Marine Scotland Licensing Team (MS-LOT)
Marine Scotland
By email

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27 September 2022

Attn: Marine Scotland Licensing Operations Team (MS-LOT)

Granton Harbour – Marine License MS-00009904 (Construction)
Request for a Screening Opinion

We write on behalf of our clients, PiP Asset Management, to formally request a screening opinion under The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 for the above-named project. The screening request relates to the revision of the 2018 consented design as authorised by the above noted marine construction license.

As required by Part 2, Paragraph 10 of the above Regulations we have provided information relevant to this proposal (attached) which includes:

(2) A request for a screening opinion under paragraph (1) must include –

a) a description of the location of the proposed works, including a plan sufficient to identify the area in which the works are proposed to be sited;

b) a description of the proposed works, including in particular—

(i) a list of all of the regulated activities which are proposed;

(ii) a description of the physical characteristics of the proposed works and, where relevant, works to be decommissioned; and

(iii) a description of the location of the proposed works, with particular regard to the environmental sensitivity of geographical areas likely to be affected;

c) a description of the aspects of the environment likely to be significantly affected by the proposed works; and

d) a description of any likely significant effects, to the extent of the information available on such effects, of the proposed works on the environment resulting from either, or both, of the following:—

(i) the expected residues and emissions and the production of waste, where relevant;

(ii) the use of natural resources, in particular soil, land, water and biodiversity.

(3) A request for a screening opinion may, in addition to the information required in accordance with paragraph (2), also be accompanied by a description of any features of the proposed works or proposed measures envisaged to avoid or prevent significant adverse effects on the environment.

(4) The information referred to in paragraph (2) is to be compiled taking into account, where relevant—

a) the selection criteria set out in schedule 3; and
b) the available results of any relevant assessment.

The information provided is drawn from a desk-based appraisal of the 2018 Environmental Impact Assessment Report (EIAR) which was submitted to support the marine construction license application.

If you have any questions related to the information provided, please do not hesitate to contact the undersigned.

Yours sincerely
for EnviroCentre Ltd

(issued electronically)

Emma Cormack
Principal Consultant

Dr. Ian Buchan
Principal Consultant

Enc: Granton Harbour Revised Design Screening Request

CC: Gary Freckleton

GRANTON HARBOUR REVISED DESIGN SCREENING REQUEST

Introduction

PiP Asset Management Ltd seek a formal Screening Opinion from Marine Scotland as the Consenting Authority under Part 2, Regulation 10(1) of the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (hereafter referred to as the Marine EIA Regulations) in respect of the proposals to amend the consented site design which includes changes to the layout as well as the construction methods for some elements of the scheme. The proposed amendments do not impact the marine dredging license therefore this screening request relates to the marine construction license only.

The approximate Grid Reference for the site is 323710 677705 with the site boundary shown in Drawing No 776305-GIS001, Appendix A.

Site Location

Granton Harbour lies on the Firth of Forth, about 1.6km west of Newhaven and 4km north of Edinburgh City centre. The harbour sits within the Granton Harbour regeneration development area which fronts the Firth of Forth. It is approximately 9.5Ha in size, bounded to the north by the Western Breakwater, to the east by the Eastern Harbour and to the south and west by Granton Waterfront Development.

2018 Environmental Impact Assessment

An Environmental Impact Assessment Report (reference 8170, hereafter referred to as the EIAR) was prepared under the Marine EIA Regulations to accompany the marine licence applications for the construction and dredging/disposal activities associated with the development. The applications were submitted to Marine Scotland in October 2018.

The EIAR considered the environmental impact associated with developing the existing harbour into a marina, including land reclamation, construction of a quay wall, revetment, mole extension, piling to install the marina pontoons along with associated dredging activities (Refer to Drawing No SK112C, Appendix A).

The main concerns in relation to marine construction and dredging activities identified in the 2018 EIAR were:

- The Water Environment, in particular waves, sediment transport and water quality;
- Ecology in relation to Ornithology, Marine Mammals, Non-Native Species and Otter;
- Underwater Noise associated with piling operations; and

- Navigation resulting from the breakwater extension.

The topics scoped out of full EIA assessment included:

- Air Quality;
- Airborne Noise;
- Cultural Heritage;
- Human Health & Population;
- Landscape & Visual;
- Natural & Major Disasters

The EIAR concluded there were no significant impacts associated with the development as long as the mitigation measures identified in Chapter 8 Schedule of Mitigation of the 2018 EIAR were adhered to.

The Schedule of Mitigation has subsequently informed the Dredging Environmental Management Plan dated November 2019 (Document Reference Number 8794) and the Construction Environmental Management Plan dated March 2022 (Document Reference Number 9879).

Habitats Regulation Appraisal (HRA)

Due to the proximity of works to European designated sites, the marine license applications were accompanied by a HRA (refer to Edinburgh Marina, Technical Appendix 5-4: Habitat Regulation Appraisal, Ref 8399, dated 28 September 2018) to determine the effect of the proposed development on the qualifying features of the following designated sites:

- Firth of Forth Special Protection Area (SPA);
- Firth of Tay and Eden Estuary Special Area of Conservation (SAC)
- Forth Islands SPA;
- Imperial Dock Lock, Leith SPA;
- Outer Firth of Forth and St Andrews Bay Complex proposed SPA (pSPA);
- Isle of May SAC;
- Berwickshire and North Northumberland Coast (SAC); and
- River Teith SAC.

The HRA Screening process could only rule out Likely Significant Effects (LSEs) of all the qualifying features of Firth of Tay and Eden Estuary SAC. Therefore, the effects on the qualifying features for the other seven sites were taken forward for further consideration in the next HRA stage, an Appropriate Assessment.

The Appropriate Assessment concluded that if mitigation measures outlined within the EIA Report (EIAR) are adhered to, along with the pollution prevention mitigation described in Chapter13 of the HRA report, then there would be no significant effects on the integrity of the designated sites with regard to the conservation objectives for the sites' qualifying features.

Climate Change

Climate change has taken a prominent position within policy and legislation at a national level, with the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019[1] amending the Climate Change (Scotland) Act 2009[2]. The 2019 Act sets a target date of 2045 for Scotland reaching net-zero emissions.

In addition, under Schedule 4(4), the Marine EIA Regulations require:

> "*A description of the factors specified in Regulation 5(3) likely to be significant affected by the works… (Including) climate (for example greenhouse gas emissions, impacts relevant to adaption)*"

Note: Climate change was considered in the 2018 EIAR in Chapter 6.7. In summary it was concluded that the primary concern was in relation to flooding and that as this topic was scoped out of the EIA it did not constitute a significant environmental aspect.

Granton Harbour 2022 Revised Design

The proposed 2022 changes to the 2018 design are shown in Drawing SK112D, Appendix A and summarised below:

1 The 2022 footprint of the proposed marina remains unaltered from the 2018 proposals.

2 An increase in the area to be reclaimed on the western side of the harbour from 6,060 m^2 to 11,500 m^2. The method of construction remains the same. The nature and source of the infilling material also remains unchanged from that originally consented i.e. the use of the stabilised contaminated dredging arisings from the surface of the harbour basin and the stockpiled surplus inert material currently present on site. (Note: there is estimated to be sufficient inert material to accommodate the increase in the reclamation area).

3 The straightening and shortening in length of the western edge of the harbour with a 195m length of rock revetment replacing the 2018 proposal comprising 335m of vertical sheet piled harbour walls.

4 The dock inlet area will not be sheet piled as per the original proposal. Instead, it will remain in its current state.

5 A reduced sized marina which means that although there will be no sheet piling undertaken, piling activities will still be needed for the marina pontoons although to a lesser extent. The reduced size of the marina also results in a slight reduction in dredging activities.

[1] *Climate Change (Emission Reduction Targets) (Scotland) Act 2019 (asp 15).* Available at: https://www.legislation.gov.uk/asp/2019/15/enacted
[2] *Climate Change (Scotland) Act 2009 (asp 12).* Available at: https://legislation.gov.uk/asp/2009/12/contents

EIA Screening

Under the Marine EIA Regulations, proposals are screened to determine whether they fall within one of the types or scales of development which would require an EIA. The EIA Regulations do not attempt to define 'significant effects' as each development must be dealt with in its own merits. In screening an application, consideration is given to whether the proposal would fall into any of the categories set out in Schedules 1 or 2 of the Regulations.

Schedule 1 of the Regulations lists types and scales of development for which an EIA will always be required. Schedule 2 of the Regulations lists types and scales of development for which an EIA might be required, subject to assessment under Schedule 3.

The proposed development was originally identified as being a Schedule 2 development as it fell under the following classes:

> *Paragraph 12 (a) - Marinas where the area of the enclosed water surface exceeds 1,000m^2.*
>
> *Paragraph 1(e) - Reclamation of land from the sea (all works).*
>
> *Paragraph 10(m) - Coastal work to combat erosion and maritime works capable of altering the coast through the construction for example, of dykes, moles, jetties and other sea defence works, excluding the maintenance and reconstruction of such works (all works).*

The Schedule 2 class in which the revised 2022 proposed development could fall under are:

> *Paragraph 13 - Any change to or extension of works of a description mentioned in paragraphs 1 to 12 of Column 1 of this table where those works are already authorised, executed or in the process of being executed.*

The applicable threshold and criteria in relation to this Paragraph are that the thresholds and criteria in the corresponding part of Column 2 of Schedule 2 applied to the works as changed or extended are met or exceeded and in such a case the change or extension may have significant adverse effects on the environment.

As the site is located in what is considered to be an environmentally sensitive area, it is necessary to assess the proposed alterations to the site design against the criteria contained in Schedule 3 in order to established whether the proposed change would be deemed a "significant effect" and thereby require an EIA to accompany any application to vary the marine construction license.

Assessment of the Revised Scheme Against The 2018 Scheme

Schedule 3 of the Regulations provides selection criteria for the screening of Schedule 2 developments. It must be noted that there are no rigid thresholds providing a universal test of whether or not an EIA is required. The proposal must be considered on a case-by case basis by virtue of factors such as its nature, size or location. The fundamental test to be applied in each case is whether that particular type of development proposed, and its

specific impacts are likely, in that particular location, to result in significant effects on the environment.

The proposed changes to the 2018 consented scheme were reviewed against the 2018 EIAR to determine whether the proposals would result in a likely significant effect on the environment. A summary of the review findings is provided below with the detailed analysis for each key topic area presented in Appendix B.

Water Environment

A wave modelling addendum study has been undertaken to assess the impact of the revised development proposals on the local wave climate (Refer to Appendix C).

The modelling study concludes that the revised development proposals reduce wave heights for all examined storm events in comparison to both current (baseline) status, and the previously approved layout. It concludes that the position of the proposed revetment wall has no material adverse effect in the Western Harbour, whilst the proposed dredge plan results in an improved wave climate for boats within the Eastern Harbour.

Marine Ecology & Underwater Noise

The 2018 EIAR concluded that underwater noise and acoustic disturbance, vibration and suspended sediment derived from marine construction works were identified as potentially significant in their impact to marine mammals, birds, otters and habitat receptors.

Left unmitigated, dredging and piling have potential to disturb the foraging and migratory behaviour in fish or cause hearing injuries to marine mammals. Once the piling is complete marine mammals, otters and birds will repopulate the area and so the impacts will be short term, intermittent and negligible. Noise during operation will be confined to intermittent vessel engine noise and maintenance dredging.

The new proposal removes the requirement for sheet piling, although piles for pontoons will still be required. Therefore, mitigation actions outlined in the Marine Mammal Protection plan with regards to the piling element will still need to be adhered to.

Navigation

The potential impact on navigation associated with placing a structure such as the proposed marina and breakwater within the harbour is mainly related to potential obstruction, reduced space for manoeuvre, and increased traffic.

The new proposal removes the requirement for sheet piling, although piles for pontoons will still be required. There will be stone revetment for the retention of the reclaimed land. Therefore, outlined mitigation will still need to be adhered to.

Other Topics

The 2018 EIAR identified that the main impact on air quality was from development traffic and construction dust primarily from the infilling activities. The chapter concluded that for development traffic there would be a negligible increase in traffic emissions as a result of the development. Suitable mitigation measures were developed to manage dust arising during the construction phase.

The proposed changes to the 2018 design do not alter the conclusions of the 2018 EIAR.

Construction noise levels are anticipated to be lower as a result of the site design changes. As per the previous EIA, a construction NIA will be deferred until employment of a contractor, when sufficient detail is available to carry it out. Any short term adverse effects are anticipated to be mitigated by employment of a CNMP.

No adverse effects are predicted during the operational phase of the development as a result of the design changes. These findings are in line with the previous EIA.

No changes to the 2018 consideration of Climate Change, Human Health and Population and Natural & Major Disasters are predicted as a result of the proposed changes to the consented design.

Cultural Heritage and Landscape & Visual topics were not considered in the 2018 EIAR. No impacts on these elements are envisaged as a result of the proposed amendments.

Conclusions

The 2022 scheme remains within the original footprint of the 2018 consented scheme. The only changes to the design are in relation to the size of the reclamation area increasing and the engineering of the western wall of the harbour. All other aspects of the project are either no longer proposed (i.e. sheet piling), have been reduced in scale (i.e. the marina) or remain unaltered (i.e. the proposed mole extension).

The proposed changes to the 2018 consented scheme were reviewed against the 2018 EIAR to determine whether the proposals would result in a likely significant effect on the environment. The review concludes that there are no changes to the outcomes of the 2018 EIAR nor the resulting Schedule of Mitigation as a result of the revised design.

A DRAWINGS

Legend

Site Boundary

Do not scale this map

Client

Edinburgh Marina Granton Harbour Ltd

Project

Edinburgh Marina

Title

Site Location Plan

Status

FINAL

Drawing No.

776305-GIS001

Revision

Scale

1:15,000

A3

Date

5 May 2022

Drawn	Checked	Approved
GV	EC	CCAS

ENVIRO Centre

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

Revetment outlined green approx 225LM

North Mole extension & revetment outlined blue

Revetment backfill area hatched green approx 5000sqm

Hoist dock inlet

Quay wall extension shown orange approx 110LM

Quay wall backfill area hatched orange approx 1050sqm

Extent of proposed works outlined red

Western Harbour

Granton Harbour

Eastern Harbour

Western Breakwater

Esparto Wharf

Middle Pier

Pilot Station

Eastern Breakwater

HESPERUS BROADWAY

HESPERUS CROSSWAY

SEALCARR STREET

MERLIN AVENUE

HERON PLACE

Existing Location Plan, showing position of Licensable Works

CLIENT	GCDL
DRAWING	MS LOT Application Location Plan
DWG REF- SK112C	1:2000 @ A3

-	19.04.17	first issue
A	15.08.17	NOTES ADJUSTED
B	25.08.17	Area notes added, adjust red outline
C	14.09.18	adjustment to positions

Revetment outlined green approx 195LM

North Mole extension & revetment outlined blue

Revetment backfill area hatched green approx 11,500sqm

Extent of proposed works outlined red

Western Harbour

Granton Harbour

Eastern Harbour

Western Breakwater

Mean Low Water Springs

Mean High Water Springs

Sloping Masonry

Esparto Wharf

MLWS

Light (flashing green)

Light (flashing red)

Rock

Und

EER, Burgh Const & UA Bdy

Eastern Breakwater

Pilot Station

Middle Pier

Club

Bathing Shelter

Mud

Shingle

Tank

MoP

HESPERUS BROADWAY

HESPERUS CROSSWAY

SEALCARR STREET

MEDUM AVENUE

HERON PLACE

Existing Location Plan, showing position of Licensable Works

CLIENT	GCDL
DRAWING	MS LOT Application Location Plan
DWG REF- SK112D	1:2000 @ A3

-	19.04.17	First issue
A	15.08.17	Notes adjusted
B	25.08.17	Area notes added, adjust red outline
C	14.09.18	Adjustment to positions
D	29.07.22	Alterations for amended licence app

B TOPIC REVIEWS

WATER ENVIRONMENT AND COASTAL PROCESSES

Summary of 2018 EIAR Conclusions

Impact Assessment Summary

This chapter of the EIAR provided an assessment of the implications of the proposed development on the water environment and coastal processes. The water environment is considered to encompass hydrology, hydrogeology and water quality, whilst coastal processes are considered to encompass tides, waves and associated sediment transport processes.

The following topics were scoped out of further assessment on the basis of consultation responses and the baseline assessment:

- Hydrology;
- Flood risk; and
- Tidal currents

The sensitive receptors to potential impacts on the water environment and coastal processes from the proposed development were identified as:

- The coastal waters of the Firth of Forth;
- Designated sites in the vicinity of the site:
    - Firth of Forth Site of Special Scientific Interest (SSSI);
    - Firth of Forth Wetland of International Importance (Ramsar); and
    - Forth Islands Special Protection Area (SPA).

The proposed works were to involve the following key activities which have the potential to impact the water environment within the site and environs:

- Dredging of navigation channel and marina basin;
- Construction activities (breakwater and pontoons); and
- Marina Operations.

The potential impacts on the water environment and coastal processes include:

- Water Environment:
    - Contamination of coastal water and sediments through spillages, leakages and/or sediment transfer (oils, fuels and suspended solids).
- Coastal Processes:
    - Changes in local wave climate.
    - Changes in local sediment transport regime.

The potential interactions between water environment impacts and ecology were assessed within Chapter 5: Marine Ecology.

A wave modelling study was undertaken to assess existing wave conditions within Granton Harbour and look at the impact of the development proposals. The results of the wave

modelling study highlighted that the proposed breakwater extension is likely to reduce significant wave heights within the western harbour, and have negligible impact on significant wave height within the eastern harbour. Overall, the impact of the proposed development on the wave climate within Granton Harbour was considered to be of negligible magnitude.

In the absence of significant impacts to the drivers of sediment transport, it was considered that there are unlikely to be significant impacts to ongoing sediment transport processes. Overall, the impact of the proposed development on sediment transport processes within Granton Harbour was considered to be of negligible magnitude.

Mitigation Measures Proposed

The following mitigation measures were proposed within the EIAR:

General Management

A suitably qualified Environmental Clerk of Works (EnvCoW) will monitor the construction works to ensure that the CEMP and associated mitigation measures are being implemented effectively.

Best practice will be adopted throughout all phases of development, following current guidance. The programme of works, including timing, direction and method of capital dredge, will be planned, monitored and managed to minimise the potential negative environmental impacts.

A pollution incident response plan will be set out in the CEMP relating to the construction of the proposed development, statutory requirements and identification of areas of highest sensitivity. This will provide site spill response procedures, emergency contact details and equipment inventories and their location. All staff will be made aware of this document and its content during site induction. A copy will be available in the site office at all times.

It is anticipated that a monitoring plan will be implemented. The aim of this will be to characterise the baseline conditions prior to construction works commencing and to continue throughout the construction phase to confirm that the mitigation measures are performing as expected. The monitoring plan will be established and implemented with the agreement of SEPA and Marine Scotland, and will be incorporated into the CEMP.

It is considered that the following elements would be included within the agreed monitoring plan:

- Regular visual inspection of:
    - Harbour waters, more frequent during periods of dredging activity, in order to monitor levels of sediment suspension and dispersion.
- Water quality monitoring: A monitoring plan, covering baseline, construction and post-construction will be agreed with SEPA and Marine Scotland.
- Monitoring as required to satisfy the conditions of any future discharge licence(s) or other environmental legislation.
- Monitoring following any pollution incidents.
- On-going liaison with SEPA and Marine Scotland as required during construction.

All activities with potential to affect the water environment require to be authorised under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR). The level of

authorisation required is dependent on the anticipated environmental risk posed by the activity to be carried out. These activities could include construction drainage.

Dredging Mitigation

- Dredging method to be designed to limit release of sediment during works.
- Physical Barrier – a physical silt barrier will be placed between dredging within the western harbour and Eastern harbours/Firth of Forth.
- Turbidity Monitoring – to ensure that material is not being widely displaced. A baseline would need to be established for contaminant levels within the eastern harbour sediments as well as baseline turbidity levels prior to dredging to enable direct comparisons.

Concrete

There is unlikely to be concrete batching undertaken on-site. However, in the case that batching was to be undertaken on-site the following mitigation measures would be implemented to minimise the potential impact of concrete batching on the water environment in line with PPG6:

- Concrete batching will take place on an impermeable designated area and at least 10m from any waterbody.
- Equipment and vehicles will be washed out in a designated area that has been specifically designed to contain wet concrete/ wash water.
- A closed loop system will be used for wash waters. Wash waters will be stored in a contained lined pond for settlement before being reused (e.g. for mixing and washing).
- No discharge of wash waters will occur on-site. All excess wash water that cannot be reused will be disposed of off-site.

The following mitigation is proposed for concrete handling and placement:

- Pouring of concrete will take place within well shuttered pours to prevent egress of concrete from the pour area.
- Pouring of concrete during adverse weather conditions will be avoided.
- The CEMP will include a Pollution Incident Response Plan, and drivers of vehicles carrying concrete will be informed so as to raise awareness of potential effects of concrete and of the procedures for clean-up of any accidental spills.

Concrete acidity (pH) will be as close to neutral (or site-specific pH) as practicable as a further precaution against spills or leakage.

Oil, Fuel, Site Vehicle Use and Storage

The risk of oil contamination will be minimised by good site working practice (further described below) but should a higher risk of oil contamination be identified then installation of an oil separator will be considered.

The storage of oil is considered a Controlled Activity which will be deemed to be authorised if it complies with the Regulations. The mitigation measures to minimise any risk of contaminant release are in line with SEPA PPG and GPP documents and include the following:

- Storage:

    - Storage for oil and fuels on site will be designed to be compliant with GPP 2 and 8.
    - The storage and use of loose drums of fuel on site will be not permitted.
    - The bund will provide storage of at least 110% of the tank's maximum capacity.
- Refuelling and maintenance:
    - Fuelling and maintenance of vehicles and machinery, and cleaning of tools, will be carried out in a designated area where possible in line with PPG 7.
    - Multiple spill kits will be kept on site.
    - Drip trays will be used while refuelling.
    - Regular inspection and maintenance of vehicles, tanks and bunds will be undertaken.

Emergency procedure: The Pollution Incident Response Plan will include measures to deal with accidental spillages.

Operational Phase Mitigation

General Management

An Environmental Management Plan (EMP) will be in place throughout the operational phase. Best practice will be followed throughout the operational phase, with reference to the SEPA Guidance for Pollution Prevention (GPPs), and best practice outlined in The Green Blue: The Green Guide for Marinas, as outlined in Section 4.3.3.

A Pollution Incident Response Plan will be prepared for the operational phase, and included within the EMP, taking full consideration of best practice, statutory requirements and identification of areas of highest sensitivity. This will provide site spill response procedures, emergency contact details and equipment inventories and their location. All operation staff will be made aware of this document, and its contents, and it will be available in the marina office. Appropriate spill kits and absorbent materials will be stored in a suitable location which is easy to access. Staff/contractors will be trained in the use of spill kits and other pollution control equipment and the operation of pollution control devices.

Pump out facilities will be provided to enable berth holders and visitors to empty holding tanks.

Oil, Fuel, Site Vehicle Use and Storage

Fuel, oil and chemical storage will be sited on an impervious base within a bund and secured area. All wastes will be stored in designated areas that are bunded to contain any spillage. Refuelling facilities will be inspected regularly and the maintenance record will be available for inspection, whilst fuel collars and drip trays will be in operation to reduce the risk of spillages. Weekly inspections will be undertaken of oil storage bunds, tanks and pipework for signs of damage. The boat hoist will be inspected on a weekly basis to check for signs of hydraulic oil and fuel leakage.

Statement of Significance of Effect

The residual effects were considered to be either minor or negligible, and accordingly the effects of the proposed development on the water environment and coastal processes were not considered to be significant.

Current Proposals

Changes to the Impact Assessment

A wave modelling addendum study has been undertaken to assess the impact of the revised development proposals on the local wave climate (Refer to Appendix C).

The modelling study concludes that the revised development proposals reduce wave heights for all examined storm events in comparison to both current (baseline) status, and the previously approved layout. It concludes that the position of the proposed revetment wall has no material adverse effect in the Western Harbour, whilst the proposed dredge plan results in an improved wave climate for boats within the Eastern Harbour.

In the absence of any predicted negative change to wave climate, no further changes to the impact assessment are required for the updated development proposals.

Amendments to the Mitigation Measures Proposed

No changes to the proposed schedule of mitigation measures are required for the updated development proposals.

Revised Statement of Significance of Effect

No changes to the statement of significance are required for the updated development proposals.

MARINE ECOLOGY

Summary of 2018 EIAR Conclusions

Impact Assessment Summary

The original EIAR concluded that underwater noise and acoustic disturbance, vibration; and suspended sediment derived from marine construction works were identified as potentially significant in their impact to marine mammals, birds, otters and habitat receptors.

Left unmitigated, dredging and piling have potential to disturb the foraging and migratory behaviour in fish or cause hearing injuries to marine mammals. Once the piling is complete marine mammals, otters and birds will repopulate the area and so the impacts will be short term, intermittent and negligible. Noise during operation will be confined to intermittent vessel engine noise and maintenance dredging.

Pollution to water bodies from construction vehicles, refuelling and storage of oils, fuels and chemicals, engineering works and use of artificial lighting were also identified as possible risks in the original EIAR.

Mitigation Measures Proposed

- An Ecological Clerk of Works (ECoW) and Marine Mammal Observer (MMO) shall be appointed to audit and provide advice throughout the construction duration. Site attendance frequency will be agreed with statutory consultees.
- The possible occasional presence of otter, marine mammals and a range of bird species on site and in the wider landscape will be included in tool box talks and site induction for construction staff operating in this area;
- Works associated with land above the high water mark shall be preceded by a pre-works check for otter resting sites and nesting birds;
- If an otter is observed within the proposed working areas, guidance will be sought from the appointed ECoW and do not commence works until the otter has dispersed. All observations of otter shall be recorded and submitted to local biological records centres;
- Should an otter resting site be discovered, prior to or during works, said works shall be assessed by the ECoW with regards to the need for additional mitigation species disturbance licensing;
- Potential otter holts and shelters should be checked prior to works commencing by a qualified ecologist;
- The removal of boulders and concrete with the potential to shelter otter must be supervised by a qualified ecologist;
- All site contractors should be made aware of the potential presence of otter in the locale, and in the event that otter is discovered on site, all work in that area must stop immediately and a suitably qualified ecologist contacted;
- The development design seeks to retain or create new otter sheltering habitat wherever possible;

- Works and related site mobilisations will commence no earlier than one hour after dawn and will cease no later than one hour before sunset to avoid times where otter are likely to be active;
- Temporary lights used during construction must be fitted with shades to prevent light spillage outside the working area. Temporary lights must not illuminate scrub and scattered trees as lighting can affect commuting and foraging success of otter and other species;
- Any trenches or pits made during construction must be covered when unattended or a shallow angled plank inserted to allow animals to escape, should they become trapped inside them. The ends of any pipeline must be capped when unattended, or at the end of each working day to prevent animal access;
- Scottish Environment Protection Agency (SEPA) Guidance for Pollution Prevention (GPPs) would be followed;
- In the event that any protected species is discovered all work in that area must stop immediately and a suitably qualified Ecologist contacted. Details of the SNH Area Officer and Scottish Society for the Prevention of Cruelty to Animals (SSPCA) relevant Officer could be held in site emergency procedure documents.
- Refer to Technical Appendix 5-2: Marine Mammal Protection Plan for the Marine Mammal Mitigation Protocol submitted as a Technical Appendix as part of the 2018 EIAR.
- Artificial lighting shall be directed towards the working areas only in order to minimise the effects on otter which can be more active between dusk and dawn;
- Pollution of the marine environment will be prevented in order to safeguard water quality and marine life which otter rely on within these habitats; and
- The ECoW and MMO will keep accurate records of site observation monitoring, including compliance and non-compliance details.

Statement of Significance of Effect

The Marine Ecology Chapter of the 2018 EIAR concluded that following the proposed mitigation, which was designed upon review of engineering design and construction techniques, adverse effects would not be significant upon the identified receptors.

Current Proposals

Changes to the Impact Assessment

No changes to the Impact Assessment have been identified upon review of the information provided for the revised works scope.

Amendments to the Mitigation Measures Proposed

The new proposal removes the requirement for sheet piling, although piles for pontoons will still be required. Therefore, mitigation actions outlined in the Marine Mammal Protection plan with regards to the piling element will still need to be adhered to.

Revised Statement of Significance of Effect

No changes to the statement of significance are required for the updated scope of works.

NAVIGATION

Summary of 2018 EIAR Conclusions

Impact Assessment Summary

Navigation formed a section within the "Other Issues" Chapter of the 2018 EIAR i.e., the topic was not scoped into the full EIA given significant effects were not deemed to be likely. The navigation section of the EIAR provided an assessment of potential impacts resulting from construction and operation of the proposed development.

The potential impact on navigation associated with placing a structure such as the proposed marina and breakwater within the harbour is mainly related to potential obstruction, reduced space for manoeuvre, and increased traffic.

The sensitive receptors have been identified as vessels approaching and leaving the harbour, in particular recreational vessels using the eastern harbour.

Large commercial vessels do not access the proposed marina site. Smaller vessels will use the navigational channel with sufficient room for manoeuvre through the marina entrance

The quay wall works and piling activities are assessed as having a low to moderate impact on navigation within the harbour for the short term as it will be necessary for vessels to operate in the navigation channel. The actual approach will depend on the detailed design and preferred approach of the main contractor for the works.

Mitigation Measures Proposed

A Construction Environmental Management Plan will incorporate navigation and the mitigation below (where appropriate).

Mitigation with regard to the marina construction commences with the requirement for the successful contractors to provide full methods, risk assessments and mitigation measures and to agree and amend these as necessary.

Mitigation relates to correct lighting and buoyage during and post construction. New navigation lights shall be installed as appropriate and buoyage may be deployed to ensure marina traffic follows a visible and shallow entry angle into the main shipping channel.

Health and Safety during construction will be followed in accordance with The Construction (Design and Management) Regulations 2015.

The following recommendations are generic and will be specified according to the construction method and type of plant deployed.

Moving the piling barge/rig

To be handled be a competent vessel and crew at all times, advised to harbour and other traffic and co-ordinated prior to commencement through a single contact.

Obstruction of channel

- Ensure barge/jackup is on the 'non' channel side of the sheet pile installation if possible.

Foundering of barge in the channel

- As above and additionally contractor emergency procedures to be in place, dovetailing with harbour emergency procedures;
- Contractor insurance;
- Barge surveys; and
- Best operating practice for the barge.

Collision with other vessels while engaged in dredging/disposal/piling

- Navigational and minimum ambient lighting on barge;
- Local Notice to Mariners;
- Publicity in local press for recreational users, who are most likely to be affected.
- Communication issues
- VHF ch12 continuous monitoring; and
- Mobile numbers of single contact point with emergency action responsibility on barge and vice versa with Harbour contacts.

Support vessels

- Control of movement by harbour;
- VHF ch12 continuous monitoring; and
- Contractor methods and risk assessed boarding and transfer methods to barge/shore for all weather conditions.

Wave/wash of passing vessels affecting passenger transfers or barge

- Pre-planned and co-ordinated movements to lessen risk by contractor.

Damage to piling mid construction by vessels

- Contractor to advise on fragility of structure when not complete and proposed mitigation should irreparable damage be a risk.

Damage to vessels by piles mid construction

- Lighting or other highlighting of danger areas to be used particularly during darkness;
- Local Notice to Mariners; and

Publicity in local press for recreational users.

Contact with vessels passing by the operation of piling

- Methods and risk assessments to be provided, agreed and adhered to (e.g. barge mounted crane jib extending into navigational channel and the like).
- The piling operation to be arranged in such a way that no physical encroachment can be made into the navigational channel.

In addition to the foregoing, the marina operator is committed to complying with the Port Marine Safety Code and 2018 Guide to Good Practice on Port Marine Operations.

Statement of Significance of Effect

Effects on navigation were assessed to be low to moderate significance within the harbour over the short term as it will be necessary for vessels involved in the works to operate within the navigation channel.

Current Proposals

Changes to the Impact Assessment

No changes to the Impact Assessment have been identified upon review of the information provided for the revised works scope.

Amendments to the Mitigation Measures Proposed

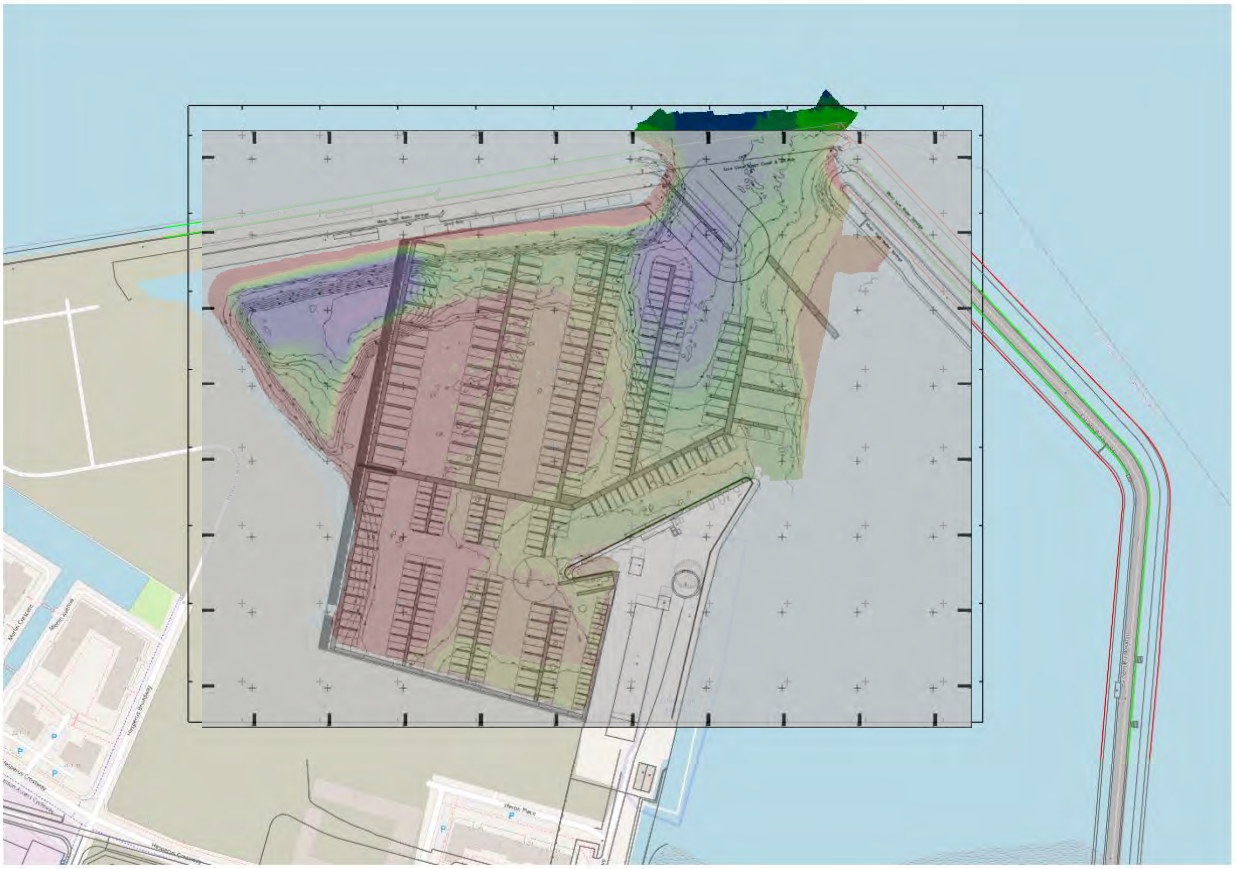
The new proposal removes the requirement for sheet piling, although piles for pontoons will still be required. There will be stone revetment for the retention of the reclaimed land. Therefore, outlined mitigation will still need to be adhered to.

Revised Statement of Significance of Effect

No additional adverse effects on navigation are predicted as a result of the design changes. These findings are in line with the previous EIA.

C WAVE MODELLING ADDENDUM

Granton Harbour Wave Disturbance Modelling - Addendum



Granton Central Developments Ltd

Report

March 2022

The expert in WATER ENVIRONMENTS

This report has been prepared under the DHI Business Management System certified by Bureau Veritas to comply with ISO 9001 (Quality Management)

Granton Harbour Wave Disturbance Modelling - Addendum

Prepared for Granton Central Developments Ltd

Represented by Garry Freckleton, PIPAM

Granton Harbour Current Status and Proposed Masterplan

Project manager	Nicholas Elderfield
Quality supervisor	Peter Sloth

Project number	26801453	
Approval date	18th February 2022	
Revision	**Revision History**	**Comment**
17 March 2022	Addendum v0.2	Incorporation of optimized dredge plan. Client comments.
22 February 2022	Addendum v0.1	Addendum to original report to address wave climate inside proposed marina for revised layout in relation to land reclamation and introduction of new 2 :3 wall revetment
Classification	Public	

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Nomenclature

Abbreviation	Definition
GH	Granton Harbour
GCDL	Granton Central Developments Limited
BW	Boussinesq model
SW	Spectral wave model
MWHS	Mean High Water Spring
MSL	Mean sea level
WL	Water level
SWL	Still water level
OD	Ordnance Datum
CD	Chart datum
RYP	Return year period
Hm0	Spectral Significant Wave Height - Four times the standard deviation of seas surface elevation
Tp	Peak wave period
Tz	Zero crossing period
MWD	Mean wave direction

1 Introduction

Granton Central Developments Ltd (GCDL) have appointed DHI Water Environments (UK) Ltd to conduct a wave disturbance study as an addendum to the previous study [1]), with an update based on a revised proposed scheme layout (Edinburgh Marina Revised GA Plan 28.01.22, herein referred to as *GH_Rev2022*) in relation to a new marina in the western basin of Granton harbour.

The revised proposed scheme relevant to this addendum is updated as:

- a new 1:1.5 sloping rock revetment wall which is introduced in front of the reclamation land, see also Figure 1.1. The new wall replaces part of a vertical sheet pile section in the inner west part as per the previous proposed layout in [1].
- Berthing areas are dredged to levels from -2.5mCD to -4.0mCD from inner to outer sections as in Figure 1.2.
- An approach channel, dredged to -4.0mCD, is extending all the way to Granton harbour entrance, see also Figure 1.2.
- The north mole breakwater inner side is now proposed as a 1:1.5 sloping rock revetment rather than a vertical wall as in [1]. The roundhead at the end of the north mole breakwater extension is now proposed to be replaced by a heavy breakwater pontoon (not modelled herein). The north mole extension seaward slope remains unchanged at 1:2.

The present alignment of Granton harbour's entrance to the maximum fetch in the Firth of Forth allows relatively large waves to enter through the harbour mouth. For much of the existing Granton harbour this provides no specific problem, however the western basin is subject to incident waves from the north-east and it is considered from previous studies that there is a need to provide additional protection to any new infrastructure and/or berthing areas residing within the west harbour.

1.1 Project description

Granton Harbour is located in the Firth of Forth, in an area identified to be affected by waves due to North to East extreme wind conditions [2]. The breakwater structures are exposed to wave attack during extreme weather conditions particularly the swell from the east that penetrates through the Firth of Forth from the North Sea, predominantly during the summer months. During the winter months, dominant stronger Westerly and weaker North-westerly winds blow over fetch lengths of 7km to 9km to reach Granton Harbour.

The area of interest for GCDL is the western part of Granton harbour where a proposal for a new marina is part of the proposed development within Granton Harbour (Figure 1.1). As noted, the present alignment of the harbour entrance to the maximum fetch in the Firth of Forth allows relatively large waves to enter through the harbour mouth which leads to potential problems for the western basin. Consequently, there is a need to understand the specific requirements for adjustments to the north mole to provide adequate protection for berthed vessels in the western basin in line with international standards and guidance.

DHI has previously undertaken wave transformation modelling to inform coastal flood assessments of the area [2] and wave disturbance modelling [1] to assess wave conditions at the western inner harbour, in relation to berthing criteria as per international standards and guidance. [2] provided the wave conditions at the harbour entrance. The information available from that study included the wave height, period and direction for a range of extreme storm conditions ranging from a typical 1 in 1 event up to more infrequent 1 in 50yr conditions with additional provision of the associated direction and period.

The effectiveness of the proposed adjustments to the north mole as per the previous layout was assessed in [1] with consideration of the detailed interaction of the wave conditions with the edge structures in the harbour, for both the existing and proposed layouts. In particular, the orientation and extent of the proposed changes to the north mole were assessed along with the key physical processes of wave diffraction and reflection. Thus, [1] provided required information to inform the ongoing design process, through the development of a specific wave disturbance model of Granton Harbour to test the effectiveness of the proposed protection system for wave and wind directions as in **Table 1.1** in [1]. Additionally, assessment of

north-west incident waves was considered in order to quantify impact of proposed north mole extension breakwater to the eastern basin of Granton harbour.

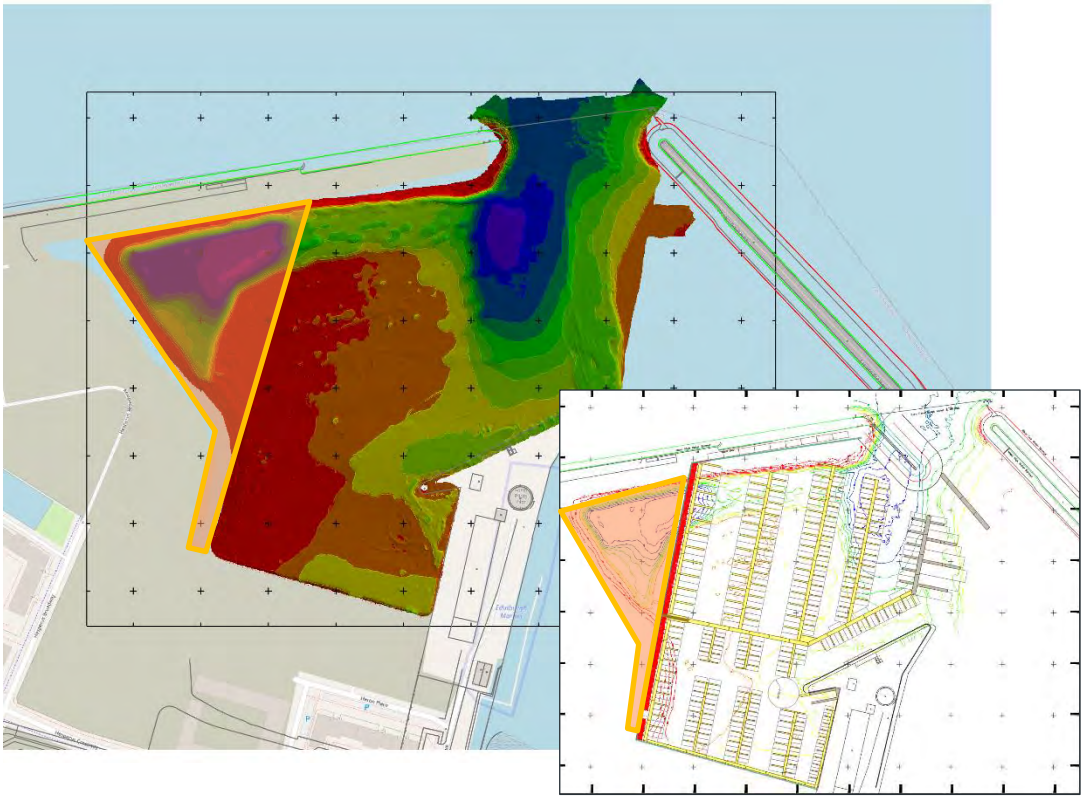


Figure 1.1 Overview of the current status of Granton harbour (with 2019 bathymetry also shown) and the revised proposed layout master plan (inset image) covering Granton Harbour and showing the north mole breakwater extension and new revetment wall in the inner west harbour with reclamation land (orange polygon).

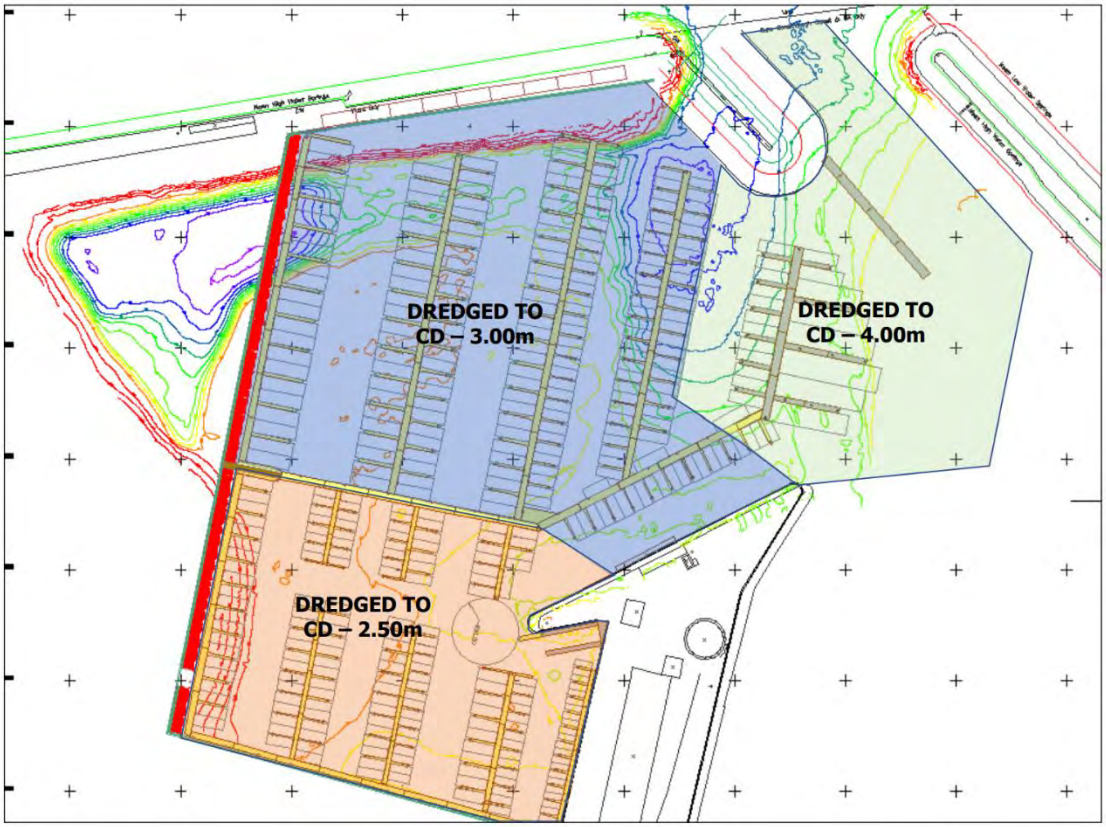


Figure 1.2 Proposed dredge plan for berthing marina and approach channel, dredged to -4.0mCD, extending all the way to the Granton harbour entrance (courtesy of Marina Solutions Ltd).

1.2 Scope of work

DHI's approach to the wave disturbance modelling defines a suitable way of transforming a range of design wave conditions from the North Sea and the wider Firth of Forth to a point adjacent to Granton Harbour, and subsequently how these conditions then impact the proposed marina layout.

To achieve this over the distances required, a spectral wave model (MIKE 21 SW model) [3], which provides a description of the prevailing sea state rather than individual waves, was employed. From these boundary conditions, a surface resolving Boussinesq wave model (MIKE 21 BW model) [4] is utilised in order to understand the particular wave disturbance problems within Granton Harbour. More details on the scope of each stage are provided below.

1.2.1 Granton Harbour wave disturbance model (Boussinesq Wave Model)

The principal focus of this study is the development of a wave disturbance model to assess the revised Granton harbour layout as described in section 1.1. The penetration of waves into the marina requires the use of a high-resolution wave model that resolves the key wave conditions of interest including wave diffraction and reflection.

Worst case scenario for this assessment, based on the spectral wave analysis results in [2], is a combination of NE wind direction with the same wave direction. An additional combination of extreme wind and wave conditions was also examined for NW wind direction (direction aligned to eastern harbour) along with the NE wave direction (worst case scenario for this wind direction [2]).

As agreed in the scope, the following wave return periods will be used to assess the wave penetration into the marina basin in accordance to Table 1.1 which reiterates wave conditions assessed in [1] and herein.

- 1:1 year (annual average wave conditions)
- 1:50 year (extreme wave condition)

Table 1.1 Boundary wave conditions (BW model) nearshore for 1:1 and 1:50 (see also [2]) for NE wind direction (top) and NW wind direction (bottom).

Nearshore wave parameters at 9.4 m depth offshore of Granton Harbour for NE wind and wave directions	**1 in 1 year event**	**1 in 50 years event**
Hm0 (significant wave height, *m*)	1.6	2.8
Tp (peak period, *s*)	5.34	6.9
Peak direction (coming from-*degrees from north*)	45	45
Spreading (Directional Standard Deviation, DSD, *in degrees*)	23	23

Nearshore wave parameters at 9.4 m depth offshore of Granton Harbour for NW wind and NE wave directions	**1 in 1 year event**	**1 in 50 years event**
Hm0 (significant wave height, *m*)	0.71	1.01
Tp (peak period, *s*)	9.82	9.82
Peak direction (coming from - *degrees from north*)	45	45
Spreading (Directional Standard Deviation, DSD, *in degrees*)	23	23

The 1 in 1 and 1 in 50-year events include both the criteria as suggested in the Guidelines and Codes of practice on which to base “good wave climate in small craft harbours”. The 1 in 200yr event is the typical standard of protection considered in coast protection/breakwater design. It should be noted that the 1 in 200yr condition has not been assessed for wave disturbance modelling.

The water levels used to analyse the wave disturbance within the marina are based on a *Mean High Water Spring* (MHWS) level for each of the storm return periods and layouts. This is considered suitable as the prevailing worst case NE wave and NW wind conditions being tested are considered unlikely to be specifically coincident with the passage of low pressures, see also [1] and [2].

The primary purpose of this study is to ascertain the wave conditions in the harbour for the safety and comfort in the berthing areas. In addition, it aims to maintain confidence that the proposed revisions as part of the Granton harbour development does not constitute a deteriorated situation, in terms of wave climate, than the current status as also in comparison to layout as in [1]. Generally accepted wave heights within marinas that are allowable for comfort of the users and to limit damage to vessels, pontoons and other ancillary equipment are described in the following documents:

- Australian Standard, AS3962 - 2020
- The Yacht Harbour Association Ltd – A Code of Practice for the design, construction and operation of coastal and inland marinas and yacht harbours, British Marine Federation – 2007
- PIANC Report No 134 – 2013, design and operational guidelines for super yacht facilities.

The general principles taken from these documents are that good to moderate climate waves should be limited to the following:

- 1-yr storm event wave height <0.3m to 0.4m
- 50-yr storm event wave height <0.4m to 0.5m

These conditions will be specifically tested and reported on in this study.

2 Wave disturbance modelling

2.1 Description of wave disturbance model

The Boussinesq Wave model, MIKE 21 BW, is a state-of-the-art numerical model for calculation and analysis of short- and long-period wave disturbance in ports and harbours. MIKE 21 BW can also be used for modelling of surf zone dynamics and swash zone oscillations.

The present model is based on the numerical solution of the enhanced Boussinesq equations formulated by Madsen and Sørensen (1992).

The 2DH Boussinesq Wave module used here can reproduce the combined effects of most wave phenomena of interest in port, harbour and coastal engineering. These include shoaling, refraction, diffraction, partial reflection and transmission, non-linear wave-wave interaction, frequency spreading and directional spreading (see Figure 2.1).

Phenomena, such as wave grouping, generation of bound sub-harmonics and super-harmonics and near-resonant triad interactions, can also be modelled using MIKE 21 BW.

The flexibility of parameterizations of structures reflective characteristics allows adequate representation of different wall types that ultimately affect wave disturbance. No consideration is made however of the effect of waves overtopping and being further transmitted in the harbour.

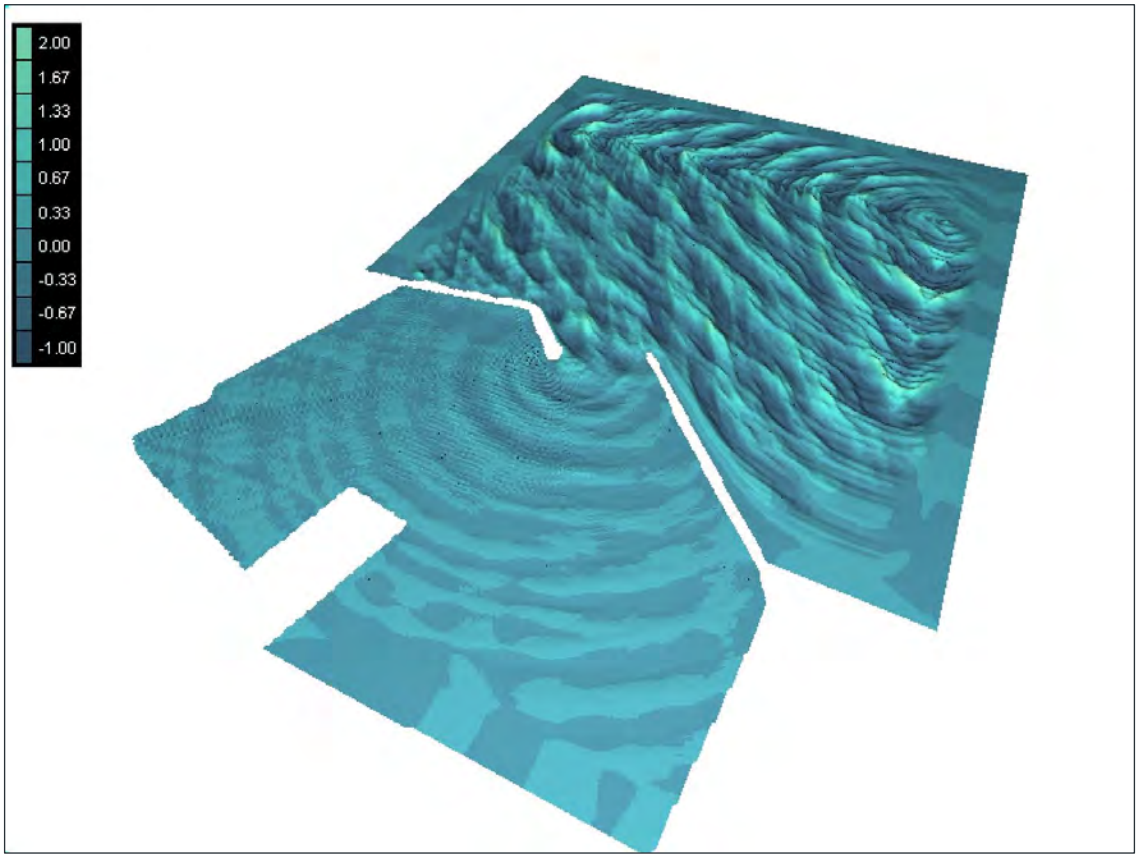


Figure 2.1 Example of the instantaneous solution for a BW model run result for the updated harbour layout wave simulations.

2.2 Wave disturbance assessment options

Based on the revised masterplan layout provided by GCDL and the results of the spectral wave tests described in Section 3 of [1], a BW model of Granton harbour was developed to test the selected design. In [1], a number of designs were tested mainly focusing on the north mole breakwater extension. Herein, we retain the selected north mole extension design as in [1] only in overall length of structure and outer structure characteristics and slope, namely herein as **Option rev2022**. **Option rev2022** is based on the initial GCDL masterplan and consists of a ~55m long breakwater with a roundel at the extension ending. In addition, the inner vertical wall is now replaced by a sloping rock revetment of 1:1.5 This is the worst-case scenario for examining wave disturbance in the east section of the harbour as a shorter breakwater will attenuate a lower amount of incoming wave energy.

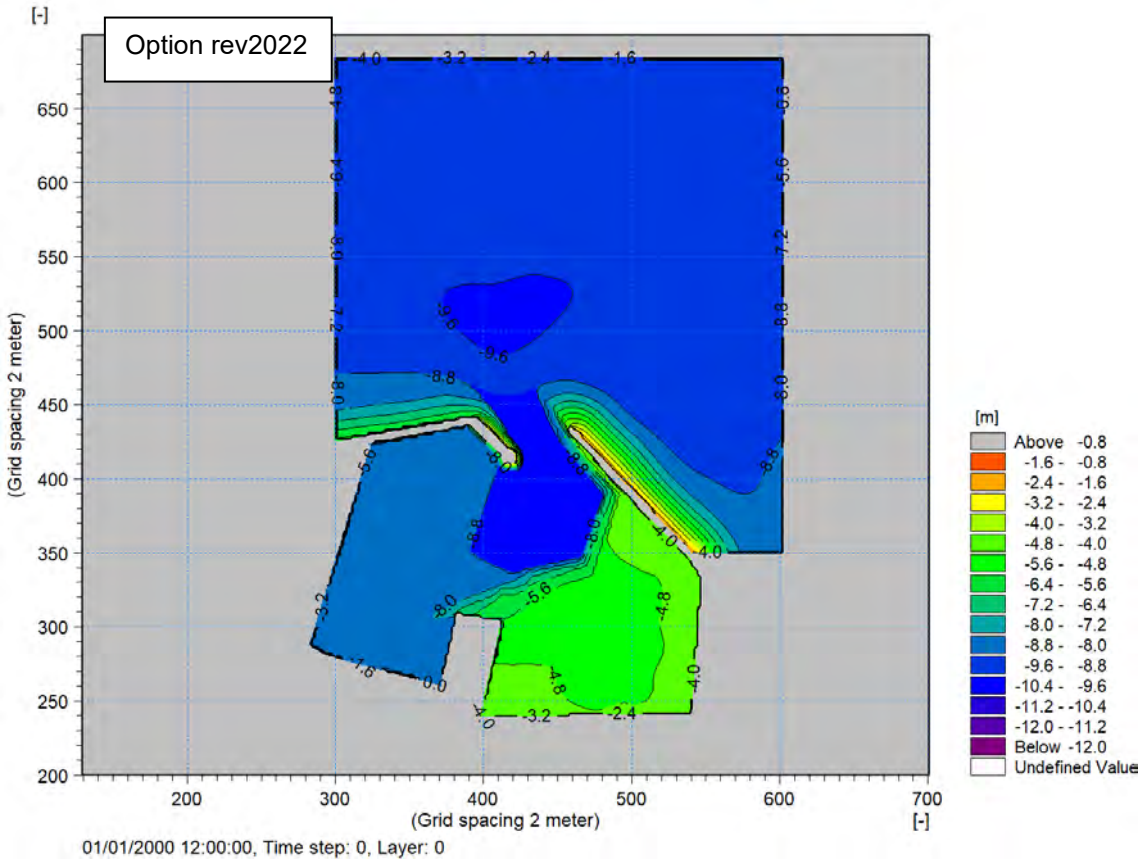
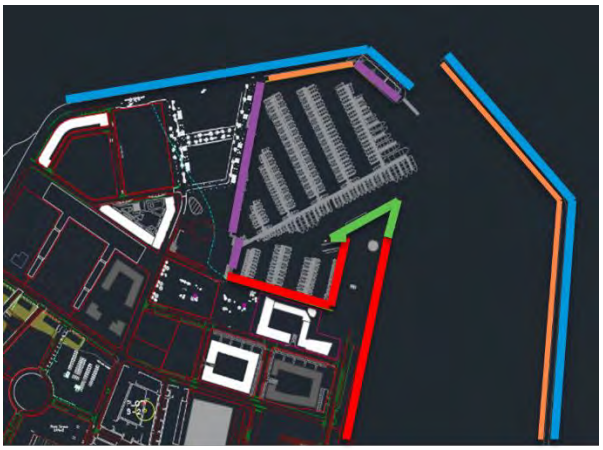


Figure 2.2 Bathymetry used for the MHWS scenario(compare to Figure 4.2 in [1]). Grey denotes either artificial land or porosity/sponge layers used to represent edge treatments. Option rev2022 layout (as in revised proposed GCDL masterplan – similar to Option 01 in BW model assessment in [1] a 55m breakwater with a roundel. Slope of seaward north mole extension breakwater wall remains the same at 1:2. Inner north mole extension is changed to 1:1.5 sloping rock revetment.

Wave disturbance conditions are assessed for events representative of 1:1 and 1:50 RYP. These conform to the AS3692-2020 marina guideline in relation to berthing limits regarding “good wave climates in small craft harbours”.

The wave climates simulated represent the annual average wave conditions as a 1 in 1yr event and extreme wave conditions of a 1 in 50yr return period. Both RYP for both wave conditions, see Table 1.1, are output from the SW wave transformation runs, discussed previously and presented in detail in [2], for a nearshore point at a depth of 9.4mCD.



Treatment of harbour's physical boundaries

Red	vertical walls
Blue	'pitched' stone 1:2
Green	piled pier fully permeable with vertical wall at the backend
Purple	1:1.5-1.7 rubble mount rock revetment
Orange	1:1.5-1.7 sloping impermeable wall

Note:
The proposed breakwater is treated as a rock armour wall of 1:2 slope for the seaward side and 1:1.5 sloping rock revetment on the inner side

Figure 2.3 Treatment of Granton Harbour's physical boundaries in the BW model porosity parameterization. Reflection parameters are computed based on design characteristics of respective reflection elements (width, diameter of stones, permeability etc.) in relation to wave parameters in front of the porous structure (wave height, period and water depth) (see text for details).

A JONSWAP spectrum of random directional incident waves was reconstructed from the SW model output in order to represent boundary wave conditions for the BW model. The timeseries prescribed waves at a point in front of the wave generation line can be seen in Figure 2.4 for 1:1 and 1:50 RYP events.

Calculation of reflection coefficients for breakwater/inner wall characteristics

Calculation of reflection coefficients K_r is based on an iterative process of approaching theoretical/empirical derived K_r for the proposed material, structure slopes and incident wave conditions [5], [6], [7] and [8].

In the MIKE21 Boussinesq wave modelling framework, porosity values are used to model either partial reflection and/or transmission through structures. Wave reflection from e.g., structures, or a beach, can be modelled by applying porosity values (less than 1) at the grid points representing the structures. If no porosity values are specified, the reflection will be 100% from land points. If porosity values are backed up by land, partial reflection will take place. Conversely, (partial) transmission will also take place if the porosity values are not backed up by land points, see also [4], representing for example a permeable breakwater.

As the porosity results in dissipation of energy, the reflection may be controlled by the porosity values and the number of porosity layers. On the contrary, if no reflection is wanted, sponge layers are applied - absorbing all wave energy entering the layers.

This translates to a simple approximation to a porosity parameterisation for the respective design as follows:

- As the wave and depth conditions vary inside a harbour most often you have to use different values of porosity along the porous structures. The model area was, thus, divided into a number of sub-areas characterised by having reasonable uniform wave and depth conditions, see also Figure 2.3. For each of these sub-areas a porosity value is determined using the MIKE 21 Toolbox programme Calculation of Reflection Coefficient given wave characteristics and proposed structure design. Reference values for expected K_r can be found in [5], [7] and [8] and can also be seen in Figure 2.5.

- A rough estimate of the wave disturbance inside a harbour is achieved by running a simulation using a porosity map with a constant porosity along all porous structures. The results of this

simulation (wave height distribution) were then used subsequently for an improved estimate of the porosity.

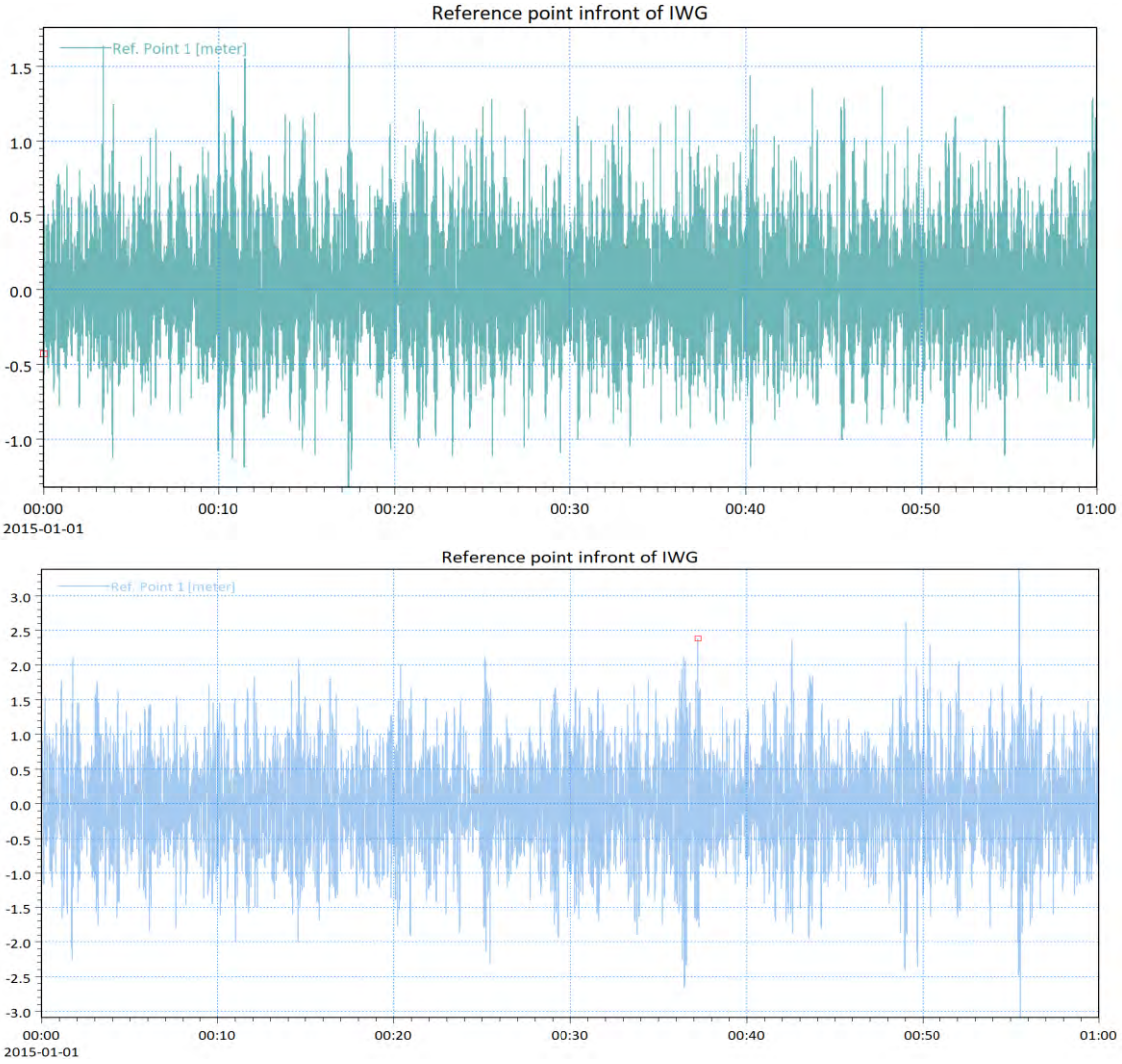


Figure 2.4 Surface elevation timeseries at reference point further offshore from Granton harbour entrance propagated from the wave generation lines in BW model. Timeseries representative of wave conditions for 1:1 (top) and 1:50 (bottom) RYP events.

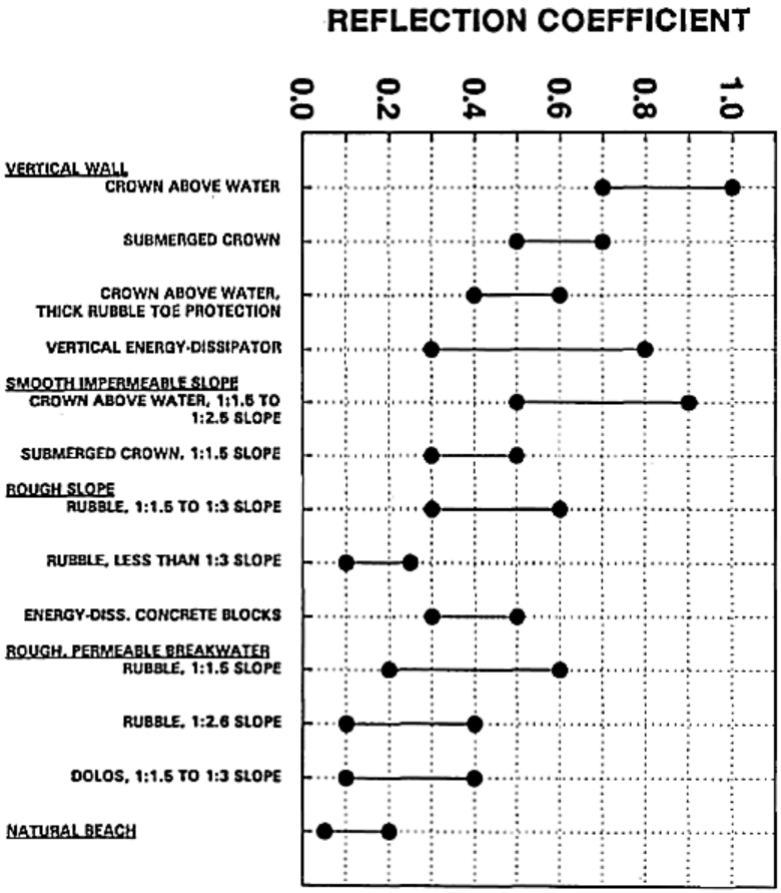


Figure 2.5 Typical reflection coefficient ranges for short period waves after [5].

Wave disturbance framework

In order to assess wave disturbance differences between the current state and the proposed installation two BW models were set-up respectively, the harbour layout as it currently is, see also Figure 2.6, and the proposed design layout as in Figure 2.3.

As in [1], the Middle Pier is represented as a piled structure with limited reflection as the condition survey suggested under the pier to be very open with a vertical sheet pile wall at the back. As such, the pier itself is not shown on the BW model outputs.

Results of the wave disturbance modelling are discussed hereafter.

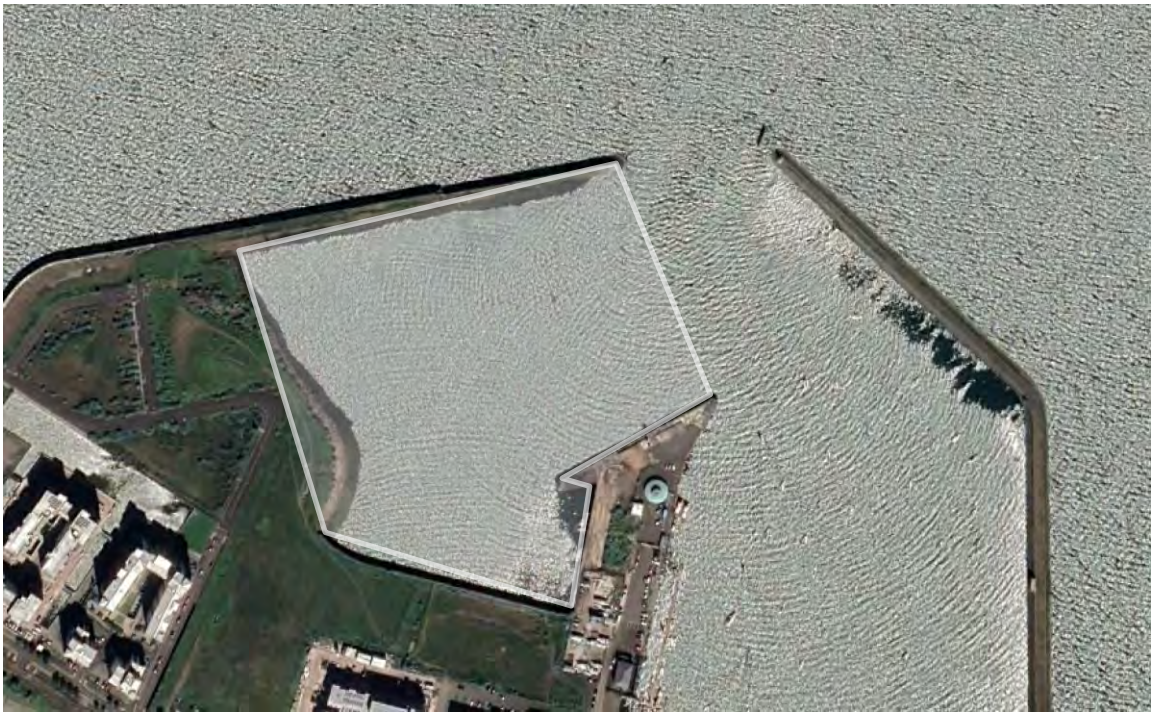


Figure 2.6 Existing wave conditions for a small wave height (estimated to be <0.5m Hm0) showing the lack of reflection from the Middle Pier. The area of interest for the proposed marina development is outlined by the grey polygon.

2.3 Results of Wave disturbance analysis for Option rev2022 for NE wind and wave conditions

Wave disturbance analysis was conducted based on the general procedures in Australian Standard, AS3962 - 2020 referring to wave heights at berthing areas [9].

The general guidance for this assessment is that good to moderate climate waves should be limited to the following:

- 1-year storm event wave height <0.3m to 0.4m
- 50-year storm event wave height <0.4m to 0.5m

The wave disturbance statistics based on the GCDL breakwater extension as is in the current masterplan results in:

- **Reduction** of wave heights in **both** the western and eastern harbour areas **in comparison to current status** of Granton harbour for both the **1** and **50RYP** storm events
- In comparison to the **previous layout** as in [1] for the **50RYP** event the wave disturbance is **'similar'** for most of the **western** marina event (please compare to Figure 4.5 in [1]). These relatively high levels are **expected** to be mitigated by the heavy pontoon breakwater as described in section 1 and can be seen in Figure 1.2 and the marina pontoons themselves. None of these structures have been modelled herein. The wave disturbance is also, **'improved'** for most of the **eastern** harbour (please compare to Figure 4.5 (top right panel) in [1] and Figure 3.1).
- In comparison to the **previous layout** as in [1] and for the **1RYP** event the wave disturbance is **'improved'** for both of the Granton harbour basins (please compare to Figure 4.6 in [1]).

A significant improvement of 0.1 - 0.5 m is seen for both the area in the lee side of the breakwater and in an approximate N-SSE direction in the vicinity of the middle pier and just opposite on the lee side of the eastern breakwater. The same distribution seems to follow the 1RYP result though the improvement is more spatially homogeneous and of a generally smaller magnitude.

For both the 50RYP and the 1RYP there is an area further inshore of the east harbour where a decrease in Hm0 is recorded (light blue) in the range 0.1-0.3m. It is significantly larger for the 50RYP event where we also see a decrease in wave heights differences if comparing the proposed layout in [1] versus the updated layout herein, see also Figure 3.1.

As expected, the breakwater extension provides significant protection in the western harbour improving wave conditions by reducing Hm0 by more than 1 m compared to the current situation. Conversely, as stated in [1], the construction of the breakwater leads to an increase in wave heights in the approach channel with the presence of reflected waves in the immediate vicinity of the new breakwater.

With respect to satisfaction of berthing criteria for the western marina:

- Wave disturbance for the 50RYP event conditions can be considered as ‘good’ (<0.4m) for about 50% of the berthing area and ‘moderate’ (<0.5m) for the whole western marina. It is anticipated that the proposed heavy pontoon breakwater at the edge of the north mole extension will render conditions to ‘good’ for 100% of the berthing area
- For the 1RYP event conditions berthing can be considered as ‘good’ for the majority of the berthing area and ‘moderate’ for the area on the N-S direction from the middle pier to the north mole extension. Again, it is anticipated that the proposed heavy pontoon breakwater at the edge of the north mole extension will render conditions to ‘good’ for 100% of the berthing area.

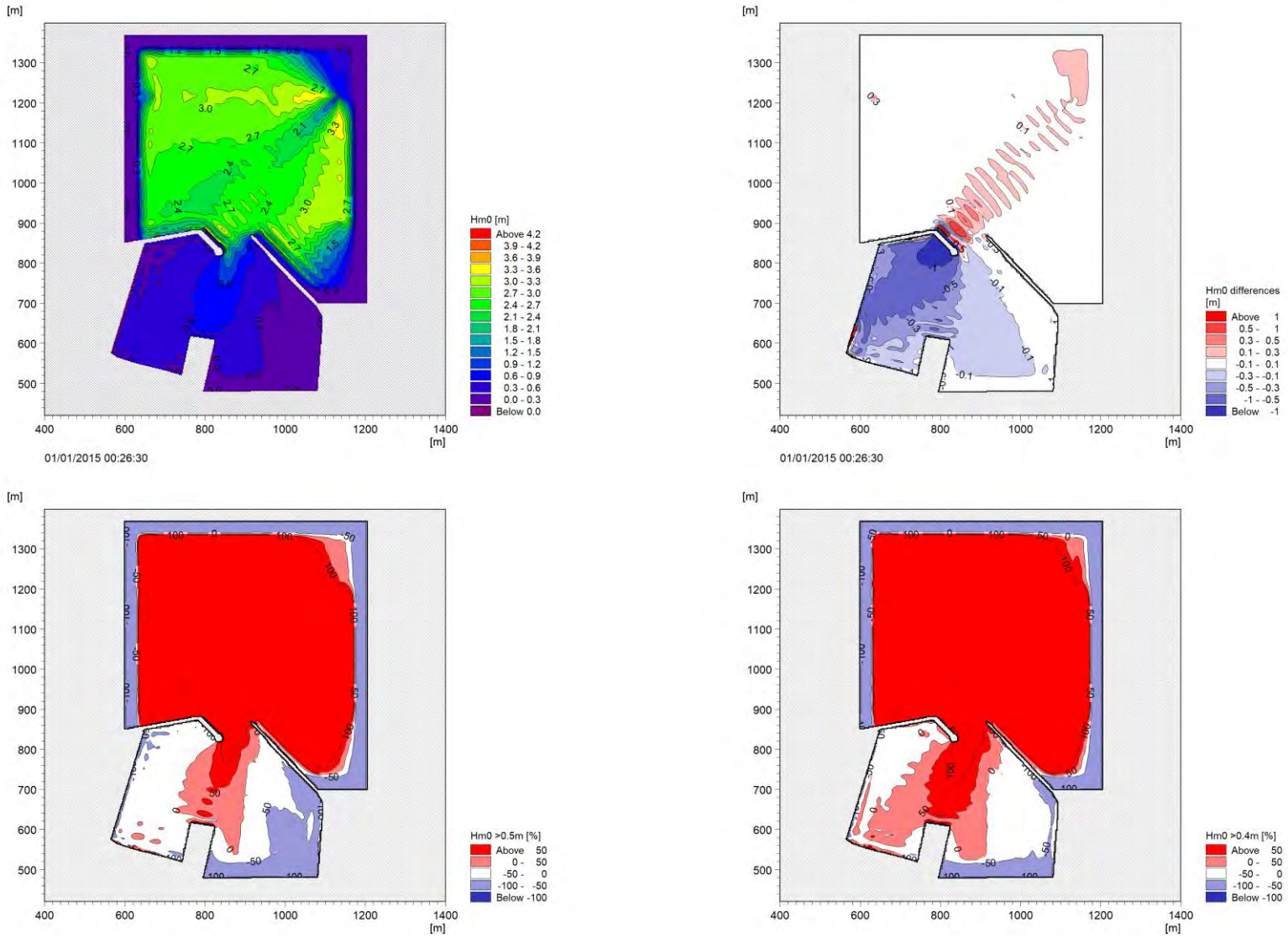


Figure 2.7 Wave disturbance plots Option rev2022 - (top left) Hm0 for 50-year return period wave conditions offshore; (top right) difference in Hm0 between breakwater extension (GCDL proposal) vs current state – positive (negative) numbers indicate areas where significant wave height is increased (decreased), white areas are less than 0.1m. (bottom left/right) percentage of Hm0 exceedance (i.e., how much larger or smaller vs wave height criteria) of the 0.5m and 0.4m limits respectively as in AS3692-2001 guideline for 50RYP events. Note that the piled section of the middle pier is assumed to have no significant reflections and as such is parameterised to be excluded from the solution (see text for details).

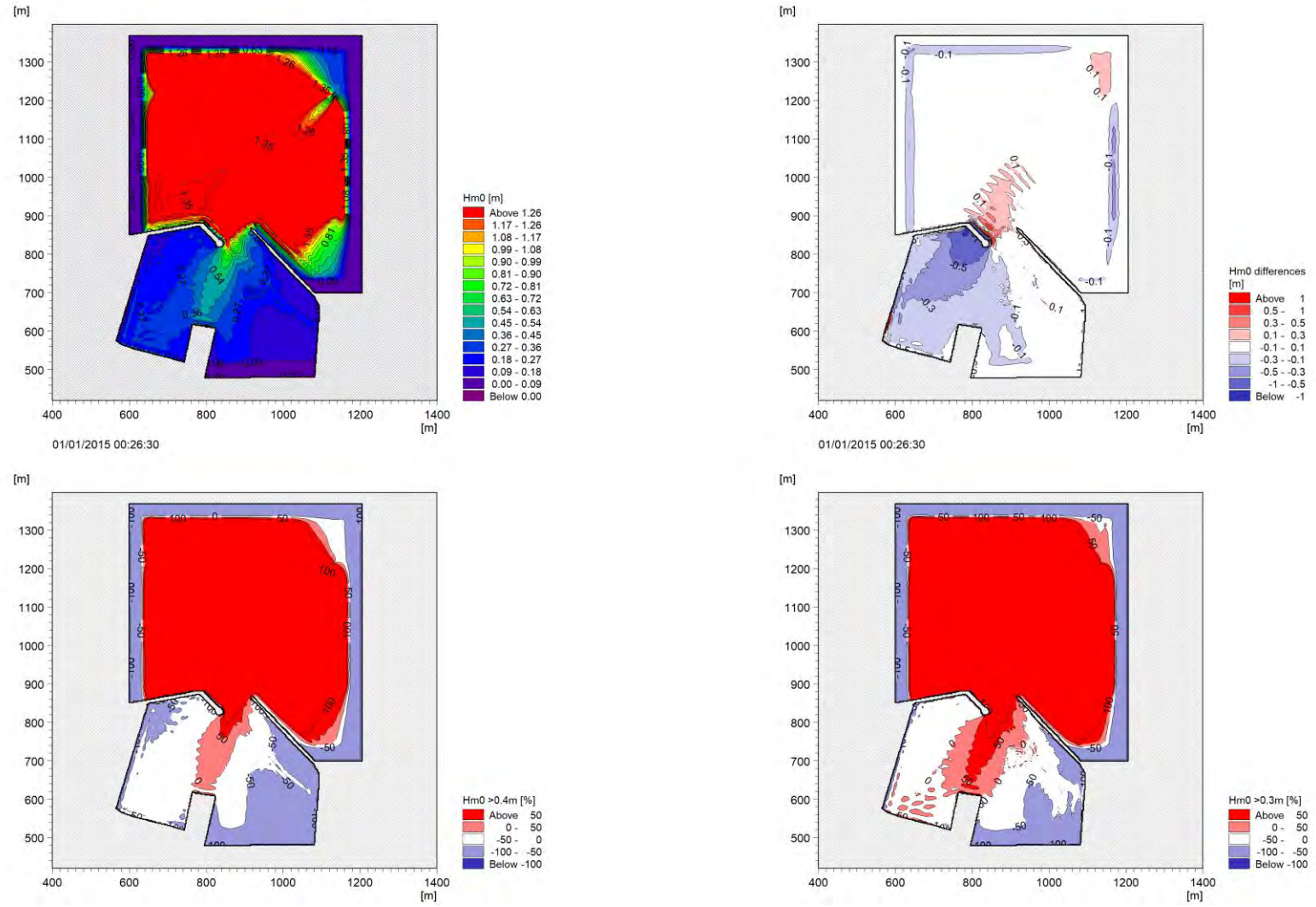


Figure 2.8 Wave disturbance plots Option rev2022 - (top left) Hm0 for 1-year return period wave conditions offshore; (top right) difference in Hm0 between breakwater extension (GCDL proposal) vs current state – positive (negative) numbers indicate areas where significant wave height is increased (decreased), white areas are less than 0.1m. (bottom left/right) percentage of Hm0 exceedance (i.e., how much larger or smaller vs wave height criteria) than the 0.4m and 0.3m limit, respectively, as in AS3692-2001 guideline for 1RYP events. Note that the piled section of the middle pier is assumed to have no significant reflections and as such is parameterised to be excluded from the solution (see text for details).

2.4 Results of Wave disturbance analysis for Option rev2022 for NW wind and NE wave conditions

As per the results in Section 2.3 the general principle for this assessment is that good to moderate climate waves should be limited to the following:

- 1-year storm event wave height <0.3m to 0.4m
- 50-year storm event wave height <0.4m to 0.5m

The wave disturbance statistics based on the breakwater extension results in:

- In 100% of the area inside the interests of the proposed development in the west harbour Hm0 is below the 0.4 m limit for the 50RYP (bottom right panel, Figure 2.9). Subsequently, all wave height criteria, as in AS3962-2020, for 50RYP events are satisfied.
- In 100% of the area inside the interests of the proposed development in the west harbour Hm0 is below the 0.3 m limit for the 1RYP (bottom right panel, Figure 2.10). Subsequently, all wave height criteria, as in AS3962-2020, for 1RYP events are satisfied.
- **Reduction** of wave heights in the western and eastern marinas **in comparison to current status** of Granton harbour for both the **1** and **50RYP** storm events
- In comparison to **previous layout** as in [1] and for the **50RYP** event the wave disturbance is **'similar'** for all of the **western** marina (please compare to Figure 4.9 in [1]). The wave disturbance is, in overall, **'similar'** for most of the **eastern** marina event with a slight improvement.
- In comparison to **previous layout** as in [1] and for the **1RYP** event the wave disturbance is **'similar'** for both of the Granton harbour basins.

Regarding the east section of the harbour, wave height conditions show improvement (0.1-0.3m) due to attenuation of wave energy from the proposed breakwater. Some slight deterioration of wave conditions (0.05m-0.10m) can be seen in the north lee side of the east Granton Harbour breakwater due to focused wave energy from the existing eastern arm (see Figure 2.9, top right panel).

As noted in the previous section and as also stated in [1], the construction of the breakwater leads to an increase in wave heights in the approach channel with the presence of reflected waves in the immediate vicinity of the new breakwater (see Figure 2.9 and Figure 2.10, top right panels). NOTE: the reduction in wave height seen outside of the eastern breakwater is an effect of the BW model settings in absorbing wave energy at the boundaries of the computational domain in order to avoid re-reflections into the domain rather than improvement due to the proposed layout.

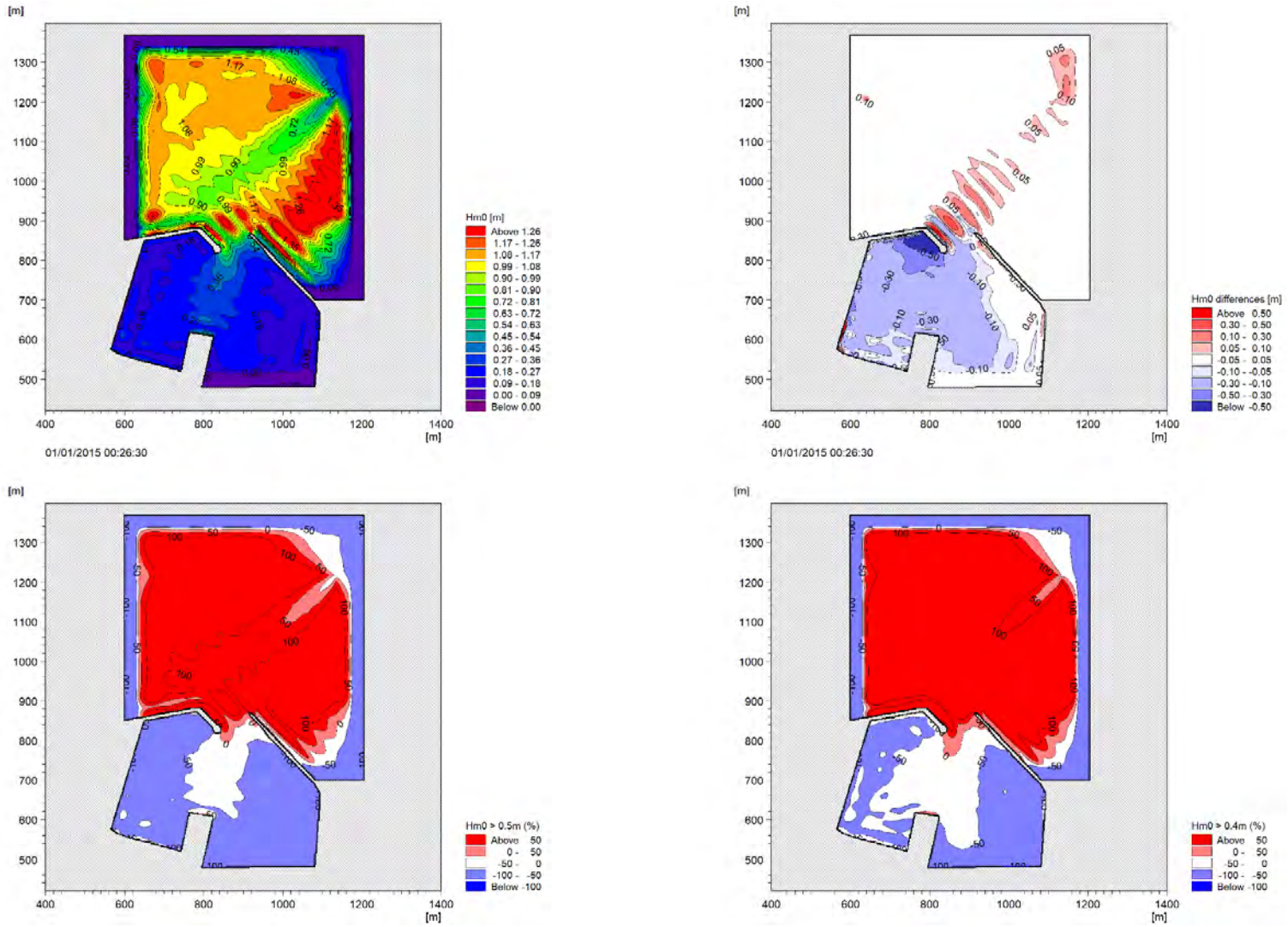


Figure 2.9 Wave disturbance plots Option rev2022 - (top left) Hm0 for 50-year return period wave conditions offshore; (top right) difference in Hm0 between breakwater extension (C&N proposed design) vs current state – positive (negative) numbers indicate areas where significant wave height is increased (decreased), white areas are less than 0.05m. (bottom left/right) percentage of Hm0 exceedance (i.e., how much larger or smaller vs wave height criteria) than the 0.5m and 0.4m limit, respectively, as in AS3692-2001 guideline for 50RYP events. Note that the piled section of the middle pier is assumed to have no significant reflections and as such is parameterised to be excluded from the solution (see text for details).

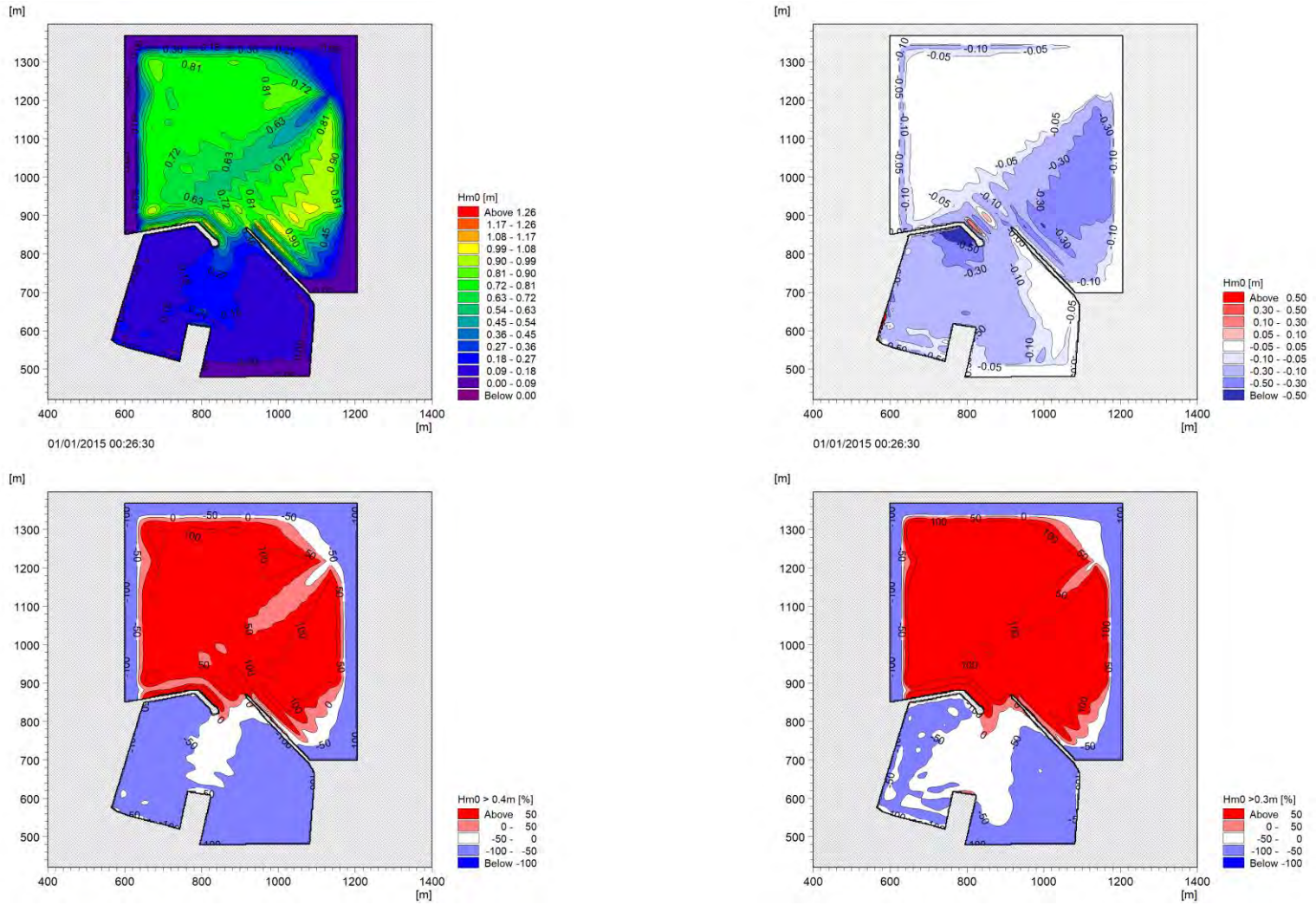


Figure 2.10 Wave disturbance plots Option 01 - (top left) Hm0 for 1-year return period wave conditions offshore; (top right) difference in Hm0 between breakwater extension (C&N proposed design) vs current state – positive (negative) numbers indicate areas where significant wave height is increased (decreased), white areas are less than 0.05m. (bottom left/right) percentage of Hm0 exceedance (i.e., how much larger or smaller vs wave height criteria) than the 0.4m and 0.3m limit, respectively, as in AS3692-2001 guideline for 50RYP events. Note that the piled section of the middle pier is assumed to have no significant reflections and as such is parameterised to be excluded from the solution (see text for details).

3 Conclusions and recommendations

3.1 Conclusions

A numerical wave transformation model has been developed to transform offshore wave conditions to the local area around Granton Harbour, for the purposes of understanding the local wave climate for an updated layout for the western basin of Granton harbour in comparison to the originally proposed as in [1].

The modelling has quantified the magnitude of wave conditions in the area under a range of design storm conditions and has assessed the response of breakwater structures in the harbour.

As in [1], in order to reproduce conditions inside the harbour a high resolution (2m) Boussinesq model has been developed that allowed calculation of wave disturbance statistics representative of storm conditions.

Two wave climates were used as forcing (an extreme event 1 in 50RYP and an annual average event 1 in 1RYP) consistent with the requirements of the AS3692-2020 marina guidelines regarding acceptable wave height limits in berthing areas. Fixed wave periods and water levels (MHWS – 5.6mCD) were considered for this assessment.

Two directions, **NE** and **NW**, representing worst case scenarios for the west and east marina respectively, were examined. Hereinafter, only results for the NE direction are further addressed. The **NW** direction has shown to have **no adverse** effect on the generated wave conditions in the harbour.

The results for the **NE direction** indicate that GCDL's proposed updated design of:

- a 55 m overall length with a roundel ending,
- a rock armour outer of 1:2 slope (north mole extension)
- an inner sloping rock revetment of 1:1.5 (north mole extension)
- an inner 1:1.5 sloping revetment wall on the western basin along the reclaimed land part

satisfies in general the 'good' berthing criteria (wave heights of less than 0.4m) only for part of the western basin (~50%) and 'moderate' berthing criteria for the majority of the berthing area when considering for the 50-year return period conditions. In the more frequent 1-year return period event this increases to 80% for the good criteria (<0.3m).

For the 50-year return period case it is considered that the proposed heavy pontoon breakwater and berthing pontoons will be sufficient to address any standing modes due to reflections between the inner north mole extension and inner western walls as it will filter out a significant portion of the incoming wave energy. These structures and their effects, though, have not been modelled or quantified within this study as the Boussinesq wave engine used herein cannot effectively accommodate their parameterisation.

As in [1], based on the proposed layout there will be some areas in the outer harbour that will be uncomfortable to remain berthed on a regular (annual storm) basis. It is apparent that this is currently limited to the first two outer southern pontoons immediately to the north of the Middle Pier. As stated, the introduction of the proposed heavy pontoon breakwater will certainly improve conditions on the lee side of the pontoon and further in.

Some standing waves are seen in all model runs close to the existing sheet pile wall on the southern edge of the western harbour. While all of the standing waves are seen to be lower than the critical criteria, it is still of importance that the standing wave pattern appears as this could lead to berthing discomfort. It is expected that in reality, the pontoons themselves will modulate standing wave modes for the better. As stated in [1], further analysis will be required to address the effect of specific pontoon designs and respective disturbance modes inside the harbour.

The proposed layout improves waves conditions for all examined storm events in comparison to both current status and previously approved layout as in [1]. Exception are small parts in the southern western marina where conditions are deteriorating by <0.1m, see also Figure 3.1 .

In comparison to layout as in [1] and metocean conditions examined in accordance to [9]:

- there are **no adverse** effects for the NW direction for all storm events.
- there are **no adverse** effects for the NE direction for annual averaged storm events.
- there are **no adverse** effects for the NE direction for 50-year return period events. In fact, there is **improvement** of wave conditions in the range of 0.1-0.3m for the eastern marina.

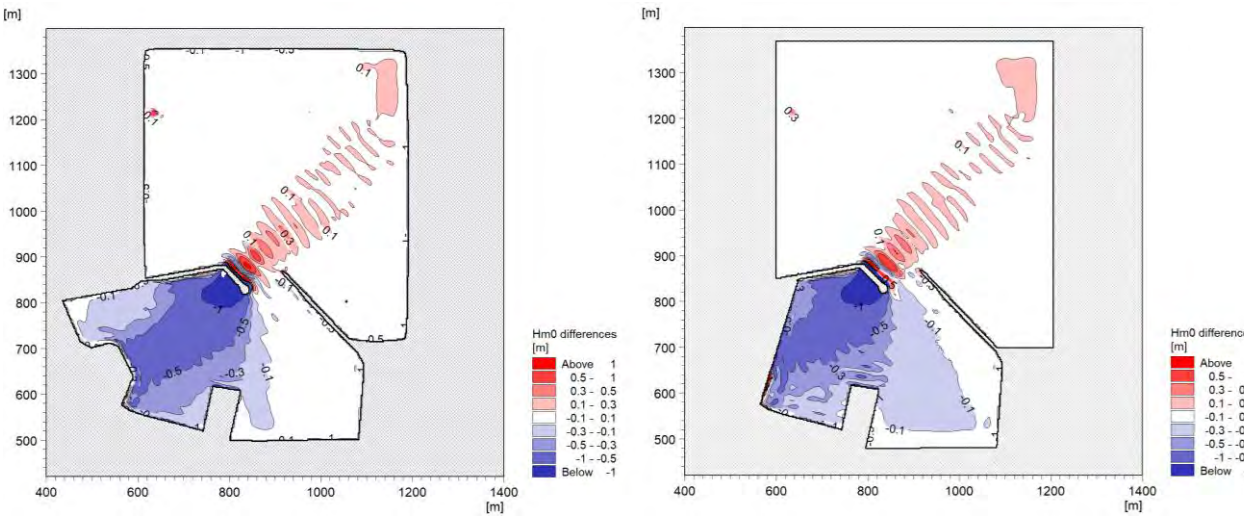


Figure 3.1 Hm0 differences [m] between examined layouts versus current status for the 50RYP NE wind NE wave conditions. Layout as in [1] (left) vs proposed layout in this study (right). A distinct decrease in wave heights vs current status can be seen for both layouts. The updated layout (right) shows 'improved' conditions for the eastern basin vs the previous approved layout (left) but with no significant differences with respect to satisfaction to berthing areas (western basin).

Concluding with respect to proposed layout (Rev2022) and optimised dredge plan as in Figure 1.2:

- The revised position of the revetment wall has no material adverse effect in the Western Harbour compared to the previously approved scheme as in [1].
- The optimised dredge plan produces an improvement in the wave climate of the Eastern Harbour compared to the previously approved scheme as in [1].

3.2 Recommendations

Following on from this technical note it is assumed that the wave disturbance results will be used by others to assess the suitability of GCDL proposed designs, progress towards a final detailed design and consideration will be given to recommended amendments to the alternative solution as necessary.

In addition, the following recommendations, partly reiterated as acknowledged in [1], have been provided for consideration as part of any ongoing studies:

1. It is anticipated that the presence of a floating pontoon grid will further reduce wave height in the area of interest. Nonetheless, floating pontoons have not been parameterized in the current models.

2. It should be noted also that any upgrades on the piled section of the middle pier should consider the potential of introducing reflections in the proposed marina. In its current state, wave reflections are considered insignificant. As in [1], there is though some uncertainty as to the exact orientation of the

backend vertical wall on the Middle Pier (modelled here as facing the west harbour with a very small angle). If this angle is significantly larger, reflections will propagate in the west harbour that could deteriorate further the wave height conditions as presented herein. Confirmation of the exact position and reflection from the backend vertical wall should be considered.

3. The adoption of breakwater style floating concrete pontoons for the outer berthing areas to reduce wave energy into the harbour is considered beneficial for the overall wave conditions in the western basin as does the placement of wave attenuators in positions that were identified from this study as potentially problematic.

4 References

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