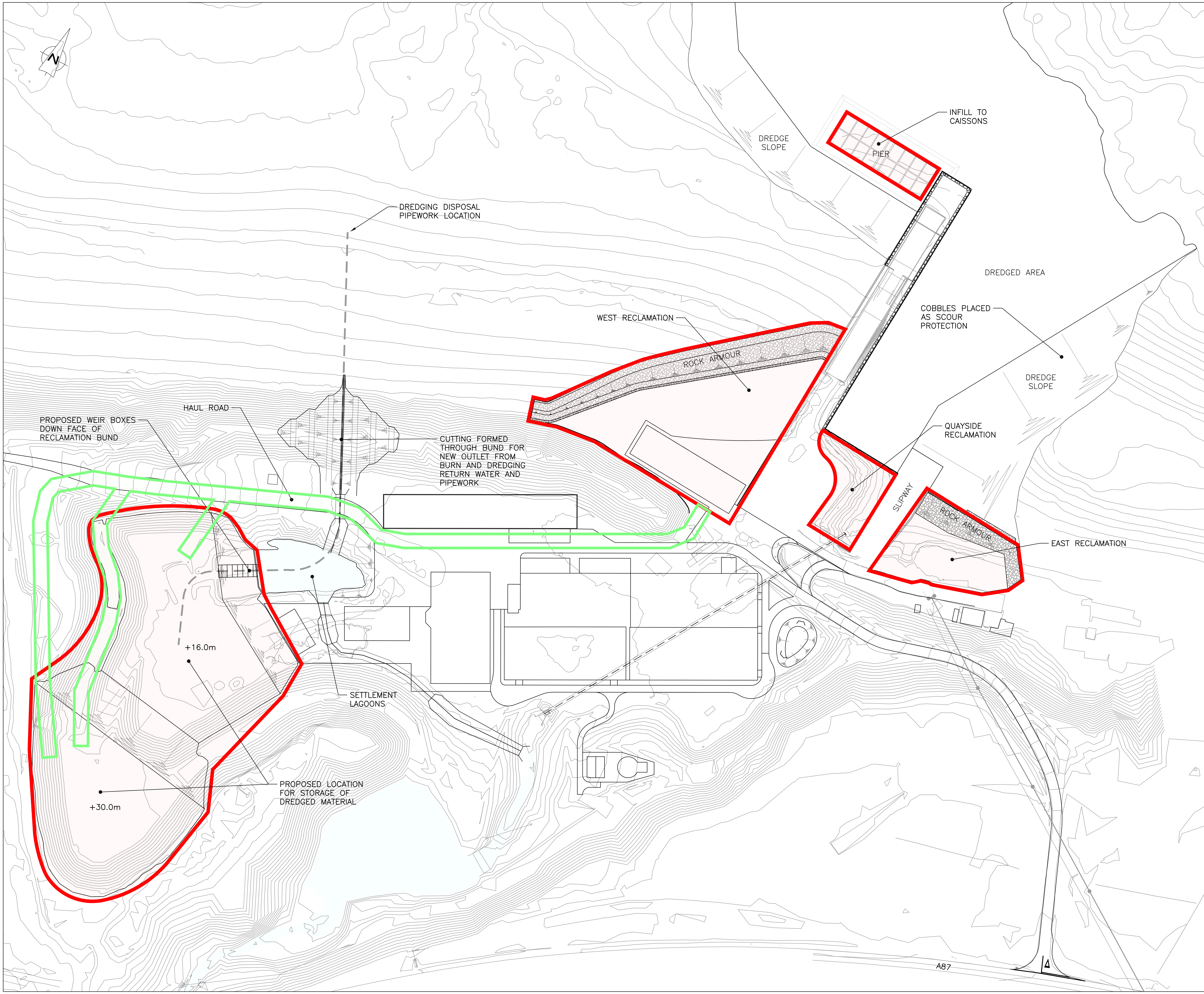

GENERAL NOTES

LEGEND

DREDGE DISPOSAL AREA

HAUL ROAD

REV	DATE	DETAILS	DRAWN	CHK'D	APP'D
A	24.11.16	HAUL ROAD AMENDED	JHG	TR	TR

AMENDMENTS

CLIENT: marineharvest

PROJECT: KYLEAKIN FEED MILL MARINE WORKS

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DRAWING TITLE: PROPOSED DREDGE DISPOSAL AREAS

DRAWN	CHECKED	APPROVED
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Kyleakin Pier Development

Hydraulic Modelling

Addendum to Report

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AD1 IMPACT OF PROPOSED CAPITAL DREDGING ON WATER QUALITY

AD1.1 INTRODUCTION

Based on initial advice from various dredging contractors, three methodologies were modelled and reported in Chapter 8 of the Hydraulic Modelling Report supporting the EIA for the Kyleakin Pier Development. When tenders were received for the marine works for the proposed pier development it was noted that the methodology proposed for the dredging included the use of backhoe dredging plant for both the outer and inner dredged areas. In addition a temporary unloading jetty to the west of the existing pier was proposed by at least one of the marine contractors. The combination of the use of the backhoe dredger for both areas and the inclusion of a temporary unloading jetty had not been included in any of the three scenarios given in the original hydraulic modelling study. Therefore it was decided to re-run the models to show the impact of these revised dredging proposals.

The hydraulic model of these revised proposals was undertaken using the existing hydraulic models and procedures as outlined in Chapter 8 of the main hydraulic modelling report. The reporting of the modelling of the revised proposals is in the form of an addendum to the original hydraulic modelling report and should be read in conjunction with Chapter 8 of the Kyleakin Pier Development Hydraulic Modelling Report. Reference is made to the relevant parts of Chapter 8 where appropriate.

The layout of the proposed temporary jetty for the unloading of the dredged spoil from the barges is shown in Figure AD1 below. It should be noted that during the dredging process the caisson structures forming the return leg of the new jetty will not be in place as the area beneath these structures will require to be dredged prior to their installation.

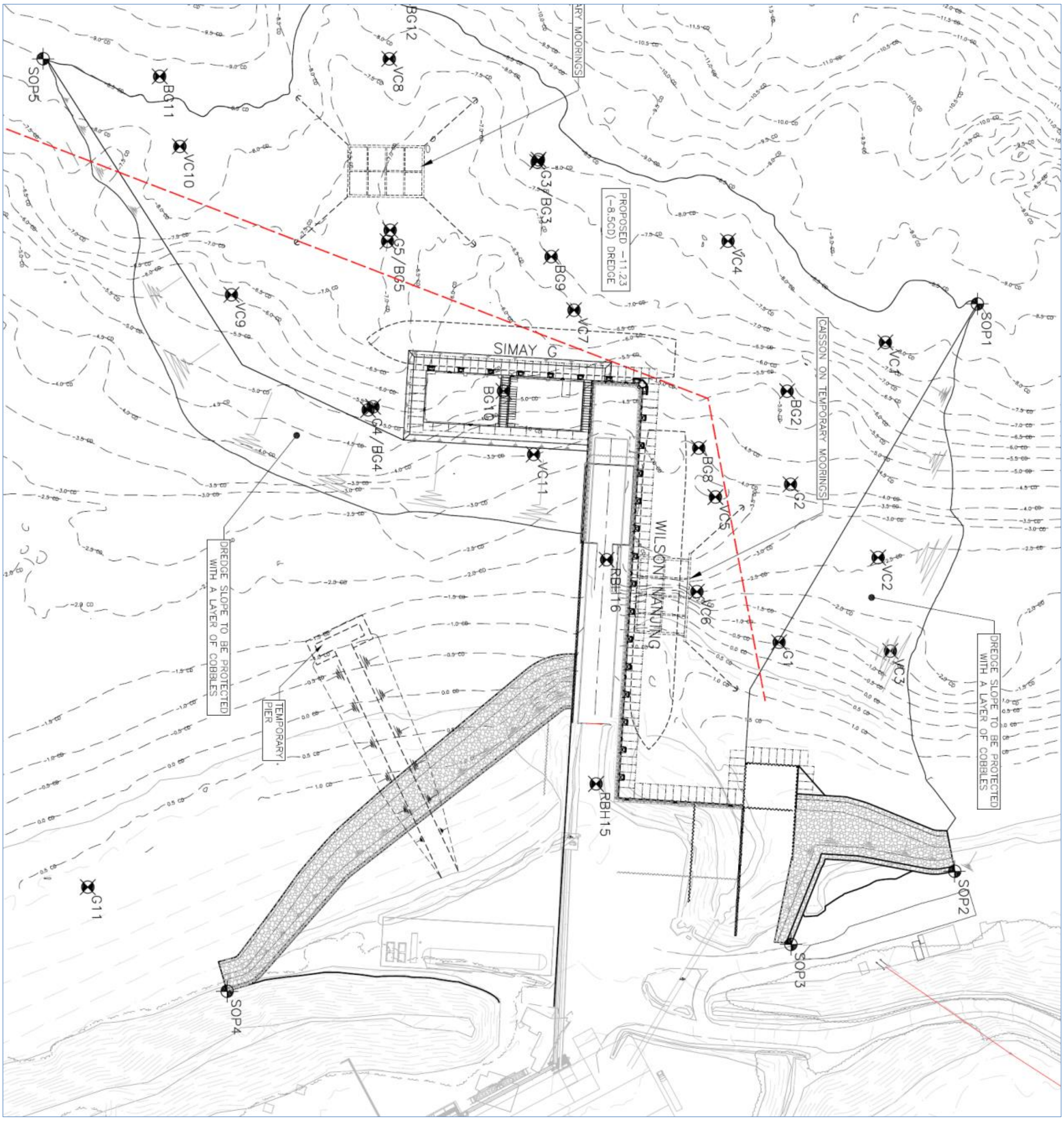

Figure AD1 Location of temporary dredged spoil unloading jetty

AD1.2 SEA BED CHARACTERISTICS AND MODELLING TECHNIQUES

AD1.2.1 Characterisation of seabed

Details of the composition of the seabed in the dredged area are given in section 8.1.2 of the Hydraulic Modelling Report. For convenience the distribution of sediments in the outer and inner areas shown in tables 8.1 and 8.2 are reproduced in tables AD1 and AD2 below.

Table AD1: Composition of bed material in the inner and outer dredge areas at Kyleakin.

Dredge area	Capital Dredge Requirements [m^3]	% material <1000µm	% Sand material (1000 – 63 µm)	% Silt material (<63 µm)
Outer	85,500	46	42.5	3.5
Inner	104,500	80	60	20
Total	**190,000**			

Table AD2: Modelled sediment characteristics.

General Classification	Class	Mean Particle Diameter [um]
Sands	1	1000
	2	500
	3	125
Silts	4	63
	5	44
	6	22

AD1.2.2 Modelling of dredging techniques

The modelling of the dispersion and fate of the dredging plume was undertaken using the existing model bathymetry with the inclusion of a structure to west of the existing pier to represent the effect of the temporary unloading jetty on the hydrodynamic regime of the area. During the dredging simulations the backhoe dredger moved along the same path in the inner and outer dredge areas as used in the previous simulations and shown in Figure 8.4 in the Hydraulic Modelling Report. These paths are also illustrated overleaf in Figure AD2. It should be noted that it is no longer proposed to dredge the north westerly tip of the outer area shown outlined in **red**. However for consistency with pervious simulations, the outer area dredging has included this area so that the results of the simulation are conservative.

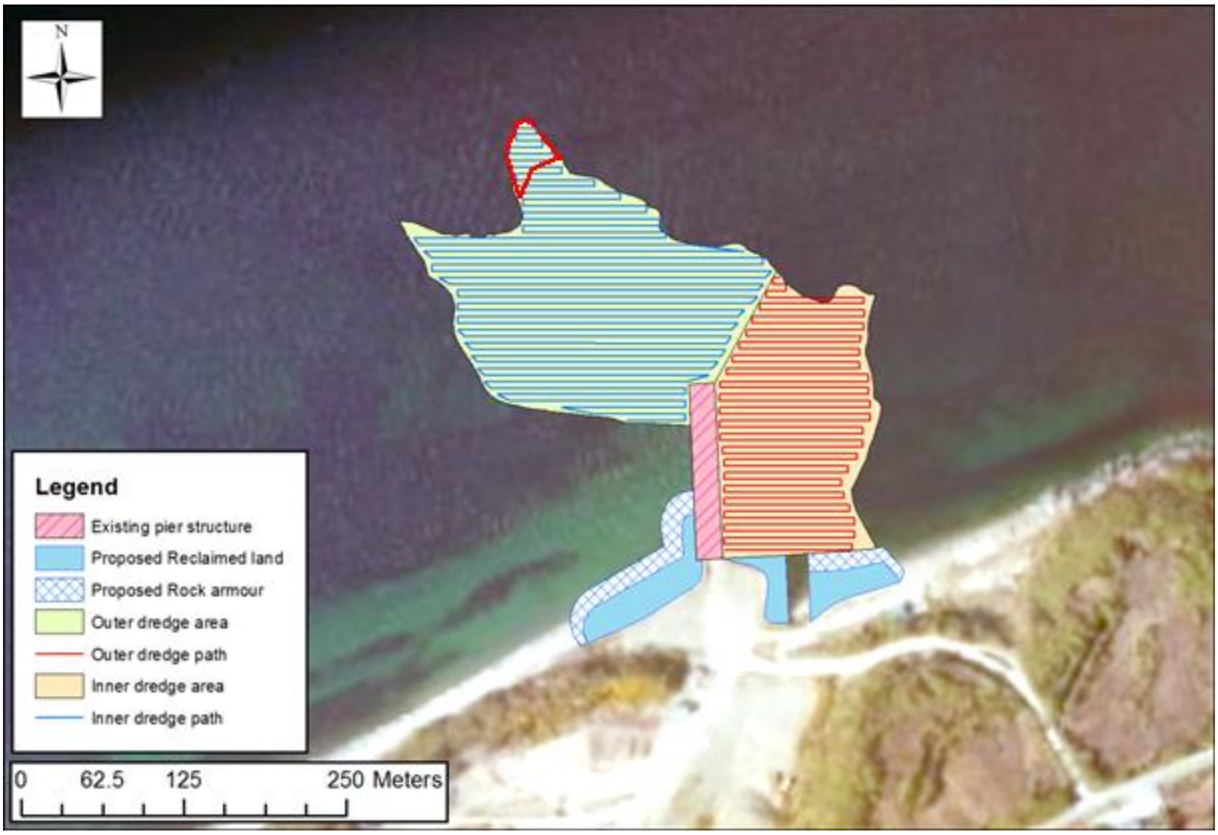

Figure AD2: Anticipated dredge paths of the inner and outer dredge areas.

Based on the capital dredge requirements of both the outer and inner dredge areas, the duration of the total capital dredging programme using the BHD for both areas was assumed to be 84 days with the split between the outer and inner areas as shown in Table AD3 below.

Table AD3: Possible durations to undertake the capital dredging in the Inner and Outer areas using Backhoe Dredger (BHD).

Approach	Dredging Method		Dredging Duration [Days]		
	Outer area	Inner area	Outer area	Inner area	Total Duration
4	BHD		28	56	84

AD1.3 DREDGING APPROACH 4: BHD EQUIPMENT

AD1.3.1 Assumptions

For this additional scenario it has been assumed that Backhoe Dredger (BHD) will be used to remove material from both the inner and outer dredge areas. The Backhoe Dredger (BHD) will excavate the dredge material using a hydraulically operated bucket that will be used to transfer the dredge material into a barge. The barge will take the material to the temporary unloading jetty where it will be off-loaded and transported to quarry area.

The Backhoe Dredger is expected to operate on a 24/7 until the dredging has been completed. Based on this assumption it is expected that the BHD will take 28 days to complete the dredging of the outer area and 56 days to complete the dredging of the inner area.

AD1.3.2 Source term analysis

The material introduced into the marine environment as a result of BHD dredging operations can be represented by two source terms representing the loss of material near the bed during the digging operation and the loss of material from the bucket as it breaks the surface.

The losses at the BHD bucket were taken as 3% of the sand and silt material in the inner and outer areas. These losses were simulated by introducing half of this quantity in the bottom layer of the numerical model and the other half in the top layer of the numerical model as shown in Table AD4 below.

Table AD4: Source terms and fractions for the BHD in the inner and outer dredge areas.

Area	Dredge Equipment	Source	Fraction
Inner	BHD	Losses - bottom	1.5% of Sand and Silt
		Losses - top	1.5% of Sand and Silt
Outer	BHD	Losses - bottom	1.5% of Sand and Silt
		Losses - top	1.5% of Sand and Silt

AD1.3.3 Numerical representation

Using the source terms summarised in Table AD4 to represent the input of sand and silt material into the marine environment, the sediment plume simulations were run over the course of a 15 day period which included a full range of spring and neap tidal conditions, this 15 day period relative to the tidal cycle is illustrated in Figure AD3. The results of the model simulations were then scaled up to represent the full 84 day dredging campaign across the inner and outer dredge areas.

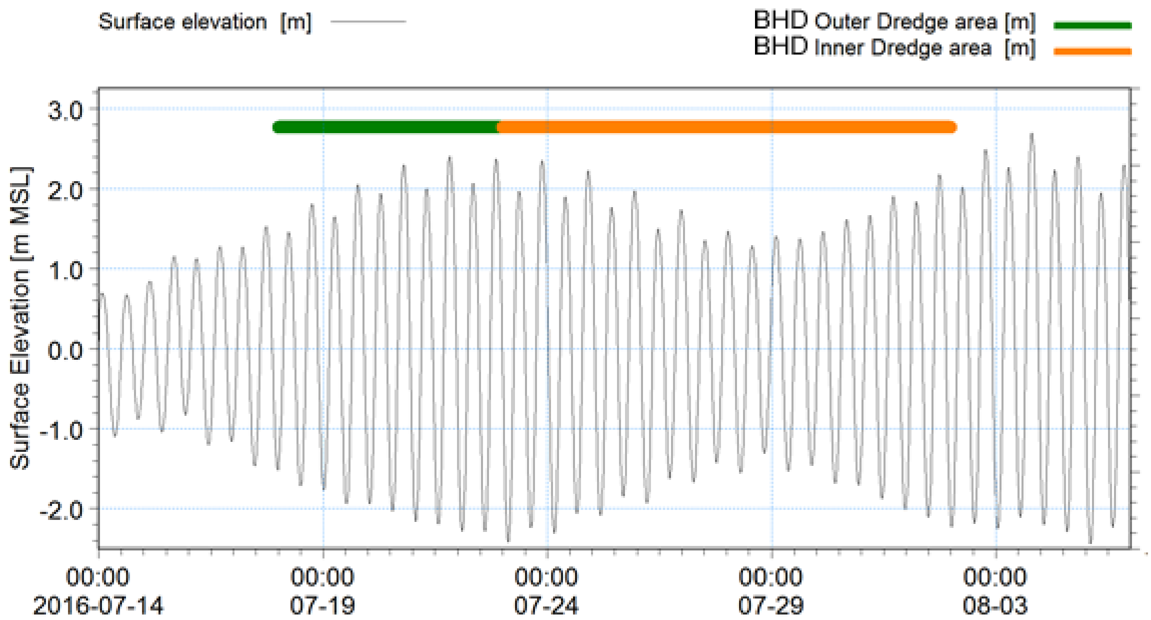

Figure AD3: The simulated 15 day BHD dredger programme in relation to the tidal cycle at Kyleakin Pier.

To account for the possible effect of wind driven currents on the dispersion of the dredge material, a Force 3 southerly wind was applied throughout the entire domain for the duration of the dredging programme.

Given that the capital dredging programme will be undertaken prior to the construction of the new 84m concrete caisson, the coupled hydrodynamic and sediment transport simulations were run using the existing Kyleakin Pier model domain with a structure included to the west of the existing pier to represent the effect of the temporary unloading jetty. This is illustrated in Figure AD4 which shows the bathymetry and mesh around the area of the Kyleakin Pier.

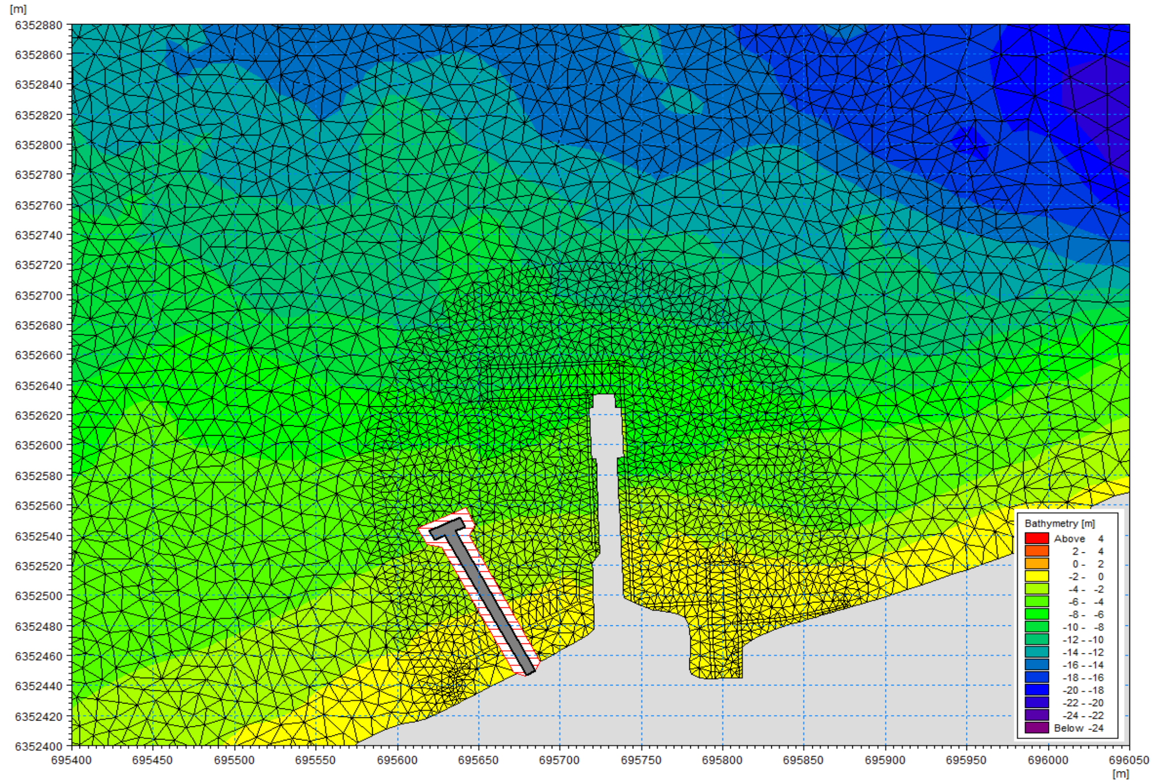

Figure AD4 Model bathymetry and mesh of the existing Kyleakin model to MSL with the addition of the proposed temporary unloading jetty

AD1.3.4 Dredging with BHD in both areas: Simulation results

As the sediment plume created during the course of the dredging programme would be greatest when dredging the inner area due to the higher fraction of fine material, the total increase in suspended sediment concentrations (SSCs) as a result of using the BHD in this area has been illustrated in Figure AD5. This Figure illustrates the increase in SSCs at spring peak flood, high water, peak ebb and low water tidal conditions when the BHD is nearest to the -9.5m CD contour and within the inner dredge area, i.e. where the percentage of fine material is greatest.

Based on simulation results it was found that within the confines of the dredge area, the typical total increase in SSCs due to the losses at the BHD bucket do not generally exceed 0.03kg/m^3 and where they do, increases are highly localised (<200m^2) and very short in duration. Under normal tidal conditions there were no increases in SSCs greater or equal to 0.01kg/m^3 beyond either the overall dredge extent or the -9.5m contour.

The average increase in SSCs as a result of a BHD undertaking the capital dredging work across the inner and outer dredge areas in 84 days is illustrated in Figure AD6. It will be seen from this Figure that there are no changes in SSCs > 0.01kg/m^3 either within or beyond the overall dredge extent.

The deposition of material less than 1000µm in size at the end of the 84 day BHD dredging campaign is illustrated Figure AD7. Like the other dredging scenarios it will be seen that the deposition of material is strongly influenced by the residual tidal current regime which acts to transport material in a westerly direction. Results demonstrated that sediment deposition as a result of the BHD dredging campaign did not exceed 0.10m and that deposition levels across the majority of the study area was generally <0.05m (5cm). It was also apparent that within 50m of the assumed boundary of the flame shell bed, the deposition of sediment was below 0.50mm.

It is important to note that it is common practice for dredging contractors to account for the effect of sediment deposition during the dredging programme by making very minor adjustments to the final target dredge depth. As such, only material beyond the dredge extent should be considered when assessing sediment plume deposition levels.

AD1.3.5 Summary of the BHD dredging campaign

Based on the modelling results presented above it was found that the increase in SSCs as a result of losses from the BHD under typical tidal conditions would not generally exceed 0.03kg/m^3 and that this increase in SSCs is completely confined within the dredge area. It should be noted that the scale of the SSC figures presented in this report does not illustrate values <0.01kg/m^3.

The BHD modelling results demonstrated how the residual tidal currents transported the suspended sediments in a westerly direction to result in deposition levels of *c.*0.016m within 600m to the west of the Pier which then decreased to < 0.001m within another 800m.

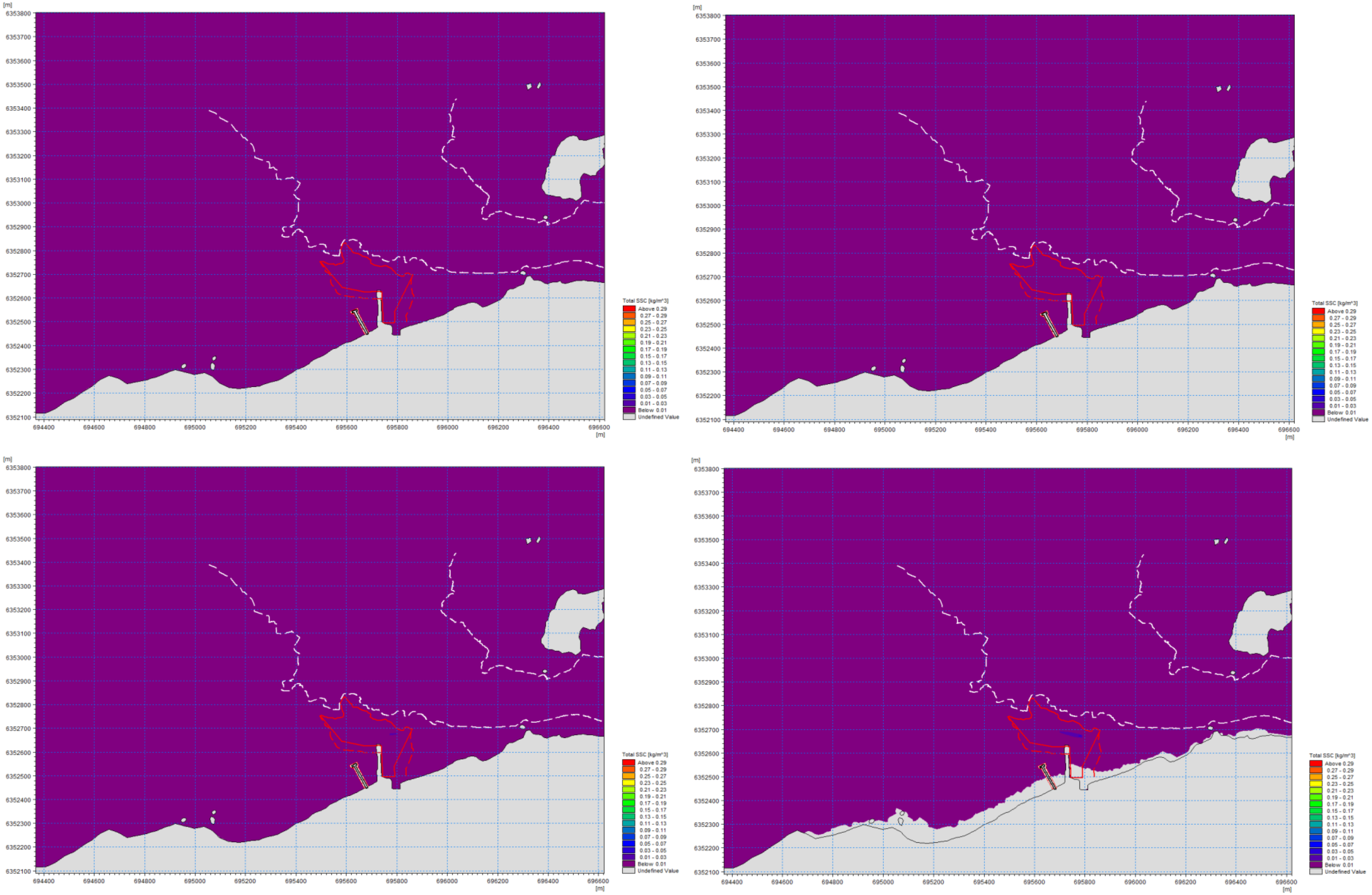

Figure AD5: Total SSCs created by a BHD in the inner dredge area at Peak flood (top left), High Water (top right), Peak Ebb (bottom left) and Low Water (bottom right) spring tidal regimes.

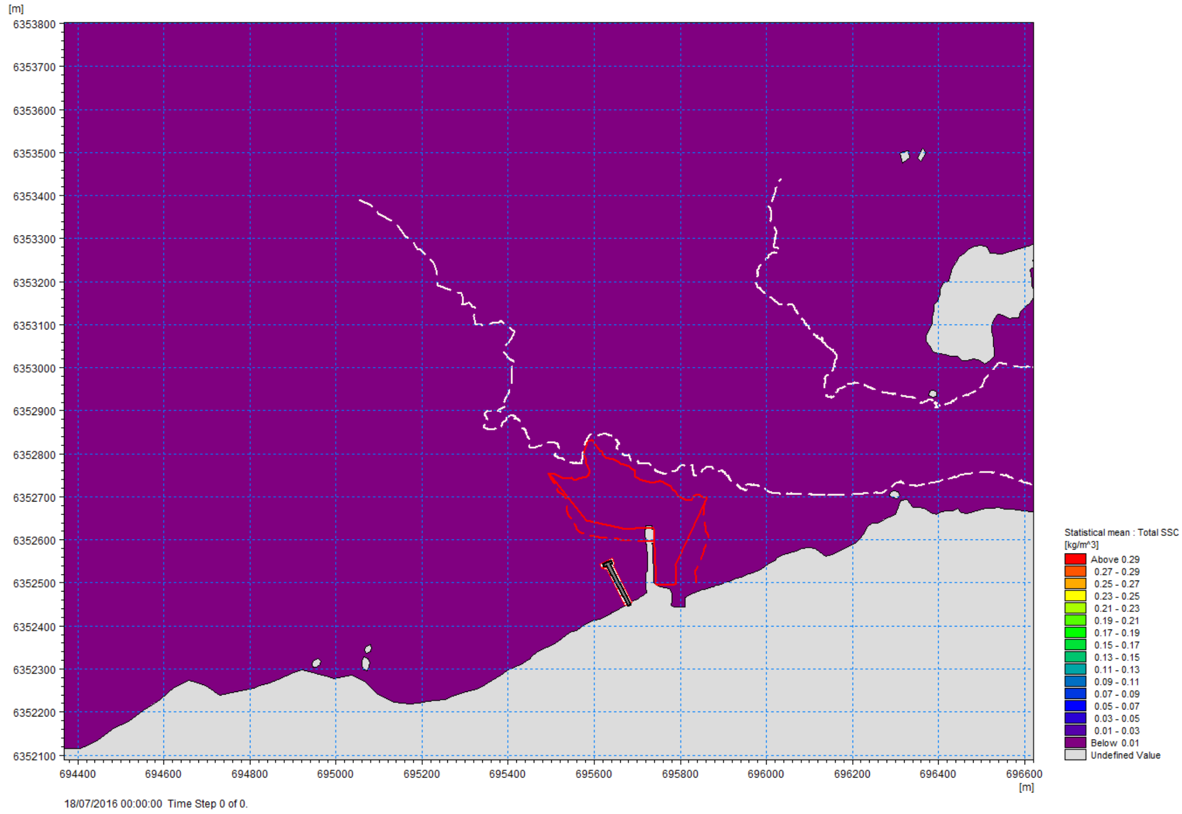

Figure AD6: The mean total SSCs created by the BHD during the entire capital dredging programme.

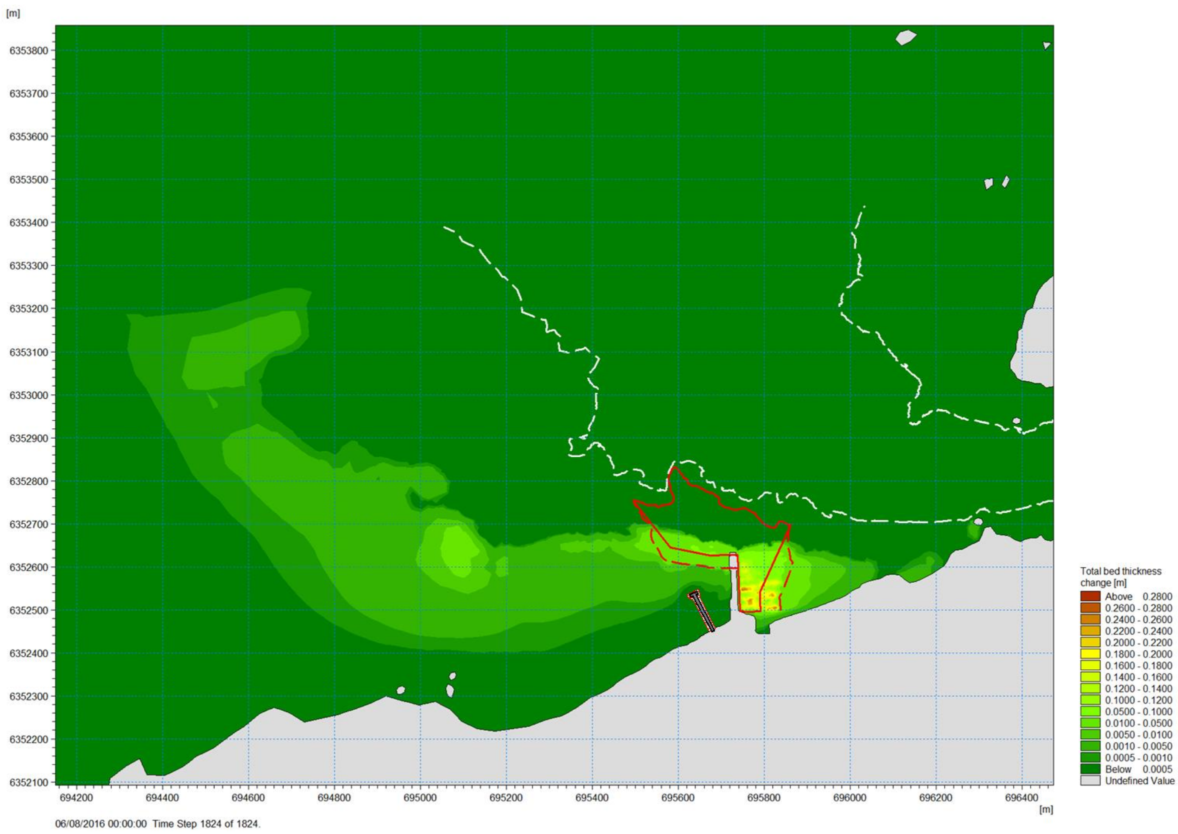

Figure AD7: Deposition levels at the end of the 84 day BHD dredging campaign.