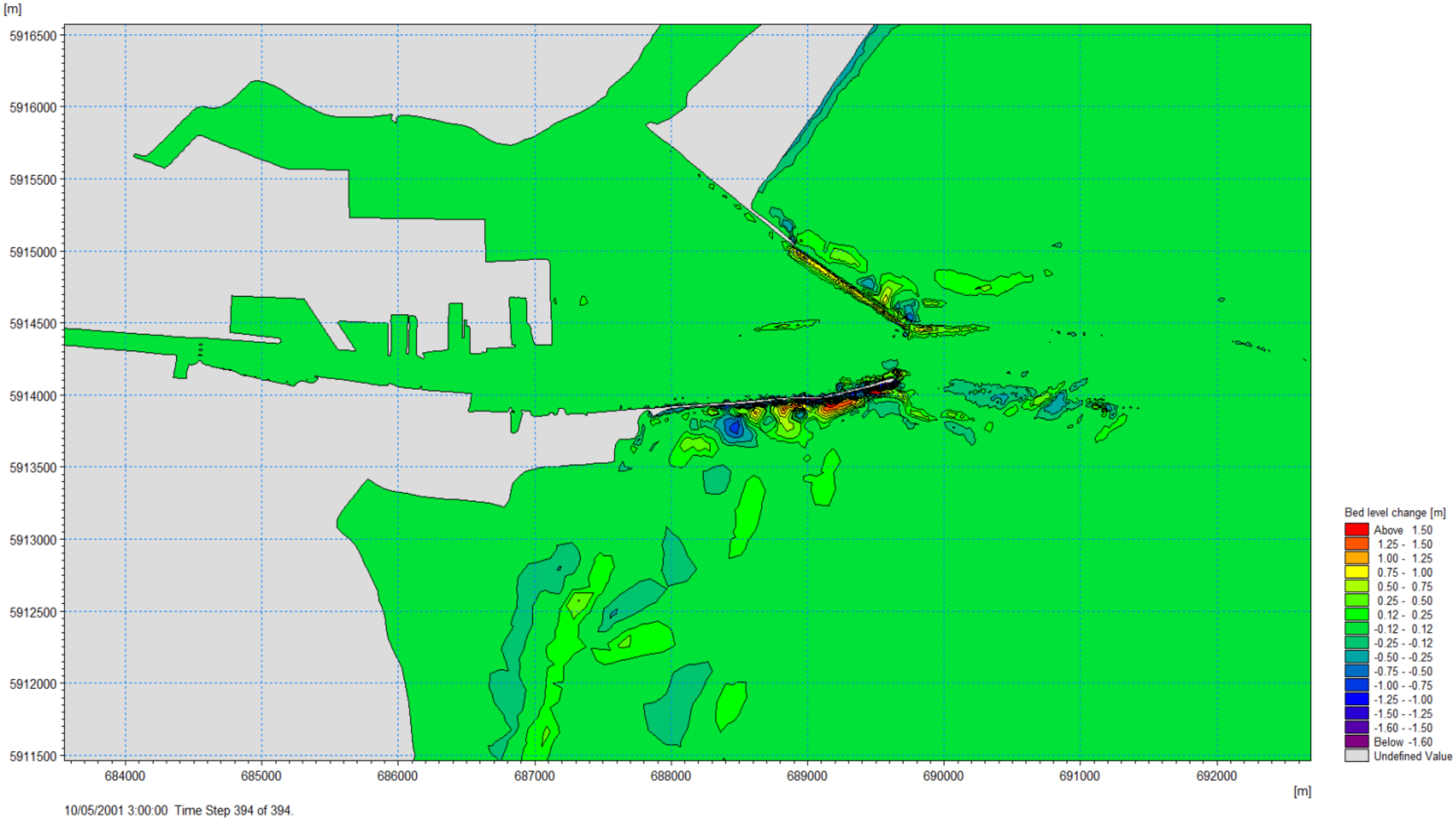


Figure F44: Change in bed levels after an Easterly storm event with contours – Proposed Port Channel

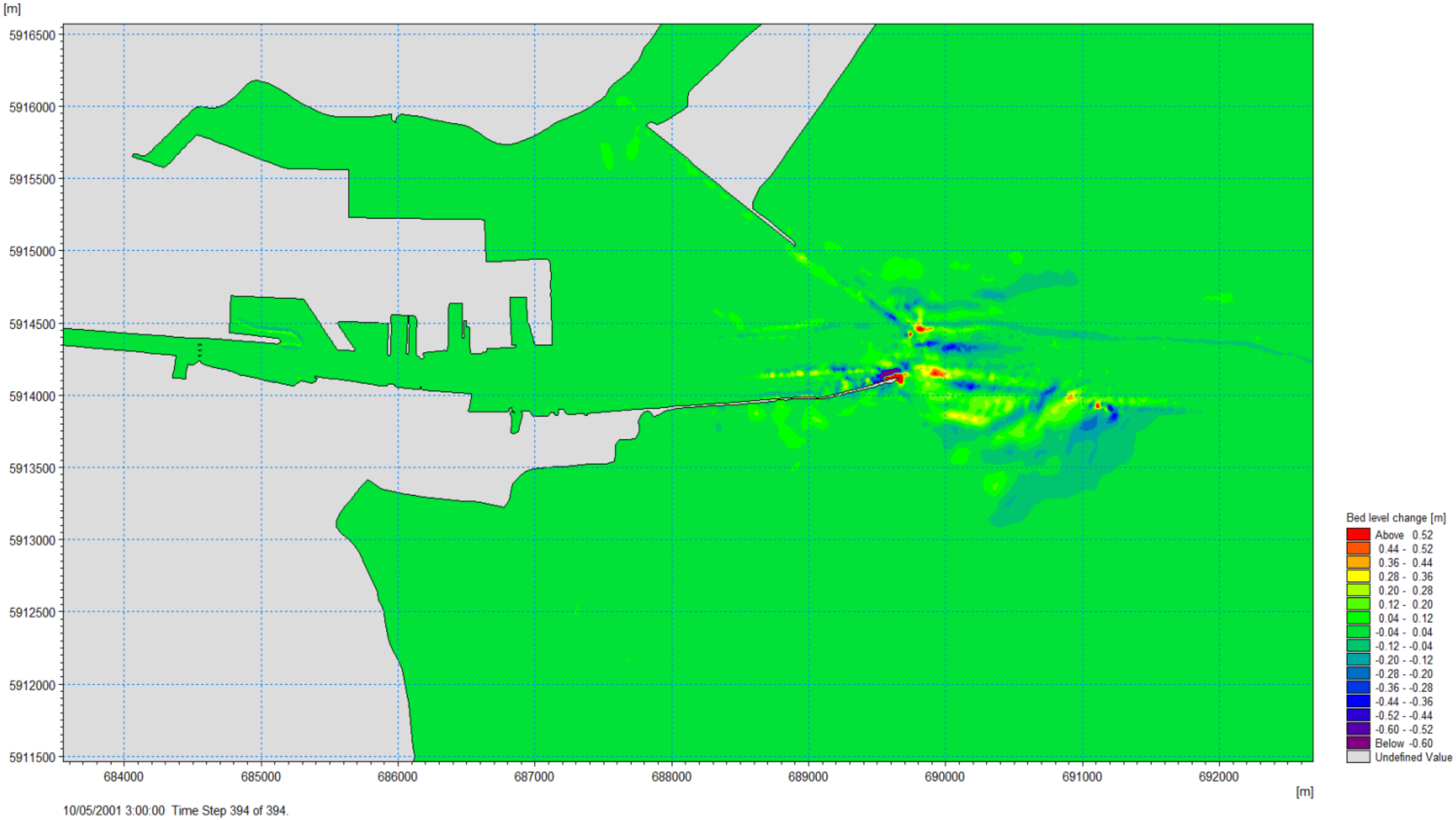


Figure F45: **Difference in bed level change as a result of the proposed capital dredging scheme - Easterly storm event**

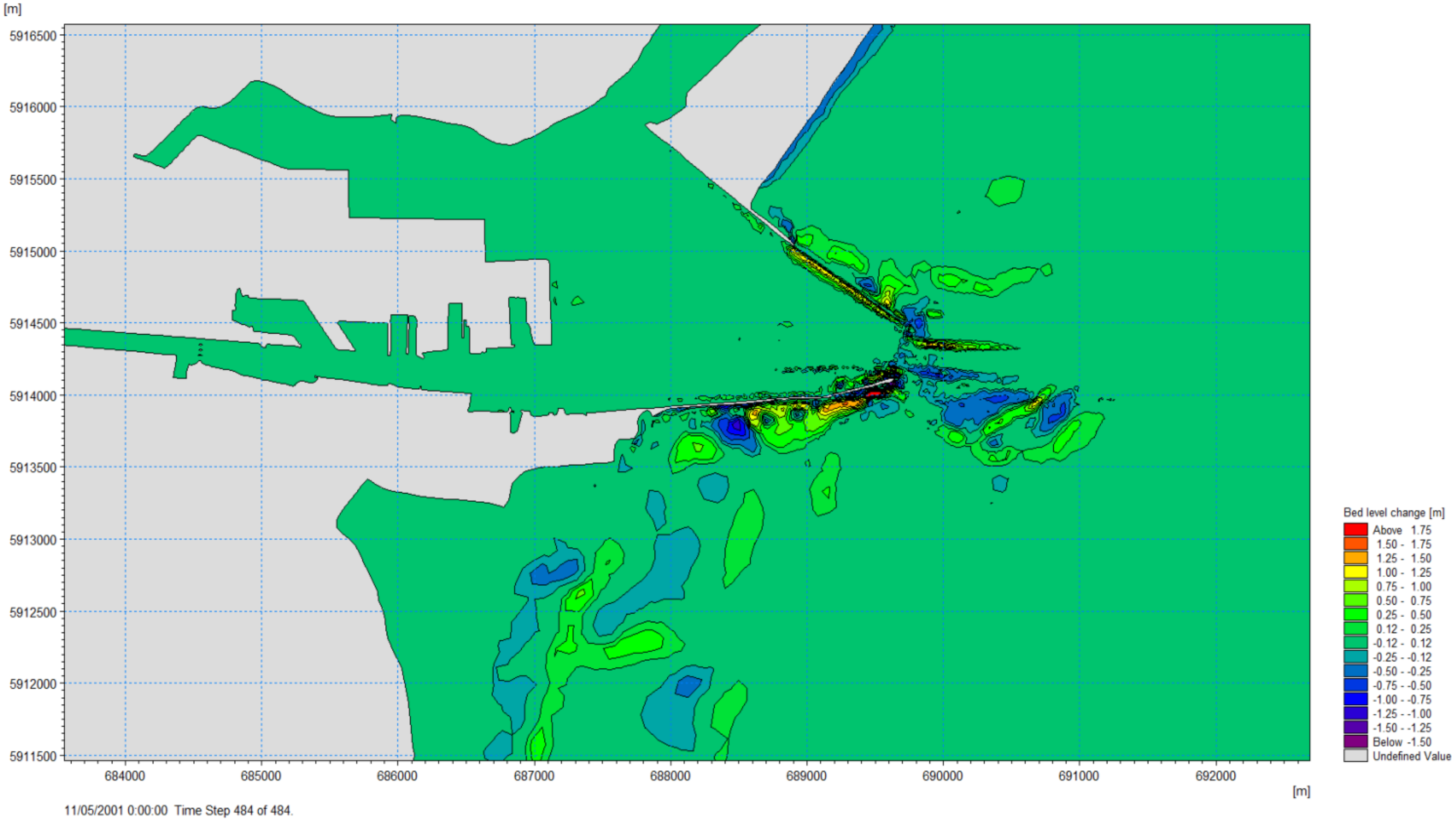


Figure F46: Change in bed levels after a South Easterly storm event with contours – Existing Port Channel

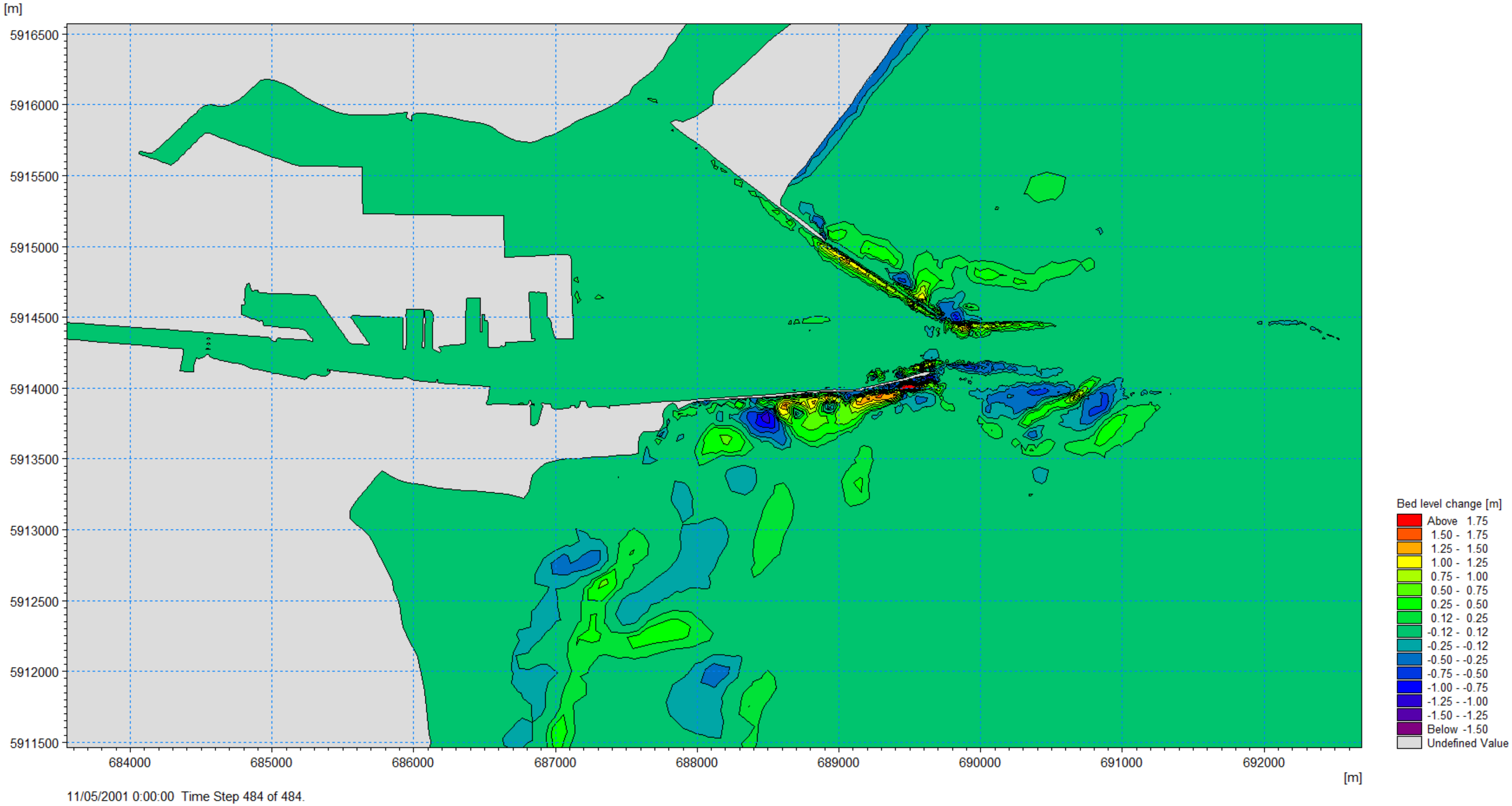


Figure F47: Change in bed levels after a South Easterly storm event with contours - Post Capital Dredging Scheme

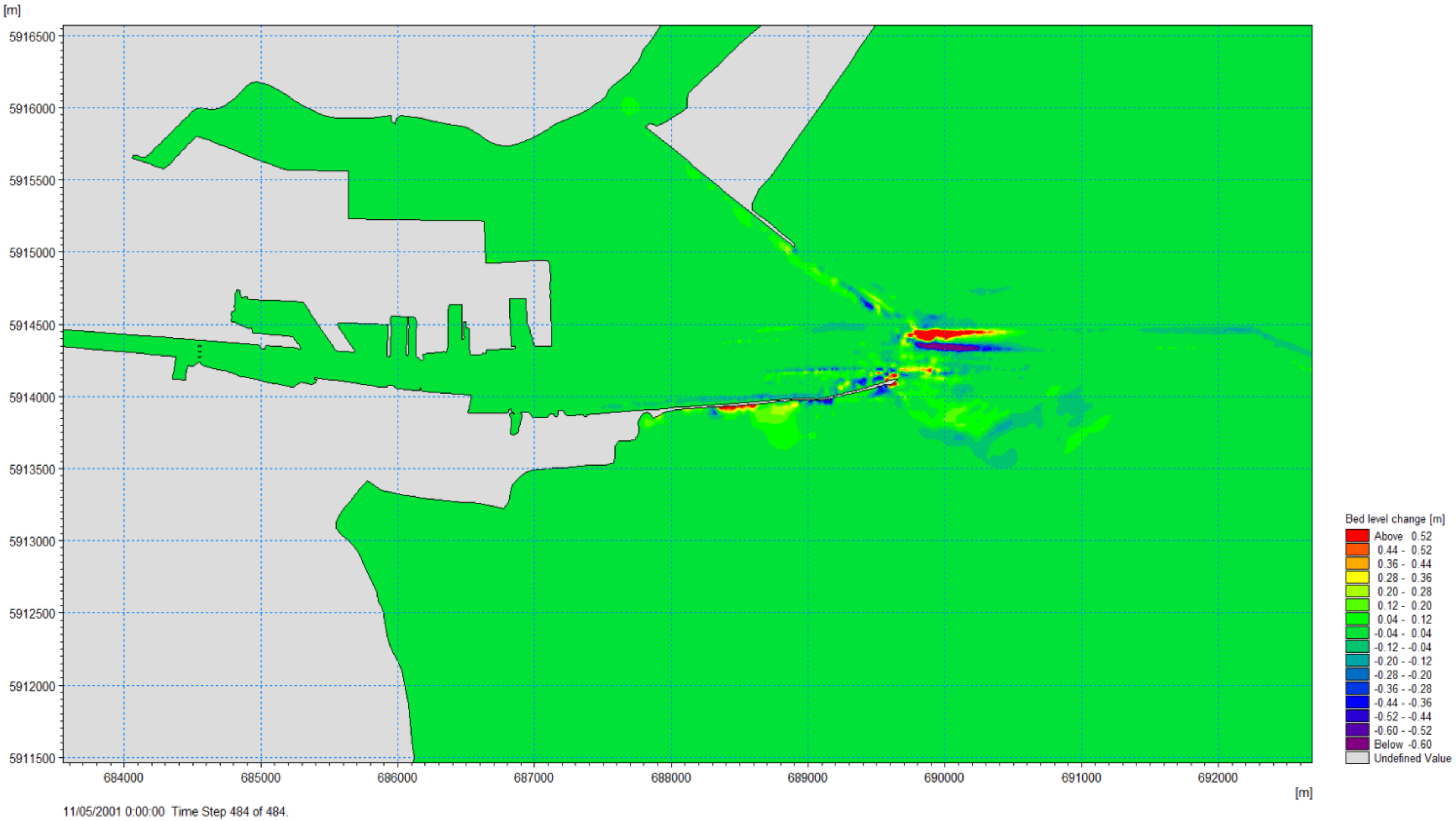


Figure F48: Difference in bed level change as a result of the proposed capital dredging scheme – South Easterly storm event

13. Sediment Sampling for contaminants

13.1 Comment on the relatively small number of sediment cores provided for the Liffey Navigation channel and the accuracy of the contamination classification given to sections of the channel and in particular how the delineation of slightly/moderately contaminated sediments from sediments suitable for disposal was arrived at. Comment on the how representative the cores are with respect to capital dredge depth.

Response

Prior to the sampling and analysis regime undertaken by Hydrographic Surveys and National Laboratory Service (a division of the UK's Environment Agency) in 2013 in support of the ABR planning application (refer to Section 11.2.4 of Chapter 11, Volume 1 of the EIS), a number of previous studies, testing regimes and analyses had been undertaken within Dublin Port. Such studies include:

- MCOS- Phase 3 - Assessment of Sediment Contamination and Toxicity, November 2002
- Fugro Engineering Services Ltd - Factual Report on Ground Investigations (Alexandra Quay East and West), February 2008
- Glover Site Investigations Ltd - Soil Sampling Alexandra Basin Dublin Port, March 2008
- Jacobs - Dumping at Sea Permit, Supporting Information - September 2009
- Egan Environmental Consultancy - Assessment of Sediment Samples Alexandra Basin, January 2013

Following on from these investigations and associated sediment testing, consultations were undertaken with the Marine Institute regarding the assessment of the suitability of sediments from Alexandra Basin West, the Liffey Channel and fairway for disposal at sea as part of the ABR project (as per Section 4.14 of Chapter 4, Volume 1 of the EIS).

In light of the previous sampling and testing results, sampling and vibro-core locations for the basin, navigation channel and fairway were agreed with the Marine Institute in advance of the 2013 site investigation works. The Marine Institute advised on both the locations and testing regime to be carried out for the samples. The locations of these sampling points are shown in Figures F49-F51 below.

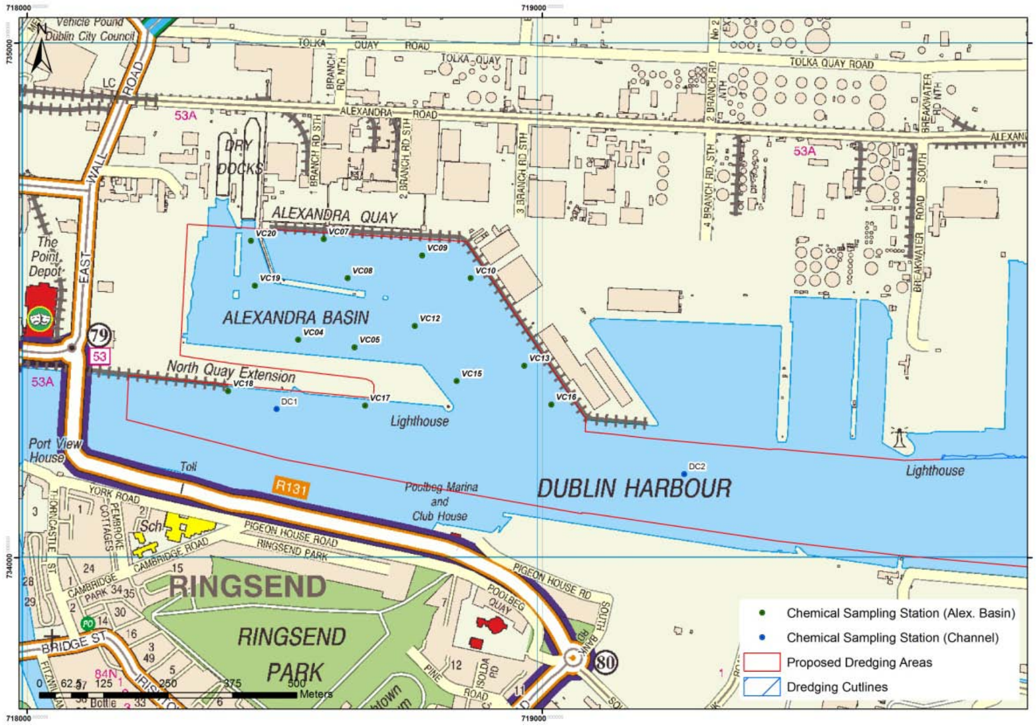


Figure F49 2013 Sampling Locations (as per Figure 11.2 of Chapter 11 of Volume 1 of EIS)

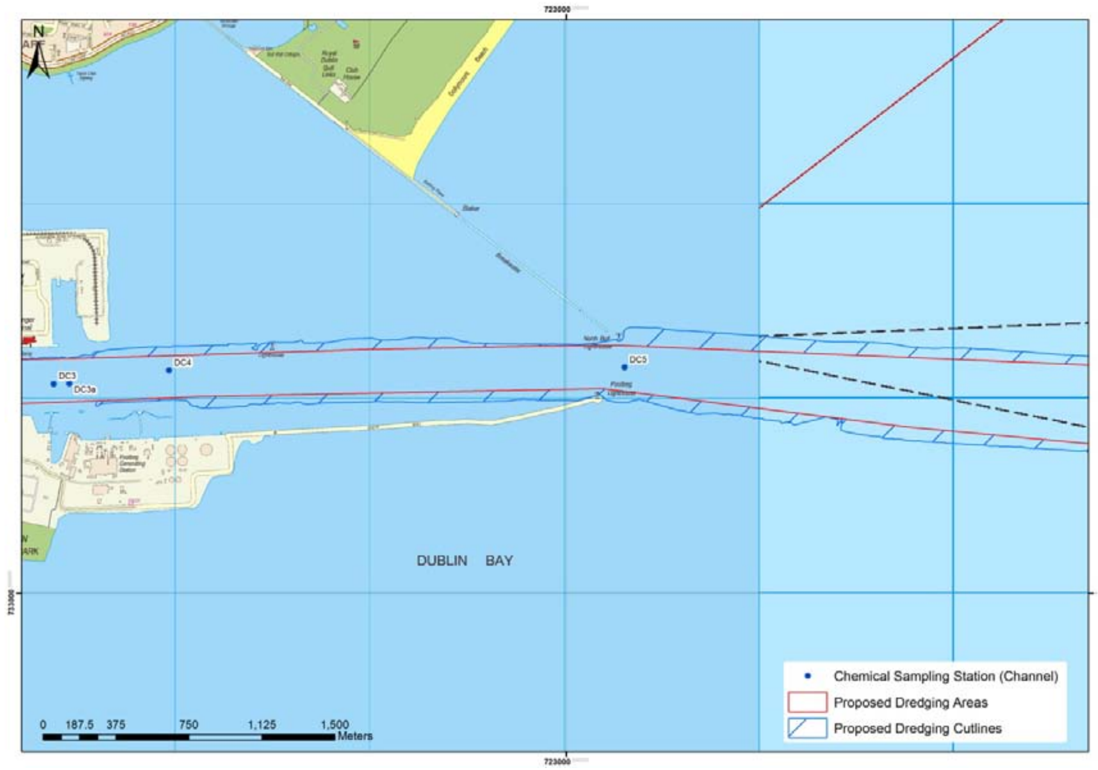


Figure F50 2013 Sampling Locations (as per Figure 11.3 of Chapter 11 of Volume 1 of EIS)

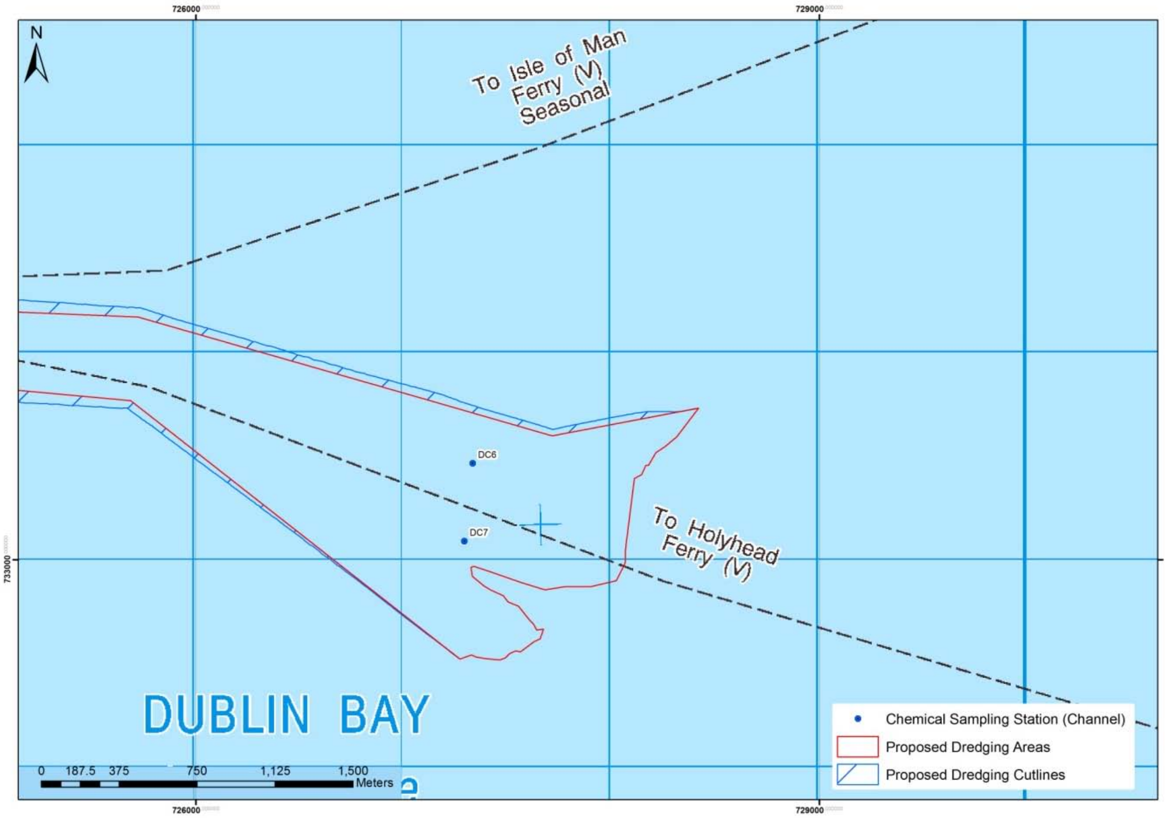


Figure F51 2013 Sampling Locations (as per Figure 11.4 of Chapter 11 of Volume 1 of EIS)

As part of the 2013 investigations, sampling within Alexandra Basin West was taken at depths of up to 4m below current bed level. Samples within the navigation channel and fairway were taken at depths of up to 2m below current bed level. It is considered that these depths are representative in respect of the capital dredge depth, as an average depth of approximately 2.5m is to be dredged from Alexandra Basin West, and an average of approximately 1.5m depth is to be dredged from the navigation channel.

The assessment of these samples identified three "zones" of material within the boundary of the proposed dredging campaign, namely:

- Moderately to severely contaminated
- Uncontaminated material
- Slightly to moderately contaminated

Moderately to Severely Contaminated Material

The assessment of the samples showed that the chemistry of the sediment in Alexandra Basin West varied from moderately to severely contaminated, at all depths and throughout the area of the Basin. On this basis the Marine Institute indicated that they would recommend to the EPA that none of the basin sediments would be permitted for conventional disposal at sea.

The sediment chemistry for the Liffey Channel and fairway showed that the concentrations of contaminants were similar to those seen in previous analyses (such as the regime undertaken in 2006 in support of the DPC Dumping at Sea Application submitted by Jacobs), with concentrations decreasing with distance downstream.

The Marine Institute subsequently advised that it would be reasonable at this stage to assume that similar conditions for dredging and sea disposal would be granted for the channel and fairway sediments.

Uncontaminated Material

Samples taken in the outer approaches and navigation channel showed the material to be uncontaminated. This material was therefore deemed suitable for disposal at sea (based on previous dredging campaigns).

Slightly to Moderately Contaminated Material

The assessment of the samples taken from the channel adjacent to Alexandra Basin West showed that the chemistry of the sediment varied from slightly to moderately contaminated.

In accordance with their current Dumping at Sea Permit (ref: S0004-01 issued on 28th July 2011 for a 6yr maintenance dredging campaign), DPC are permitted to dredge contaminated sediments from this area of the navigation channel, and dispose of these sediments subject to specific conditions (capping of contaminated material at the dump site with a 0.5m thick layer of clean coarse uncontaminated material yielded from the dredging campaign).

Figure F52 below is extracted from the supporting information supplied for the Dumping at Sea Application, and shows the extent of contaminated material and uncontaminated material (based on analysis of the 2006 testing regime).

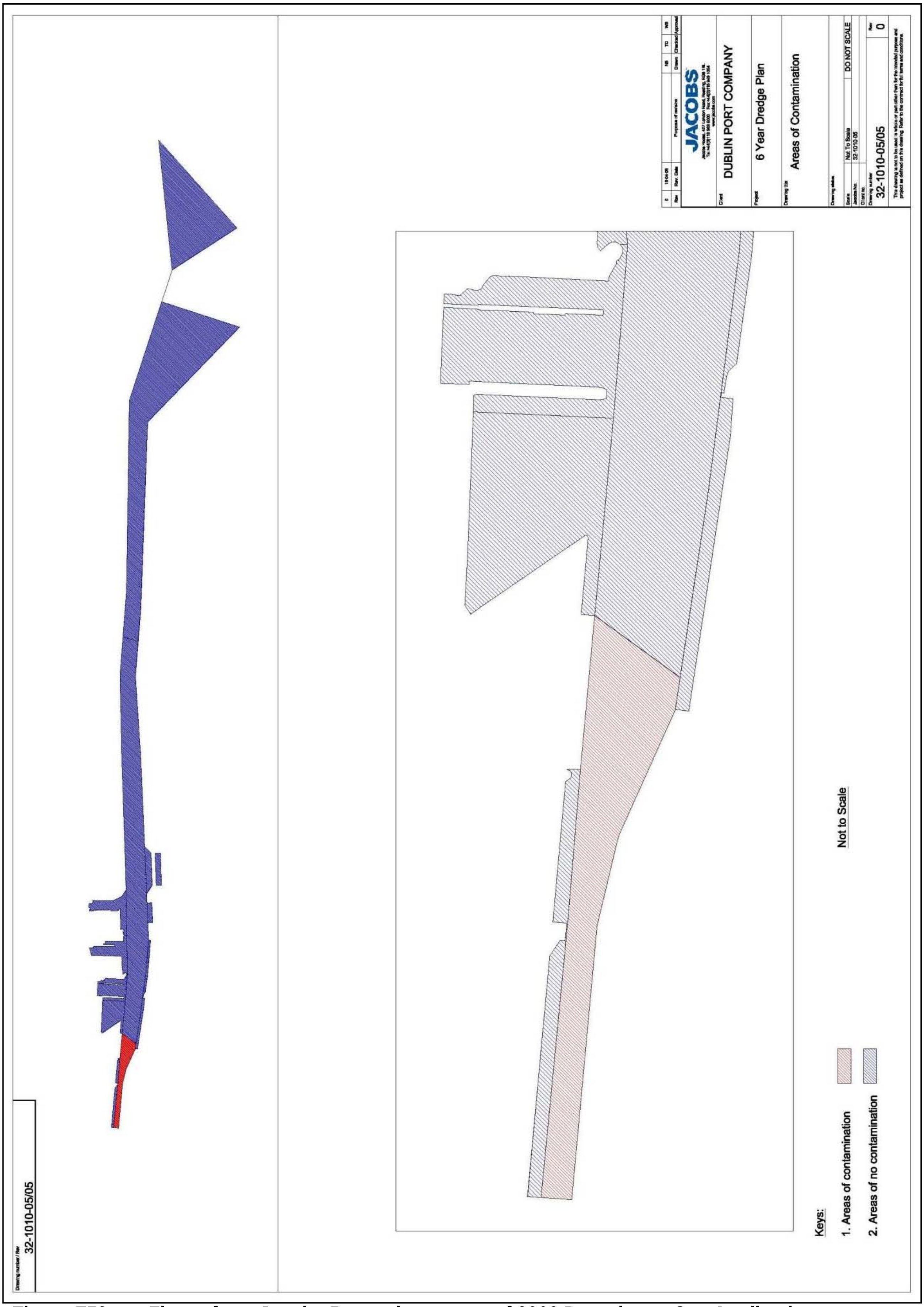


Figure F52 Figure from Jacobs Report in support of 2009 Dumping at Sea Application

On this basis therefore for the ABR project, a line delineating the boundary between slightly/moderately contaminated material and material suitable for sea disposal was developed. This area is shown in green on Figure F53 below (as per Figure 4.11 in Chapter 4, Volume 1 of the EIS).

A conservative approach was taken when positioning this boundary, locating it further downstream than the current permitted dumping at sea license permit (extent of which is shown on Figure 5 below in a blue dashed hatch). This assumes a buffer zone between clean and contaminated material in the navigation channel.

Prior to the commencement of dredging, further sampling and testing will be undertaken in accordance with a regime approved by the Marine Institute. This further testing will confirm the location of the delineation between material which is slightly/moderately contaminated and suitable for sea disposal.

Figure F53 below shows the following:

Heavily contaminated material requiring treatment prior to re-use as infill

(As per Figure 4.11 in Chapter 4, Volume 1 of the EIS)

Extent of contaminated silts dredged previously by DPC , deemed suitable for disposal at sea with conditions (i.e. capping of material at dump site)

Approximate extent of slightly/moderately contaminated material suitable for sea disposal with possible requirement for capping of material at the dump site

(As per Figure 4.11 in Chapter 4, Volume 1 of the EIS)

Area where further testing is required to confirm the location of the delineation between material which is slightly/moderately contaminated and suitable for sea disposal.

Testing to be undertaken in accordance with Marine Institute testing regime

(Area previously determined as non-contaminated material, Jacobs 2009 report prepared in support of DPC's Dumping at Sea Application- Figure 4 of this response)

Dredge material suitable for sea disposal

(As per Figure 4.11 in Chapter 4, volume 1 of the EIS)

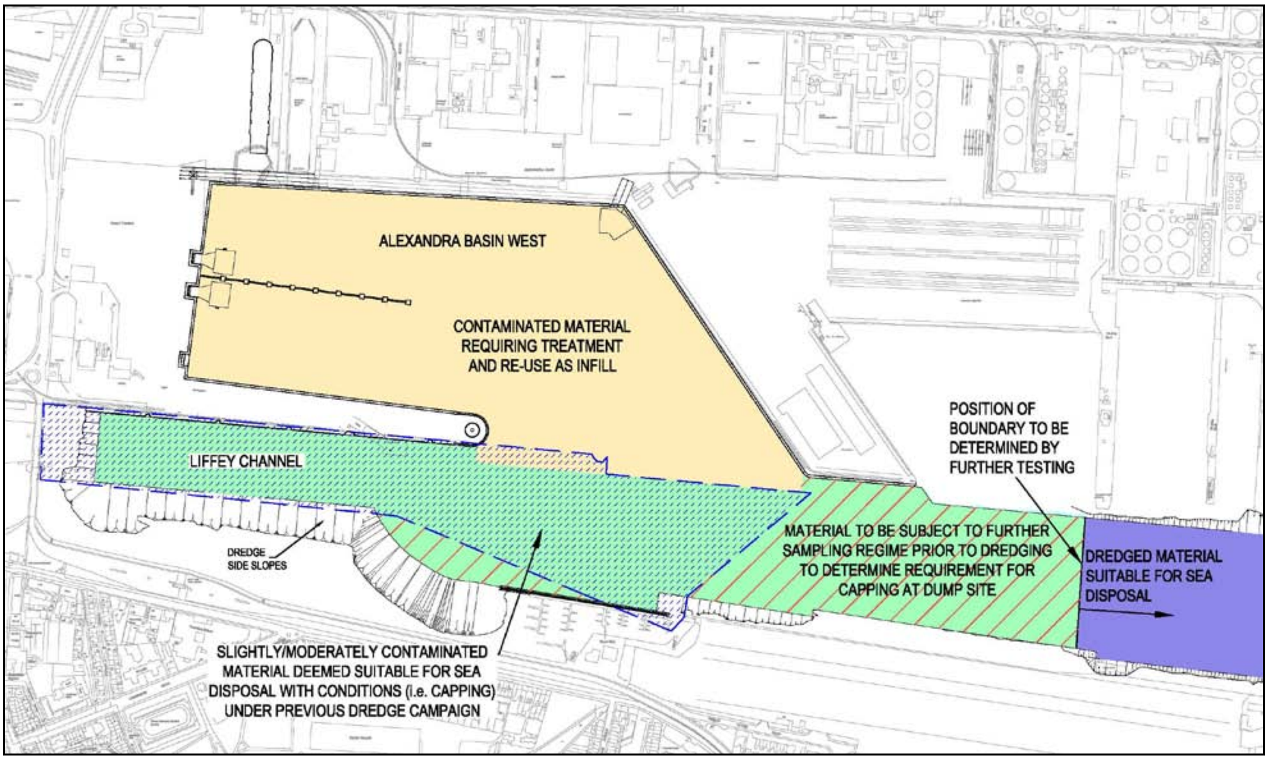


Figure F53 Extent of Contaminated Material

13.2 Consider alternate treatment options for moderately polluted sediments from the section of the Liffey channel located adjacent to the Alexandra Basin and provide details of a monitoring program that should be carried out to identify such sediments prior to dredging.

Response

For the slightly/moderately contaminated material in the navigation channel a number of alternatives were considered. An outline of these are presented below together with an outline analysis of each one.

1. **Dumping at Sea**
   As referenced in the response to RFI 13.1, under the current Dumping at Sea Permit (ref: S0004-01 issued on 28th July 2011 for a 6yr maintenance dredging campaign), DPC are permitted to dredge contaminated sediments from this area of the navigation channel, and dispose of these sediments at the dump site, subject to specific conditions (capping of contaminated material at the dump site with a 0.5m thick layer of clean coarse uncontaminated material yielded from the dredging campaign).

   There are a number of benefits associated with this approach, such as, there is no requirement for the dredged material to be brought ashore within the Port for treatment and/or disposal, there is no road traffic generated hence minimising the impact of the works on the general public and energy consumption is kept to a minimum.

   Furthermore dumping at sea is considered to be the most economical option for dealing with material of this nature and allows for the material to be dealt with in close proximity to the location where it arises.

2. **Filling to lands at Port**
   The areas of the Port which have been identified as requiring fill material are limited to Graving Dock #2 and Berth 52/53. Material within Alexandra Basin West has been identified as being heavily contaminated and unsuitable for disposal at sea (Section 5.1.4 of Volume 1 of the EIS). As such the material from Alexandra Basin has been proposed to be reused as fill material for Graving Dock #2 and Berth 52/53 after being solidified and stabilised. The processing and recovery of the heavily contaminated material will be subject to the appropriate authorisation from the Environmental Protection Agency (EPA).

   The recovery and reuse of material as fill material for works identified within the Port is technically feasible and is consistent with European and national policy objectives to reduce the amount of waste disposed to landfill. However, the capacity of Graving Dock #2 and Berth 52/53 for infilling is limited. This will be largely used by the material generated by the dredging of Alexandra Basin West, due to bulking from the introduction of additives during the solidification/stabilisation process.

   Hence there is no further capacity at these locations to receive the slightly/moderately contaminated material from the navigation channel.

3. **Landfilling of material**
   The number of non hazardous landfills in Ireland accepting waste for disposal is continuing to decrease, as is the remaining licensed landfill disposal capacity. In order to take this material to landfill it would have to be brought ashore within the port, dewatered and transferred onto road transport. This would have an increased impact on the environment in terms of traffic volumes, nuisances to the general public, time to complete the works, the need for additional space within the port to handle the dredged material and associated dewatering activities when compared to the dumping at sea proposal outlined above.

   Furthermore the energy consumption associated with the transport of this material to a landfill site, and the cost of disposal to landfill, would be significantly greater than the option proposed in the EIS.

4. **Export of Material**
   The slightly/moderately contaminated sediments could be treated and transported for disposal abroad, however the volumes involved are large (approx. 500,000m^3). This area of the navigation

channel consists mainly of silt. Therefore, there is minimal reusable material that could be separated from the slightly/moderately contaminated material for reuse without treatment.

Given the large volume of slightly/moderately contaminated material, the cost associated with this option would be prohibitive and the energy consumption associated with exporting the material would be significantly greater than the disposal option proposed in the EIS.

In addition, as with the landfilling of dredged material, the time to complete the works, the need for additional space within the port to handle the dredged material and associated dewatering activities are all additional impacts when compared to the proposed option of controlled Disposal at Sea.

Based on the above analysis and as outlined in Section 11.2.4 of Volume 1 of the EIS, dumping at sea and capping with dredged gravels is considered the most appropriate method for dealing with the slightly/moderately contaminated material. Disposal of this dredged material to the licensed dump site will require an application for a Dumping at Sea Permit from the EPA.

13.3 Provide a timescale for dredging works in the Basin, a risk assessment and an emergency plan in the event of an accident, spillage or containment breach.

Response

The programme for the construction phase of the ABR project is discussed in Section 4.2.1 of Volume 1 of the EIS. In addition, a project programme is provided as Appendix 4 in Volume 2 of the EIS. The dredging of the Alexandra Basin West according to the project programme (Appendix 4 of Volume 2 of EIS) will take place from Quarter 4 of 2017 and extend until end of Quarter 2 of 2019.

A dredging risk assessment has been carried out which discusses the risk of spillage occurring when dredging the Alexandra Basin West. This dredging risk assessment is provided as Appendix 3 of the Draft High Level Construction Environmental Management Plan which is being submitted as a separate report as part of the RFI response.

Dublin Port Company (DPC) has an existing Emergency Management Plan (EMP) in place. The EMP is designed to provide guidelines to the DPC for responding to an emergency within their area of jurisdiction. As such the EMP is designed to cater for both marine and land based emergencies and the plan outlines the DPC structures and arrangements for responding to emergencies that may occur within Dublin port. As the structures and arrangements are well defined, this EMP will be adhered to during the construction phase of the Alexandra Basin Redevelopment and as such it will cover the dredging works in the event of an accident, spillage or containment.

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14. Channel dredging

14.1 The coastal process models assume that dredging operations would take place evenly over a 6 year period and that dredge disposal would take place 24/7 during each 6 month winter dredging campaign. In the event that operations take place during normal working hours (Monday to Friday, 9am to 5pm) the available time for dredging and dredge disposal would be reduced. Furthermore, the EIS and NIS mitigation measures (in relation to the protection of marine mammals) impose further restrictions on the time available for the commencement of daily dredging and dredge disposal operations. Any significant reduction in available time could either extend the overall dredging timetable or give rise to the dredging and disposal of increased concentrations of material which could in turn have implications for benthic communities, water quality, sediment transport and marine mammals.

Response

The dredging rates specified in the Chapter 9 Volume 1 of the EIS are based on standard dredging industry vessel operating hours, taken as 168 hours per week (24 hours per day, 7 days per week). Furthermore, the operating hours assumed in the study have been based on dredging rates at which numerous past and present dredging operations have been undertaken over a number of decades - the rates also account for stoppages in the dredging operations that may result from adverse weather conditions.

It is also important to dredge on a 24/7 basis due to the magnitude of the proposed redevelopments coupled with the potential risks of weather delays. Furthermore, the proposed 24/7 operations will also allow the contractor to complete the project in the shortest time possible and in turn minimize local disturbances and the overall impacts to the surrounding environment. As such, it is unrealistic and unnecessary to consider a scenario in which the dredging operations were restricted to normal construction working hours.

14.2 Confirm the anticipated time period and operational hours for dredging and dredge disposal. The coastal process models should be re-calibrated to take account of any <u>significant</u> changes to the timescale. This information is required to enable the Board to assess the potential adverse effects of the proposed works on coastal processes and marine ecology.

Response

As specified in Chapter 9 Volume 1 of the EIS, for the purpose of this study it was assumed that that the volume of dredging would be spread relatively evenly over a six year period with an average volume of circa 0.177million m^3 dredged per month. It was also assumed that the dredging would be undertaken on a 24/7 basis with barges disposing of the material over the dump site on a regular basis throughout each winter dredging campaign.

It should be noted that the channel dredging at the rate proposed for this project has already been undertaken during various previous maintenance dredging campaigns without creating any environmental issues.

Both the direct and indirect impacts of the proposed dredging operations as well on the flora and fauna, along with the appropriate mitigation measure are already addressed in full in Chapter 5 Volume 1of the EIS.

14.3 The EIS and NIS refer to potential future dredging of berths to a depth of -15m CD. However this future dredging and the likely future channel deepening that would be required to provide vessel access to the deepened berths has not been addressed in the EIS or NIS. Comment on the likely potential environmental impacts arising from any future dredging to a depth of -15m CD, including any effects this might have on the submarine pipeline under Dublin Bay which brings wastewater from North Dublin to Ringsend for treatment.

Response

The ABR Project has been designed to future-proof the Port given the strategic importance of Dublin Port and its infrastructural assets. The level of the new quays and berths has been designed to accommodate predicted increases in water level by the year 2100 as a result of climate change (Volume 1 of the EIS, Chapter 10, Section 10.5). The piles used to form the quay walls have been designed, with appropriate corrosion allowance incorporated into the design of the piles and a suitable maintenance regime, for a lifespan of over 50 years.

The pile lengths have been designed to accommodate potential future dredging of the berthing pockets, up to -15m CD. Given the cost of piling, it was considered prudent to sink the piles to this depth in order to facilitate future deeper berths. This was considered sensible in order to future proof these critical assets for future generations. The submitted EIS and NIS address the issue of piling as such. It is not known at this stage whether future dredging of the berths to -15m CD will be required.

DPC's approach to future proofing is similar now to what it proposed in a previous application to An Bord Pleanála (PL29N.PA0007). The inspector's report on this application noted in Section 10.1.2.5 that:

> *Building in a design flexibility to allow for possible future deepening, subject to market requirements, and which would also be subject to further appropriate statutory consents, is, in my view, a perfectly reasonable way to proceed. In this regard I am also satisfied that there is no issue of project-splitting involved.*

DPC believes that this approach remains appropriate in the context of the ABR Project.

An analysis of the size of ships across all modes was undertaken to allow Dublin Port Company to take a view on the reasonable maximum size ship that the Port should cater for in the coming decades (Volume 1 of the EIS, Chapter 1, Section 1.2). The results of this analysis show that there is no intention or requirement to dredge the navigation channel deeper than -10m CD for the foreseeable future. The cumulative impact of dredging to -15m CD is therefore not a consideration at this stage.

The Masterplan does, however, state that future capital dredging of the Port's approach channel from -10m CD to -12m CD may take place within the lifespan of the Masterplan (prior to 2040). This will only be needed should there be a further significant increase in the draughts of ships calling to Dublin. Any future capital dredging works to -12m CD would constitute a major new project and would be the subject of statutory consent including the preparation of an EIS and NIS.

The submarine pipeline under Dublin Bay which brings wastewater from North Dublin to Ringsend for treatment is shown on Planning Drawing IBM0498-CH-006. The level of the top of the pipeline is -15.7m CD. The currently proposed channel dredging to -10m CD would have no impact on this pipe. Nor also would any possible future dredging to-12m CD.

The proposed demolition of part of the North Wall Quay Extension necessitates the removal of the 220kV cable crossing of the River Liffey shown on Planning Drawing IBM0498-CH-002. The replacement cable is required to maintain the connection between the Poolbeg and North Wall Power Stations.

The construction of the replacement cable will, however, occur within the timeframe of the ABR Project and therefore in-combination effects were considered through engagement with ESB and Eirgrid.

With regard to the separate, though associated, replacement 220 kV cable crossing of the River Liffey, the specific, nature, extent, location and construction methodology of this has yet to be confirmed and will be the subject of a separate future proposal for Statutory consent. It is therefore not possible for the cumulative impact of the proposed development and the separate associated cable crossing development to be established and quantified.

14.4 Clarify the future maintenance dredge requirements for the Port in respect to the navigation channel (e.g. please provide an estimated annual average dredging volume for disposal).

Response

As specified in Chapter 9 Volume 1 of the EIS, it is expected that the new channel will require maintenance dredging of a similar magnitude to that required with the existing channel - this currently a value of *c*. 1,000,000m^3 per every six years.

References (Section F)

Bedri *et al*. (2011). A Three-Dimensional Hydro-Environmental Model of Dublin Bay. *Environmental Modelling & Assessment.*

DHI (2006). Dublin Waste to Energy Project, Numerical Modelling of Cooling Water to River Liffey

DHI (2010). Ringsend Waste Water Treatment Plant, Long Sea Outfall, Dublin Bay

John *et* al. (2000) Scoping the Assessment of Sediment Plumes from Dredging. *CIRIA publication 547*

OPW, ICPSS, Phase 3, Work Packages 2, 3 & 4A (2010) Strategic Assessment of Coastal Flooding and Erosion Extents – North East Coast - Dalkey Island to Meath.

APPENDIX A

REPORT ON UNDERWATER NOISE

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1. INTRODUCTION

1.1 BACKGROUND

RPS were requested by Dublin Port Company (DPC) to carry out measurements of underwater noise from pile driving activities at Alexandra Basin East in June 2014. The target of the study was to determine the ensonification of the underwater environment (i.e. acoustic noise) during pile driving in the Alexandra Basin Eastand wider Dublin Bay area.

Piling activity was being carried out at Alexandra Basin East under a foreshore licence MS 51/4/462.

Acoustic measurements of the source were carried out using hydrophones deployed from a vessel during piling activity on two days; the 19th and 26th of June 2014 in Dublin Port. This report presents underwater noise level results for the range 70 m to 11,000 m from the source during piling; as well as background noise measurements.

The impulsive sound from the piling was quantified and reported using the sound exposure level (SEL), zero-to-peak sound pressure level (Peak SPL), the root-mean-squared sound pressure level (rms SPL) and power spectrum density plots.

The objectives of the study were to:

- Determine the acoustic signature of the pile driving
- Determine the underwater noise impact of the piling activity; and
- Estimate the potential impacts on two recreational diving sites and the wider bay area including the Dublin Bay Special Area of Conservation, Dublin Bay Special Protection Area and the Rockabill to Dalkey to Special Area of Conservation

1.2 SITE DESCRIPTION

The Alexandra Basin East site is located on the east coast of Ireland within the Dublin Port Estate, Dublin. The Alexandra Basin area comprises two main basins, Alexandra Basin East and Alexandra Basin West. Dublin Port is the largest port in Ireland. Dublin Port Estate comprises an area of circa 260 hectare spanning both the North and South banks of the River Liffey. The ABR site is located within the navigation channel and fairway from Dublin Port into Dublin Bay. The location of the pile driving is shown in **Figure 1.1**.

This study relates to underwater noise measurements that were undertaken during a period of piling activity being carried out at Alexandra Basin East (ABE), (see **Figure 1.1** for piling location). This data and an underwater noise model have been utilised to estimate the potential impact of proposed piling activity at Alexandra Basin West, which is located further upstream than Alexandra Basin East (indicated by Alexandra Basin in **Figure 1.1**).

Figure 1.1 - Alexandra Basin Region site showing location of pile driving

1.3 CRITERIA CHOSEN FOR THIS REPORT

1.3.1 Underwater Noise Levels

A Sound may be defined as the periodic disturbance in pressure from some equilibrium value. Underwater noise is measured in decibels (dB). Sound pressure is actually measured in Pascals. The unit of pressure is given in Pascals (Pa) or Newton per square metre (N/m^2). In order to avoid dealing with a very large range of numbers, i.e. from 0.00002 Pascals to 20,000 Pascals the logarithmic decibel scale is used. This simplifies the same range of numbers, by setting up a logarithmic scale based on a reference pressure.

For historical and scientific reasons the reference pressure chosen for airborne noise is not the same as that chosen for underwater noise. This means that there is no DIRECT relationship between decibels in air and decibels in water.

decibels in Air ≠ decibels in water

Quoted (peak) source levels for underwater noise sources are quoted in dB re µPa at 1 metre. This is a 'notional' figure extrapolated from far field measurements as it is not practicable to measure sound levels at 1m from an active source such as a ship or a pile-driver. Measurements are taken in what is known as the far field and extrapolated back to a notional 1m (horizontal distance) from the idealised point source. It is usual to take measurements at several hundred metres or kilometres in deep water and extrapolate the measured levels to what has become known as a 1m source level. This is illustrated in **Figure 1.2.** The actual propagation of sound in the near (Fresnel) field produces an undulating curve, but the extrapolated dashed line produces a much higher source level (I0).

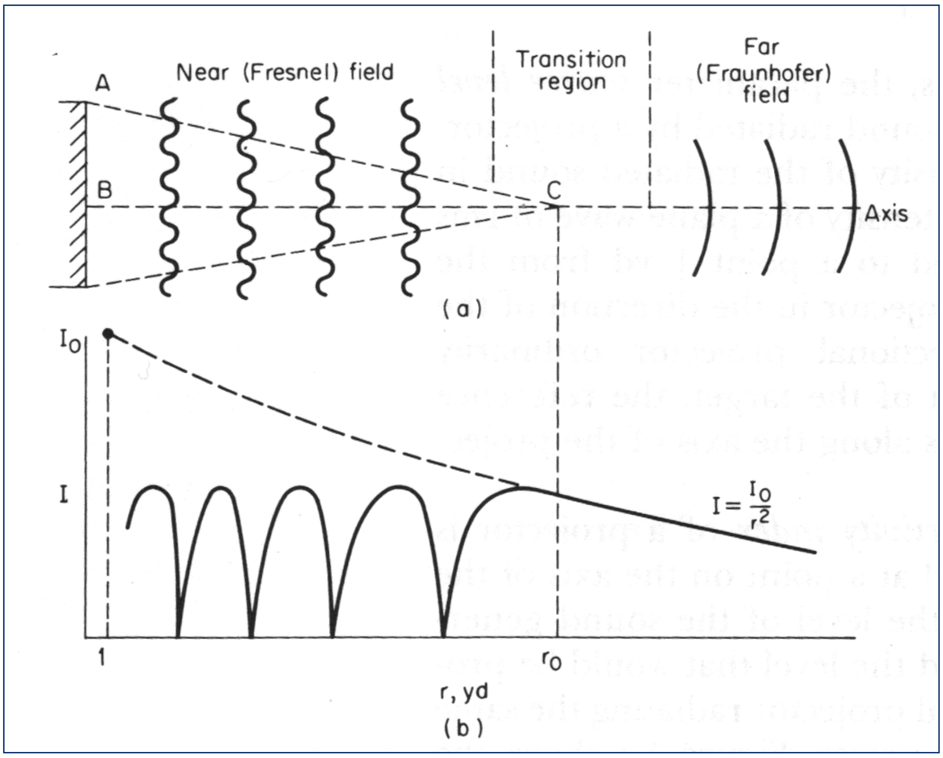

Figure 1.2 - Extrapolation for evaluating Underwater Noise source levels (Urich 1983, Fig. 4.2).

This extrapolation leads to apparently high values for the source level and can lead to erroneous conclusions about the impact on marine mammals and fish for the following reasons:

- Far field source levels do not apply in the near field of the array where the sources do not add coherently; sound levels in the near field are, in fact, lower than would be expected from far field estimates.
- Source level calculations are generally based on theoretical point sources with sound propagating equally in all directions. This is not easily replicated in real world conditions.
- The majority of published data for underwater sources is based on deep water exploration. Sound propagation in shallow water is significantly more complex and sound does not propagate as efficiently as it would in deep water.

As indicated previously underwater noise is referenced to a different pressure value so decibels underwater do not correspond to decibels in air. A table of typical underwater noise levels is set out below in **Table 1.1**.

Table 1.1 Typical Underwater Noise Levels

Source	SPL dB re: 1µPa @ 1m	SEL dB re: 1µPa^2-s	Sound Duration seconds	Peak Frequency Hz	Band Width Hz
Super Tanker 337m long @ 18 knots	185	-	constant	23	5-100
Drilling (Ship/Semi-submersible)	145-191	-	constant	-	1-600
Dredging (Suction/Hopper dredge)	177	-	constant	80-200	20-8,000
Acoustic Harassment Device (AHD)	185	185	0.5-2.0	10,000	600
Tug vessel (while towing)	145-170	-	constant	-	37-5,000
Wind turbine (power output - 1MW)	142-153	-	constant	16	15-20,000
Fishing vessel (12m long @ 7 knots)	150	-	constant	300	250-1000

***Table adapted from NPWS Guidelines, December 2013**

1.3.1.1 Pile Driving

There are essentially 3 types of pile driving used in construction; (a) impact pile driving, (b) vibratory pile driving and (c) auger piles. Auger piling comprises a drilling process where the pile effectively ‘lines’ the excavated hole until the desired depth is reached; it is suited for soft ground which is easily extracted. Auger piles provide a relatively quiet means of installing piles where ground conditions are suitable. Vibratory pile driving is normally used for sheet piles, which are thin overlapping sheets, and is similar to rock-breaking in implementation. A hydraulic driver provides small vibratory movement to the pile in combination with a static weight which forces the pile through the ground. Impact pile driving comprises the use of a drop weight or equivalent force transmitting a downward blow to the pile until target resistance is met. It is the noisiest form of piling. The pile driving source in this case was an impact pile driver.

Underwater noise levels arising from pile driving have been extensively studied, in particular for the installation of offshore wind turbines. While the data for offshore wind-farms is useful it must be put in context. Offshore wind farms are typically installed on 4 to 6m diameter piles in relatively deep water. The energy required to drive a pile is proportional to the square of the diameter of the pile. In this project we are proposing to use piles no greater than 900mm in diameter with a consequent reduction in source level.

For pile driving the criteria is generally quoted with reference to SEL. This is due to the impulsive nature of the sound and more accurately reflects the total energy transmitted to the water body in pile driving.

Noise source level data for piling is quite complex as different parameters are often reported. One of the most widely accepted sources of information on pile driving noise levels is the Compendium of Pile Driving Sound Data compiled by Reyff (2007). This compendium reports 10m peak sound pressure levels of 208 to 210 dB re 1 µPa for 0.9 to 1.5m diameter piles when impact driven and 175 to 182 dB re 1 µPa for sheet piles when driven by a vibratory driver. The reduction in noise level is due to the lower energy required to drive a sheet pile and the change in driver to a vibratory machine.

A report prepared by URS Consultants for construction work in Darwin Harbour indicates a spectrum level in the range 185-210 dB re 1 µPa for a 1.5m impact pile driver with a peak frequency in the 200 to 500 Hz region.

Studies by Thomsen et al. (2006), Southall et al. (2007) for example, provide detailed reviews of the metrics used to measure and assess the impact of underwater noise in the marine environment. Unfortunately no uniform standards have been internationally agreed on underwater noise metrics to date.

The most comprehensive approach to date has been proposed by De Jong et al (2011) who have provided clarification on appropriate metrics, from which a brief overview is provided below. This draft standard is being increasingly adopted across Europe, by professional bodies and academics.

2. METHODS

2.1 MEASUREMENT LOCATIONS

The locations of the noise measurements are shown in **Figure 2.1**. Two measurements were made in the Wider Dublin Bay at either side of the Bay (S1 and S2). Noise measurements were also made at four stations (A-D) in Alexandra Basin East: along a transect **(Transect 1)** from the piling location in the ABE, across the channel to the opposite pier (**Figure 2.2**). Measurements were also made at three stations (D-H) in the River Liffey Channel: along a transect **(Transect 2)** starting upriver from the source and continuing parallel to the channel, to Location H (near the North Bull Light) 3.5 km from the source (**Figure 2.2**). Measurement locations were located just north or south of the navigation channel for safety reasons. Station D is common to both transects.

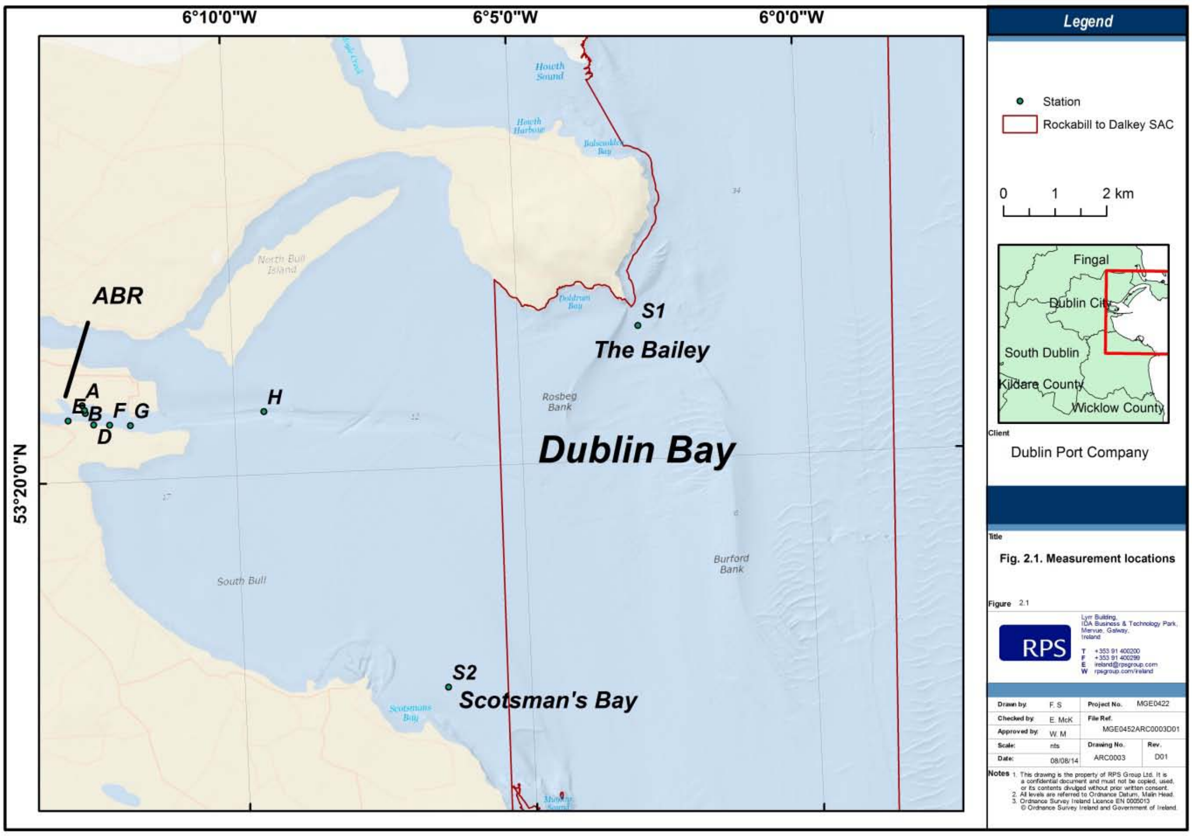

Figure 2.3 - Measurement Locations

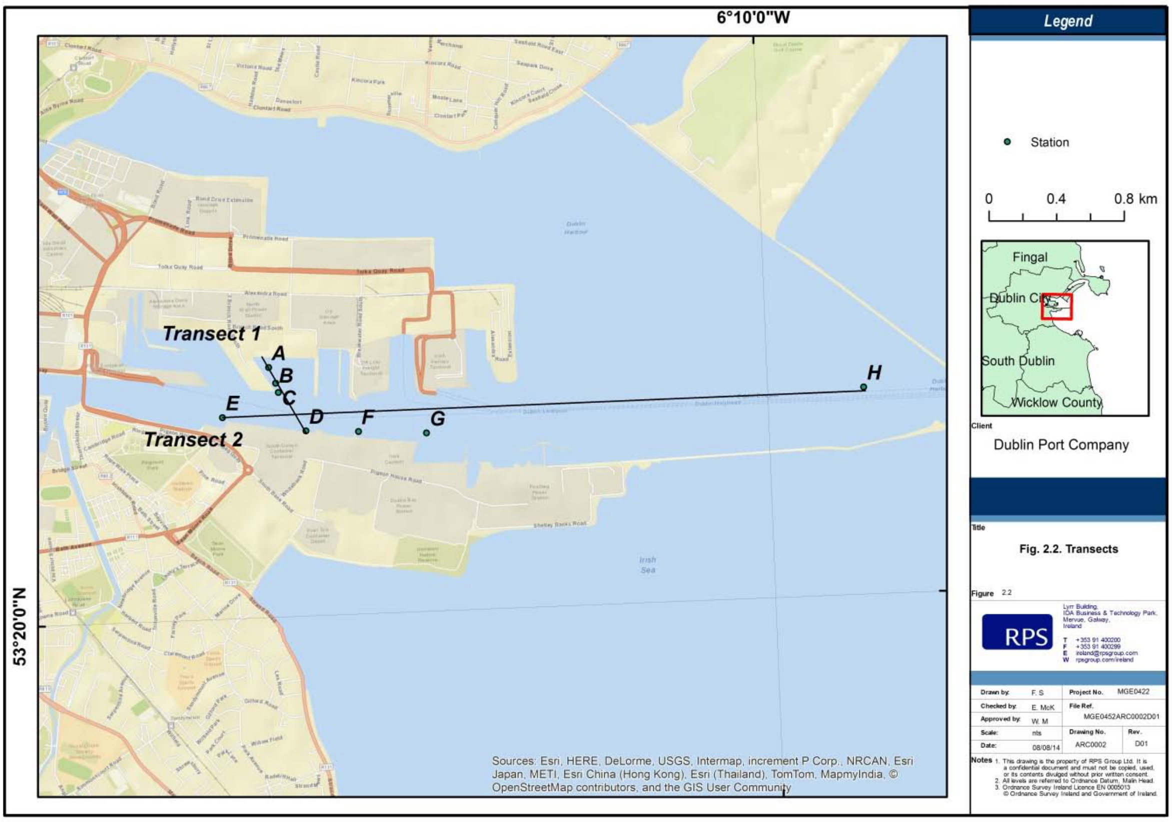

Figure 2.4 – Measurement transects

2.2 THE SOUND SOURCE

2.2.1 Pile Driving

Pile driving emits a low-frequency impulsive sound with peak energy between 100 and 200 Hz (OSPAR, 2009). Source levels from pile driving activity depends on many factors and levels as high as 243–257 dB (P-P) re 1 μPa at 1 m (Nedwell et al., 2004) have been reported. Source levels are dependent on a number of factors including the diameter of the pile. Smaller piles tend to have higher frequency noise emissions. **Figure 2.1** illustrates the typical impulsive nature of pile driving.

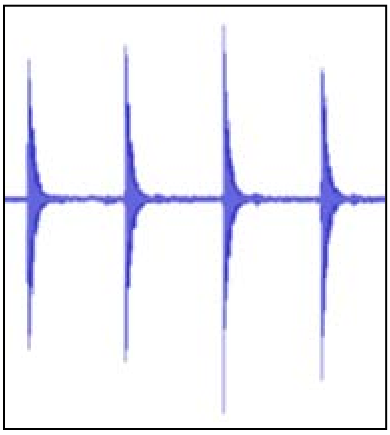

Figure 2.5 – Typical impulse generated by pile driving

2.3 DATA ACQUISITION

The hydrophone was suspended at a depth of approximately 5 m below sea level using a combination of floats and weights to provide heave compensation. The survey vessel's engines and other equipment that might have interfered with measurements, such as an echo sounder, were switched off and the boat was allowed to drift to minimise flow noise. The hydrophone output was examined before recording began to ensure that self-noise caused by cable strum, own-ship noise and electrical interference was at a minimum.

Sound recordings were made using a Geospectrum Technologies M8 broadband hydrophone and recorded directly onto a laptop computer using an Avisoft USG signal acquisition system. Data were in the form of WAV files providing a continuous audible record of the noise events. Sampling was at 48,000 Hz.

Noise recordings were taken at 10 locations from 70 m from the piling operation out to a range at which the sound could no longer be distinguished from background noise (**Figure 2.1-2.2**). Recordings were also made near two diving sites in the outer Bay, one of which is located in the Rockabill to Dalkey SAC (S1 in **Figure 2.1**). A GPS position was taken for each recording.

The measurements were made under favourable conditions, leading to good signal to noise ratio over a frequency range that included the piling noise energy. For each of the measurement locations the Sound Exposure Level (SEL), Peak Sound Pressure Level (PEAK SPL) and Root-Mean-Square Sound Pressure Level (RMS SPL) were calculated and are reported in the results.

2.3.1 Calibration

Three separate calibration mechanisms were employed:

- Manufacturer's calibration certificate issued at purchase.
- Field calibration using a Bruel & Kjaer Hydrophone type 4223 calibrator: carried out before and after each set of measurements and cross-checked with a Bruel and Kjaer type 2250 sound level analyser.
- Voltage injection calibration at a range of frequencies: 250.12 Hz, 500 Hz and 1 kHz.

2.4 DATA ANALYSIS

Post-analysis was carried out using Matlab's Signal Analysis Toolbox. Noise measurements were divided into three categories:

1. Locations where piling noise was the dominant noise
2. Locations where piling noise was inaudible
3. Locations in the ABE area when piling noise was not taking place

Where piling noise was present SEL was the primary metric, where piling noise was not evident SPL was the primary metric. In both cases Peak SPL and Power Spectrum Density were also reported.

2.4.1 Acoustic Metrics

This report utilises the standards and definitions set out by De Jong et al. (2011).

2.4.2 Sound Exposure Level (SEL)

The problems associated with the time period over which the Sound Pressure Levels are averaged, as highlighted above, can be overcome by describing a transient pressure wave in terms of the Sound Exposure Level (SEL). The Sound Exposure Level is the time integral of the square pressure over a time window long enough to include the entire pressure pulse. The Sound Exposure Level is therefore the sum of the acoustic energy over a measurement period, and effectively takes account of both the level of the sound, and the duration over which the sound is present in the acoustic environment. Sound Exposure (SE) is defined by the equation:

$$SE = \int_0^T p^2(t)\,dt$$

where p is the acoustic pressure in Pascals, T is the duration of the sound in seconds and t is time. The Sound Exposure is a measure of the acoustic energy and therefore has units of Pascal squared seconds (Pa^2s).

To express the Sound Exposure as a logarithmic decibel, it is compared with a reference acoustic energy level of 1 μPa^2s. The Sound Exposure Level (SEL) is then defined by:

$$SEL = 10\ \mathrm{Log}_{10} \int_0^T p^2(t)\,dt / {P_{ref}}^2$$

SEL values were calculated on the time interval between piling strikes.

2.4.3 Peak Sound Pressure Level (PEAK SPL)

For transient pressure pulses such as an explosion or a single discharge of an airgun, the peak sound level is the maximum absolute value of the instantaneous sound pressure recorded over a given time interval. Hence:

$$\text{Peak Level (zero-to-peak)} = 20 \times \log_{10} (P_{peak} / P_{ref})$$

When the pulse has approximately equal positive and negative parts to the waveform, the peak-to-peak level is often quoted and this is equal to twice the peak level or 6 dB higher.

2.4.4 RMS Sound Pressure Level (RMS SPL)

The Root-Mean-Square (RMS) Sound Pressure Level is used to quantify noise of a continuous nature. Underwater sound sources of this type include shipping, sonar transmissions, drilling or cutting operations, or background sea noise. The RMS Sound Pressure level is the mean square pressure level measured over a given time interval (t), and hence represents a measure of the average sound pressure level over that time. It is expressed as:

$$\text{RMS Sound Pressure Level} = 20 \times \log_{10} (P_{RMS}/P_{ref})$$

Where RMS Sound Pressure Levels are used to quantify the noise from transients, the time period over which the measurements are averaged must be quoted as the RMS value will vary with the averaging time period. Where the noise is continuous, as in the examples given above, the time period over which measurements are taken is not relevant as the measurement will give the same result regardless of the period over which the measurements are averaged. For this report the averaging time period has been taken as 125 milliseconds. This is in line with ‘fast’ weighing as defined in ISO 80000.

2.5 MODEL

2.5.1 Shallow Water Noise Models

Many forms of noise model are available for underwater propagation. The complexities of a shallow water environment require significant modelling effort and simplified spherical or cylindrical propagation rules do not apply. The complex interaction between the seabed and sea surface mean that propagation paths are not coherent and significant attenuation occurs as a result. Different approaches range from Marsh-Schulkin to Finite Element Modelling (FEM) in terms of calculation complexity. Modelling of pile driving as a source is also complex due to the nature of the activity (Reinhall & Dahl, 2011). While an FEM approach is suitable in close proximity to the source greater ranges make FEM impractical due to computational complexity.

With the availability of validated industry standard approaches Normal Mode (NM), Fast-Field Programs (FFP) and Parabolic Equation (PE) models based on a contour integral representation of the acoustic pressure have become increasingly popular in deriving long range solutions. FFP models evaluate the integral directly by stepping along the contour. The normal mode series neglects certain contributions which tend to be important in the near-field. Recent work (Lippert & Lippert, 2012) has validated an FFP approach with reference to an FEM model.

2.5.2 Scooter Model

For this report an FFP model based on the SCOOTER code was used. SCOOTER is a finite-element FFP code for computing acoustic fields in range independent environments with fluid/elastic seabeds (Etter, 2013). It is both more accurate and more reliable than the normal mode method and is the preferred technique for low frequency, short range, range independent problems. It is, however, much more computationally intensive than normal modes for long-range problems, and the computational load increases rapidly with increasing frequency.

The method is based on direct computation of the spectral integral (reflectivity or FFP method). Pressure is approximated by piecewise-linear elements as are the material properties. (One exception is the density which is approximated by piecewise constant elements).

2.6 MODEL CONSTRUCTION

In order to predict noise levels occurring at the Rockabill to Dalkey SAC the model was created to produce transmission loss predictions for a transect of 18 km (M1 to M2 on **Figure 2.4**).

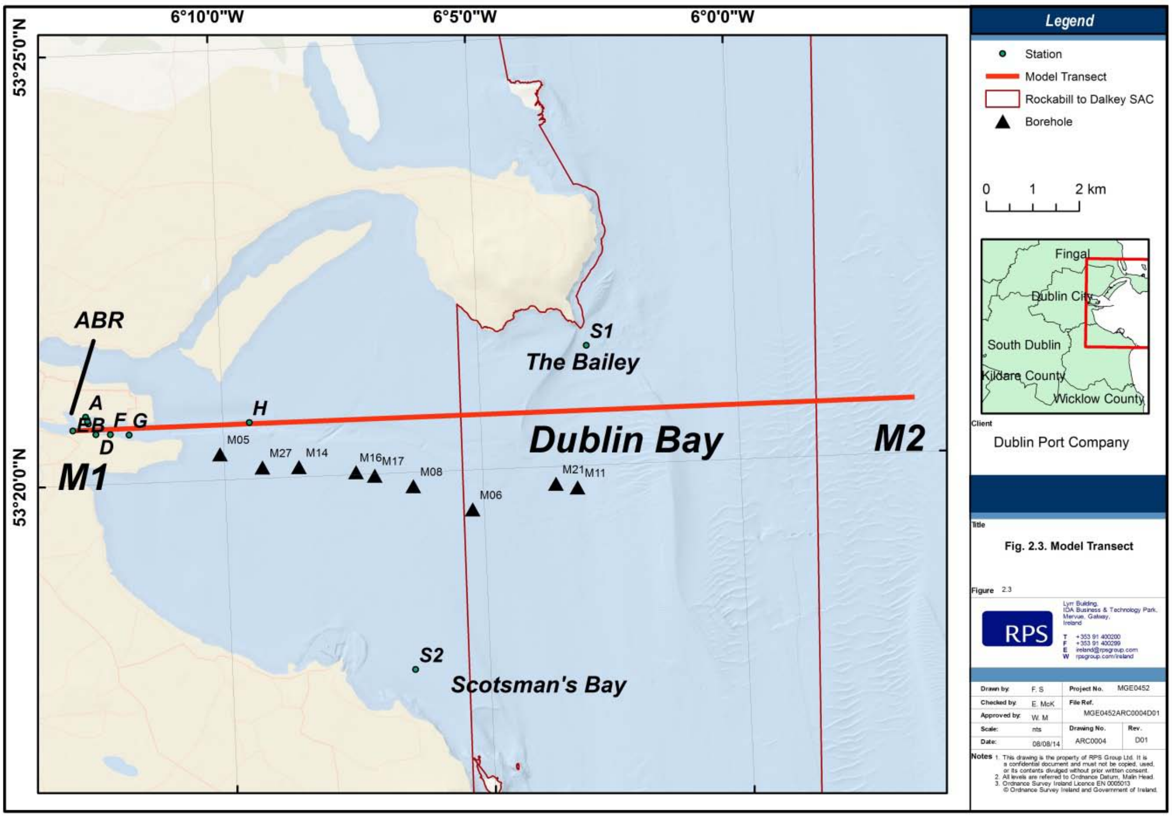

Figure 2.6 - Model Transect from M1 to M2.

Stratigraphic logs of a series of boreholes located in Dublin Bay (**Figure 2.4**) were examined to understand the underlying geology of the area. The thicknesses and geoacoustic properties of the layers inputted into the layered model were based on this information (**Table 2.1)**.

Table 2.2 Seabed Geoacoustic Parameters Used for the Model

Geoacoustic Parameters
***Silt layer*: 1.5 m thick, top: cp = 1500 m/s, ρ = 1000 kg.m-3 bottom: cp = 1575 m/s, ρ = 1700 kg.m-3**
Coarse sand: 3.5 m thick, cp = 1750 m/s, ρ = 1950 kg.m-3
Gravel: 16.3 m thick, cp = 1800 m/s, ρ = 2100 kg.m-3
Clay: 5.7 m thick, cp = 1575 m/s, ρ = 1700 kg.m-3
Gravel: 6 m thick, cp = 1800 m/s, ρ = 2100 kg.m-3
Limestone half-space: cp = 1800 m/s, ρ = 2100 kg.m-3

3. MEASUREMENT RESULTS

3.1 SOUND SOURCE CHARACTERISTICS

The noise signal profile from piling at Location A is shown in **Figure 3.1**, indicating clearly the impulsive nature of the noise. This can be compared with **Figure 3.2** indicating the noise profile for the same duration at Location H. At Location H, located 3.5km from the source there is no trace of the impulsive pile driving noise.

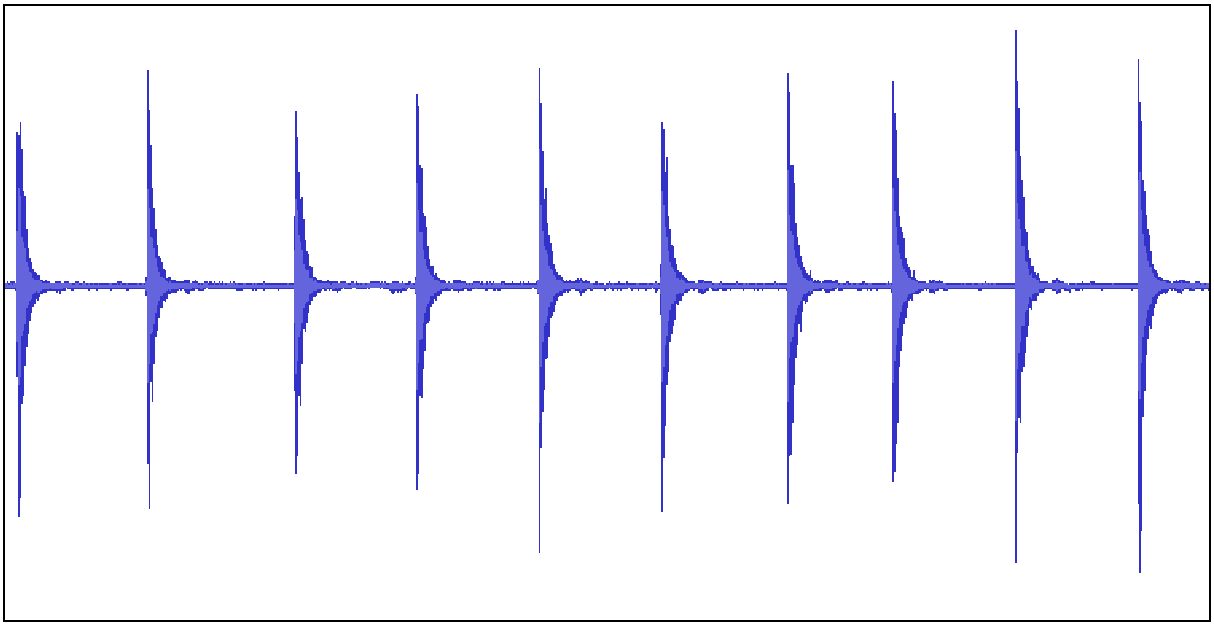

Figure 3.7 - Typical impulsive pile driving noise profile at Location A

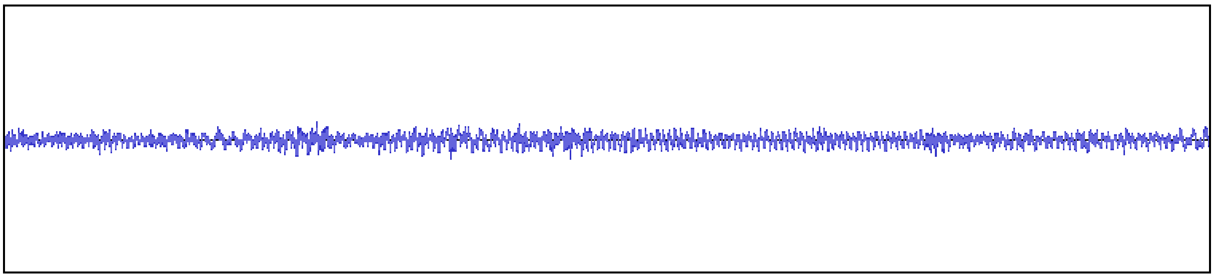

Figure 3.8 Typical noise profile at Location H

3.2 ALEXANDRA BASIN EAST

The metrics on measurements for Transect 1 were calculated and plotted as follows:

- Sound Exposure Level per pulse as a function of range
- Peak Sound Pressure Level as a function of range

- Root-Mean-Square sound pressure level as a function of range

The results of the noise measurements for Transect 1 (station A-D) in the Alexandra Basin East are shown in **Table 3.1.** Measurement results of RMS Sound Pressure Level (RMS SPL), Peak Sound Pressure Level (PEAK) and Sound Exposure Level (SEL) are shown in **Figure 3.3**, and **Figure 3.4** shows the power spectrum density results. **Figure 3.3** shows a decreasing trend in sound levels with increasing range from the source, with the levels dropping sharply closer to the source. The average SEL of 202 dB re 1 μPa^{2}s at Station A, 77 m from piling, drops to 187 dB re 1 μPa^{2}s at Station D, 511 m from piling. The Power Spectrum Density plots of individual pile strikes confirm that the pile strike noise is predominantly below 1000 Hz.

SPL levels at these four locations, A-D, are dominated by piling noise.

Table 3.3 Noise Measurements for Transect 1: Alexandra Basin East

Location	SEL dB re 1 μPa^{2}s	**PEAK dB re 1 μPa**	**RMS SPL dB re 1 μPa**
A	202	178	154
B	193	170	145
C	191	168	143
D	187	161	139

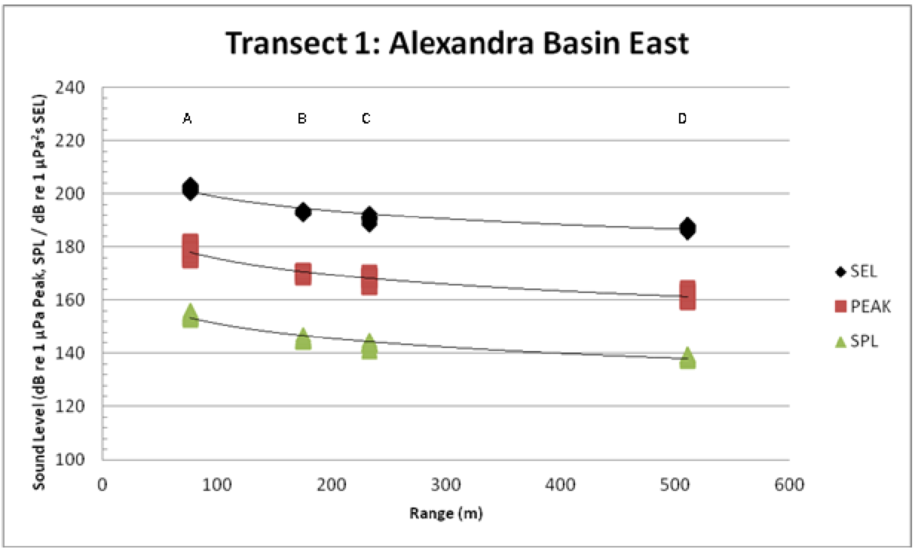

Figure 3.9 - Measurement Results for Transect 1:Alexandra Basin East

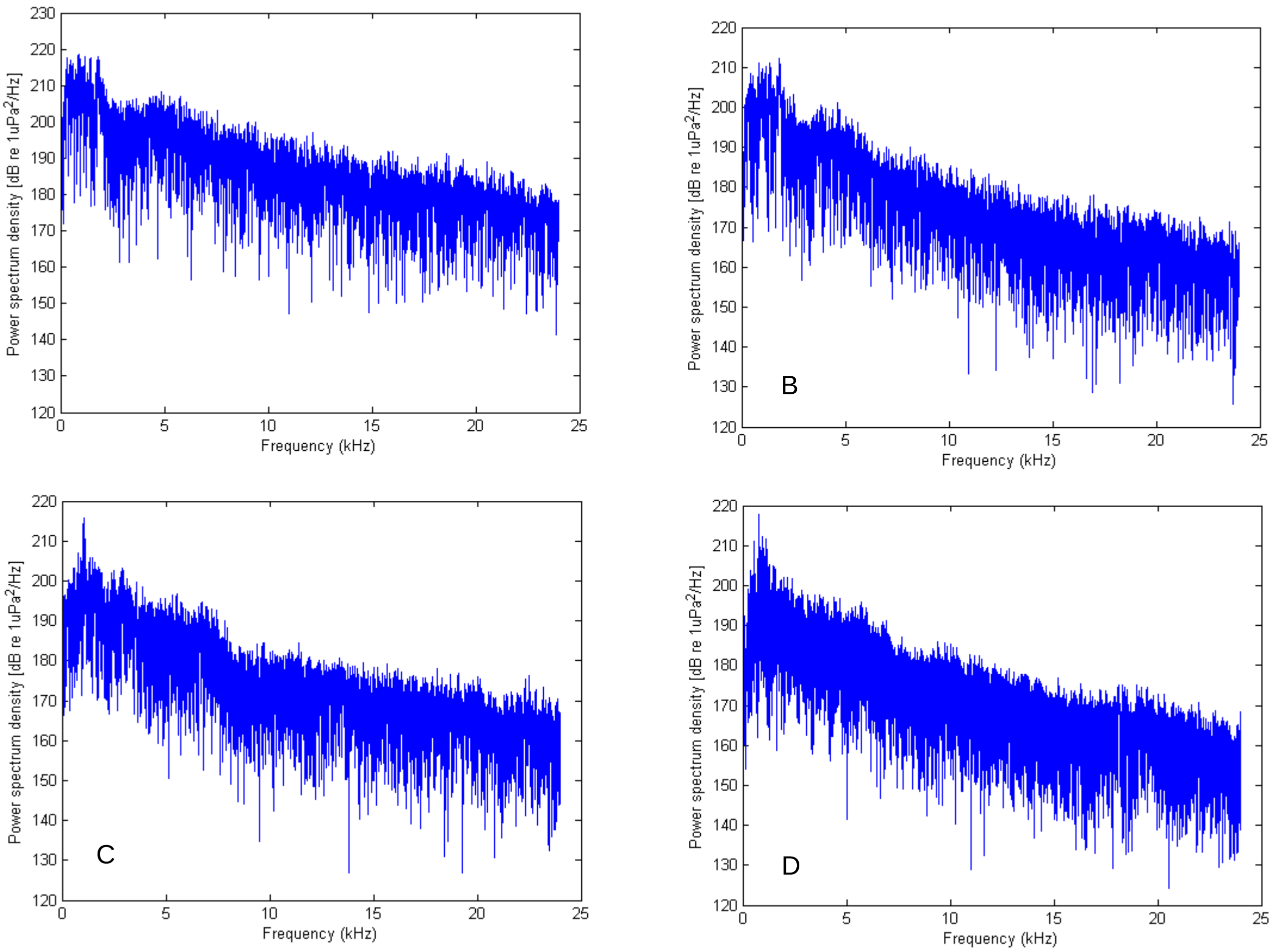

Figure 3.10 - **Power spectrum density results for Stations A-D of Transect 1: Alexandra Basin East**

3.3 RIVER LIFFEY CHANNEL

The results of the noise measurements for Transect 2 (Stations D-H) in the River Liffey Channel are shown in **Table 3.2** and **Figure 3.5** shows the power spectrum density results.

Location E is located 500m upriver from the piling source, Location F is 300m located downstream and both show significant attenuation of piling noise. This attenuation is primarily due to the locations being outside the confines of the Alexandra Basin and not subject to the reverberation occurring in the confined area. Propagation to these locations is along the River Liffey channel.

The River Liffey discharges to an estuary, where river discharge and tidal stirring strongly affect the sound velocity profile. Scales of temporal and spatial variability are often particularly short, resulting in abrupt changes to the acoustic environment. Such small-scale estuarine sound velocity structures and temporal changes have significant impacts on sound propagation. The significant attenuation occurring in this short space is evident in these measurements.

The timing of the measurements at Station G did not coincide with an incident of piling. During the measurement at Location G a ship was docking at Alexandra Basin. The docking manoeuvre required the use of thrusters and main engines, giving rise to elevated noise levels at this location. The measurement reported is taken from the period during which the ship was docking in order to provide an indication of noise levels in the River Liffey channel during ship movements.

At location **H (Figure 2.2)** 3570 km from the piling location, only background levels of noise were recorded i.e. there was no detection of a signal from the piling. There were no nearby noise sources (such as shipping) at this location during the measurement period. The background RMS SPL noise level at this location was measured at 113 dB. This background noise level is consistent with that reported in 2013. Beck et al. 2013 reported the mean Sound Pressure Level for Dublin Bay at 113 dB re 1 µPa with a standard deviation of 8 dB.

Table 3.4 Noise Measurements for Transect 2: River Liffey Channel

Station	SEL dB re 1 µPa^{2}s	PEAK dB re 1 µPa	RMS SPL dB re 1 µPa
D	187	161	139
E	156	127	108
F	173	146	127
G	191	146	132
H	170	128	113

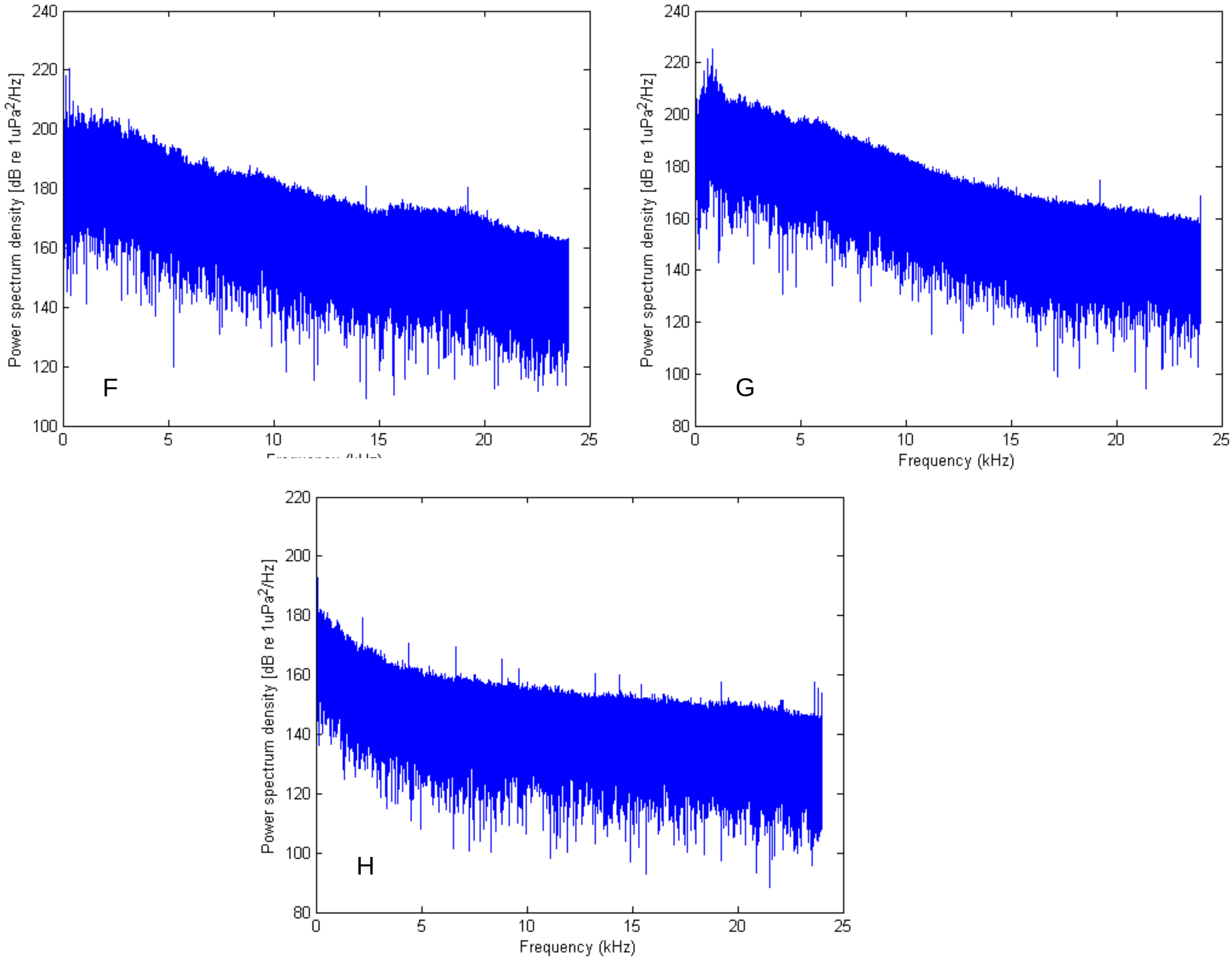

Figure 3.11 - Power Spectrum Density Results for Transect 2: River Liffey Channel

3.4 WIDER DUBLIN BAY

At the Bailey and Scotsman's Bay (Station S1 and S2 respectively**)** measurements of shipping noise were undertaken in order to compare against the background sound levels. The results of the noise measurements for the Wider Dublin Bay are shown in **Table 3.3,** and **Figure 3.6** shows the power spectrum density results**.**

3.4.1 The Bailey

At the Bailey a trawler passing by produced RMS SPL measurements of 120 dB re 1 µPa. This elevated level is above the 'background' level for Dublin Bay. This elevated level will occur for a short period of time while the vessel transits through the area. Typically the elevated level arises for a period of about 10 minutes. Longer durations of elevated noise may occur if the vessel was trawling or engaged in fishing activity.

The measurement location at the Bailey is close to a popular dive site on the wreck of the Queen Victoria. No impulsive noise from piling could be detected at this location.

3.4.2 Scotsman's Bay

Scotsman's Bay is a popular diving area in south Dublin Bay. It is located east of Dun Laoghaire Harbour. A large ship was at anchor near the entrance to Dun Laoghaire Harbour during the period in which measurements were taken. Underwater noise from this vessel dominated the noise levels in the area and resulted in RMS SPL measurements of 128 dB.

No impulsive noise from piling could be detected at Scotsman's Bay.

Table 3.5 Noise Measurements for Wider Dublin Bay

Station	SEL	PEAK	RMS SPL
S1	178	138	121
S2	180	139	128

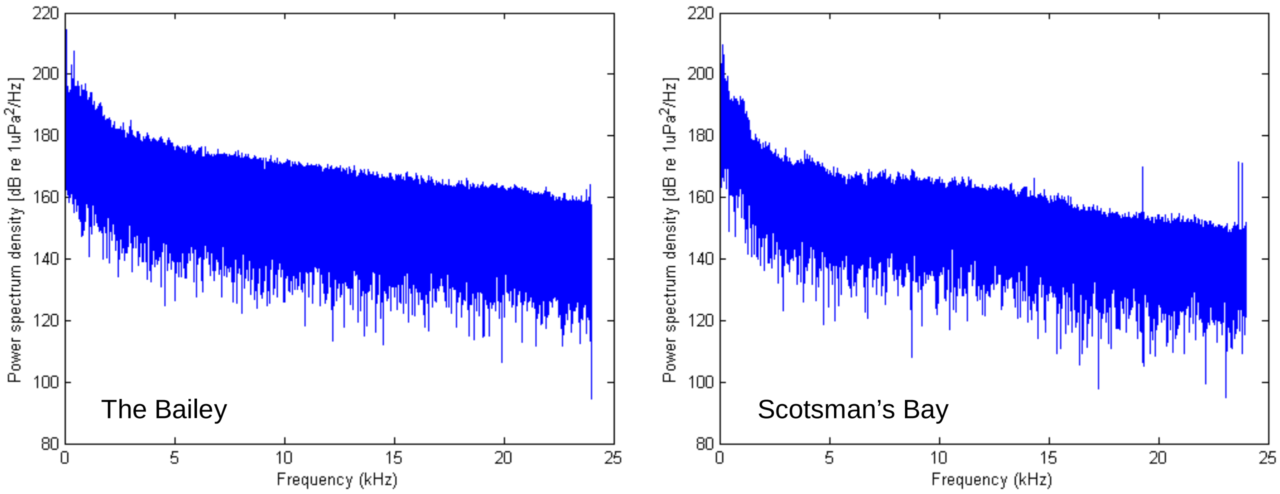

Figure 3.12 - Power Spectrum Density Results for the Wider Dublin Bay

3.5 MODEL RESULTS

The Transmission Loss output from the SCOOTER model for the transect M1 to M2 (see **Figure 2.4**) is plotted for range and depth in **Figure 3.7**. The model is confined to a single transect along the navigation channel.

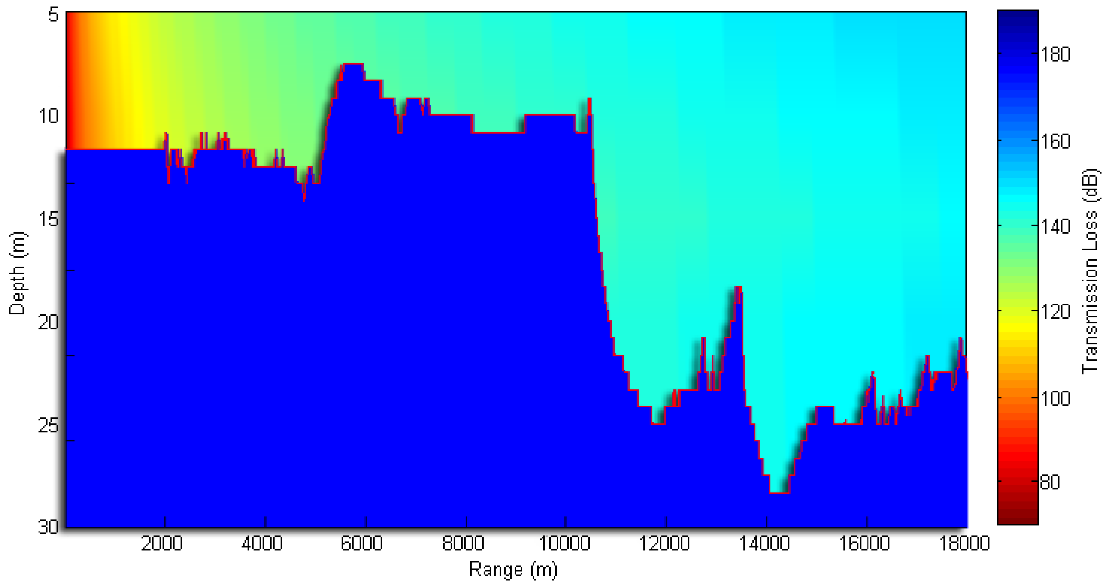

Figure 3.13 - Model Results of Transmission Loss Overlaid with the Bathymetry from M1 to M2

3.6 MODEL CALIBRATION

Measured results were compared with the SCOOTER model output and the results presented in **Table 3.4.**

Table 3.6 Comparison of measured and predicted propagation loss

Location	Distance from Source m	Measured Propagation Loss (dB) from location A	Predicted Propagation Loss (dB) from location A
A	70	N/A	N/A
D	500	15	25
G	1000	22	35
H	3500	>40	52

The SCOOTER code is based on open water propagation, with losses spreading in all directions. The Alexandra Basin and Dublin Port navigation channel operates as a confined environment with significant reverberation within the basin and the channel. The surfaces within this area are comprised of hard quay walls which act as near perfect reflectors. The model will therefore overestimate the transmission loss close to the source due to the reverberation.

The reverberation in the near field leads to high noise levels close to the source. A model will predict greater loss of energy in a free field situation and carry this prediction forward in the model. In practice there is a transition zone just outside the reverberant area where significant attenuation takes place in a short range due to changes in salinity and other factors. In the river and navigation channel the transmission losses revert to modelled rates albeit with an over-estimate of initial values.

This can be seen in the measured values at Location C and D across the river channel and Locations E and F a short distance up and down river from the Alexandra Basin. At Locations C and D the SPL averages 140 dB whereas at Location E (500m upriver) the SPL is 108 dB which is at background levels. The SEL at this location is 156 dB. At Location F (300m downriver) the SPL is 127 dB and the SEL is 173 dB. This is a clear indication that noise from piling reduces to background levels somewhere between 300 and 500m from the source in Alexandra Basin.

The predicted loss compared to the measured loss along the modelled transect indicate an over-estimate in the order of 12 dB at ranges in excess of 1 km. While the values are in general agreement, the relative transmission loss at ranges beyond 1km are in good agreement. Given the complex environment that exists in Dublin Bay, the model can be used to provide accurate transmission loss estimates at long ranges. The modelling data is supported by site specific measurements confirming the relative transmission loss.

4. DISCUSSION

At close ranges, the initial peak of the waveform was expected to be very pronounced, lasting approximately 10 ms. On site measurements indicate a pulse of 200 ms duration comprising the direct pulse and several reflections from the sides of the Alexandra Basin. Within 500m of the source the duration of this peak does not significantly increase and the intensity decreased rapidly at increasing range. Close to source the sound was highly broadband. Peak sound energy occurred at below 1000Hz but there was substantial energy up to 10 kHz. High frequencies were rapidly attenuated with distance and beyond 500m the majority of the impulsive pile driving sound was attenuated.

The results for station H (3570 km from the source) show that no noise emanating from the pile driving activity is detected. The background sound levels recorded at station H are similar to previously reported noise measurements for Dublin Bay (see location of previously reported measurements in Fig. #)

The noise measurements at the Bailey and Scotsman's Bay were above expected background levels due to the nearby shipping traffic. Piling noise was not audible at Location H i.e. at any point outside the North Bull or Great South Walls.

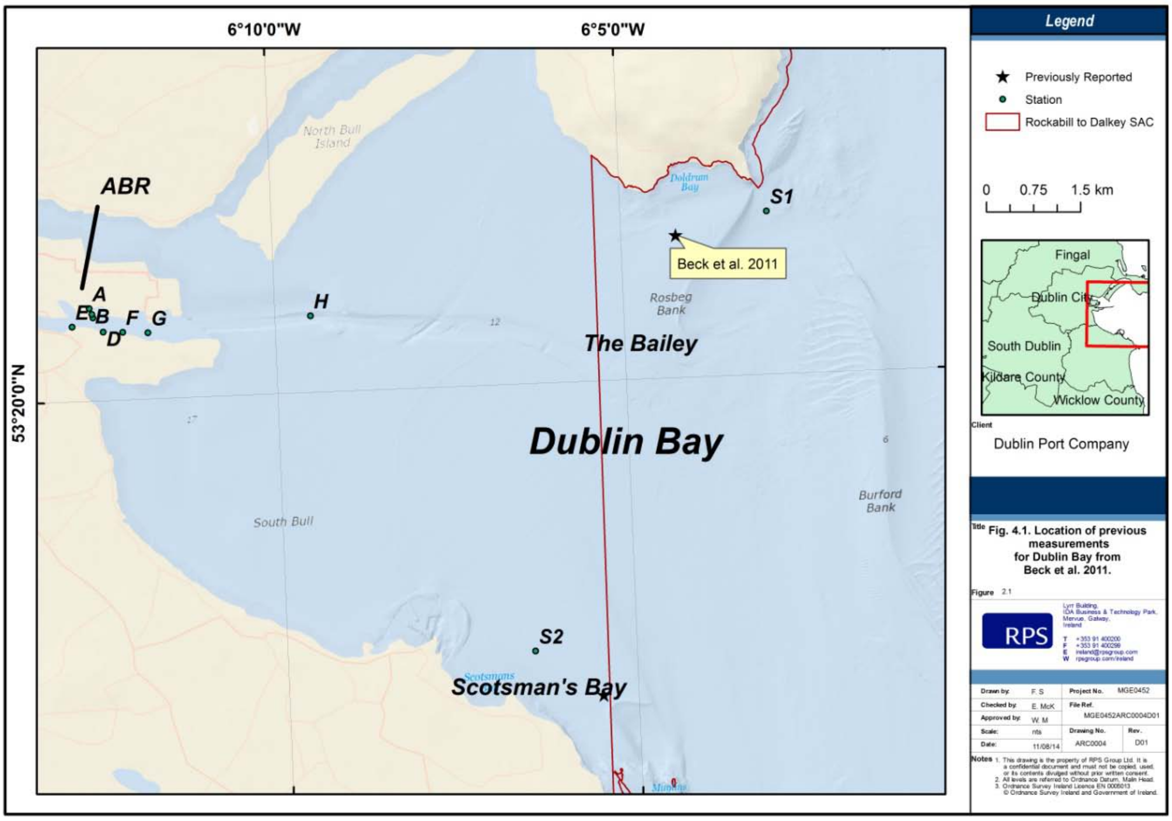

Figure 4.14 Location of previously reported noise measurements for Dublin Bay.

4.1 COMPARISON WITH MODEL RESULTS

4.2 INCREASING PILE SIZE

The measurements on which this report is based took place while H-section piles with a cross sectional area of 333 cm^2 were being driven to depths of 35m in Alexandra Basin East (ABE). Several pile driving options are feasible for the Alexandra Basin Refurbishment (ABR) project. The ABR project has a worst case scenario requirement for 1.6m diameter piles. 1.6m dia. piles with a wall thickness of 27.5mm wall thickness have a cross sectional area of 679 cm2 or approximately twice the cross sectional area of the piles measured for this report. The pile driving energy required for the larger cross-sectional area will result in an increased acoustic output. The estimated noise levels have therefore been increased by 6 dB to provide worst case noise levels.

4.3 OVERALL UNDERWATER NOISE IMPACT

The overall noise output has been estimated for a number of specific locations. These estimates are based on the results of the site specific measurements and the modelling carried out for the Dublin Bay area.

4.3.1 Noise Levels in Alexandra Basin & River Liffey Channel

Noise levels arising from 1.6m diameter piles being driven in the Alexandra Basin in the River Liffey channel and the Alexandra Basin area will be higher than those reported in **Table 4.1** by approximately 6 dB. The levels in this area are significantly increased due to the reverberation within the confined space. At distances beyond this the noise level attenuates rapidly so that at 500m the levels are at background noise levels.

Table 4.7 Predicted Piling noise levels from ABR project

Location	SEL dB re 1 μPa^2s	PEAK dB re 1 μPa	SPL dB re 1 μPa
A	208	184	160
F	179	152	133
E	165	133	114

4.3.2 Noise Levels at Seal Haul Out Sites

Underwater noise levels at all recognised seal haul out sites will not be impacted by piling noise from the Alexandra Basin.

4.3.3 Noise Levels at Dive Sites

Underwater noise levels at recognised recreational diving sites will not be impacted by piling noise from the Alexandra Basin. This has been confirmed with measurements taken at Locations S1 and S2 as shown in Figure 2.1. These are the two nearest dive sites to the Alexandra Basin. In both cases the underwater noise level was determined by the presence of vessels in the area. Noise modelling for pile driving indicates that the Transmission Loss between the Alexandra Basin and these sites is such that no noise from pile driving will arise.

4.3.4 Noise Levels in the Rockabill-Dalkey SAC

Piling noise from the Alexandra Basin Refurbishment project will not impact underwater noise levels at the Rockabill to Dalkey Special Area of Conservation. The measurement of underwater noise levels at the SAC while piling was taking place in ABE and a noise prediction model indicates that the Transmission Loss between the Alexandra Basin and the SAC is such that no noise from pile driving will arise.

4.3.5 Noise Levels in the South Dublin Bay and River Tolka Estuary SPA

Piling noise from the ABR project will not change underwater noise levels at the South Dublin Bay and River Tolka Estuary Special Protection Area. Underwater noise measurements taken at Location G (close to the pontoon at Ringsend Power Station) indicate no piling noise is audible when shipping movements are taking place and is close to background levels at other times. For wading birds generally, underwater noise propagates least at low water, when they are likely to be foraging.

While some level of piling noise may be present close to the Alexandra Basin it will have no significant environmental impact on the South Dublin Bay and River Tolka Estuary Special Protection Area

4.3.6 Noise Levels due to Proposed Dredging for ABR

Underwater noise levels from dredging activity will be significantly lower than those arising during piling. From the modelling carried out, the underwater noise transmission loss is significant due to the shallow water and the sediment/sand based seabed in Dublin Bay. Proposed dredging activity is limited to the navigation channel and the Alexandra Basin.

The navigation channel is close to the North Bank and some dredging noise will arise at low tide in this area. Due to the extremely shallow water depths at low tide, transmission loss will be far greater than that outlined in the model in section 2.5. Underwater noise propagating in this area will be at background levels and will not have any significant environmental impact.

Underwater noise arising from dredging the navigation channel inside the North Bull Wall will not propagate to Bull Island. Dredging in the navigation channel east of the Bull Wall is located 1500m from North Bull Island from which it is separated by very shallow water. Noise from dredging will not cause any significant environmental impact at North Bull Island.

Dredging and dumping of spoil in the SAC represent a small portion of the total project and appropriate mitigation can ensure that no significant environmental impact occurs.

4.4 RECOMMENDATIONS

The pile driving activity at Alexandra Basin East was of limited duration. This necessitated short measurement periods in order to maximise the number of measurement locations during pile driving activity. Should the ABR project go ahead underwater noise monitoring should be carried out in the Alexandra Basin area and the wider Dublin Bay area to confirm that underwater noise levels are not having any significant environmental impact.

Underwater noise levels inside the Alexandra Basin and a short stretch of the River Liffey will be elevated as a result of piling activity. In order to avoid any impact on migrating salmon smolts a three month break in piling activity is proposed for the months of March to May inclusive. Piling activity will be limited to 12 hours per day, with no activity on Sundays or Bank Holidays. These breaks in piling activity provide periods of at least one tidal cycle per day and a lengthy exclusion period where no piling takes place.

The worst case piling noise will reduce to background levels within 500m from the source. This limited area is not frequented by cetaceans or seals. Introducing mitigation measures to reduce piling noise further, such as using dry caissons or bubble curtains is not warranted. Such mitigation measures will serve to prolong the period over which piling takes place and could result in unnecessary disturbance of the sediments in the Alexandra Basin.

The use of real-time acoustic monitoring and Marine Mammal Observers as part of the project construction Management Plan should be implemented. Acoustic monitoring can be provided in both the navigation channel and at the spoil dump site for both noise measurement and detection of cetaceans.

5. CONCLUSIONS

Noise from piling in the Alexandra Basin area of Dublin Port has an impact on an area confined to the Basin in which piling takes place, and a short distance upstream and downstream of that point. No piling noise is detectable at the North Bull Lighthouse or the outer Dublin Bay area.

Model results using a validated methodology is in good agreement with the measured results for Transect 1, 70 -500 m from the source, and consistent with the measurements at location H, 3570m from the source. There is no noise from piling detected at a distance of 3570 m from the source.

The background sound levels measured are consistent with previously reported background levels for Dublin Bay.

Mitigation measures comprising of bubble curtains etc. to reduce piling noise will serve to prolong the piling period for no beneficial environmental impact. Piling at the Alexandra Basin has no significant environmental impact at the South Dublin Bay and River Tolka Estuary SPA, the Rockabill-Dalkey SAC or popular dive sites in Dublin Bay.

Dredging of the navigation channel and dumping of the dredging spoil at the Spoil Ground will cause short term localised increases in underwater noise levels. These changes will have no environmental impact at the South Dublin Bay and River Tolka Estuary SPA, the Rockabill-Dalkey SAC or popular dive sites in Dublin Bay.

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APPENDIX A - UNDERWATER NOISE REPORT

MEASUREMENT RESULTS

Station	SEL	PEAK	SPL
A	200.7739361	174.8538776	153.1395132
A	201.469133	177.7620933	153.8340886
A	202.5961402	179.0009485	154.9617749
A	201.5245094	177.8663801	153.8896625
A	203.1289763	180.0885845	155.4937273
A	202.4778115	182.0892012	154.8434067
A	201.5711661	177.8881766	153.9362245
A	202.0999885	180.9551392	154.4649033
A	202.8013299	181.8358114	155.1663123
A	202.6138686	179.2563847	154.9793997
A	203.1729353	179.2117716	155.5379825
A	200.981383	177.3153613	153.3472443
A	203.4366688	179.115104	156.0887004
A	200.314674	175.4421095	152.6804416
A	201.2625899	176.3110799	153.6279261
A	202.1400203	177.3881369	154.505828
A	201.2634786	174.9066394	153.6293276
A	200.8723186	177.1949427	153.2380234
A	200.9380456	176.8592931	153.3029502
A	202.377772	178.7701429	154.7433717
B	193.5560112	171.1092282	146.9520794
B	193.8968691	170.5395186	145.8316074
B	193.6680128	170.307942	145.602817
B	193.4036799	170.9463762	145.3384814
B	192.7165275	170.9187298	144.6513329
B	192.9038947	170.9843233	144.8387037
B	192.8388753	169.6992177	144.7736841
B	192.1520205	168.3746091	144.0868045
B	192.5269035	170.2572914	144.4616367
B	192.6134378	168.7625229	144.5481634
B	192.9900067	169.2985381	144.924813
B	193.9214876	170.3392437	145.8562919
C	188.3563601	165.0254908	140.8265967
C	190.4368126	167.1589202	142.9093135
C	191.0811981	169.284809	143.5540618
C	191.044955	168.6189775	143.5174952
C	191.0151126	168.988679	143.4881061
C	191.2449774	167.3531049	143.7179847

Station	SEL	PEAK	SPL
C	191.5021201	169.1031897	143.9752555
C	192.5775072	170.567756	145.05086
C	188.9947801	164.6973793	141.4654268
C	190.2463904	167.4540968	142.7184371
C	191.0412328	168.338658	143.5132663
C	190.5354254	168.0895667	143.0069511
C	191.2349952	169.3303654	143.7072525
C	190.2746271	168.0618237	142.7467052
C	191.1994552	169.1353618	143.6719157
C	191.0828654	169.102052	143.5555679
D	185.4283787	159.8192834	137.4300135
D	186.8463468	161.1098139	138.1252381
D	186.9975862	160.255365	138.2764892
D	187.2388024	160.1401364	138.5177011
D	187.2207273	162.1389958	138.4996295
D	187.179933	163.0689279	138.4588366
D	187.1759835	162.7643728	138.4548829
D	187.1627251	159.1742306	138.4416168
D	187.2479427	160.485427	138.5268464
D	187.7718686	162.6247992	139.0507058
D	188.0674267	161.0544348	139.346305
D	185.8429591	159.9170082	137.081933
D	187.9551505	163.1663662	139.2339657
D	188.1935128	160.2543148	139.472408
D	188.0445283	162.6144003	139.3233583
D	188.1320779	163.9171286	139.410959
D	187.7037391	163.1468153	138.9826372
D	187.3049242	160.9328979	138.5838272
D	187.4973811	164.3955931	138.7762823
D	187.4225339	160.37323	138.7014303
D	187.9203632	162.5694621	139.1992073
D	188.1407604	161.8081304	139.419663
D	185.6771916	159.5398837	137.6841359
D	188.1243741	160.6965861	139.4031432
D	188.0010141	162.3205423	139.2798648
D	187.7143013	161.4796802	138.9923754
D	187.9389067	161.6342649	139.7354446
D	186.0994354	162.0103893	137.3384104
D	186.5369835	160.7015755	137.7759506
D	186.4558291	160.2731994	137.7347325
D	186.2101564	159.7081523	137.4890599
D	186.1438571	159.1801753	137.4227607
D	187.0154766	162.3337792	138.294366
D	185.4284	159.8193	137.43

Station	SEL	PEAK	SPL
D	186.8463	161.1098	138.1252
D	186.9976	160.2554	138.2765
D	187.2388	160.1401	138.5177
D	187.2207	162.139	138.4996
D	187.1799	163.0689	138.4588
D	187.176	162.7644	138.4549
D	187.1627	159.1742	138.4416
D	187.2479	160.4854	138.5268
D	187.7719	162.6248	139.0507
D	188.0674	161.0544	139.3463
D	185.843	159.917	137.0819
D	187.9552	163.1664	139.234
D	188.1935	160.2543	139.4724
D	188.0445	162.6144	139.3234
D	188.1321	163.9171	139.411
D	187.7037	163.1468	138.9826
D	187.3049	160.9329	138.5838
D	187.4974	164.3956	138.7763
D	187.4225	160.3732	138.7014
D	187.9204	162.5695	139.1992
D	188.1408	161.8081	139.4197
D	185.6772	159.5399	137.6841
D	188.1244	160.6966	139.4031
D	188.001	162.3205	139.2799
D	187.7143	161.4797	138.9924
D	187.9389	161.6343	139.7354
D	186.0994	162.0104	137.3384
D	186.537	160.7016	137.776
D	186.4558	160.2732	137.7347
D	186.2102	159.7082	137.4891
D	186.1439	159.1802	137.4228
D	187.0155	162.3338	138.2944
E	152.5977	124.5082	104.2893
E	151.6412	126.2223	103.3476
E	157.4193	125.7421	109.1382
E	152.3311	124.3975	104.772
E	166.0284	134.1364	118.4693
F	172.383	147.446	126.3151
F	172.7075	148.3535	126.6081
F	172.7836	145.9922	126.7085
F	173.5101	146.4498	127.348
F	178.2361	143.5388	131.5513
F	175.3955	149.3929	129.2197
F	174.074	146.1126	127.997

Station	SEL	PEAK	SPL
F	173.6816	146.4613	127.4662
F	173.2045	144.4828	126.7579
F	172.6349	144.1407	126.2208
F	174.1373	146.7161	127.7764
F	172.8924	145.5825	126.7712
F	173.2635	147.0606	127.1811
F	173.3448	147.098	127.1955
F	173.2082	146.0646	127.0661
F	173.0795	145.0213	127.0114
F	173.5612	147.0927	127.4801
F	175.7054	147.0014	129.5795
F	174.5753	146.6797	128.5064
F	171.784	145.5283	125.7122
F	173.3941	147.7608	127.2505
F	171.6376	145.2916	125.5627
F	172.8625	147.9637	126.784
F	171.5354	145.4834	125.4672
F	172.0325	146.1036	125.9618
F	172.1621	146.4153	126.0834
G	192.1964	145.0821	130.5012
G	189.887	147.2751	133.0811
H	169.2358	130.3629	111.564
H	171.717	125.8339	114.005

APPENDIX B

BIRDS

(No appendix for this section)

APPENDIX C

MARINE MAMMALS

A report on the potential effects of Dublin Port development on marine mammals.

January 2014

Dr. M Cronin & Dr. M. Jessopp

1. INTRODUCTION

This report details the potential risks to marine mammals and recommendations for mitigation measures related to the proposed Alexandra Basin Redevelopment Project in Dublin Port. It is based on a site visit by the author, information from published and unpublished literature and communication with local relevant authorities. This report is based on information on proposed development which involves demolition works, piling, dredging and dumping of dredge spoil.

2. LEGISLATION PERTAINING TO MARINE MAMMALS IN IRISH WATERS

Marine mammals are protected by national legislation and by a number of international regulations which the Republic of Ireland is signatory to. The main legislation that affords protection to marine mammals in Irish waters is the Wildlife Act (1976) amendment Act (2000), which prohibits wilful interference to wild mammals and disturbance of resting and breeding sites.

All cetacean (whales, dolphins and porpoises) species occurring in European waters are afforded protection under the EC Habitats Directive (92/43/EEC), of which Ireland is a signatory. The current transposition of this legislation in Ireland is the EC 'Birds and Natural Habitats' Regulations (2011). All cetaceans are included in Annex IV of this Directive as species '*in need of strict protection*'. Additionally the harbour porpoise (*Phocoena phocoena*) and bottlenose dolphin (*Tursiops truncatus*) are designated Annex II species ('*those animals of community interest, whose conservation requires the designation of special areas of conservation*'). Ireland's two pinniped (seals) species, the harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*), are also designated Annex II species under the EC Habitats Directive.

The Republic of Ireland is also signatory to conservation orientated agreements under the Bonn Convention on Migratory Species (1983); the OSPAR Convention for the Protection of the Marine Environment of the northeast Atlantic (1992); and the Berne Convention on Conservation of European Wildlife and Natural Habitats (1979).

In light of the legislation and conservation status of marine mammals, careful assessment and consideration must be given prior to and during all anthropogenic activity with potential for effects on these species and their habitat. Lambay Island in Co. Dublin is designated as a Special Area of Conservation (SAC) with the grey seal listed a species of qualifying interest and the harbour seal has also recently been added as a qualifying feature. Furthermore the recently designated Rockabill to Dalkey Island SAC (designated in 2012) overlaps with the proposed dredge material dump site. Harbour porpoise is listed as a qualifying interest for this site, as it is an Annex II species under the Habitats Directive. Please note that the proposed capital dredging scheme also extends into the new Rockabill to Dalkey SAC. As there are other SACs within Dublin Bay (with habitats, flora and fauna other than marine mammals listed) in accordance with Article 6.3 of the Habitats Directive, An Appropriate Assessment screening has been carried out by RPS and an AA will be produced for the proposed project.

3 MARINE MAMMALS IN THE AREA

It is necessary to determine what marine mammals use the waters in the vicinity of the proposed works, and likely extended zone of influence in order to estimate the likely significance of any impacts resulting from the proposed development.

3.1 CETACEANS

Based on species' ecology and sighting records cetacean species likely to use the area of Dublin Bay and the dump area at Burford bank include harbour porpoises (*Phocoena phocoena*), bottlenose dolphins (*Tursiops truncatus*), minke whales (*Balaenoptera acutorostrata*), Risso's dolphins (*Grampus griseus*) and common dolphins (*Delphinus delphis*) (Evans, 1992, Berrow *et al*., 2001; 2008; Ingram, 2000; Ingram *et al.*, 2001 and 2003; Rogan *et al*., 2001; Ó Cadhla *et al*., 2004; O Brien *et al*., 2009; IWDG, 2013).

An overview and literature review for each cetacean species occurring within and likely to occur within the study area is set out below.

3.1.1 Harbour Porpoise

Sightings of Europe's smallest cetacean species, the harbour porpoise, have been relatively common off all coasts of Ireland and in the Irish Sea (Northridge *et al*., 1995; Hammond *et al*., 1995; Pollack *et al*., 1997; Berrow *et al.,* 2001; Ó Cadhla *et al.,* 2004; Anderwald et al., 2011). The small size of harbour porpoises and their erratic surfacing behaviour can make them difficult to detect. There are however relatively frequent sightings of the species within Dublin Bay, including the dredge disposal site and shipping channel (IWDG, 2013). Surveys of harbour porpoise carried out at specific sites around the Irish coast identified Dublin Bay as an important area for the species, with high densities in Dublin Bay of 1.19 per km^2 reported, representing one of the highest densities of the species recorded in Ireland to date (Berrow *et al*., 2008). Surveys of cetaceans in the waters outside of Dublin Bay, in the western Irish Sea, indicated that harbour porpoise were by far the most abundant species in the area with relative abundance of harbour porpoise estimated at 0.55 porpoise per $kmkm^2$ (Berrow *et al*., 2011). Sighting rates of harbour porpoise, and thus local densities, were notably higher adjacent to Rockabill and Lambay Islands. This was consistent with Berrow *et al*. (2008) who recorded high densities during smaller scale harbour porpoise surveys in the same area. This suggests that this could be a good habitat for harbour porpoises. The Rockabill to Dalkey Island SAC is designated for the conservation and protection of this species. The proposed dredge material dump site at the Burford Bank overlaps with this SAC site boundary.

Harbour porpoises produce high-frequency sounds used for echolocation and communication, but do not make frequency-modulated whistles typical of many delphinids. The high frequency sounds are comprised entirely of click trains, produced in two narrow band frequency components, one between 1-20 kHz and the other between 120-160 kHz (peaking around 125-130 kHz) (Goodson *et al*., 1995). Maximum source level is estimated at between 149 and 177 dB re 1µPa at 1 m (Akamatsu *et al.,* 1992).

Harbour porpoises are very sensitive to vessel noise and activity and are unlikely to approach areas of high activity (Polacheck & Thorpe, 1990). However it is the cetacean species most likely to be affected by the proposed works considering the importance of the area for harbour porpoise. Mitigation measures outlined in Section 9 will minimize potential impacts of the proposed works on this species.

3.1.2 Bottlenose Dolphin

A coastal species of cetacean commonly sighted in western Irish waters (Evans, 1992, Pollock *et al.,* 1997) bottlenose dolphins are numerous on the south and west coasts (Ingram and Rogan, 2003; Ingram *et al*., 2001, 2003). There are resident communities in the waters of the outer Shannon estuary (Ingram, 2000; Ingram and Rogan, 2003) and a transient population recorded off all Irish coasts (O Brien *et al*., 2009). Bottlenose dolphins have been occasionally recorded in Dublin Bay (IWDG 2013) However the area is not significant at national level for bottlenose dolphins and the dolphins sighted there are likely to be part of a transient population. Bottlenose dolphins are a wide-ranging species and individuals commonly travel between coastal regions especially during the summer months (Ingram *et al*., 2003).

The bottlenose dolphin makes a wide range of vocalisations. Echolocation clicks (used for orientation and foraging) are composed of intense short duration broadband clicks (40-130 kHz) (Au, 1993). Burst pulse vocalisations may have a variety of social functions (0.2-16 kHz). Whistles are pure tone frequency modulated calls ranging from 2-20 kHz. Clicks and whistle vocalisations can be made simultaneously.

Bottlenose dolphins may be attracted to vessel activity, making them potentially vulnerable to physical harm from industrial activities, including dredging. Mitigation measures outlined in Section 9 will minimize potential impacts of the proposed works on this species.

3.1.3 Minke Whale

The most common species of baleen whale found around Irish coasts, the minke whale is frequently recorded around all parts of the west coast (Pollock *et al*., 1997, Berrow *et al.,* 2002; Ó Cadhla *et al.,* 2004). Research conducted in UK waters suggest that the species moves southwards to inshore Atlantic Margin waters in spring and summer, remaining until late autumn following which numbers decline (Pollack *et al.,* 2000; Northridge *et al*., 1995). The minke whale has been sighted in near inshore waters around Ireland and of all whale species that use Irish waters is the species with the most near-shore distribution, and therefore potentially the most vulnerable to anthropogenic noise resulting from development in the marine environment Vocalisations of minke whales involve intense, low frequency, broadband (0.5-1 kHz bandwidth) and harmonic down-sweeps with maximum source level of 165 dB re 1 re 1µPa at 1 m (Edds, 1988).

Minke whales have been sighted in outer Dublin Bay (IWDG, 2013) and it is possible they occasionally use the proposed dredging/dumping area at Burford Bank. There were six sightings of individual minke whales off the Dublin Coast during cetacean surveys of the north Irish Sea in 2011, with most sightings east of Rockabill and Lambay Island off north County Dublin (Berrow *et al*., 2011). Mitigation measures outlined in section 9 will minimize potential impacts of the proposed works if there is occasional use of the area by this species.

3.1.4 Common Dolphin

Although a mainly oceanic species, common dolphins have been frequently observed in large schools around the coasts of Ireland (Pollock *et al.,* 1997; Gordon *et al*., 2000) and it is the most commonly stranded cetacean around the Irish coast (Berrow & Rogan, 1997). The mobile schools of common dolphins seen in coastal waters tend to be foraging for shoaling fish species.

Vocalisations of common dolphins vary from whistles of 1-50 kHz frequency (mainly 6-12 kHz, max. source level 172dB re 1µPa at 1 m) to echolocation clicks which may reach 150 kHz (max. source levels 170 dB re 1µPa at 1 m) (Evans, 1973; Moore & Ridgway, 1995). Clicks and whistles may be given simultaneously.

Common dolphins are attracted to vessels and are easily sighted and identified. It is considered unlikely that the proposed works within Dublin Port will not impact upon common dolphins in the area as they do not frequent the waters of inner Dublin Bay; however it is possible they will occasionally use the area of the outer bay, where the proposed dumping of dredged material will take place, at the Burford Bank. Mitigation measures outlined in section 9 will minimize potential impacts of the proposed works on this species.

3.1.5 Risso's Dolphin

In Ireland Risso's dophin have generally been recorded close to the coast with highest numbers of sightings between August and February (Pollack *et al*., 1997; 2000). A large and robust species, Risso's dolphins are slow moving and often seen in small schools (Berrow *et al.,* 2002). Risso's dolphins will not usually approach vessels but are readily recognised by their distinctive colouration patterns and large size.

Vocalisations include a variety of clicks, whistles, and pulsed calls. Whistles are rarely heard, but range over 2.5-20 kHz, maximum source level of 170 dB re re 1µPa at 1 m. Clicks have peak frequency at 65 kHz and durations of 40-100 secs (Au, 1993).

It is considered unlikely that the proposed works will impact upon this species as there are no records of this species in Dublin Bay, however mitigation measures outlined in section 9 will minimize potential impacts of the proposed works if there is occasional use of the area by this species.

3.2 PINNIPEDS

Based on species' ecology and sighting records, seal species likely to use the area of Dublin Bay and the dump area at Burford bank include harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*). An overview and literature review for both seal species occurring within and likely to occur within the study area is set out below.

3.2.1 Harbour seal

Harbour seals (also known as "common seals") have established themselves at terrestrial colonies (or haul-outs) along all coastlines of Ireland, which they leave when foraging or moving between areas, for example, and to which they return to rest ashore, rear young, engage in social activity. These haul-out groups of harbour seals have tended historically to be found among inshore bays and islands, coves and estuaries (Lockley, 1966; Summers *et al.,* 1980), particularly around the hours of lowest tide. Harbour seals in Ireland use terrestrial sites mainly on the western seaboard, with highest numbers in NW and SW Ireland (Cronin et al., 2008).

The closest haul-out site of harbour seals to Dublin Bay is Lambay Island where approximately 30 harbour seals were observed during national census in 2003 (Cronin *et al*., 2004), and 2012 (Duck & Morris, 2013). Smaller haul-out groups were also observed at Skerries Island (n=3) and further north at Clogher Head (n=8) and Dundalk harbour (n=18) (Cronin *et al*,. 2004). Larger haul-out groups of harbour seals occur further north in Carlingford Lough. An aerial census of harbour seals in Carlingford Lough during 2011 recorded a total of 255 harbour seals at haul-out sites within the Lough (SMRU, unpublished). The number of harbour seals counted during surveys at terrestrial sites generally represent 60-70% of the seals using the area, as some will be at sea, therefore using a correction factor on the haul-out count data over 400 harbour seals could potentially use Carlingford Lough. There are no known harbour seal haul-out sites within Dublin Bay. Recent findings from tagging harbour seals in SW Ireland suggest that harbour seals are local foragers, generally staying within 20km of their haul-out sites (Cronin *et al*., 2008); however, studies in the UK have shown that harbour seals travel further distances from haul out sites (over 100km), therefore it is possible that harbour seals from sites in Carlingford Lough use the waters of Dublin Bay and very likely that harbour seals from haul-out sites on Lambay and Skerries and Dundalk harbour use Dublin Bay.

Harbour seals are most vulnerable at their terrestrial haul-out sites during breeding and moulting periods. These events occur between June and September in Ireland.

In addition to the identified terrestrial sites, the surrounding waters surrounding haulout sites are likely to be critical habitat for harbour seals, for feeding and/or for navigation to more offshore foraging areas. Results from a study by the author on the haul-out behaviour of harbour seals in southwest Ireland in recent years suggests that harbour seals spend up to 80% of their time at sea (Cronin, 2007; Cronin *et al.,* 2008). Similar behaviour patterns have been seen in studies of harbour seals in Scotland (Sharples, SMRU *pers comm*, Thompson & Miller, 1990). Unlike grey seals, harbour seal adults continue to forage during the breeding season (Bonnes *et al.,* 1994). In addition the mating strategy is based on males diving and calling at aquatic display sites (Van Parijs *et al.,* 1997, 2000, Hayes *et al*., 2004). Disturbance from anthropogenic noise during this period could potentially affect mating success. The hearing range of harbour and grey seals extends over wide frequencies, including the ultrasonic spectrum. The area of best hearing is between 8 and 25 kHz, with acute hearing also at lower frequencies (Møhl 1968; Terhune & Turnbull 1995). There is potential for harbour seals using the waters in and in the vicinity of Dublin Bay to be at risk to potentially detrimental impacts of the proposed piling, dredging and dumping. Mitigation measures outlined in section 9 will minimize potential impacts of the proposed works.

3.2.2 Grey seal

Grey seals are distributed throughout Irish coastal waters and commonly seen hauled out on more exposed shores than the harbour seal (Kiely, 1998). The large colonies of grey seals on the Irish coastline are predominantly on the western seaboard on the northwest and southwest coasts and islands; although relatively large numbers of grey seals are also found in southeast Ireland e.g. Wexford harbour, Saltee Islands (O Cadhla *et al*., 2007).

A national census of the grey seal population in 2005 identified grey seal breeding sites in Co. Dublin at Lambay Island, Dalkey Island, Irelands Eye and St. Patricks Island (Ó Cadhla *et al.,* 2007). Pup counts were small at these sites (n<3); apart from Lambay where 49 pups were counted. Further surveys conducted in 2009 recorded 77 pups on Lambay Island and Ireland's Eye (Ó Cadhla *et al*. 2013). These sites are also important to grey seals during the annual moult (Jan-April) in particular St. Patricks Island and Lambay Island, where 137 and 110 grey seals respectively were observed during a moult census in 2007 (O Cadhla & Strong, 2007). A group of 36 grey seals were also observed on Dalkey Island during the 2007 census and 26 grey seals on Rockabill. Four grey seals were sighted in Dublin Bay during aerial surveys as part of a harbour seal population survey in August/September 2012, with a further 62 observed on Lambay Island at this time (Duck & Morris 2013). This suggests over 300 grey seals use the islands in Co. Dublin, particularly for moulting. Grey seals are frequently seen in the waters of Dublin Bay at Dun Laoghaire and Howth harbour, Bull Island and Sandycove. Larger colonies of grey seals occur further south in Wexford Harbour at Raven Point, where up to 450 grey seals haul-out during the annual moult period (pers. ob.). The Saltee Islands in Co. Wexford are also an important breeding and moulting site for grey seals.

Grey seals are also most vulnerable at their terrestrial haul-out sites during breeding and moulting periods. These events occur between September and March in Ireland. The waters surrounding terrestrial haulout sites are likely to be a critical habitat for grey seals, for feeding and/or for navigation to more offshore foraging areas. Grey seal have a wider offshore foraging distribution than harbour seals and therefore grey seals from haul-out sites in Co. Dublin as well as from the large breeding and moult colonies on the coast and islands of Co. Wexford will potentially use the waters of Dublin Bay for foraging and/or navigation. They will therefore be at risk to potentially detrimental impacts of the proposed piling, dredging and dumping. Mitigation measures outlined in section 9 will minimize potential impacts of the proposed works.

4 SITE VISIT

A visit to Dublin Bay and site of the proposed works was made by the author on 27th – 28th July 2013.

4.1 METHODS:

The waters in Dublin Bay were surveyed from two vantage points on the north shore of the harbour (see Fig 2) using a telescope (equipped with a 30x eyepiece) mounted on a tripod and 10 x 50 Leica binoculars for all marine mammals at sea between 14.00 and 18.00 on 27th July 2013 (2 hours either side of high tide). The two vantage points (A & B) provided visibility of Dublin Bay, as well as the waters surrounding the bay. (Figs. 1-2). The conditions on July 27th were favourable for visual surveillance, with a Beaufort sea-state of 2-3 and a light SE breeze. Observations of marine mammals at sea are affected by prevailing sea conditions with a decline in sighting probability in Beaufort sea-states of three or higher.

The shorelines and waters of Dublin Bay (Fig. 3) were surveyed using 10 x 50 Leica binoculars for all marine mammals ashore during the low water period between 08.00 and 12.00 (2 hours either side of low water) on 28th July. The low water period was surveyed in order to maximise the likelihood of observing seals hauled out on the shoreline. Supplementary data on marine mammal presence was collected during bird surveys in the area.

4.2 RESULTS:

- One seal (unidentified species) was observed approximately 300m southeast of North Bull Island on 27th July at 17.35

- Two grey seals were observed approximately 100m from shore at Dun Laoghaire on 28th July at 10.30

- While no cetaceans were observed during the dedicated visual observations, this does not indicate that the area is not visited by dolphins or porpoises particularly given the transient nature of cetacean movement patterns. Supplementary visual observations by consultants undertaking visual surveys for birds recorded three harbour porpoise at the outer channel near the Dublin Bay Buoy on 25th June, and three further harbour porpoise between North Bull Light and Buoy 3 at the north side of the outer channel on 26th August 2013.

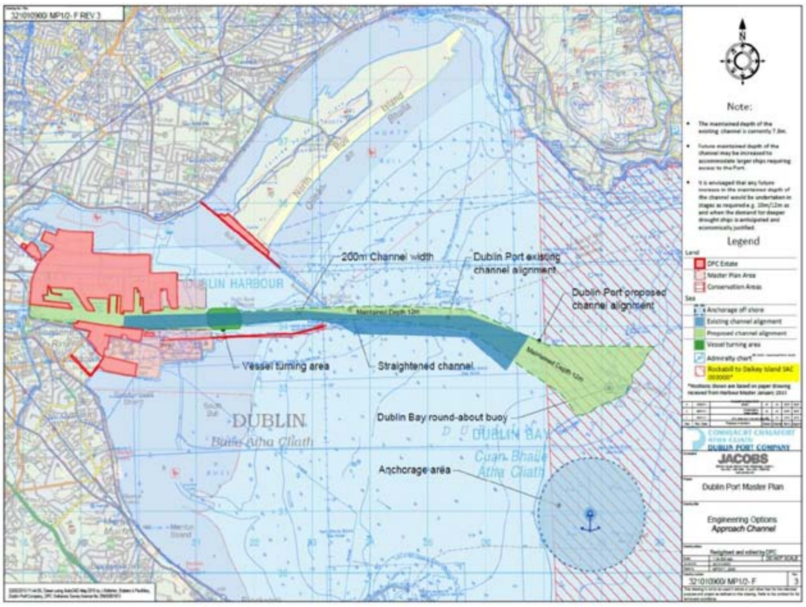

Fig. 1 Map of Dublin Bay and proposed channel alignment *(source*

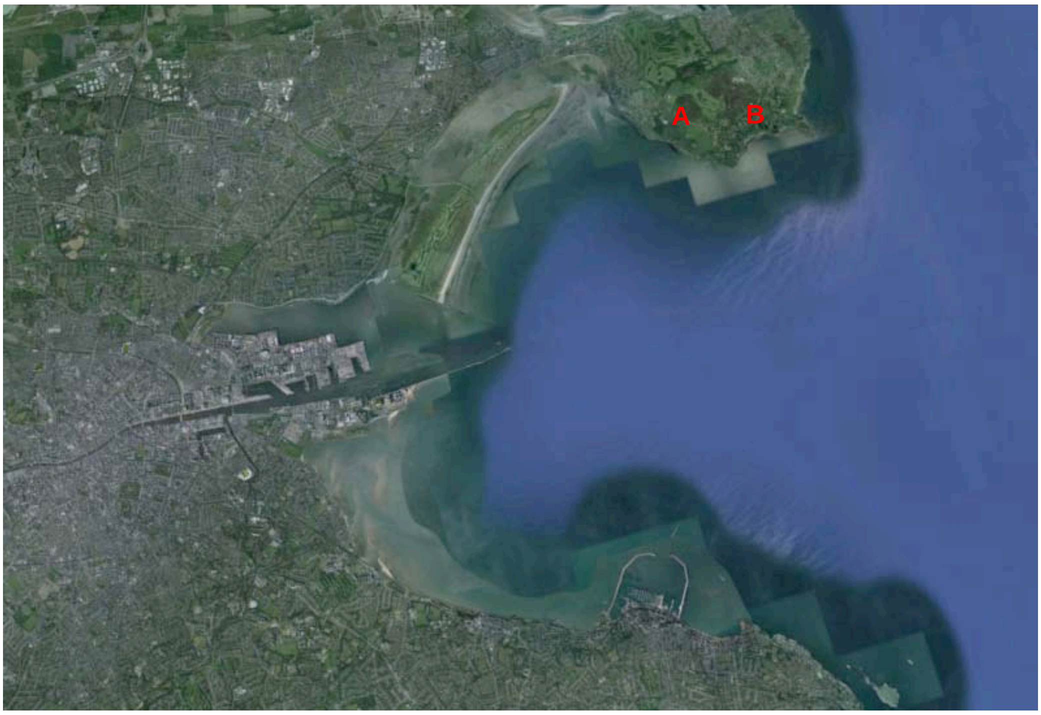

Fig 2 Dublin Bay and location of observation points A, B for marine mammal survey

Fig 3. Waters of outer Dublin Bay scanned for marine mammals at high tide

Fig 4. Alexandria Basin, Dublin Port.

Fig 5. Shore of Dublin harbour scanned for marine mammals

5 POTENTIAL IMPACTS OF THE PROPOSED WORKS ON MARINE MAMMALS AND IDENTIFICATION OF SENSITIVE RECEPTORS.

Studies on the responses of marine mammals to anthropogenic noise have identified the following factors as influencing the degree of response given by animals: (i) source intensity levels, (ii) degree of background noise, (iii) distance to source, (iv) species involved, (v) behavioural state and season, (vi) prior degree of exposure and (vii) age, sex and time of day (Anguilar *et al*., 2004). The peak pressure, duration and the frequency spectrum of anthropogenic sound are important factors relating to potential biological impacts. Several studies have examined the direct and indirect impacts of underwater noise on marine mammals, and in general have indicated that source levels of 180-200dB P-P re 1 µPa are sufficient to induce behavioural effects on marine mammals within a few kilometres from the sound source (Gausland, 2000). Biological damage from high-level sound may be categorized as either direct injuries (lethal, sub-lethal or non-lethal) or indirect effects (changes in behaviour or distribution patterns).

Playback experiments of drilling sounds in the presence of cetaceans have shown avoidance reactions and reduction of calling rates by various baleen whale species (Richardson *et al*., 1995). Phocid seals are more sensitive than small odontocetes to noise of low frequency and are therefore potentially more susceptible to disturbance from low frequency anthropogenic noise (Thompson *et al.,* 1998). Consequently, both harbour seal and grey seal will be susceptible to disturbance from underwater anthropogenic noise associated with demolition works when at sea.

Pile driving associated with the proposed development is considered to be a potentially detrimental activity to marine mammals because it produces a very high source level and broad bandwidth pulse, which is biased towards the lower frequencies. Sound produced during pile-driving propagates through the air into water, through the water column and, to a lesser degree, through the sediment and from there back into the water column (Thompson *et al*., 2006). Sound pressure levels in impact pile-driving are dependent on the length and the diameter of the pile and the impact energy (Nedwell *et al*., 2003) as well as the seabed conditions or substrate hardness. The response thresholds of cetaceans are usually the lowest for pulsed sounds and pile driving is one of the loudest sources of this type of noise (Richardson & Wursig, 1996). Peak source levels of 228 dB re 1 µPa @ 1m have been estimated for 1.5m diameter jacket-piles (ITAP 2005). The piles to be used in the development in Dublin Port are 1.6m approximately.

Extended exposure to high levels of continuous noise and/or impulsive sounds with high rise times can lead to injuries of the hearing structures in cetaceans and pinnipeds resulting in permanent or temporary hearing loss and other injuries (Richardson *et al*., 1995). Source levels of pile-driving noise are very similar to tactical sonar, which has been linked to noise-related injuries (Evans & Miller, 2004). However piling noise differs in duration, frequency content, duty cycle and directionality, and it is therefore difficult to assess their potential for causing severe injury in cetaceans and pinnipeds based on current evidence. Animals close to the source, exposed to a sudden onset of pile-driving noise might be injured (Thomsen *et al*., 2006). Temporary threshold shift (TTS), a temporal elevation of the hearing threshold due to noise exposure, could be induced by exposure to pile-driving noise. In addition to potentially injuring marine mammals, pile driving and industrial noise can adversely impact behaviour, communication and breeding with effects from some operations detected at distances of up to 20km for harbour porpoises and harbour seals (Thomsen *et al*., 2006). Behavioural modifications including the haulout behaviour of pinnipeds (Teilmann *et al*., 2006) and echolocation in harbour porpoise (Tougaard et al., 2003) have also been observed during pile driving activities. The literature contains some reference values for biological thresholds for onset of PTS, TTS and behavioural changes integrated over a duration of 1 second, as well as accumulation of sound energy over a continuous 24-hour period (Southall et al., 2007; Lucke et al., 2009). These thresholds are listed in Table 1 below. Sound propagation in the marine environment is context specific and largely dependent on water depth, bathymetry, sediment type, oceanographic conditions and ambient noise levels. Furthermore, behavioural responses depend on many factors including the properties of the sound source, species, age, condition, sex, season, social state and existing behaviour (Richardson et al. 1995). For these reasons, obtaining accurate and reliable predictions of the zone of PTS, TTS and behavioural responses is complex, and involves the interplay of a large number of variables. Available evidence based on examples obtained from published literature are mostly site specific and hence should be regarded as merely indicative in the context of the proposed works. in order to reliably quantify the zone of responsiveness associated with the proposed programme of piling activities in Alexander Basin, a dedicated sound propagation modelling approach with associated field measurements would be necessary. This approach would establish the context within which site specific mitigation measures could be devised. Generalised mitigation measures recommended by the statutory body, National Parks & Wildlife Service, may be employed to minimise the risk of direct effects on marine mammals.

Table 1. Thresholds for onset of PTS, TTS and behavioural response to impulsive anthropogenic noise (following Southall *et al*., 2007 and Lucke *et al.* 2009).

Species	**Approx. frequency range of sensitivity**	**Sound Exposure Level (dB ref 1µPa^{2}s)**					
		Behaviour Disturbance Threshold (BDT)		**Temporary Threshold Shift (TTS)**		**Permanent Threshold Shift (PTS)**	
		1 second	**24 hours**	**1 second**	**24 hours**	**1 second**	**24 hours**
Harbour porpoise	0,200-180kHz	145(*)	162	164(*)	181	198(#)	215(#)
Dolphin spp	0,150-160kHz	?	?	183(#)	195	198(#)	215(#)
Harbour/ grey seal	0,075-75kHz	?	?	171(#)	188	186(#)	203

(#) Southall et al. (2007)

(*) Lucke et al. (2009)

The most likely impact of the proposed dredging and infilling in the harbour, and dumping in the outer bay will be through sound disturbance and local habitat modification. Benthic dredging activity results in significant short to medium term modification to the biological environment. Destruction of benthic communities through substrate removal and smothering of benthic communities through plumes and dumping of dredge spoil will displace many species of invertebrate and fish, and may subsequently affect the food chain and impact on marine predators at a local scale. However, the effects of substrate removal will be determined by the extent of dredging activity and the value (in terms of foraging or conservation) of the existing habitat. Grey seals and cetacean species are highly mobile, with ranges that are likely to overlap with the dredging and dumping works. In addition to the physical act of sediment removal, dredging activities will result in potential disturbance to marine mammals through increases in vessel activity and increase local ambient marine noise levels.

There are limited studies describing dredging noise from North America and the UK, covering a variety of dredger types. The sparse data available indicate that vibration levels close to the source are relatively small and that dredging is not as noisy as seismic surveys, pile driving and sonar; but it is louder than most shipping, operating offshore wind turbines and drilling. Thomsen *et al.* (2009) suggest it should be viewed, therefore, as a medium impact activity and because of its continuous nature, which might last for extended periods, the potential adverse effects, especially in areas of high ecological sensitivity should not be overlooked.

Noise associated with dredging is predominantly of low frequency, below 1 kHz; estimated source sound pressure levels range between 168 and 186 dB re 1 µPa at 1 m. In most cases the noise is continuous in nature. Audibility of dredging noise is dependent on many factors (hearing sensitivity of the species in question, prevalent ambient noise, transmission loss etc). Since dredging noise is predominantly of low frequency, it would potentially affect low frequency cetaceans such as minke whales to a greater extent than mid or high frequency cetaceans. The harbour porpoise is a potential exception, as it has a relatively high sensitivity across most frequencies. There is also a potential issue with seals as both harbour and grey seals have relatively good underwater hearing at frequencies below 1 kHz (Thomsen *et al*., 2009).

Studies have shown that in shallow water, which would also characterise the situation at most dredging sites, received sound pressure levels were above 140 dB re 1 μPa, respectively at 1 km distance from the source; a value that is probably detectable for most marine mammals sensitive to sound pressure, depending on hearing abilities and local ambient noise conditions. Even at 10 km distance, sound pressure levels were well above 120 dB re μPa, a value which might exceed ambient noise levels in several areas (Thomsen *et al*., 2009).

Most of the information on diet in porpoises comes from an examination of the stomach contents of stranded animals or animals taken in fisheries by-catch. It has been suggested that porpoise are opportunistic feeders, altering their diet in response to prey availability at any given time and while this behaviour is difficult to prove there is some, at least weak, evidence to support it (Santos and Pierce 2003). Both porpoises and seals feed on pelagic, demersal and benthic species although they are believed to feed mainly close to or on the seabed. Dredging can remove large amounts of seafloor sediment along with associated benthic communities, with potential loss of foraging opportunities for marine mammals. The dredging of the shipping channel is likely to reduce the feeding quality for a range of benthic and demersal fish species for at least one season after the dredging, which in turn may reduce the density of fish feeding in the affected areas. However, it won’t eliminate fish from the site as they were present there in 2013 despite channel dredging in 2012. Furthermore, only about 20% of the channel is earmarked to be dredged each year over the lifetime of the project, thereby restricting the footprint of the impact each year. It is unlikely, that porpoises, which tend to avoid areas of busy port traffic, feed much in the inner part of the channel, so that dredging in these areas is less likely to impact the species. Indeed a survey of the distribution of the species based on sightings from a boat (Berrow, 2008) found that porpoises were almost absent from the inner and middle part of Dublin Bay. The dumping of dredged material of fine sand and silt has the potential to affect water quality and create a plume effect which will travel according to local water currents. The main tidal currents in the area of the Burford Bank are in a north-south direction, away from the intertidal areas of Dublin Bay, with fine sediment particles being transported northwards before settling out in the northern part of the Irish Sea (Anon 2013). This may have a temporary impact on marine mammals’ visibility in the immediate vicinity of the vessel and dump site. Dumping is likely to have a similar impact to dredging on fish feeding within and immediately adjacent to the dredge spoil dumpsite as noted for the dredge channel above, i.e. a reduction in feeding density of fish due to a suppression in macroinvertebrate food density following each 6 months of spoil disposal. Unlike much of the dredged channel which may not be the site of foraging by porpoises, or at least be used to a minor degree, the species are recorded in the general area of the dump (Berrow, 2008), although not in the same intensity as the waters around Howth peninsula. If we consider the fact that the dumpsite has been utilised on a fairly constant basis for more than 10 years and is therefore likely experience a regular, periodic suppression of benthic fish production, then it is reasonable to suggest that the area is unlikely to be a critical feeding area for porpoises. This is further supported when it is considered that the waters adjoining the site to the north, east and south are important nursery grounds for several of porpoises’ most important prey species (i.e. whiting, cod and herring). For these reasons, it is expected that the project will not have a significant adverse impact on the local population and any displacement of marine mammals resulting from impacts on available prey are unlikely.

To **summarise**, the potential effects of demolition works, piling, dredging and dumping on marine mammals include;

1. Physical injury or death of individuals resulting from collisions with operator vessels.

2. Physical injury or death of individuals resulting from close-range exposure to pile-driving noise.

3 Chronic hearing damage or disturbance/displacement as a result of piling or dredging noise.

3 Consumption of contaminated prey items resulting from contaminants entering the food chain (this is only a problem where contaminated substrates are disturbed).

4 Temporary impact on marine mammals’ visibility should they intersect the sediment plume during the dumping of dredged material.

5 Changes in prey availability due to local changes in benthic ecology caused by accumulation of dredge spoil on the seabed.

The likelihood and scale of each of these effects can be estimated and appropriate precautionary mitigation measures can be employed to reduce the estimated effects.

6 DIRECT, INDIRECT AND CUMULATIVE IMPACTS OF PROPOSED DEMOLITION WORKS, PILING, DREDGING AND DUMPING OF DREDGED MATERIAL ON PINNIPEDS.

The noise associated with the proposed port developments in Alexandra Basin represents a source of acoustic degradation in the marine environment. The proposed development and dredging of the channel within the harbour and bay are unlikely to cause detectable impacts on seals at the population level. However sightings by the author and local reports show that seals enter the harbour area, and there is a possibility that impacts may occur on individual grey or harbour seals entering the works zone. The numbers of seals in the adjacent coastal areas represent a small fraction of the population, both on the east coast of Ireland, and at a national level.

There are no known terrestrial sites for grey or harbour seals in the immediate proximity of the proposed works; and therefore there is no considered threat of physical disturbance to harbour seals at the haul-out sites by the proposed works. However the waters of Dublin bay are likely to be important habitat for grey seals, for feeding and/or for navigation to more offshore foraging areas. Risks to these animals will be small and with a degree of vigilance from operators, collisions between seals and dredging vessels as well as excessive disturbance will be avoided. Strict mitigation measures therefore are recommended (see section 9).

Rock-breaking and piling associated with the proposed demolition and construction of quay walls is considered to be a potentially detrimental activity to marine mammals because it produces a very high source level and broad bandwidth sound. Extended exposure to impulsive sounds with high rise times can lead to injuries of the hearing structures in pinnipeds resulting in permanent hearing loss and other injuries (Richardson *et al*., 1995). Animals close to the source, exposed to a sudden onset of pile-driving noise might be injured (Thomsen *et al*., 2006). Temporary threshold shift (TTS), a temporal elevation of the hearing threshold due to noise exposure, could be induced by exposure to pile-driving noise. Thomsen et al (2006), using a model impact pile-driving broadband sound pressure level of 229dB$_{rms}$ re 1 µPa at 1m, based on 1.5m diameter piles and scaled up by 10dB for larger diameter piles, estimated the resulting TTS-zone for pinnipeds as 400m. In this regard, it is unlikely that piling will result in significant PTS and TTS effects on seals in the area if appropriate mitigation is carried out. However, pile driving and industrial noise can also impact behaviour, communication and breeding. Pile driving in the western Baltic has been shown to effect the haul-out behavior of harbour seals up to 10km from the construction site, however the effect was of short duration and overall number of seals remained the same during the whole construction phase (Edren et al. 2004). The potential impact of the proposed works on the haul-out behaviour of seals and important annual events such as breeding and moulting is negligible as there are no significant seal haul-out sites within 10km of the proposed works. The radius of the zone of behavioural responses to pile-driving noise has been provisionally defined as up to at least 20km for harbour seals (Thomsen *et al*., 2006), which overlaps with observations of seals in Dublin bay, although given the uncertainties in defining responses, it is impossible to quantify the significance at the local population level.

Noise levels from vessels or from the dredging process are highly unlikely to cause hearing damage to exposed seals provided they have the opportunity to leave the affected works area. As the received sound pressure levels can be 140 dB re 1 µPa at 1 km distance from the source, a value that is detectable for seals, and as the area is of ecological importance, it is suggested that appropriate mitigation measures be put in place to minimise acoustic disturbance to seals (see section 9).

Some of the material to be dredged has been identified as containing contaminants. These materials will be dredged using curtain dredging, treated, and used as infill during construction works rather than being transported to the dump site. Therefore any contamination is likely to be extremely limited.

Sediment plumes may present habitat disturbance to local seals foraging in the area. The dredging and dumping of material, particularly of fine sand and silt, will likely effect water quality and create a plume effect which will travel according to local water currents. This may have a temporary impact on marine mammals' visibility, particularly in the immediate vicinity of the vessel, particularly as seals are curious and will often approach vessels. However this effect will be temporary and dredged material will be transported to the dump site on Burford bank. The dump site is in an open body of water approximately 6 nautical miles from Alexandra Basin and 2 nautical miles outside Dublin Bay in about 20m water depth. The main tidal currents in the area of the Burford Bank are in a north-south direction, away from the intertidal areas of Dublin Bay, and the dumping of dredged material is unlikely to cause any adverse effects on seals in the area. The changes to the benthos in this region will most likely effect prey availability to seals in the area. Small shoaling fish that occur regularly in the diet of seals are likely to move away from the disposal area during operations. However, the disposal site has been used for dredge spoil disposal for several decades, with the benthos and demersal fish species subject to periodic smothering, and the dump site is not a known 'hotspot' for seal foraging. Therefore, any displacement resulting from impacts on available prey are unlikely and temporary, with fish returning to the area at the completion of dumping activity. It is suggested that mitigation measures outlined in section 9 be followed to minimise any potential impact of dredging and dumping on individual seals.

7 DIRECT, INDIRECT AND CUMULATIVE IMPACTS OF PROPOSED DEMOLITION WORKS, PILING, DREDGING AND DUMPING OF DREDGED MATERIAL ON CETACEANS

The noise associated with the proposed port developments in Alexandra Basin is a source of acoustic degradation in the marine environment. The proposed development and dredging of the channel within the harbour and bay are unlikely to cause detectable impacts on cetaceans at the population level. However the Dublin Bay is an important area for harbour porpoise. The noise levels from dredging are unlikely to cause hearing damage to exposed cetaceans provided they do not approach the immediate vicinity of operations and have the opportunity to leave the affected area. However, recent investigation by Diederichs et al. (2010) showed a 600m zone of effect of sand extraction on harbour porpoises, with it taking three times longer before a porpoise was recorded following sand extraction than during times without sand extraction. After the ship left the area, porpoises were detected at the usual rate. As the received sound pressure levels from dredging can exceed 140 dB re 1 µPa at 1 km distance from the source, a value that is detectable for most cetaceans (in particular the auditory range of harbour porpoise and minke whale) and as this is likely to extend to the SAC, it is suggested that appropriate mitigation measures be put in place to minimise acoustic disturbance to cetaceans (see section 9).

Rock-breaking, pile and sheet-driving associated with the proposed demolition and construction activity is considered to be a potentially detrimental activity to cetaceans because it produces a very high source level and broad bandwidth sound. The response thresholds of cetaceans are usually the lowest for pulsed sounds and pile driving is one of the loudest sources of this type of noise (Richardson & Wursig, 1996). Extended exposure to impulsive sounds with high rise times can lead to injuries of the hearing structures in cetaceans resulting in permanent hearing loss and other injuries (Richardson *et al*., 1995). Animals close to the source, exposed to a sudden onset of pile-driving noise (in this case piling of 1.6m diameter piles and sheet piles) might be injured as injury is a concern when the sound pressure level exceeds $180dB_{rms}$ re 1 µPa at 1m for cetaceans (Thomsen *et al*., 2006). Temporary threshold shift (TTS), a temporal elevation of the hearing threshold due to noise exposure, could be induced by exposure to pile-driving noise. Applying a broadband sound pressure level of $229dB_{rms}$ re 1 µPa at 1m scaled up by 10dB for larger diameter piles, Thomsen *et al*., (2006) estimated the resulting TTS-zone for harbour porpoise as 1.8km. Since the SAC for harbour porpoise is outside this range, the likelihood of population-level impacts from TTS is considered insignificant, and effects on individual cetaceans entering the works area will be insignificant if appropriate mitigation measures are carried out. However, pile driving and industrial noise can adversely impact behaviour, communication and breeding. Thomsen *et al*., (2006) have provisionally defined a radius for the zone of behavioural response to pile-driving noise as up to at least 20km for harbour porpoises. At 9kHz this noise is capable of masking strong dolphin vocalizations within 10-15km and weak vocalizations up to approximately 40km; behavioural modifications have been observed in bottlenose dolphins in response to noise produced by pile driving (David, 2006), and the abundance of echolocating harbour porpoise was found to decrease during pile driving activities in Denmark within 15 km of the construction site (Tougaard *et al*., 2003). However it remained inconclusive if the abundance changes were directly attributable to the construction activities or were related to overall temporal variation in abundance. More recent data from the field indicate that porpoise would react to pile driving at received sound exposure levels of approximately 140 dB re $\mu Pa^2 s$. Source levels of broadband sheet piling (smaller piles) can be compared to the original ITAP (2005) values (206 dB re $\mu Pa^2 \cdot s$), and applying a reasonable transmission loss of 15 or 20 log (r), we would expect the sound to be reduced to 140 dB SEL at a distance of between approximately 2 - 25 km, although this represents only a rough estimate and will be very site and context specific (Thomsen, pers comm). These examples demonstrate the potential for impacts at a scale that overlaps with the SAC. Considering the potential for indirect impacts of pile driving and industrial noise on cetaceans, in particular harbour porpoise, it is suggested that appropriate mitigation measures be put in place to minimise acoustic disturbance to cetaceans (see section 9). There is potential for behavioural effects from piling to extend into the SAC. Although behavioural responses to construction noise are considered to be temporary, with either habituation to the noise source, or normal behaviour resuming following cessation of the noise-generating activity, planned works involve piling throughout the year for a period exceeding five years. Behavioural responses depend on many factors including the properties of the sound source, species, age, condition, sex, season, social state and existing behaviour (Richardson et al. 1995), all of which complicate the task of determining the nature and significance of behavioural responses. It is therefore recommended that a precautionary approach be adopted with establishment of a monitoring programme to determine any effects on harbour porpoise within the SAC.

It is most likely that any effects of the proposed dredging work in Dublin harbour and bay on cetaceans will be minimal provided correct management and communication procedures are followed. Some of the material to be dredged has been identified as containing contaminants. These materials will be dredged using curtain dredging, treated, and used as infill during construction works rather than being transported to the dump site. Therefore any contamination is likely to be extremely limited.

Sediment plumes may present habitat disturbance to local cetaceans foraging in the area. The dredging and dumping of material, particularly of fine sand and silt, will likely effect water quality and create a plume effect which will travel according to local water currents. This may have a temporary impact on marine mammals' visibility, particularly in the immediate vicinity of the vessel. As with seals, the dredged area is not considered (or known to be) an important cetacean foraging area and therefore any displacement resulting from impacts on available prey are unlikely and not considered significant.

The dump site on Burford Bank is in an open body of water approximately 6 nautical miles from Alexandra Basin and 2 nautical miles outside Dublin Bay in about 20m water depth. However, the site overlaps with the Rockabill to Dalkey Island SAC with harbour porpoise listed as a qualifying interest. The main tidal currents in the area of the Burford Bank are in a north-south direction, away from the intertidal areas of Dublin Bay. The dumping of large quantities of dredged material may cause adverse effects on local harbour porpoise populations. Porpoises feed mainly on small shoaling fishes, with many prey items taken on or close to the benthos (NPWS 2013). Dumping of dredged material will smother benthic communities, and shoaling fish are likely to move away from the dump site during operations, with potential loss of foraging opportunities for harbour porpoise. The disposal site has been used for dredge spoil disposal for several decades, with the benthos and demersal fish species subject to periodic smothering, and the dump site is not a known 'hotspot' for harbour porpoise foraging. Data on the distribution of cetacean species from January 2009-July 2011 show only a single harbour porpoise sighting in the vicinity of the Burford Bank with a more inshore/coastal distribution of harbour porpoise and bottlenose dolphin (CDM 2012). Therefore, any displacement resulting from impacts on available prey are unlikely and not considered to be significant. An earlier study also concluded that the effects of dredging and dumping at the Burford Bank on harbour porpoise would, at worst, be localised and temporary (Anon 2013). It is expected that animals would habituate to stationary vessels, and would return to foraging in the affected areas when operations area completed (Anon 2013). However, given the volumes of material to be dumped, and the long time-scale of these operations, it is suggested that mitigation measures outlined in section 9 be followed to minimise any potential impact of dredging and dumping on harbour porpoise.

To effectively assess cumulative impacts of the proposed works the temporal and spatial elements of the planned operations needs to be considered. Piling and dredging within the basin at the same time would increase the potential impacts of sound exposure to marine mammals therefore simultaneous dredging, demolition and piling should not occur, or should be strictly limited in the basin to minimise risk.

The dump site has been routinely used for the dumping of dredged material, and licences have been issued for the dumping of approximately 8 million tonnes of material at this site between 1997 and 2012. It is possible that there will be a cumulative impact on prey availability from further proposed dumping. However the proposed dump area is not considered to be a significant feeding area for cetaceans or seals therefore any displacement resulting from impacts on available prey are unlikely.

8 ASSESSMENT OF IMPACT MAGNITUDE AND SIGNIFICANCE

It is considered that the proposed piling and dredging in Dublin Port; dredging works within Dublin bay; and dumping of dredged material east of Dublin Bay on the Burford bank will have little likelihood of direct impacts on marine mammals in the area at a population level and is not considered significant. It is however, likely that individual marine mammals entering the works area will be affected by acoustic disturbance resulting from noise and boat activity associated with demolition works, piling, dredging, and dumping, and it is recommended that vigilance as a mitigation measure should be maintained for any marine mammal approaching the area throughout operations. The proposed works will occur at all stages of the tide, and there is an increased likelihood of marine mammals using the harbour at the high tide stage. It is best practise to employ a marine mammal observer to ensure impacts of coastal works (including piling, demolition, dredging and dumping) are minimised. Given the proposed works will take place in the vicinity of a Special Area of Conservation for harbour porpoise, the zone of behavioural responses to noise from piling operations is likely to extend into the SAC, the uncertainty in assessing the type and significance of behavioural responses, and the duration of piling works, it is wise to employ a precautionary approach with regards to impacts on populations within the SAC. Assessing and monitoring of the responses of harbour porpoise to noise, particularly within the SAC, during construction is recommended.

9 MITIGATION MEASURES

Following guidelines from the regulatory authorities, the National Parks & Wildlife Service (2013), the following precautionary measures are therefore advised to minimise the risk of direct injury to marine mammals in the area of operations:

- A trained and experienced Marine Mammal Observer* (MMO) should be put in place during piling, dredging, dumping, and demolition operations. The MMO will scan the surrounding area to ensure no marine mammals are in a pre-determined exclusion zone in the 30-minute period prior to operations. It is suggested that this exclusion zone is 500m for demolition and dredging activities, and 1000m for piling activities considering the potential risks outlined.
- Noise-producing activities shall only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved. Where effective visual monitoring is not possible, the sound-producing activities shall be postponed until effective visual monitoring is possible. Visual mitigation for marine mammals (in particular harbour porpoise) will only be effective during daylight hours and if the sea state is 2-3 (Beaufort scale) or less. In the absence of year-round data on marine mammal use within Dublin Bay, there is no justification for limiting works to any particular season.

- For piling activities, where the output peak sound pressure level (in water) exceeds 170 dB re: 1μPa @ 1m, a ramp-up procedure must be employed following the pre-start monitoring. Underwater acoustic energy output shall commence from a lower energy start-up and thereafter be allowed to gradually build up to the necessary maximum output over a period of 20-40 minutes.
- Once operations have begun, operations should cease temporarily if a cetacean or seal is observed swimming in the immediate (<50m) area of piling and dredging and work can be resumed once the animal(s) have moved away.

- Dumping of material at sea should not take place if a cetacean or seal is within 50m of the vessel.

- Any approach by marine mammals into the immediate (<50 m) works area should be reported to the National Parks and Wildlife Service.

- If there is a break in piling activity for a period greater than 30 minutes then all pre-activity monitoring measures and ramp-up (where this is possible) should recommence as for start-up.

- Once normal operations commence (including appropriate ramp-up procedures), there is no requirement to halt or discontinue the activity at night-time, nor if weather or visibility conditions deteriorate, nor if marine mammals occur within a radial distance of the sound source that is 500m for dredging and demolition works, and 1000m for piling activities.

- The MMO will keep a record of the monitoring using a ‘MMO form location and effort (coastal works)’ available from the National Parks & Wildlife Service (NPWS) and submit to the NPWS on completion of the works.

- Further more detailed guidance on the above can be found in NPWS (2013)

- In the absence of a predictive sound propagation model** it is not possible to accurately predict the likely impact of sound on marine mammals within the SAC. However evidence from the literature suggests that the distance to the SAC from the proposed works occurs within the range within which behavioural responses have been recorded and therefore reasonable potential exists for behavioural impacts. Assessing and monitoring noise levels and the responses of harbour porpoise to noise, particularly within the SAC, during construction is therefore recommended, with additional noise-reducing mitigation employed as appropriate if received sound levels exceed the threshold for behavioural responses.

*A qualified marine mammal observer (MMO) is a visual observer who has undergone formal marine mammal observation training (JNCC MMO training course or equivalent) and has a minimum of 6 weeks marine mammal survey experience at sea over a 3 year period. MMO's for use in Ireland should have field experience in marine mammal monitoring in European waters and be familiar with the Irish regulatory procedures relevant to the activity to which they are assigned, in order to ensure compliance. MMOs should have at least 3 years experience in surveying/identifying harbour porpoise as the area is important for this species and they are difficult to visually detect even in a favourable sea-state.

**In order to reliably predict the zone of responsiveness associated with the proposed programme of piling activities in Alexander Basin within the SAC, a dedicated sound propagation modelling approach with associated field measurements would be necessary. Field measurements of underwater sound in the SAC would determine the attenuation rates under various tidal conditions and the noise levels encountered by marine mammals, particularly within the SAC area. Deployment of hydrophones in combination with passive acoustic monitoring in the SAC is suggested as a potential alternative to sound propagation modelling. This will enable quantification of the received sound levels from construction activity within the SAC. If this monitoring shows noise levels exceeding threshold levels for expected behavioural responses of harbor porpoise, and/or if passive acoustic monitoring highlights behavioural responses, further mitigation to reduce noise transmission, such as the use of bubble curtains during piling, should be employed.

10 RESIDUAL IMPACTS

It is unlikely that there will be negative residual impacts of the proposed works on marine mammals in the area. Potential direct impacts from the noise from the proposed construction activities on marine mammals will be minimal once the mitigation measures suggested are put in place. The changes to benthos in the dump area will have potential impacts on prey availability to marine mammals in the area but as it is not known to be a critical foraging area for marine mammals any effects will be negligible on both the population as well as the individual level. Behavioural responses to noise from dredging and construction are considered to be temporary and limited to the duration of the works, and will be reduced for the duration of the works once the suggested mitigation measures are put in place. The residual impacts therefore of the proposed work on marine mammals is considered to be insignificant.

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APPENDIX D

BENTHIC COMMUNITIES

(No appendix for this section)

APPENDIX E

UNDERWATER DIVERS

(No appendix for this section)

APPENDIX F

COASTAL PROCESSES

APPENDIX F1

Time series are presented below in Figure 2.49 to Figure 2.52 to show the impact of the proposed channel on the hydrodynamics at the four stations identified Figure 2.18 for the top middle and bottom layers of the 3D hydrodynamic model. As can be seen the ABR project has no significant impact on the hydrodynamic regime at any of the four sampling stations.

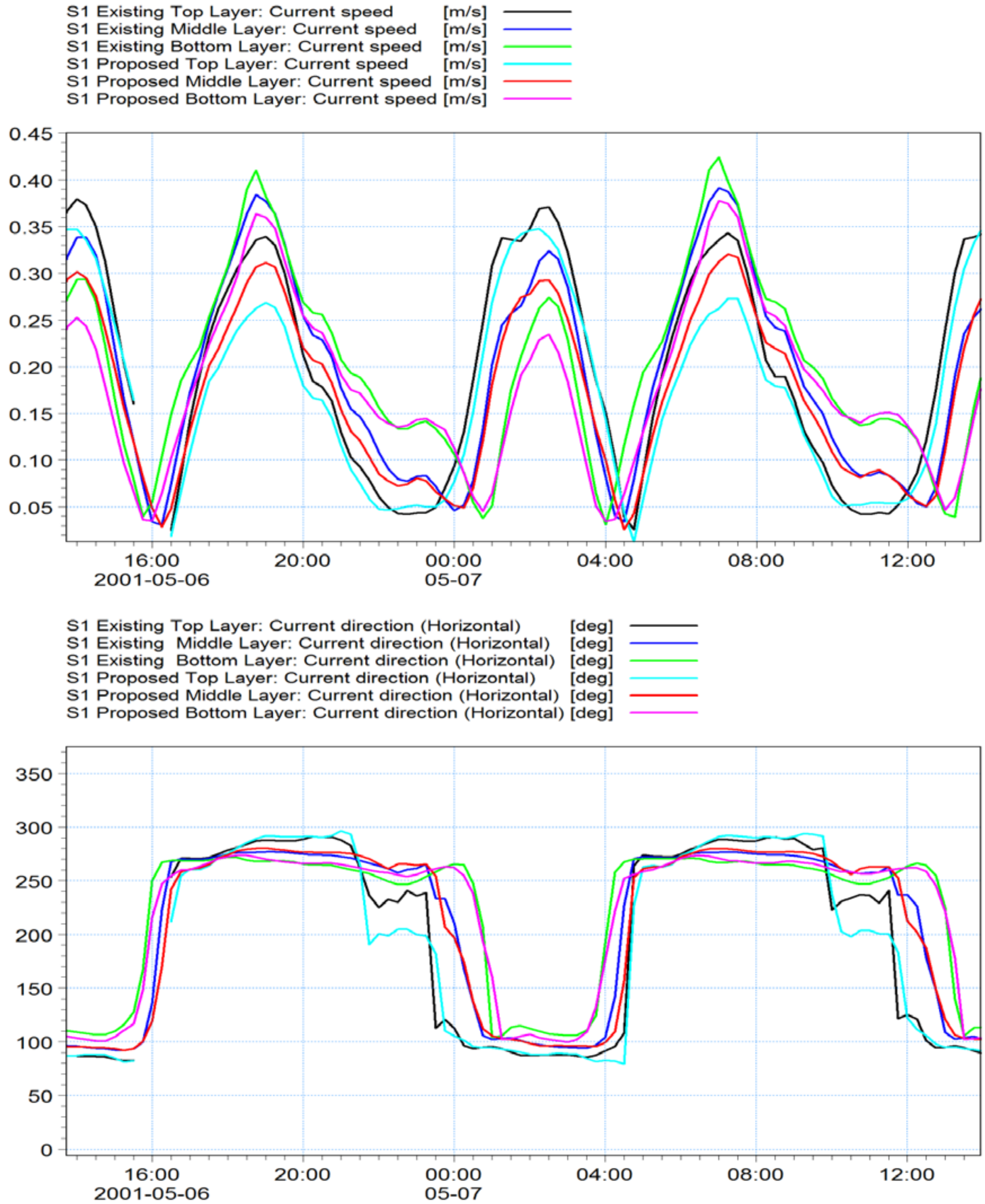
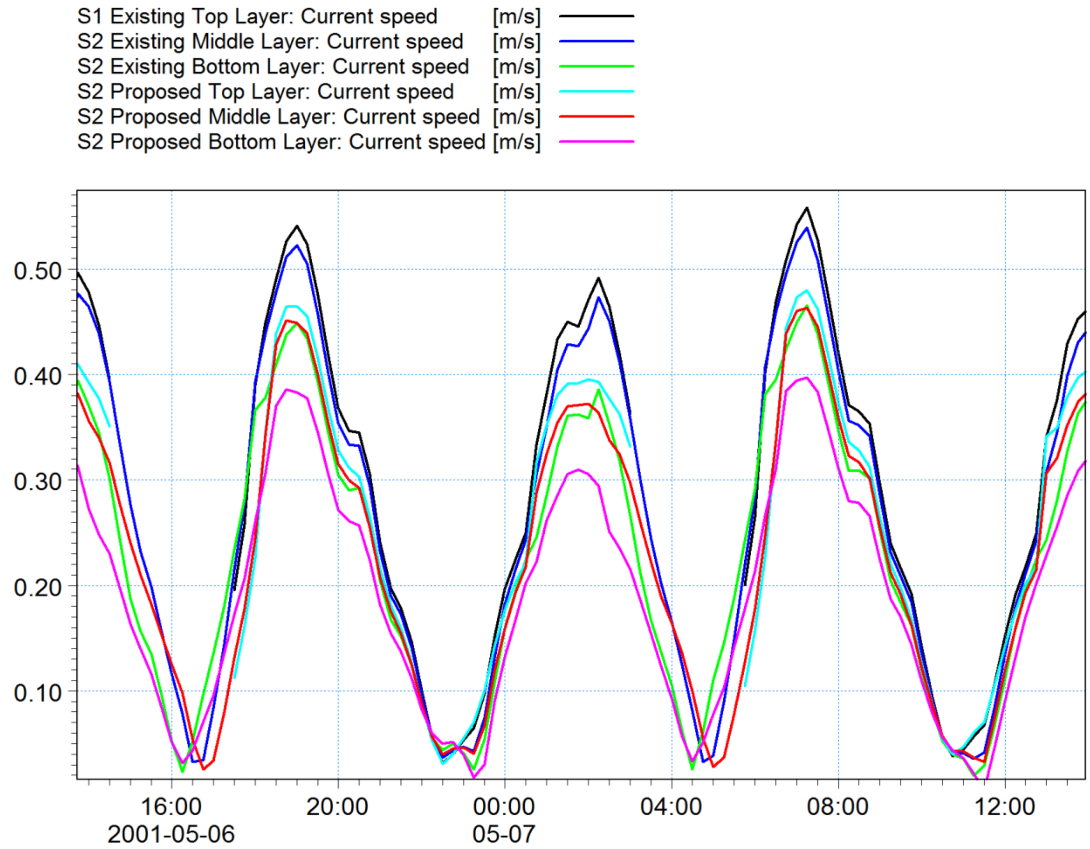


Figure 2.1: Existing and proposed current speeds (upper) and horizontal current directions (lower), taken from top, middle and bottom layers - Sampling station S1



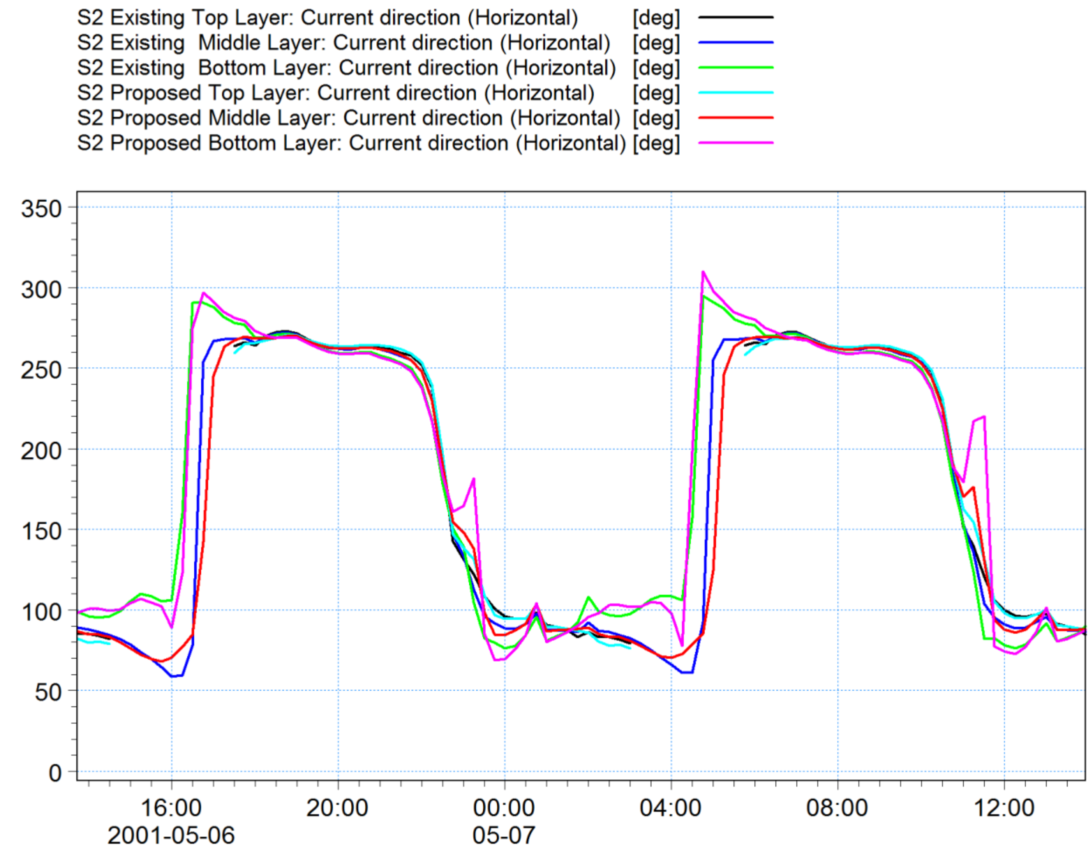
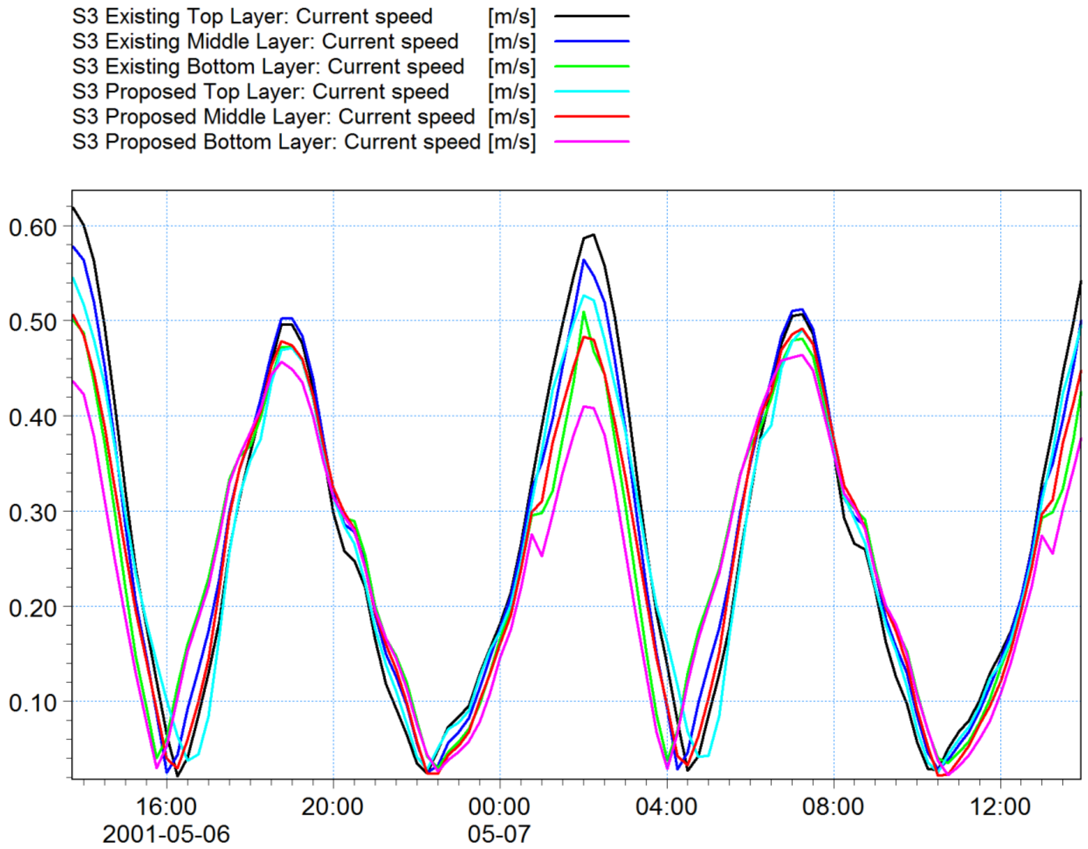


Figure 2.2: Existing and proposed current speeds (upper) and horizontal current directions (lower), taken from top, middle and bottom layers - Sampling station S2



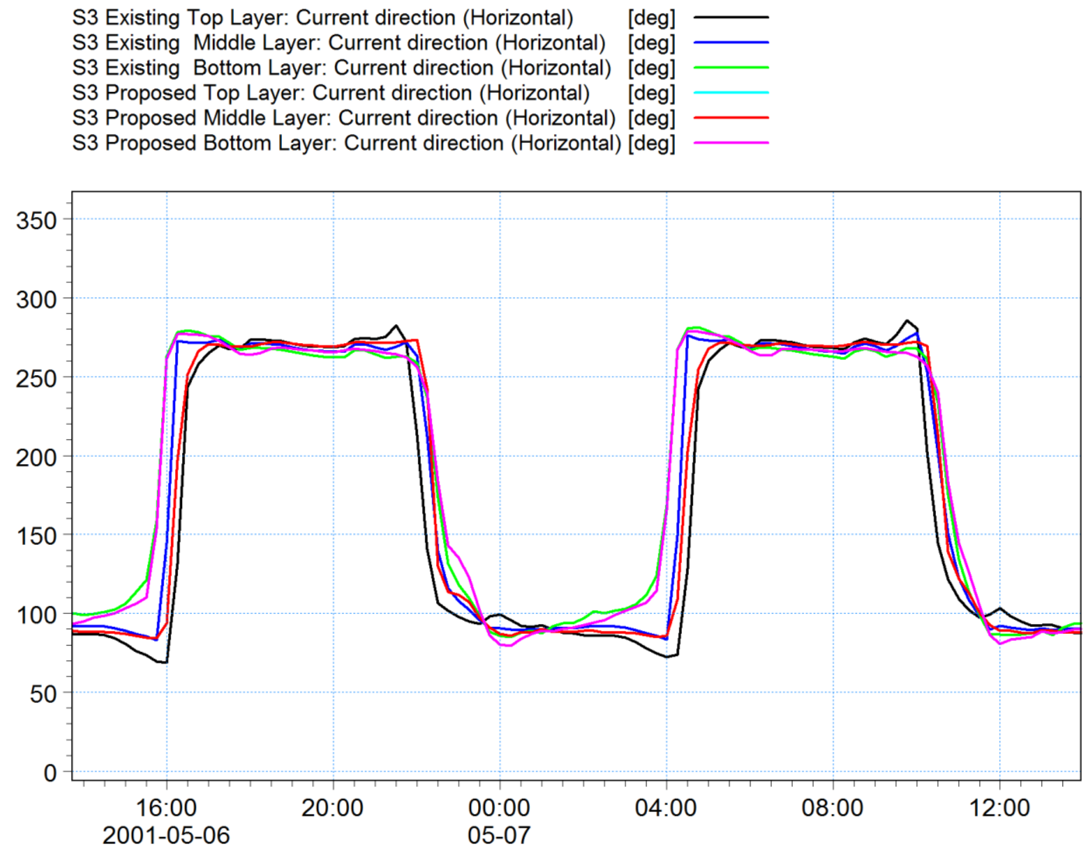
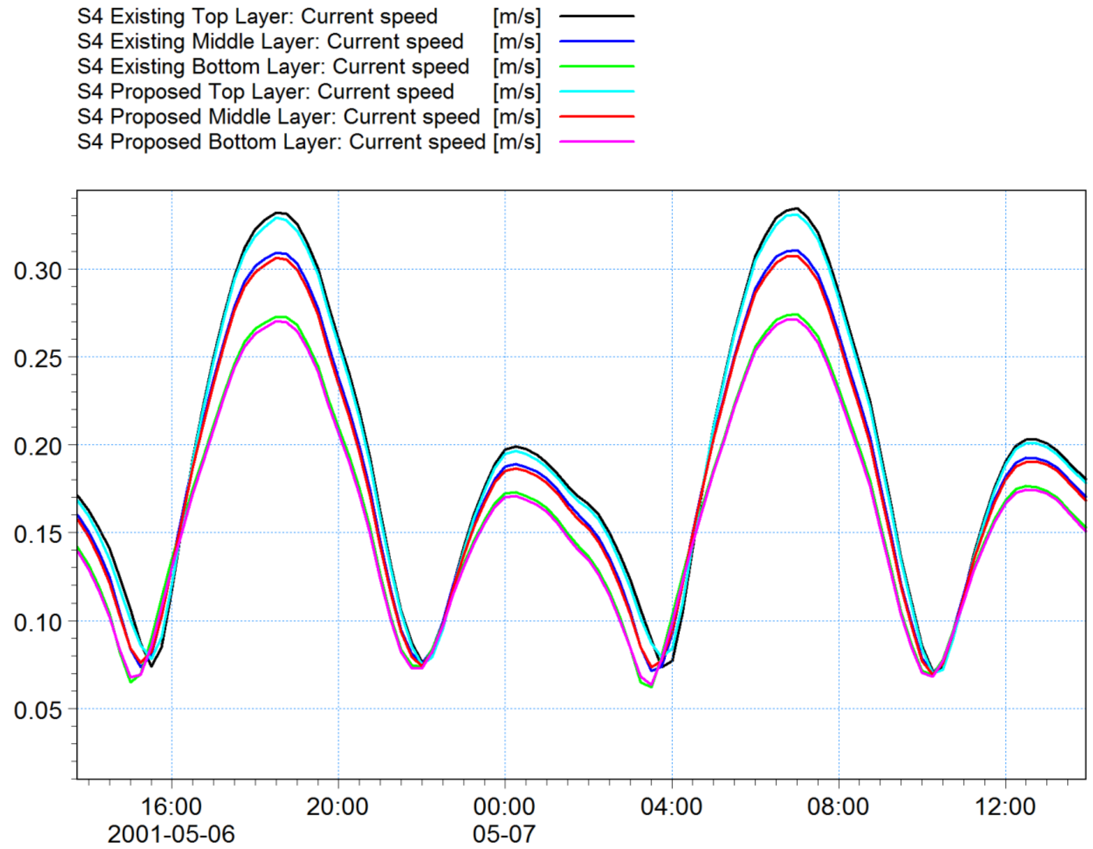


Figure 2.3: Existing and proposed current speeds (upper) and horizontal current directions (lower), taken from top, middle and bottom layers - Sampling station S3



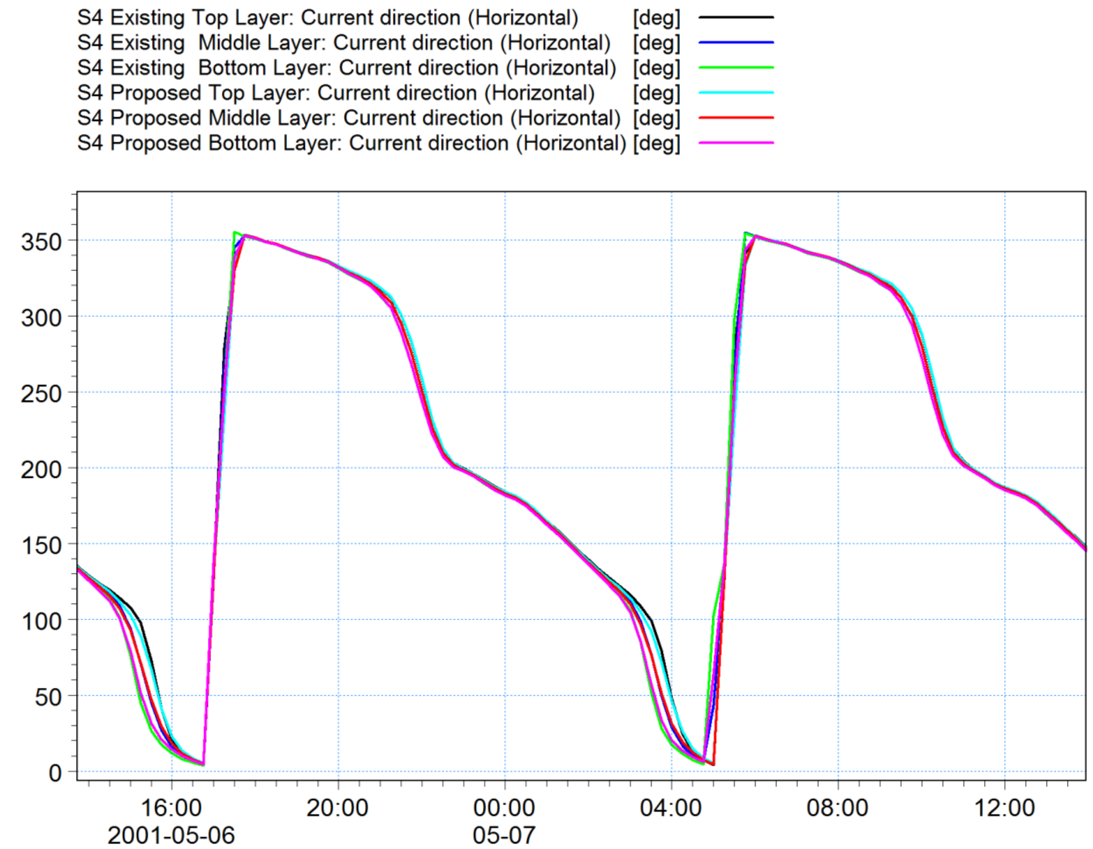


Figure 2.4: Existing and proposed current speeds (upper) and horizontal current directions (lower), taken from top, middle and bottom layers - Sampling station S4

APPENDIX F2

Irish Water scraps €340m expansion of Ringsend plant

Plan to construct 9km pipe under Irish Sea dropped

Article in Irish Times, 12th May 2014

Irish Water has scrapped Dublin City Council's planned redevelopment of the State's largest sewage works which included a 9km pipe into the Irish Sea.

The upgrade and expansion of the Ringsend waste-water treatment plant would have cost €340 million, the utility said, an outlay which it could not justify. Irish Water said the necessary works to the plant, which is inadequately sized and does not meet EU standards, would be carried out at half that cost and the underwater pipe would not be built.

Dublin City Council had been planning the expansion of the plant since it began operations in 2003, and secured planning permission in 2012 for the work, including construction of the 9km pipe to bring treated waste-water outside Dublin Bay. The €270 million job was due to begin this year.

Irish Water took over responsibility of waste-water services from the council last January, and undertook a risk-assessment of the scheme which showed it was likely to cost some €340 million to develop.

"That would have constituted our entire capital budget for one year to built one pipe for one area. To commit all the money to one plant would have put us in a desperate situation," an Irish Water spokesman said.

He said new technologies have emerged which would allow the upgrade of the plant to meet EU standards and expand the facility to deal with the equivalent of 450,000 people's waste – the expansion as planned by the council – within a budget of €170 million. Of that some €70 million would be spent on expansion and some €100 million retrofitting tanks.

Minister for the Environment Phil Hogan welcomed what he said was a "strategic national decision" by Irish Water.

The council said the decision was a matter for Irish Water.