Licensing Operations Team
Marine Scotland
By Email

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15 February 2019

Dear Sir/Madam

Hunterston Marine Construction Yard
Response to letter dated 2 November 2018

We write on behalf of our clients, Clydeport Operations Ltd, in response to your letter dated 2 November 2018 in which you requested clarification and further information on the proposed construction works to upgrade the hammerhead quay at the above site. Responses to your comments are provided below.

1. Dredging Amount

We can confirm there will be a component of dredging associated with the project. It is calculated that a total of circa 615,000m^3 of material will be produced as a result of dredging the approaches to the hammerhead quay (estimated 423,000m^3) as well as the new caisson gates (estimated 192,000m^3 tonnes). A separate Dredging application will be submitted later in the year for this activity.

2. Deposit Location

We can confirm that the current proposals are to bring all dredged material to shore for recovery and re-use. The suitability of the sediment for this purpose will be determined through a site investigation to confirm sediment characteristics and the presence or not of any contaminated material. A Sampling Plan is currently being developed on this basis and will be submitted to Marine Scotland for approval prior to the investigation commencing.

3. Proposal for construction of Quay

Please refer to Point 8 below.

4. Extent of revetment works

Please refer to Point 8 below.

5. Further Assessments

The Environmental Review Document (dated February 2017) identified the following specific assessments would be required

- ***Recommendations made for the adoption of good working practices in line with appropriate guidance during the construction and operational phase***

Measures are available to appropriately mitigate the environmental impacts during construction and operation. Refer to Point 6 below regarding the protection of the water environment during the construction phase. In relation to the operational phase, consultation is currently ongoing with SEPA regarding suitable measures to protect the water environment from site activities. Consultation on this matter with the Council will also be held prior to operations commencing at the site;

- ***A qualitative assessment of the impact on sediment transport processes utilising existing hydrodynamic modelling and data***
  The current construction licence application is to upgrade the existing hammerhead quay and it is considered there will only be minimal impact on sediment transport associated with this proposal and as such a specific assessment is not required for the construction licence. This type of assessment is deemed to be more relevant to the dredging works and therefore, if required, will be included to support the dredge licence application;
- ***Coastal Flood Risk (including wave overtopping)***
  Please refer to enclosed Hunterston Construction Yard Coastal Assessment (Report No 8039, dated 19 February 2018);
- ***Underwater noise assessment of piling activities and its potential to disturb porpoise***
  An application to disturb European Protected Species is currently being progressed. As part of the application an assessment of the impact on marine mammals from temporary piling works associated with the upgrade to the hammerhead quay will be undertaken. This will be submitted to Marine Scotland in due course.
  As you are aware an EPS license could only be granted if it could be demonstrated that suitable mitigation had been defined to avoid unacceptable impacts. The mitigation options for piling are well understood by industry and the Regulators. Whilst the specific mitigation for a particular site will vary the licencing of piling is a fairly frequent occurrence and significant impacts can therefore be avoided through the EPS licence process. We are aware of one recent such licence within the Firth of Clyde (licence reference MS EPS 29/2018/0);
- ***Possible provision of a visual assessment or representative views of the site***
  The requirement or not for this information was to be established through consultation. Can you confirm if this detail is needed to support the construction application?

6. Schedule of Mitigation

The Construction Environmental Management Document (CEMD) is a working document and as such it is intended that it will be populated and maintained for the duration of the construction works by the appointed construction contractor. The intention of the Schedule of Mitigation contained in the submitted CEMD is to identify key environmental issues and provide high level guidance on how mitigation measures can be appropriately managed and implemented during construction. Contractual obligations on the appointed construction contractor will necessitate them to develop appropriate Construction Environmental Management Plans (CEMP's) for each construction phase as well as populate the CEMD. It is the intention to submit the completed CEMD along with the associated CEMP's for approval to Marine Scotland prior to construction works commencing.

7. PAC Report

As requested, a signed copy of the PAC report will be submitted along with the construction license application.

8. Relevance of Previous Environmental Review to 2019 Designs

As requested please find a comparison of the 2017 design against the current 2019 design. It is noted that the fundamental principles of the proposed development have not changed from the 2017 design with the main components still including:

- Provision of an improved hammerhead quay;

- Revetment Works; and
- Associated dredging for both the access to the hammerhead quay and the proposed caisson gates.

To aid the comparison please find enclosed the following drawings:

Drawing 168612j-019 Rev B – This shows the extent of the proposed works, the position of the existing and upgraded quay with outlines of the envelope for dredging and the position of the Caisson Gate (which is being built and erected out with the marine environment);

Drawing 168612j-020 - This shows the rock armour currently around the periphery of the site, the general outline of the yard (using high resolution 2009 aerial photography) and the relative location of the Site of Special Scientific Interest (SSSI);

Drawing 168612j-021 Rev A –This zoomed in drawing (with a more recent aerial photograph) shows the overlay of the dredging areas, existing rock armour, the location of the Caisson Gate and abutments and also the SSSI; and

Drawing 168612j-022 Rev A – This final drawing shows the areas of rock armour to be removed and those new areas of rock armour that are anticipated to be required. Approximate dredge volumes are also noted.

The Environmental Review prepared by us in 2017 was prepared for the entirety of the Works as we understood them at the time. Whilst the designs have evolved in certainty, it was always our understanding for example that:

- Revetment adjustment works were required around the hammerhead quay (they are shown on the drawings submitted in 2017);
- We were also aware, and consider it self-evident even in 2017, that the revetment in front of the caisson gates would require to be removed ultimately to dredge and to facilitate access the caisson gates; and
- Dredging in front of the caisson gates was always going to be required and was noted in the 2017 submissions. It is acknowledged that the exact nature of the dredge area is now more accurately defined but it is as was expected by us to allow vessels to approach the gates.

Our client intends submitting the construction application for the upgrade work to the hammerhead quay in due course and would welcome any feedback you may have in relation to the proposals.

We trust the above addresses your comments however should you require further clarification or information please do not hesitate to contact the undersigned.

Yours sincerely
for EnviroCentre Ltd

(issued electronically)

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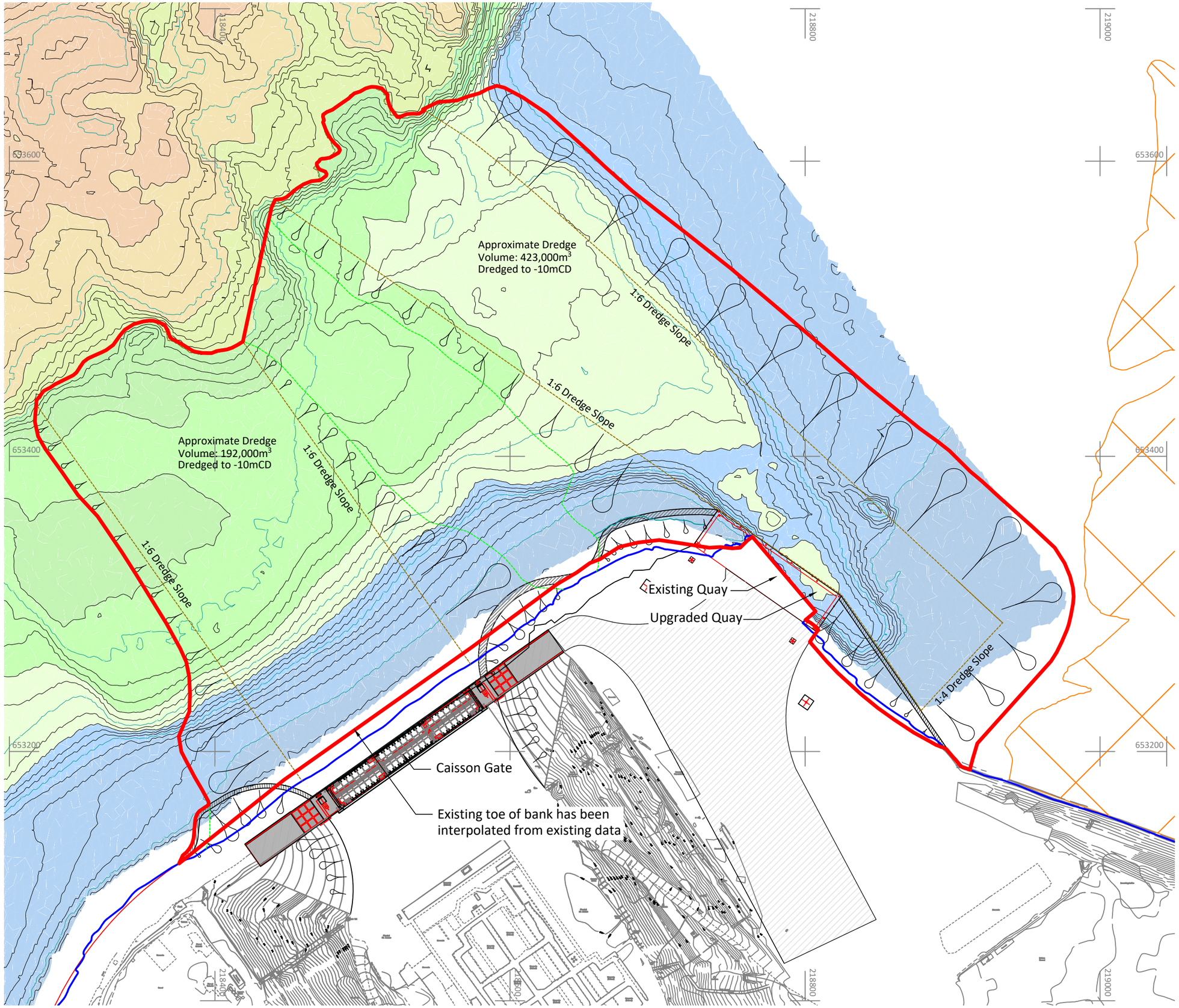
Enc: Hunterston Construction Yard Coastal Assessment Redacted dated 19 February 2018)
Drawings (x4)

CC: Peel Ports, (by email); and
North Ayrshire Council (for information only).



Notes

2019 Proposed Works Outline:
Plan Area - 175,600m^2

Mean High Water Springs Derived from UKHO (2019). *Admiralty Tide Tables Volume 1B: United Kingdom and Ireland.*

Site of Special Scientific Interest - Southannan Sands

Bathymetric Data Height Ranges (mCD)

- < -16
- < -14
- < -12
- < -10
- < -8
- < -6
- < -4
- < -2
- < 0

Engineering detail as produced by Redacted
(Refer to Drawing Numbers: 1850 351
and 185060/354).

Approximate Dredge Volumes calculated to Mean Low Water Springs by Envirocentre.

Levels outwith survey areas have been interpolated from interpolated from existing bathymetric and topographic data.

Do not scale this drawing

Rev	Date	Amendment	Initials
B	14/02/19	Dredge area increased	R
A	14/02/19	Dredge area revised	R

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Client
Peel Ports Group

Project
Hunterston Marine Yard

Title
Hunterston Construction Yard:
Proposed Works Outline 2019

Status
FINAL

Drawing No.
168612-019

Revision
B

Reda Redacted

Scale
1:2,500

A3

Date
7 February 2019

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Legend

- Armoured Slopes
- Site of Special Scientific Interest
- Mean High Water Springs

Armoured Slopes annoted as per 2009 aerial photography.

Mean High Water Springs Derived from UKHO (2019). Admiralty Tide Tables Volume 1B: United Kingdom and Ireland.

Do not scale this map

Client
Peel Ports Group

Project
Hunterston Marine Service Centre

Title
Current Layout

Status
FINAL

Drawing No.
168612-020

Revision

Scale
1:3,000

A3

Date
7 February 2019

Drawn	Checked	Approved
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Legend

- Approximate Limit of Works
- Proposed Works
- Mean High Water Springs
- Site of Special Scientific Interest
- Armoured Slopes

Mean High Water Springs Derived from UKHO (2019). Admiralty Tide Tables Volume 1B: United Kingdom and Ireland.

Do not scale this map

Client: Peel Ports Group

Project: Hunterston Marine Service Centre

Title: Proposed Dredge Layout

Status: FINAL

Drawing No.: 168612-021

Revision: A

Scale: 1:2,500

A3

Date: 7 Feb 2019

Drawn	Checked	Approved
Re	R	Re

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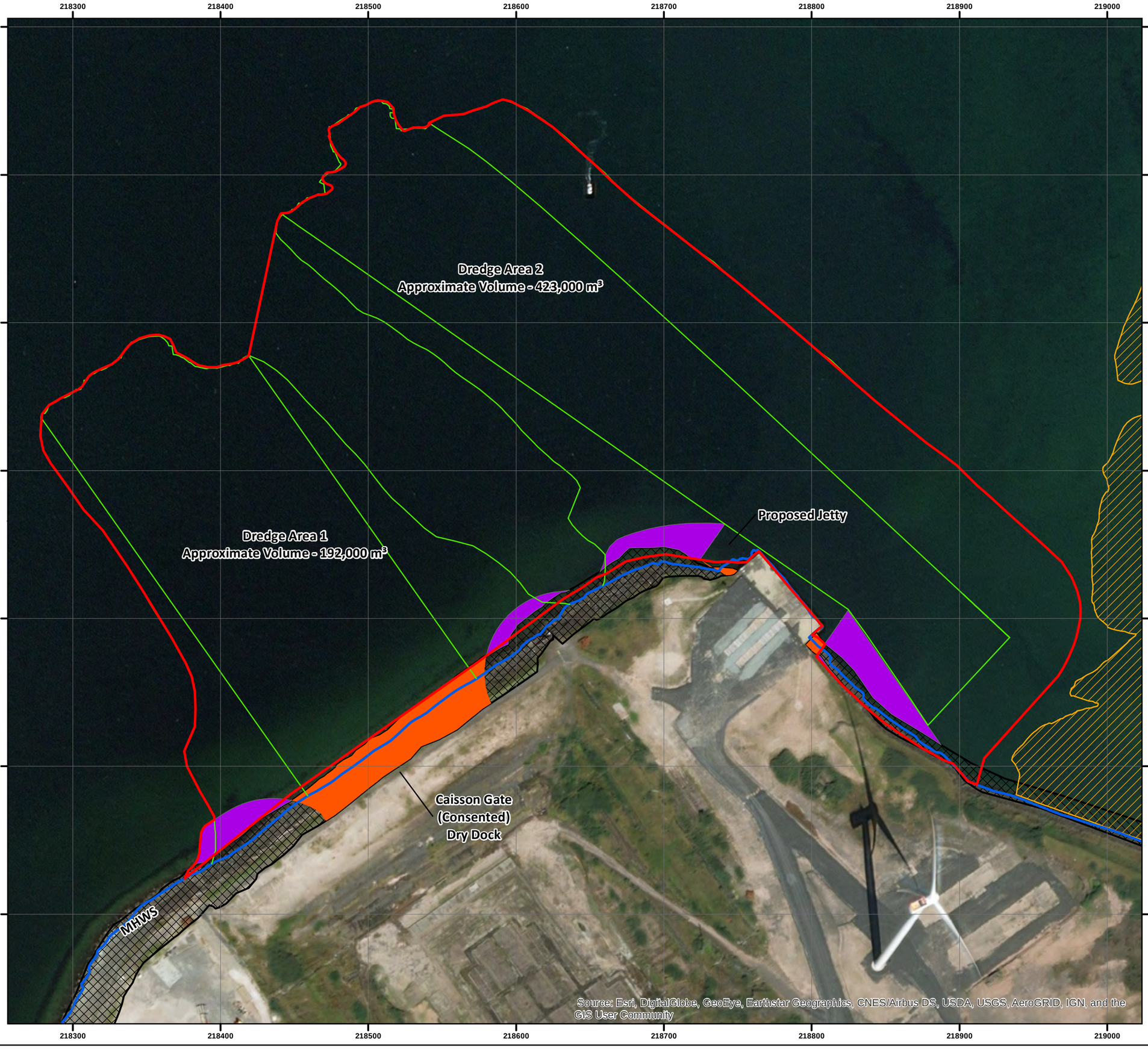

Legend

- Approximate Limit of Works
- Proposed Works
- Mean High Water Springs
- Site of Special Scientific Interest
- Armoured Slopes Areas To be Removed
- Armoured Slopes Additional Areas
- Armoured Slopes

Area of Armoured Slopes to be Removed - 3989 m²
Additional Area of Armoured Slopes - 4441m²

Total Additional Area of Armoured Slopes - 452m²

Mean High Water Springs Derived from UKHO (2019). Admiralty Tide Tables Volume 1B: United Kingdom and Ireland.

Do not scale this map

Client
Peel Ports Group

Project
Hunterston Marine Service Centre

Title
Armoured Slopes

Status
FINAL

Drawing No.
168612-022

Revision
A

Scale
1:2,500

A3

Date
7 Feb 2019

Drawn	Checked	Approved
Re	R	Re

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Hunterston Construction Yard
Coastal Assessment

February 2018

Hunterston Construction Yard
Coastal Assessment

Client:	Peel Ports
Document number:	8039
Project number:	168612
Status:	Final
Revision:	A
Date of issue:	19 February 2018

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1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre was commissioned by Peel Ports to undertake a Coastal Assessment for Hunterston Marine Yard, Firth of Clyde.

1.2 Site Location

The existing Peel Ports Hunterston Marine Construction Yard, lies on the Firth of Clyde, north of the EDF Hunterston Power Stations and west of the Hunterston Coal Terminal. The site is adjacent to the Offshore Wind Turbine Test Facility operated by SSE, but is otherwise vacant at present, although maintenance is ongoing. The site is reclaimed land that has historically been used for industry and currently comprises an access road, service infrastructure, a deep void (dry dock) with a bund in place and a hammerhead quay.

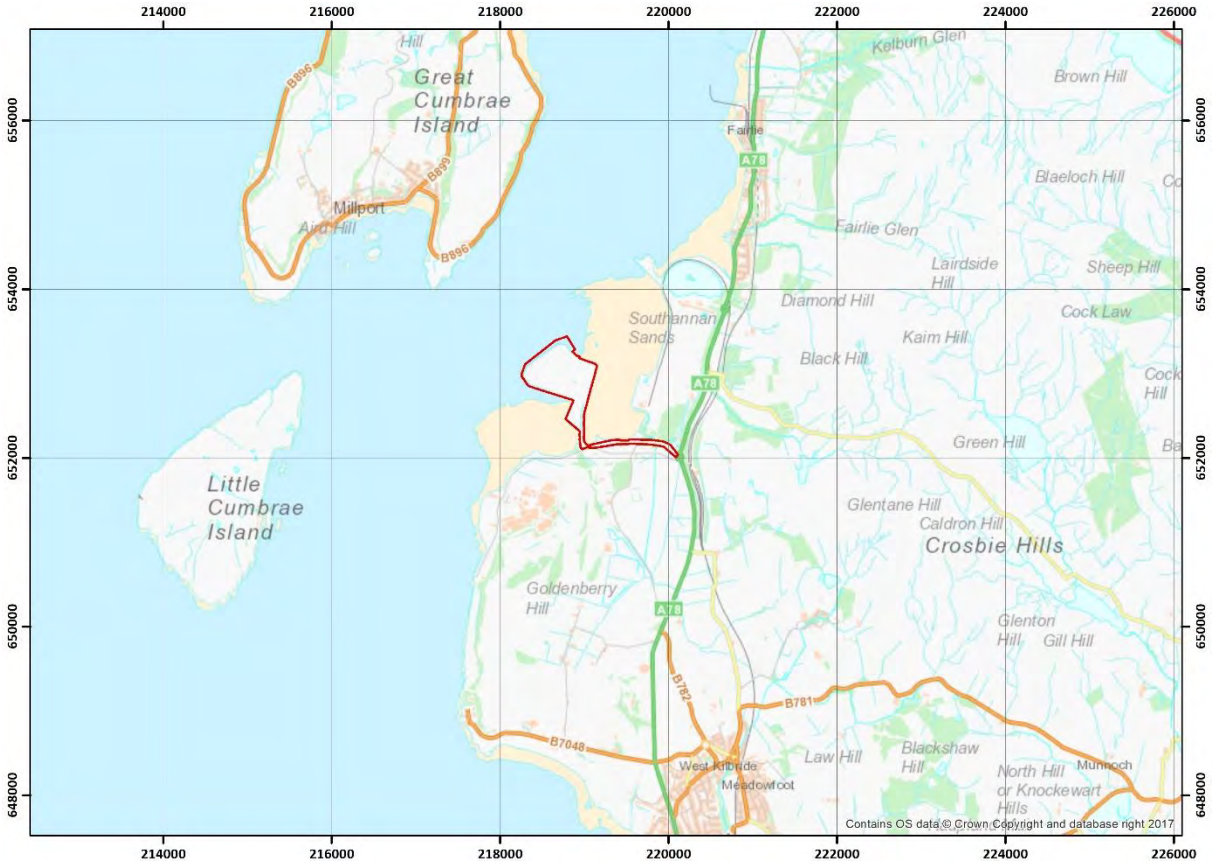

Figure 1.1: Site Boundary

1.3 Proposed Development

The existing marine yard is a facility for constructing large marine structures. Separately Peel Ports Group are seeking to amend this to also include the decommissioning / reverse engineering of marine structures, including oil and gas industry structures, within the existing dock area. Designs have been developed to provide a more functional facility and minimise/eliminate impacts on the site surrounds. The proposed development

will consist of a concrete caisson structure to allow ready access and egress to the dry dock. In addition it is proposed that the existing quay will be raised, extended and strengthened. Design crest levels for the caisson gate and quay are 6 metres above Ordnance Datum (mAOD), this is also the existing crest level of the construction yard bund. The berth will also eventually be deepened to approximately -10m Chart Datum (CD).

1.4 Scope of Report

This report aims to provide an assessment of coastal conditions based on the following scope of works:

- Confirmation of extreme sea water levels for design, including consideration of climate change;
- Wave analysis to establish significant wave heights for design;
- Joint return period analysis for water level and waves;
- Overtopping analysis; and
- Provision of a summary report on the above.

1.5 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

EnviroCentre do not accept liability to any third party for the contents of this report unless written agreement is secured in advance, stating the intended use of the information.

EnviroCentre accept no liability for use of the report for purposes other than those for which it was originally provided, or where EnviroCentre have confirmed it is appropriate for the new context.

2 SEA LEVELS & WAVE CLIMATE

2.1 Overview

The tidal regime and extreme water levels adjacent to the site have been assessed, using information including the Admiralty Tide Tables, SEPA Scottish Coastal Flood Boundary Dataset, and UK climate projections 2009 (UKCP09). To characterise the wave climate, deep water wave theory has been applied utilising 2010 UK wind map published wind velocities. The results are presented in the following sections, and form the input to the wave overtopping assessment (section 3).

2.2 Tidal Range

The closest tide table port to the site is at Millport, Great Cumbrae, <3km from the quay. The astronomical tidal range for Millport is shown in Table 2.1, where the highest astronomical tide is 3.9mCD which is equivalent to 2.3mAOD.

Table 2.1: Tidal Range at Millport

Tide Condition	Chart Datum (mCD)*	Ordnance Datum (mAOD)**
Highest astronomical tide	3.9	2.3
Mean high water spring	3.4	1.78
Mean high water neap	2.7	1.08
Mean level	1.99	-0.26
Mean low water neap	1.0	-0.62
Mean low water spring	0.4	-1.22
Chart datum	0	-1.62

* Admiralty Tide Tables

** Chart Datum correction for Ordnance Datum is -1.62m (relative to OD at Newlyn)

2.3 Extreme Sea Level Analysis

The lower lying internal area of the construction yard is shown on the SEPA indicative flood map as being at risk of flooding from the sea (SEPA, 2014a). SEPA's Extreme Sea Level datasets for Scotland (McMillan et al., 2011; SEPA, 2014b) indicate the 1 in 200 year and 1 in 1,000 year return period extreme still water levels for Hunterston Construction Yard are 3.67mAOD and 4.03mAOD respectively, with a confidence interval of 0.5m and 0.7m respectively. The existing bund, proposed caisson gate, and quay, all have crest levels of 6mAOD, 2.33m above the predicted 1 in 200 year water level. A range of SEPA extreme sea levels adjacent to Hunterston Construction Yard are presented by return period in Table 2.2.

Table 2.2: Hunterston Extreme Sea Levels (SEPA Dataset)

Return Period (Years)	Water Level (mCD)	Water Level (mAOD)
2	4.39	2.77
5	4.55	2.93
10	4.68	3.06
50	5.00	3.38
100	5.14	3.52
200	5.29	3.67
1000	5.65	4.03

2.4 Future Projections and Effects of Climate Change

The UK government has published a range of climate projection reports and data for use in the assessment of climate change risks. At the time of writing the latest set of comprehensive reports produced by the UK Climate Projections was published in 2009 (UKCP09, n.d.), and provides relative sea level rise projections at a 25 km grid resolution.

Within the SEPA Flood Modelling Guidance for Responsible Authorities (SEPA, n.d.), given subsequent developments in scientific understanding following the publication of UKCP09, SEPA have adopted the UKCP09 2080 high emissions scenario, 95%ile value of relative sea level rise for the production of their national coastal hazard maps. This approach has also been adopted within the recently published Ayrshire Coastal Management Plan (RPS, 2018) jointly commissioned by North and South Ayrshire Council, and is therefore considered suitable for use in this assessment.

The UKCP09 future projections of relative sea level rise at Hunterston were obtained for the period 1990 to 2080, this allowed the calculation of projected increases from 2018 to 2080, the results are summarised in Table 2.3 and Table 2.4. At Hunterston the UKCP09 high emissions scenario, 95%ile relative sea level rise 1990 to 2080 is **+0.537m**, resulting in a predicted 2080 1 in 200 year extreme water level of 4.2mAOD, 1.8m lower than the existing bund, proposed caisson gate and quay crest level (6mAOD).

Table 2.3: UKCP09 Projected Relative Sea Level Rise at Hunterston from 1990

Emissions Scenario	1990 - 2018			1990 - 2080		
	5%ile (m)	50%ile (m)	95%ile (m)	5%ile (m)	50%ile (m)	95%ile (m)
Low	-0.002	0.033	0.067	0.018	0.165	0.312
Medium	0.001	0.046	0.091	0.029	0.222	0.415
High	0.005	0.062	0.119	0.048	0.292	0.537

Table 2.4: UKCP09 Projected Relative Sea Level Rise at Hunterston from 2018 to 2080

Emissions Scenario	5%ile (m)	50%ile (m)	95%ile (m)
Low	0.020	0.132	0.245
Medium	0.028	0.176	0.324
High	0.043	0.230	0.418

2.5 Wave Climate

The extent of wave action has been considered using the Significant Wave Height (Hs – the average level of the highest third of waves). In the absence of site specific wave data, Wilson's equations for deep water waves (Goda, 2003) have been used to estimate the extreme event significant wave heights. This approach has previously been used in the assessment of wave action at Hunterston (Fairhurst & Partners, 2010), and given the existing and proposed dredging operations at the Hunterston Construction Yard, it is considered that waves of heights predicted by deep water wave theory would reach the site.

Wind speed is a required input to the deep water wave equations, the required design wind speeds have been taken from BS EN 1991-1-4 (Hughes, 2014), which presents the 2010 UK wind map, providing 10 minute mean wind velocities with 50 year return periods. These values have been adjusted using standard methodologies to provide predictions for a range of return periods from 1 to 500 years as shown in Table 2.5.

The geography of the construction yard dictates that the likely fetch for wave generation varies depending on the location being assessed. The north and north-western faces of the construction yard, including the proposed caisson gate and quay facility, have been assessed for a longest fetch of 27.25km to the north (0°).

The southern face of the construction yard has been assessed for a longest fetch of 35km to the south (200°). The predicted 1 in 200 year return period significant wave height for the northern fetch is 3.16m, equivalent to 1.58m above mean water level. The predicted 1 in 200 year return period significant wave height for the southern fetch is 3.54m, equivalent to 1.77m above mean water level.

Table 2.5: Summary of Design Wind Speeds and Significant Wave Heights

Return Period (Years)	Probability Factor, Sp	Design Wind Velocity, Vs (m/s)	Significant Wave Height North (0°), Hs (m)	Significant Wave Height South (200°), Hs (m)
1	0.75	19.5	2.12	2.36
2	0.77	20.0	2.19	2.43
5	0.82	21.3	2.35	2.62
10	0.90	23.4	2.61	2.91
50	1.00	26.0	2.93	3.28
100	1.04	27.0	3.06	3.42
200	1.07	27.8	3.16	3.54
500	1.12	29.1	3.33	3.72

3 WAVE OVERTOPPING

3.1 Overview

A wave overtopping assessment has been undertaken for new vertical faced structures (applicable also to the proposed caisson gate and quay developments), as well as for the existing construction yard bund. The methodology utilises the sea level and wave climate data presented in section 2 of this report within a joint probability analysis (section 3.2), to provide input to the overtopping assessment in accordance with the guidance set out in Version 2 of the EurOtop Manual.

3.2 Joint Probability Analysis

To assess the critical combinations of water levels and waves, a joint return period analysis has been undertaken using the approach set out in the Defra guidance (Hawkes, 2005). The guidance presents correlation coefficients between wave height and sea level (see Figure 3.1), the specific value for Millport (0.55) has been adopted for this study given the proximity to the site, and indicates a strong correlation in this area. The input extreme water levels and wave heights to the joint probability analysis are presented in Table 2.2 and Table 2.5.

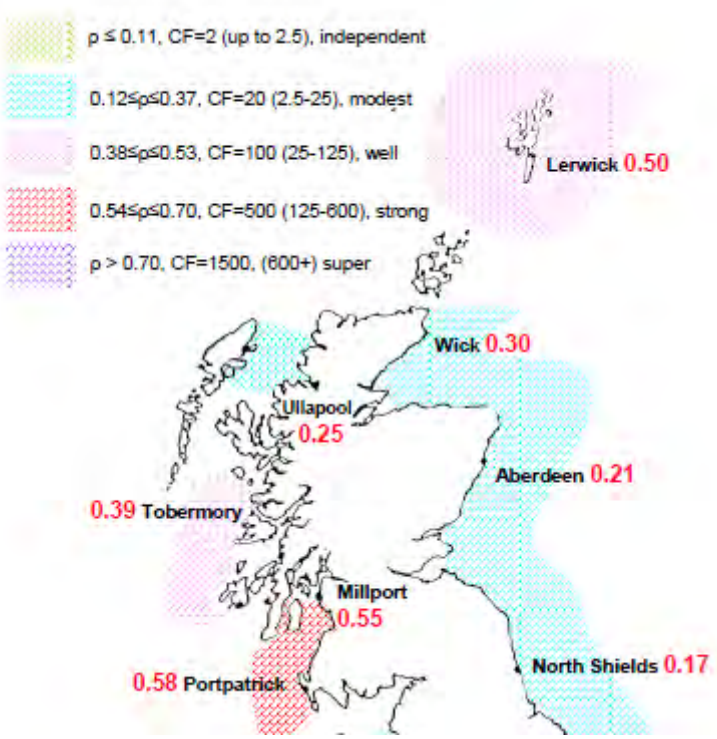

Figure 3.1: Correlation Coefficient (Wave Height & Sea Level) – Source: (Hawkes, 2005)

The results of the joint probability calculations for both the northern and southern fetches are presented in Table 3.1 below for the 1 in 200 year joint return period under present day conditions, using the correlation coefficient (0.55) described above.

Table 3.1: Joint Return Period Assessment – Water Level and Wave Height

Joint Return Period (yr)	Water Level Return Period (yr)	Wave Height Return Period (yr)	Water level (mAOD)	North Fetch (0°) Wave Height, Hs (m)	South Fetch (200°) Wave Height, Hs (m)
200	0.16	200	2.30	3.16	3.54
200	0.5	111	2.48	3.07	3.44
200	1	55	2.60	2.95	3.30
200	2	28	2.77	2.82	3.15
200	5	11	2.93	2.63	2.93
200	10	6	3.06	2.39	2.66
200	25	2	3.24	2.21	2.45
200	50	1	3.38	2.09	2.31
200	100	0.6	3.52	1.97	2.16
200	200	0.3	3.67	1.85	2.02

Climate change scenario 1 in 200 year joint probability water levels have been derived by accounting for relative sea level rise to 2080 (+0.537m) as outlined in section 2.4.

3.3 Overtopping Methodology

An overtopping assessment has been undertaken in accordance with the guidance set out in the EurOtop Manual, Version 2 (Meer et al., 2016), in order to calculate the overtopping potential of a vertical face (the proposed quay and caisson gate) on the north and north-western sides of the construction yard, and of the existing bund on the southern side of the construction yard.

For a vertical structure adjacent to a dredge pockets (see Figure 3.2) such as the proposed quay and caisson gate, the applicable calculation method consists of Eurotop II equation 7.2 (see Figure 3.3), which is applied for design and safety assessments to calculate wave overtopping discharge over a vertical wall where there is no influencing foreshore.

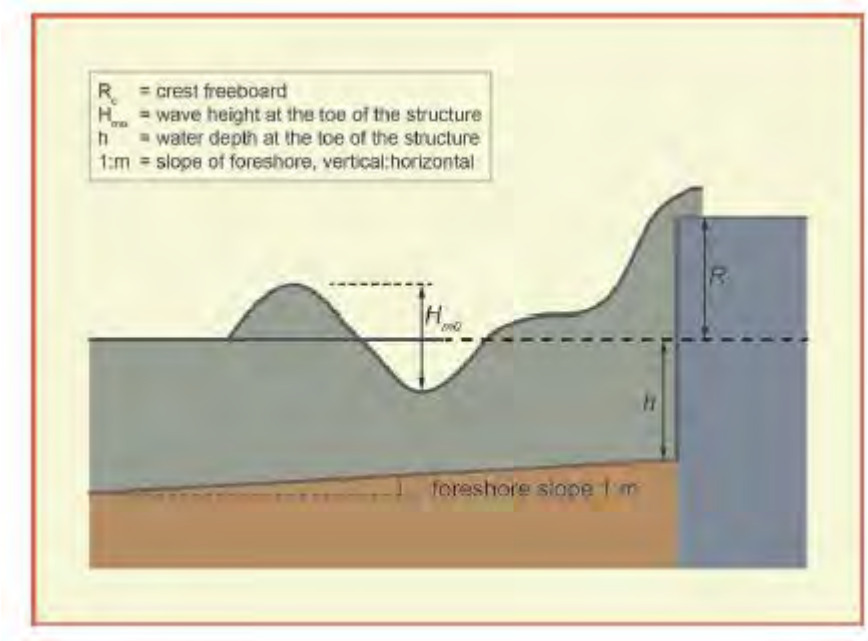

Figure 3.2: Eurotop II Definition Sketch for Overtopping at Vertical Walls

$$\frac{q}{\sqrt{g \cdot H_{m0}^3}} = 0.054 \cdot \exp\left[-\left(2.12 \frac{R_C}{H_{m0}}\right)^{1.3}\right] \qquad 7.2$$

Figure 3.3: Eurotop II Overtopping Equation 7.2

The existing bund around the construction yard forms a relatively smooth slope from shoreline to the crest level. The applicable calculation method in this instance consists of Eurotop II equation 5.12, which is applied for design and safety assessments to calculate wave overtopping discharge on a slope (dike, levee, embankment).

$$\frac{q}{\sqrt{g \cdot H_{m0}^3}} = \frac{0.026}{\sqrt{\tan\alpha}} \gamma_b \cdot \xi_{m-1,0} \cdot \exp\left[-\left(2.5 \frac{R_c}{\xi_{m-1,0} \cdot H_{m0} \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \gamma_v}\right)^{1.3}\right] \qquad 5.12$$

Figure 3.4: Eurotop II Overtopping Equation 5.12

While methods are provided within the EurOtop manual to account for reductions in overtopping due to the oblique approach of waves to the structure, these have not been applied in this assessment, and all waves are assumed to approach approximately normally to the structures. Ignoring variations in wave direction, and assuming that all waves approach the structures head on is a conservative approach.

3.4 Site Overtopping Rates

Wave overtopping calculations have been undertaken for all combinations of wave and water level predicted by the joint probability method (section 3.2) for the 1 in 200 year return period event under existing sea level conditions (2018 scenario), and with an allowance for climate change (2080 scenario). The results of the overtopping assessment are summarised in Table 3.2 for the northern fetch (vertical face – proposed caisson gate and quay), and southern fetch (sloping face - existing bund).

Table 3.2: Maximum Calculated Overtopping Rates (l/s/m)

Location	2018 Scenario: 200 Year Joint Probability Overtopping Rate (l/s/m)	2080 Scenario: 200 Year Joint Probability Overtopping Rate (l/s/m)
Northern Fetch (Vertical Face- Proposed Caisson Gate & Quay)	0.07	0.13
Southern Fetch (Existing Bund)	1.00	1.34

For a vertical face with 6mAOD crest level on the north and north-western sides of the construction yard (proposed caisson gate and quay), overtopping rates between 0.02 and 0.07 l/s/m are predicted to occur during events with a return period of around 1 in 200 years under current sea level conditions, whilst an increase in sea level as a result of climate change is likely to increase overtopping rates for a similar event to between 0.06 and 0.13 l/s/m.

For the southern face of the existing bund overtopping rates between 0.36 and 1.00 l/s/m are predicted to occur during events with a return period of around 1 in 200 years under current sea level conditions, whilst an increase in sea level as a result of climate change is likely to increase overtopping rates for a similar event to between 0.59 and 1.34 l/s/m.

Overtopping rates for storm events of less extreme exceedance probability would be lower than those described above for the 1 in 200 year return period event.

3.5 Overtopping Assessment

The main purpose of carrying out overtopping calculations at the construction yard is to provide users of the site with an indication of the risks they may face from wave overtopping during storm conditions. A secondary purpose is to highlight the potential for damage to equipment and infrastructure.

The Eurotop II manual provides guidance on overtopping rates in terms of potential impact to coastal defences, and hazards to pedestrians and property. The guidance is given in the form of extensive discussion of different wave conditions and their effect on the risk of the resulting overtopping causing damage or injury. The discussion highlights that a small number of large individual waves may give the same average overtopping flows as a larger number of small waves, but that the risks of damage or injury is not the same in both cases – the large wave case is more likely to give rise to unacceptable conditions.

Limits for people and vehicles are given in terms of mean overtopping flow rates and for the maximum volume of overtopping generated by individual waves as shown in Figure 3.5.

Hazard type and reason	Mean discharge q (l/s per m)	Max volume V_{max} (l per m)
People at structures with possible violent overtopping, mostly vertical structures	No access for any predicted overtopping	No access for any predicted overtopping
People at seawall / dike crest. Clear view of the sea.		
H_{m0} = 3 m	0.3	600
H_{m0} = 2 m	1	600
H_{m0} = 1 m	10-20	600
H_{m0} < 0.5 m	No limit	No limit
Cars on seawall / dike crest, or railway close behind crest		
H_{m0} = 3 m	<5	2000
H_{m0} = 2 m	10-20	2000
H_{m0} = 1 m	<75	2000
Highways and roads, fast traffic	Close before debris in spray becomes dangerous	Close before debris in spray becomes dangerous

Figure 3.5: Table 3.3 from Eurotop II – Overtopping Limits for People and Vehicles

The limits applicable to people and personnel are intended to provide a degree of protection against being knocked down or sucked out into the sea when the wave recedes or drains. It is clear from the Eurotop II tables that the limits are a function of the wave height causing the overtopping. Table 3.1 presents the wave heights included within this assessment.

From reference to Table 3.3 of Eurotop II (see Figure 3.5) where wave heights exceed 3m it may be dangerous to allow people onto any structure during wave overtopping. Where wave heights are 2-3m the tolerable mean overtopping discharge is around 0.3 l/s/m, for waves heights of 2m the tolerable mean overtopping discharge is around 1 l/s/m, whilst for smaller waves around 1m height the tolerable discharge increases to 10 – 20 l/s/m. The use of vehicles may also be dangerous under wave overtopping, where waves are less than 3m height the tolerable overtopping limit is of the order of 5 l/s/m, increasing as wave height reduces.

Given that the assessment indicates large wave heights (> 3m) are possible during the 1 in 200 year return period event, it may be dangerous to allow people on the structures during extreme storm induced wave overtopping. Where wave heights are less than or equal to 3m, then predicated overtopping of a vertical face on the north and north-western sides of the construction yard (proposed quay or caisson structure) is below the allowable mean discharge for people with a clear view of the sea (0.3 l/s/m). It is recommended that the working areas of the construction yard have safety plans in place during extreme storm events.

4 CONCLUSIONS

Analysis of extreme sea levels (Section 2.3) shows that the existing construction yard bund crest level, and proposed caisson gate and quay crest levels (6mAOD), are situated well above (+1.8m) the predicted 1 in 200 year extreme water level (including climate change allowance) of 4.2mAOD.

The assessment of wave overtopping potential undertaken (Section 3.4 & 3.5) indicates that only limited overtopping would be expected during an extreme 1 in 200 year return period storm event. It is anticipated that during such extreme storm events work activities on site would be limited. Given the potential for large waves (> 3m) during an extreme 1 in 200 year return period storm event, it is recommended that the construction yard has appropriate industry standard safety plans in place.

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