East Suffolk House, Riduna Park, Station Road, Melton, Woodbridge, IP12 1RT

Southwold Harbour Management Committee

Members:
Councillor David Ritchie (Chairman)
Councillor Maurice Cook (Vice-Chairman)
Mr David Gledhill
Mr Richard Musgrove
Mr John Ogden
Mr Mike Pickles
Councillor Craig Rivett
Councillor Mary Rudd
Councillor Letitia Smith

Members are invited to a **Meeting of the Southwold Harbour Management Committee**
to be held in the Stella Peskett Millennium Hall,
on **Thursday, 23 February 2023** at **4.00pm**

An Agenda is set out below.

Part One – Open to the Public

Pages

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1 Apologies for Absence
To receive apologies for absence, if any.

2 Declarations of Interest
Members and Officers are invited to make any declarations of interests, and the nature of that interest, that they may have in relation to items on the Agenda and are also reminded to make any declarations at any stage during the Meeting if it becomes apparent that this may be required when a particular item or issue is considered.

3 Minutes **1 - 7**
To agree as a correct record the minutes of the meeting of the 12 January 2023.

		Pages
4	**Draft Southwold Harbour Study ES/1463** To consider the Draft Southwold Harbour Study.	8 - 81
5	**Update from the Committee's Working Groups** To receive an update from the Committee's working groups.	
6	**Update from the Stakeholder Advisory Group** To receive an update from the Stakeholder Advisory Group.	
7	**Work Programme** To consider the Committee's forward work programme.	82 - 82
8	**Date of Next Meeting** To note the date of the next meeting as 9 March 2023.	

Part Two – Exempt/Confidential

Pages

There are no Exempt or Confidential items for this Agenda.

Close

Chris Bally, Chief Executive

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Unconfirmed

Minutes of a Meeting of the **Southwold Harbour Management Committee** held in the Stella Peskett Millennium Hall, Southwold on **Thursday, 12 January 2023** at **4.00pm**

Members of the Committee present:
Councillor Maurice Cook, Mr Richard Musgrove, Mr John Ogden, Mr Mike Pickles, Councillor David Ritchie, Councillor Mary Rudd

Other Members present:
Councillor David Beavan

Officers present:
Sharon Bleese (Resilient Coastal Communities and Businesses Manager), Andy Jarvis (Strategic Director), Alastair MacFarlane (General Manager, Southwold Harbour), Matt Makin (Democratic Services Officer (Regulatory)), Lorraine Rogers (Deputy Chief Finance Officer), Nicola Wotton (Deputy Democratic Services Manager)

Others present:
Ian Bradbury (Southwold Town Council), Simon Flunder (Chair, Stakeholder Advisory Group), Marcus Gladwell (Stakeholder Advisory Group), Vicky Gladwell (Stakeholder Advisory Group)

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1 Apologies for Absence

Apologies for absence were received from David Gledhill, Councillor Craig Rivett and Councillor Letitia Smith.

2 Declarations of Interest

No declarations of interest were made.

3 Minutes

On the proposition of Councillor Rudd, seconded by Councillor Cook, it was by a majority vote

RESOLVED

That, subject to amending the attendance to remove Councillor Maurice Cook as his apologies were recorded for the meeting, the Minutes of the Meeting held on 24 November 2022 be agreed as a correct record and signed by the Chairman.

4 Quarter 3 Budget Monitoring Report 2022/23

Councillor Cook introduced report **ES/1314** which provided an overview of financial performance against approved budgets as at Quarter 3 for the 2022/23 financial year.

Councillor Cook summarised the updated figures contained in the report, noting there had been additional touring income during the third quarter and that the combined position showed a favourable variance of £13,000 to end that period, excluding the income received in advance of Quarter 4.

The Committee's attention was drawn to the year-end forecast appended to the report. The Committee was advised that that the net surplus was expected to be £196,000, compared to a budget of £141,000. Councillor Cook highlighted that there had been an underspend on premises costs.

The Committee was informed that an internal review of data support charges had been completed and this remained in line with the previous financial year.

The Chairman invited questions from the Committee. Mr Pickles queried the higher than expected car parking income; the Deputy Chief Finance Officer highlighted that caution had been taken when budgeting for car park income and this could be revised in the next budget. In response to a follow-up question, the General Manager advised that the land used for parking near the pub was East Suffolk Council land but not harbour land.

The Chairman asked if caution on car park income related to the recent national lockdowns in response to COVID-19. The Deputy Chief Finance Officer confirmed that additional caution had been taken in response to this but caution was often taken when budgeting in relation to car park income.

The Chairman invited questions and comments from the floor. Mr Flunder, Chairman of the Stakeholder Advisory Group (SAG) thanked officers for the amount of information provided and said it was a major change to be able to see ongoing monthly accounts and the future budget. Mr Flunder noted that the SAG was concerned that the projected surplus for the 2022/23 financial year was considerably lower than the £330,000 surplus achieved in 2021/22; he noted the analysis of the changes but was concerned about the £74,000 cost against Southwold Harbour and other charges appearing to be quite high. Mr Flunder noted that 30 pitches on the caravan park remained unfilled and associated the financial impact of this with the reduction in the surplus. Mr Flunder said there was some disquiet about the results and forward projections.

The General Manager explained that the surplus was not reducing, but but was not increasing at the same rate. The Chairman added that the transition phase for Southwold Harbour had contributed to this and Councillor Cook considered the current position to be satisfactory. Councillor Cook said there was a need to improve the facilities available to encourage business to return; he acknowledged the frustration with how long this would take but highlighted the importance of this work being completed to increase income generated.

On the proposition of Councillor Cook, seconded by Councillor Rudd, it was by a unanimous vote

RESOLVED

That having reviewed financial performance against approved budgets as at Quarter 3 for 2022/23, the report be noted.

5 Draft Budget 2023/2024

Councillor Cook introduced report **ES/1411,** which presented the draft budget for the 2023/24 financial year for recommendation to the Cabinet.

Councillor Cook referred to the requirement to recommend the draft budget to the Cabinet, per the Committee's terms of reference. The Committee was reminded that it had considered the schedule of charges at its meeting on 24 November 2022 and had been considered by the Cabinet at its meeting on 3 January 2023.

Councillor Cook outlined the budget detail in the report and highlighted the key changes; an additional £35,000 revenue costs was allowed for in respect of the Capital Programme and the contract staffing costs had been increased to £43,000 to cover actual costs. Councillor Cook added that there was an increased budget for overtime and that utilities had been reduced as it had been significantly higher than what was required.

The Committee was informed there had been some revisions to recharges but overall this was in line with the 2022/23 financial year. A surplus of £35,400 was ringfenced for harbour activities. Councillor Cook noted that the East Suffolk Council general fund budget would be set at its meeting in February 2023.

The Chairman invited questions from the Committee. The General Manager was able to confirm that Southwold Harbour had a very good three-year utilities deal and it was acceptable to reduce that element of the budget.

The Chairman invited questions from the floor. Mr Flunder, Chairman of the Stakeholder Advisory Group (SAG), reiterated the points he had made during the previous item. The SAG's frustrations at the pace of improvements was acknowledged and the General Manager advised that the Council had gone to tender for an architectural landscape visualisation as part of improving the caravan park and bringing it to legal and industry standards, ahead of undertaking a public consultation on proposed improvements.

Mr Flunder said these improvements had been discussed by the SAG, which was concerned about potential changes to the character of the caravan park and hoped this would be taken into account when developing proposals. Councillor Cook and the General Manager both assured Mr Flunder that it was not intended to destroy the character of the caravan park but to improve the facilities and bring it up to an acceptable industry standard, and costs would not be put on to end users to bring this about.

The General Manager confirmed that the £74,000 costs against the Harbour related to improvements to staging and defensive maintenance, and that this may not be spent in its entirety.

Councillor Beavan, Ward Member for Southwold, highlighted the dispute on the ownership of the camping field and asked that should it be proved that the Council owned the land, it would not charge rent. The Strategic Director confirmed there were no plans to levy a charge on the land.

On the proposition of Councillor Cook, seconded by Mr Musgrove, it was by a unanimous vote

RESOLVED

That having reviewed and commented upon the draft 2023/24 Budget for the Harbour Account, at Appendix B to the report, it be recommended to Cabinet.

6 Marine Safety Management System

The General Manager introduced report **ES/1412**, which set out the proposed Marine Safety Management System (MSMS) prior to presentation to and approval by Cabinet.

The Committee was advised that as part of ensuring Southwold Harbour was fully compliant with legislative and health & safety requirements, ABPmer had been appointed as the Harbour's designated person to review the current MSMS against the Marine Safety Code (the Code). The General Manager noted that although having a MSMS in place was not a statutory requirement, the Harbour could be prosecuted in the event of an accident if there was no good reason for having a MSMS, citing an incident at Clyde involving fatalities which had resulted in prosecution.

The General Manager confirmed that ABPmer's gap analysis had identified 33 items required under the Code and had recommended that the MSMS be overhauled. The General Manager advised that he had worked with ABPmer to review published MSMSs across the UK and produce the document presented to the Committee. The Committee was informed that the Harbour had adopted the Council's policies on enforcement and environment and that the General Manager had worked with the relevant Council officers to amend wording in the MSMS to reflect the Harbour's legal position.

The Chairman invited questions from the Committee. Mr Pickles noted an unseaworthy boat currently located in the Harbour; the General Manager confirmed that issues such as this would be dealt with by way of Standard Operating Procedures (SOPs) which would cascade from the MSMS. There was some discussion on the definition of pleasure vessels by length and the difficulty to enforce issues relating to dangerous vessels in this respect; the General Manager noted this but said the length of 24 metres was specified in legislation.

Mr Pickles urged caution when naming Harbour Marine Services in relation to hot works. The General Manager said he felt it appropriate as Harbour Marine Services were by far the largest tenant of Southwold Harbour and regularly engaged in hot work; the General Manager confirmed that standing time period permissions were being explored for hot works to simplify things for all parties. The General Manager added that the SOPs would be brought to the Committee.

The General Manager stated that operating hours needed to be stated to avoid ambiguity, and it would not be viable to operate Southwold Harbour on a 24/7 basis.

The Chairman invited comments from the floor. Mr Flunder, Chairman of the Stakeholder Advisory Group (SAG) was supportive of the MSMS document but cautioned it should be implemented in a balanced way. Mr Gladwell, a member of the SAG, added that he agreed with the comments on tonnage and asked if there would be a procedure to allow towing in the Harbour in emergency situations; the General Manager advised this would be included in the SOPs. In response to a question from Councillor Beavan, the General Manager confirmed small-scale towing, such as the Sailing Club safetyboat, would be permitted.

The Chairman confirmed there was support throughout the Cabinet for the proposed MSMS and thanked the General Manager and Mr Musgrove for their hard work on the report.

On the proposition of Mr Musgrove, seconded by Mr Pickles, it was by a unanimous vote

RESOLVED

That having commented on the Marine Safety Management System documentation, it be recommended to Cabinet for approval.

7 Work Programme

The Committee noted the forward work programme. The Chairman advised that updates from the Working Groups could be received under this item, as these groups generated future business for the Committee.

<u>Health, Safety and Compliance Working Group</u>

Mr Musgrove said that issues identified during the October 2022 site visit were being progressed by the General Manager as far as possible. The Working Group had recently met and it had been recommended to Cabinet that Southwold Harbour join the British Port Authority, Port Safety and Safety Port and Skills. An aids to navigation workshop had also been completed, alongside a landslide hazard workshop. The General Manager said he would ask Democratic Services to set up a meeting to look at the outcomes of these workshops.

<u>Working Harbour Working Group</u>

Councillor Cook reported that the Working Group had recently met and had been pleased to hear progress was being made on fishing and visitor moorings. The review of costs was progressing and it had been highlighted there was a need for bathroom facilities nearer to the visitor moorings and this had been discussed at the meeting.

Councillor Cook noted the issues around the bund footpath on the Walberswick side of the Harbour, which Suffolk County Council was responsible for upkeeping; a meeting had been held with the Environment Agency and it had been agreed to restrict access but leave this under the control of Southwold Harbour.

Caravan and Campsite Working Group

Councillor Cook reported that good discussions were taking place on issues, including proposals for a landscaping plan. Councillor Cook acknowledged that the pace of this work was slow and it was unlikely any work would happen on the site before Autumn 2023. At the meeting, Councillor Smith had stressed the need to communicate well with caravan owners.

Southwold Harbour Investment Plan (SHIP) Working Group

Mr Musgrove noted the last Working Group meeting had been cancelled; the next meeting was due to take place on 6 February 2023.

Stakeholder Advisory Group

Mr Flunder said there was no further updates from the SAG beyond what he had raised during the meeting. Mr Flunder thanked the Committee for the opportunity to make points as the meeting progressed.

8 Date of Next Meeting

The dates of the next meeting were noted as being 23 February 2023 and 9 March 2023.

9 Exempt/Confidential Items

On the proposition of Councillor Ritchie, seconded by Councillor Rudd, it was by a unanimous vote

RESOLVED

That under Section 100A(4) of the Local Government Act 1972 (as amended) the public be excluded from the meeting for the following item of business on the grounds that it involves the likely disclosure of exempt information as defined in Paragraph 3 of Part 1 of Schedule 12A of the Act.

10 Exempt Minutes of meeting

On the proposition of Councillor Rudd, seconded by Councillor Cook, it was by a majority vote

RESOLVED

That, subject to amending the attendance to remove Councillor Maurice Cook as his apologies were recorded for the meeting, the Exempt Minutes of the Meeting held on 24 November 2022 be agreed as a correct record and signed by the Chairman.

The meeting concluded at 5.15pm.

…………………………………………..
Chairman

Southwold Harbour
MANAGEMENT COMMITTEE

SOUTHWOLD HARBOUR MANAGEMENT COMMITTEE

Thursday, 23 February 2023

Subject	**DRAFT SOUTHWOLD HARBOUR STUDY**
Supporting Officer	Madeline Fallon Senior Coastal Advisor Madeline.fallon@eastsuffolk.gov.uk

Is the report Open or Exempt?	OPEN

Category of Exempt Information and reason why it is **NOT** in the public interest to disclose the exempt information.	N/A
Wards Affected:	Southwold

Purpose and high-level overview

Purpose of Report:
To provide members with the opportunity to comment on the Draft Southwold Harbour Study, including Dredging Assessment and Culvert Option Assessment.

Recommendation:
That having commented on their contents, the Harbour Management Committee note the Draft Southwold Harbour Study, Dredging Assessment and Culvert Option Assessment.

Impact Assessment

Governance:
The HMC is required to approve ongoing work related to the management and compliance of Southwold Harbour.
Environmental:
The HMC must act in the best interests of the port, which includes its ongoing sustainability and success. Environmental factors will be considered in the decisions which the HMC will make.
Equalities and Diversity:
No direct impact at this time.
Financial:
No direct impact at this time.
Legal:
No direct impact at this time.
Risk:
No direct impact at this time.

Harbour Business Plan Priorities

To be added when the plan is in place.

East Suffolk Council Strategic Plan Priorities

Select the themes of the Strategic Plan which are supported by this proposal:		
T01	Growing our Economy	☐
T02	Enabling our Communities	☐
T03	Maintaining Financial Sustainability	☐
T04	Delivering Digital Transformation	☐

T05	Caring for our Environment	☒

Background and Justification for Recommendation

1	Background facts
1.1	East Suffolk Council (ESC) is responsible for the structures at the entrance to Southwold Harbour
1.2	The South Pier is in poor condition and at risk of collapse, and replacing it is expected to require substantial investment.
1.3	The North Wall within the harbour is not well used for mooring, which may be due to wave disturbance, possibly linked to the poor condition of the South Pier.
1.4	The Southwold Harbour Management Committee (HMC) aims to increase use of the harbour, which would benefit from improved conditions at the North Wall.
1.5	The harbour entrance and the estuary defences are mutually dependent, so the future management of the estuary defences and potential changes in the tidal prism need to be taken into account when considering what needs to be done to improve or replace the South Pier and other harbour structures.
1.6	If nothing was done to improve the condition of the South Pier, it is expected to collapse during a severe storm within the next 5 years. If the South Pier does not fail due to wave impact then failure from undermining (following erosion of the channel bed) might occur within 10 years.

2 Current position	
2.1	East Suffolk Council and Coastal Partnership East appointed Royal HaskoningDHV in September 2019 to develop the Southwold Harbour Investment Plan and to undertake the associated technical investigations.
2.2	Following discussions in March and September 2022, the Harbour Management Committee asked Royal HaskoningDHV to explore options for dredging with the aim of enabling increased mooring at the North Wall.

3. How to address current situation	
3.1	The attached reports present the findings of the Southwold Harbour Study and Investment Plan, advising on options to address the future function, operation, and survivability of the entrance to Southwold Harbour in the broader context of estuary management and the economic future of the harbour.

4. Reason/s for recommendation	
4.1	It is recommended that the HMC discuss the findings of the attached reports to and comment on their preferred options, considering input from the Stakeholder Advisory Group.

Appendices

Appendices:	
Appendix A	Draft Southwold Harbour Study
Appendix B	Culvert Option Assessment
Appendix C	Dredging Assessment

Background reference papers:
None

REPORT

Southwold Harbour Study Investment Plan

Project Report – Executive Summary

Client: East Suffolk Council

Reference: PB9485-ZZ-XX-RP-Z-0001

Status: Draft/P007

Date: December 2022

Project related

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Document title:	Southwold Harbour Study Investment Plan
Document short title:	SHIP – Executive Summary
Reference:	PB9485-ZZ-XX-RP-Z-0001
Status:	P007/Draft
Date:	February 2022
Project name:	Southwold Harbour Study
Project number:	PB9485
Author(s):	Amy Savage
Drafted by:	Amy Savage
Checked by:	Euan Hobson / Racheal Holsgrove
Date:	December 2021 / February 2023
Approved by:	Jaap Flikweert / Patrick Woods
Date:	December 2021 / TBC

Classification
Project related

Project related

Royal HaskoningDHV

Executive Summary

Project Overview

East Suffolk Council (ESC) is responsible for the structures at the entrance to Southwold Harbour. The South Pier is in a poor condition and at risk of collapse, and replacing it is expected to require substantial investment. The North Wall within the harbour is not well used for mooring, which may be due to wave disturbance, possibly linked to the poor condition of the South Pier. The Southwold Harbour Management Committee (HMC) aims to increase use of the harbour, which would benefit from improved conditions at the North Wall.

In 2009 the Blyth Estuary Flood Risk Management Strategy (the EA Strategy) concluded that investment to sustain or improve the condition of the present estuary flood defences could not be justified on economic grounds. The preferred option identified by the EA Strategy was for withdrawal of maintenance combined with local works to mitigate flood risk to properties in Southwold and Walberswick. The Strategy was approved by the Environment Agency (EA) in June 2009 and the estuary flood banks are no longer being maintained. The EA are responsible for the management of the Blyth estuary flood defences and East Suffolk Council is not able to take over this responsibility. Landowners are entitled to protect their land from flooding and erosion, at their own cost.

As the flood banks are no longer maintained, it is expected that they will gradually fail over their full length. This will lead to regular flooding of the marshes, which form a series of large flood cells[1] in the estuary. The tidal prism[2] of the estuary will increase if the flood defences fail, as a larger area of the marshes will be able to flood. Sea level rise due to climate change is also expected to increase the tidal prism because there is likely to be a greater depth of flooding, although this depends on the rate at which the ground level of the marshes rises due to sediment deposition. A larger tidal prism will cause higher flow rates at the harbour entrance, which could increase erosion of the channel bed and the risk of failure of the harbour entrance structures. Changes to tidal flows will also affect conditions for navigation and mooring in the harbour.

The harbour entrance and the estuary defences are mutually dependent, so the future management of the estuary defences and potential changes in the tidal prism need to be taken into account when considering what needs to be done to improve or replace the South Pier and other harbour structures.

As well as providing a defined entrance to the harbour, the North and South Piers are control structures for the adjacent coast. If the South Pier was to collapse and not be replaced or repaired, this would increase the exposure of the North Pier, which would also fail. With the loss of both structures, erosion of the coastline would accelerate, and the form and location of the estuary mouth would be expected to change.

A further issue is flood risk to properties and businesses within the harbour. Access to the harbour is already restricted on high tides, with the condition of the Harbour Road deteriorating, and the frequency of flooding will increase with climate change. Investment in the harbour entrance structures will have less benefit if the harbour is no longer viable because of the frequency of flooding.

The local economy is strongly linked to coastal tourism, with Southwold Harbour being a key component in this, so the potential benefits of works to the Harbour entrance structures (and the consequences of inaction) extend beyond flood and coastal erosion risk.

A realistic investment plan is required to inform future funding needs for the Southwold Harbour entrance structures and management of the estuary defences. This plan needs to be based on an improved understanding of the interrelation of physical processes within the estuary and the condition, performance and useability of the harbour entrance structures.

The coastal management team at Coastal Partnership East (CPE) is supporting ESC with the delivery of this project, with Royal HaskoningDHV appointed in September 2019 to develop the Southwold Harbour Investment Plan and to undertake the associated technical investigations. This report presents the findings of the Southwold Harbour Study and Investment Plan, advising on options to address the future function, operation, and survivability of the entrance to Southwold Harbour in the broader context of estuary management and the economic future of the harbour.

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[1] *A flood cell is defined as an area which can flood independently of other areas located upstream or downstream.*
[2] *The tidal prism is the volume of water held in the estuary between high tide and low tide.*

Royal HaskoningDHV

What is the problem?

Figure 1 illustrates the sequence of events that would be expected to occur if nothing was done to improve the condition of the harbour entrance structures.

SP1 If nothing was done to improve the condition of the South Pier, it is expected to collapse during a severe storm within the next 5 years. If the South Pier does not fail due to wave impact then failure from undermining (following erosion of the channel bed) might occur within 10 years.

SP1.1 Collapse of sections of the South Pier could block the entrance channel, restricting access to the Harbour and potentially causing a safety hazard.

SP1.1.1 With gaps in the South Pier, wave disturbance in the entrance channel and harbour will increase, affecting navigation and moorings at the North Wall and further upstream.

SP1.1.2 Sediment would move into the outer harbour from the south, further restricting access.

SP1.1.3 Loss of the South Pier would enable increased sediment movement from south to north, which could accelerate the rate of erosion of the dunes and increase the risk of tidal flooding to Walberswick.

SP1.2 Increased wave impact on the North Pier (this structure is not designed for direct wave impact).

SP1.2.1 The condition of the North Pier would deteriorate quite rapidly, with failure expected within 10 years of failure of the South Pier. The adjacent structures would then be affected.

Commented [AS1]: Risk of failure of N Pier is to be discussed further with ESC.

SP1.2.2 Wave penetration into the inner harbour would increase further and the North Pier would no longer retain the southern end of the Denes. The north beach would collapse into the harbour channel. This could result in increased sediment movement from north to south, which could offset erosion impacts associated with the loss of the South Pier.

SP1.2.3 Erosion of the Denes to the north would increase flooding and erosion risk for Southwold.

Figure 1: Illustration of the impacts of the Do Nothing scenario for the harbour

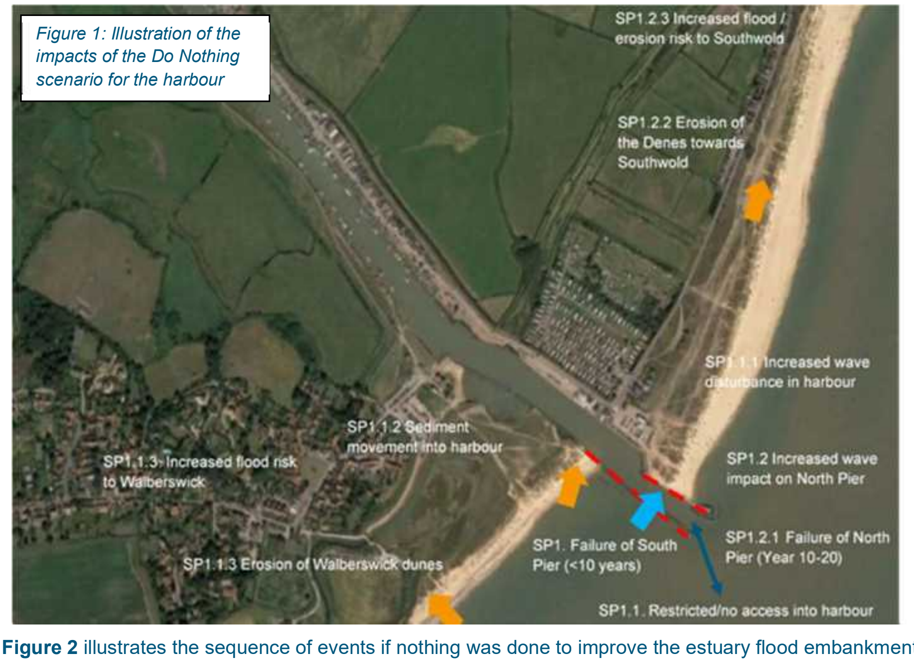

Figure 2 illustrates the sequence of events if nothing was done to improve the estuary flood embankments.

E1 Gradual failure of the estuary flood defences would occur over the next 20 years, with overtopping of the embankments to Tinkers' and Robinsons' marshes expected at least every 5 years on average, with a high risk of embankment failure if overtopping occurs.

E1.1 Following failure of the embankments, the marshes will be inundated on high tides, increasing the risk of flooding to properties in Walberswick and Southwold.

E1.1.1 Flooding of the marshes is expected to reduce the peak flood levels in the river, reducing the risk of flooding to Blackshore properties and harbour businesses.

E1.1.2 The tidal prism of the estuary will increase significantly, resulting in an increase in the peak flow rate in the river channel, particularly at the constrained harbour entrance.

E1.1.2.1 An increased flow rate is expected to increase the rate of erosion of the channel bed and therefore the risk of failure of the harbour entrance structures. Erosion of the channel bed at the narrowest point of the estuary would reduce resistance to tidal inflow and thereby increase the tidal prism.

E1.1.2.2 The increased flow rate would also impact on navigation in the Harbour.

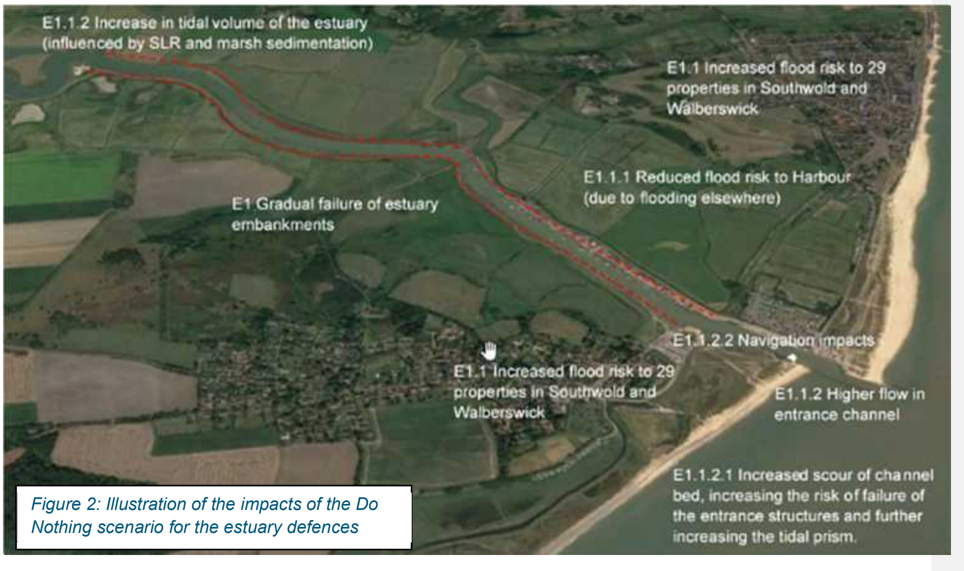

Figure 2: Illustration of the impacts of the Do Nothing scenario for the estuary defences

Options Considered

In developing the Investment Plan, a range of options were considered for: 1) the improvement or replacement of the harbour entrance structures; 2) improvement of the estuary defences; and 3) to reduce flood risk to the harbour. There are inter-relationships between some of these options.

Harbour entrance structures

The following options to improve the condition and sustain the performance of the harbour entrance structures were developed, considering the various possible structural options:

- **H1 - Do Nothing**
- **H2 - Do Minimum (Maintain South Pier)**
- **H3 - Do Minimum (Repair South Pier)**
- **H4 - Repair then replace South Pier**
- **H5 - Replace South Pier with a similar structure**
- **H6 - Replace South Pier with a rock armour breakwater**

Estuary defences

The potential strategic management scenarios for the estuary defences are as follows:

- **E0 – Maintain Integrity of Present-Day Defences:** This option aims to keep the existing estuary defences in place for as long as possible, but without major capital investment, assuming that the embankments can be maintained and repaired until about 2040. After this time a decision would be taken as to whether to (a) discontinue maintenance (Do Nothing) or (b) improve the estuary defences.

- **E1 – Do Nothing:** This scenario assumes no further works are undertaken to the estuary defences. The flood embankments and harbour structures would be allowed to deteriorate and fail.
- **E2 – Improve Estuary Defences:** This option assumes that the estuary defences are improved to provide protection against a 1 in 100 (1% AEP) surge event, allowing for sea level rise to 2070. The harbour structures would also be maintained or improved as required. Variations on this option that provide a lower standard of protection would also be possible.
- **E3 – SMP Policy:** The defences on the north side of the estuary are improved to keep pace with sea level rise. Banks on the south side of the estuary would be realigned or their crest levels reduced allowing for flooding of Robinson's Marsh and Tinker's Marsh. The harbour entrance structures would be maintained or improved as needed.
- **E4 – EA Strategy Position:** Management of the estuary defences and harbour structures would be withdrawn gradually until 2030, with defences abandoned thereafter. Secondary defences would be built to reduce the risk of flooding to Walberswick and Southwold, plus a terminal groyne at Gun Hill.
- **E5 – Tidal Barrier:** A tidal barrier would be constructed across the harbour entrance, which could be raised or lowered on surge events to prevent flooding.
- **E6 – Spillway:** The flood embankments to Robinson's, Tinker's, Town, and Reydon Marshes would be improved to keep pace with sea level rise, and the harbour entrance structures maintained or improved as necessary. A 250m long spillway would be constructed within the embankment to Tinker's Marsh which would be overtopped on surge tides to flood Tinker's Marsh.
- **E7 – Narrow Channel:** The river channel could be narrowed opposite the North Wall to constrain the volume of water entering the estuary and reduce water levels upstream. This option could be combined with any of the other management options for the estuary defences and harbour structures.

Flood risk to the harbour

The following options to reduce flood risk to the harbour were assessed:

- **B1: Do Nothing**
- **B2: Raise Harbour Road (1:5 SOP)**
- **B3: Raise Harbour Road (1:100 SOP)**
- **B4a: Raise Harbour Road plus concrete flood walls (1:100 SOP)**
- **B4b: Raise Harbour Road plus glass and concrete flood walls (1:100 SOP)**
- **B5: Raise Harbour Road (1:5 SOP) + concrete flood walls to Blackshore (1:100 SOP)**
- **B6: Do Minimum (limited improvements to road condition)**

Summary of Findings

A summary of the assessment of the options is provided in **Table 2** at the end of this Executive Summary. The preferred solutions for managing Southwold Harbour and the inter-related estuary defences, subject to securing the necessary funding, are described below. Selection of these preferred options has considered various factors, including performance against the objectives (based on the modelling results), cost estimates and stakeholder feedback (refer to **Appendix G**). It should be noted that whilst cost was considered in the assessment, affordability has not been fully assessed because a comprehensive business case (including benefits assessment) has not yet been developed.

Commented [AS2]: May require further discussion of risk of failure to N Pier, and associated costs. TBC following further discussion with ESC.

Replacement of the South Pier

The preferred option for works to the South Pier is **Option H6 – Replace South Pier with a rock armour breakwater**. The total initial capital cost of these works is **£11.5 million**[3]. A rock armour breakwater would significantly improve wave conditions within the entrance channel and the inner harbour, reducing wave heights at the North Wall to about 0.5m during conditions expected to occur once every year on average. A rock armour breakwater is the option with the greatest benefits for wave conditions and is a more cost-effective solution than other long-term options.

Commented [AS3]: This section has been updated based on the findings of the Dredging Assessment and Breakwater Culvert Assessment.

The 'windows' through the existing South Pier enable wave penetration and tidal flow into the harbour entrance channel, which benefits navigation by reducing wave reflection and disturbing tidal flow patterns.

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[3] *All cost estimates quoted in the Executive Summary include 60% Optimism Bias.*

Harbour users consider it to be important that a cross-flow is maintained in the entrance channel, which could be achieved by incorporating box culverts into the rock structure. An assessment of the performance of the proposed box culverts has been completed (see **Appendix H**), including additional tidal modelling, which concluded that incorporating culverts in the rock breakwater would be of limited benefit to improving navigation conditions. Flow through the culverts would have limited influence on the overall tidal flows in the channel, and the wave energy dissipation achieved by the rock breakwater would reduce the impact of reflected waves on channel conditions. There is also the risk that tidal flow or wave penetration through the culverts could be experienced by vessels as a strong jet of water. A rock armour breakwater continues to be the preferred option to replace the South Pier, but the inclusion of box culverts is not recommended. This recommendation is subject to further discussion with harbour users in February 2023.

The design of the mouth of the harbour entrance channel should optimise conditions for navigation into and out of the channel. Additional wave modelling and consultation is recommended (e.g. for less extreme wave conditions), to improve understanding and address any risks to navigation from the transition from disturbed conditions at the harbour entrance to calmer conditions within the channel.

A rock groyne to narrow the channel opposite the North Wall would slightly reduce wave heights in the inner harbour. With a narrowed channel, peak water levels at the Blackshore would be improved by 110mm for an event equivalent to December 2013. Other works to reduce flood risk to the harbour would still be required. Assessment and consultation on the benefits and constraints of this option has been undertaken, as discussed below.

Dredging of the bank of sediment located opposite the North Wall would increase the navigable width of the outer harbour, improve access to the inner harbour and create more space at the North Wall for vessel mooring. The potential impact of the dredging proposals on wave conditions, flow velocities and directions and peak water levels in the harbour has been assessed (**Appendix I**), including additional tidal modelling. The assessment also considered alternative locations for a rock groyne to narrow the channel in the outer harbour, combined with dredging. The additional tidal modelling for these options showed that:

- dredging would not change conditions in the entrance channel;
- flow velocities in the outer harbour would be reduced, and the impact on upstream flow velocities would be limited;
- there would be negative impacts on water levels further upstream; and
- construction of a rock groyne to narrow the channel would mitigate the impacts of dredging on peak water levels, with a location upstream of Dunwich Creek preferred for this structure;

Further discussion with stakeholders is required regarding any constraints associated with the construction of a rock groyne at this location. If the rock groyne option is taken forward, it would be most efficient to construct this at the same time as works to replace the South Pier, at an **additional cost of £1.1 million**. A marine licence would be required to enable the shoal bank to be removed, and the application process for this could take 6 to 12 months. Therefore, it may be more efficient to combine the removal of the shoal bank with construction of the South Pier. Regular bathymetric surveys would be needed to monitor future channel depths and any requirement for maintenance dredging.

Other works within the harbour area and at Dunwich Creek are not proposed as they would have limited additional benefit for wave conditions and use of the harbour.

Estuary management

The preferred option for the future management of the estuary defences is **Option E6 – Improve Estuary Defences with Spillway**. With this option, the flood embankments to Robinson's, Tinker's, Town and Reydon Marshes would be improved to provide a 1 in 100 (1% AEP) standard of protection, allowing for climate change. A 250m long reinforced spillway would be constructed in the embankment to Tinker's Marsh, which would be overtopped on surge tide events. The total initial capital cost of these works is **£15.7 million**. This option achieves the following in terms of the project objectives:

- The tidal prism would be comparable to the present day conditions. In 2070, peak flow rates in the entrance channel would be about 3.0 knots on the ebb of a spring tide, an increase of approx. 8% from the present-day peak flow rate of 2.8 knots. Peak flow on extreme events could be higher than if all banks were raised, as the flooded marshes drain. If the estuary embankments were to fail (Do Nothing), the peak flow rate would be about 4.8 knots.

- This option provides a 1 in 100 (1% AEP) standard of protection against future flooding to properties in Southwold and Walberswick. Apart from the expensive tidal barrier, or raising the defences without the spillway, other options would require additional flood protection to Southwold and/or Walberswick.
- This option maintains the present-day risk of flooding to the Blackshore. For a surge event equivalent to December 2013, peak water level at the Blackshore would be comparable to the 2013 flood level.
- This option could be delivered through a phased approach, initially focusing on the sections of defence at greatest risk of failure or with the lowest standard of protection.

Variations on this option that provide a lower standard of protection would be possible, at a lower cost although with a reduction in the economic benefits achieved. Costs for a 1 in 5 (20% AEP) standard of protection would be £10.8m, but this would deliver only limited improvements to the protection provided compared to the present day defences. A full range of standards of protection was not fully assessed as part of this project, so it is recommended that development of the business case for estuary management works considers sensitivity to the standard of protection provided, in terms of both the construction costs and economic benefits. The proposed economic appraisal should also consider the potential for phasing the construction works, whereby improvements are implemented in stages as sufficient funding becomes available. This phasing should account for the present condition and standard of protection of the defences.

It is recognised that it may be difficult to secure sufficient funding to enable Option E6 to be undertaken. A viable alternative would be **Option E0 – Maintain Integrity of Present-Day Defences**. There is no initial capital cost for this option, but a plan and budget would be needed for ongoing maintenance, so that breaches of the estuary embankments could be repaired if they occur. This option achieves the following:

- For water levels which do not exceed the crest level of the embankments, peak flow rates will be similar to those experienced at present, limiting the risk of erosion of the entrance channel. Peak flow rates in the entrance channel would be about 3.0 knots on the ebb of a spring tide in 2070 (8% increase from the present-day peak flow rate).
- This option has less impact on peak water level at the Blackshore, as overtopping of the estuary defences would occur on an extreme surge event, so peak water levels in the harbour would be less than if the height of the embankments was increased.
- There would continue to be a risk of flooding to properties in Southwold and Walberswick unless secondary defences were constructed (not currently included in this option).
- This option would enable works to the embankments in the future if funding is secured at a later date.

The main risk with this option is that multiple failures of the estuary flood embankments could occur during an extreme surge event, with the risk and frequency of failure increasing with time. Repair of a breach in the embankments can be very difficult and expensive, due to access difficulties during flood events. Repair costs could become more technically challenging following multiple breaches, further increasing costs. The cost of such works would be an operational cost rather than a capital investment, and as such grant funding is unlikely to be available. For these reasons, this option is not currently the preferred approach to future management of the estuary defences.

Flood risk to the Harbour

Following discussions with harbour users and other stakeholders, the preferred option to manage flood risk to the harbour in the short term is **Option B6 – Do Minimum** (limited improvements to road condition). This option would involve infilling the low spots in the road (to be confirmed by topographic survey), and installation of edge protection to reduce the rate of wash-out of the road surface. It is expected that these works would be undertaken by the harbour users themselves, potentially using donated materials and other resources. As such a cost estimate has not been prepared for this option.

This option would not preclude future works to raise the level of the road or to install flood walls, which are technically viable options but with much higher costs of between £3 million and £9 million, as well as complexities relating to the requirements for accessing properties, boat sheds and the harbour pontoons.

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Investment Plan

The proposed 50-year Investment Plan for the preferred options described above is set out in Table 1, including the two alternative approaches for future management of the estuary flood banks. The total initial capital cost (Year 0 to Year 5) for **Option E6** (Improve Estuary Defences + Spillway), plus **Option H6** (Rock Breakwater) is estimated at £28.3 million, with a total discounted present-value cost for all works to 2070 of £31.5 million. Construction of a rock groyne to narrow the channel upstream of Dunwich Creek, if agreed with the Harbour Management Committee, would have an additional capital cost of £1.1 million.

The alternative **Option E0** (Maintain Integrity of Present-day Defences) combined with **Option H6** (Rock Breakwater), is estimated to have an initial capital cost of £12.5 million and a total present-value cost for all works to 2070 of £22.6 million, allowing for repeated repairs to the embankments.

The timescales for the initial works recognise the time needed to secure funding and develop the design. Works to the South Pier are more time-critical than the proposed improvements to the estuary defences, although it should be recognised that failure of the embankments could occur during a severe storm event.

Table 1: Recommended Investment Plan

Year	Financial Year	Proposed works	Option E6 – Improve estuary defences + spillway		Option E0 – Maintain integrity of present-day defences	
			Cost (£)	Discounted Present-Value Cost (£)	Cost (£)	Discounted Present-Value Cost (£)
3	2024-25	Replace South Pier	11,451,000	10,543,000	11,451,000	10,543,000
3	2024-25	Rock groyne upstream of Dunwich Creek (TBC)	1,100,000	992,000	1,100,000	992,000
5	2026-27	Raise estuary defences + spillway	15,827,000	13,426,000	-	-
5	2026-27	Replace N Pier fenders[4]	1,000,000	842,000	1,000,000	842,000
0-9	2021-31	Maintenance & Monitoring	1,193,000	1,027,000	2,387,000	2,055,000
10-19	2031-40	Maintenance & Monitoring	1,193,000	728,000	2,387,000	1,457,000
20-29	2041-50	Maintenance & Monitoring	1,193,000	516,000	3,819,000	1,489,000
30	2051-42	Toe piling to South Pier[5]	6,908,000	2,461,000	6,908,000	2,461,000
30-39	2051-60	Maintenance & Monitoring	1,193,000	374,000	4,058,000	1,257,000
40	2061-62	Replace North Pier[6]	5,980,000	1,585,000	5,980,000	1,585,000
40-49	2071-72	Maintenance & Monitoring	1,193,000	278,000	4,774,000	1,112,000
TOTAL COST			**£ 48,352,000**	**£ 32,481,000**	**£ 43,505,000**	**£ 23,545,000**

Recommendations

Funding for the works proposed for the South Pier should be sought as soon as possible, so that the required consents processes (including environmental assessment) and design can be progressed. The scope of work for this project did not include the assessment of affordability or funding availability, and additional economic appraisal is expected to be required to secure funding. Alongside these activities, plans should be progressed to improve the resilience of properties and businesses against more severe flood events.

Subject to securing the necessary funding, it is recommended that replacement of the existing South Pier structure with a rock breakwater is undertaken as soon as possible.

[4] Planned replacement of fenders to North Pier (channel section), not included in annual maintenance budget. Although these works are expected to be required in Year 5, there could be a saving if they were to be undertaken at the same time as works to replace the South Pier.

[5] Costs for installing additional toe piling to the South Pier are included in Year 30, based on present erosion rates in the entrance channel. This is considered to be conservative, because the rock breakwater would be designed so that it can adapt the falling bed levels, and the breakwater would be expected to reduce scour as wave energy is dissipated. Therefore, toe piling may not be needed before Year 50.

[6] Costs for replacing the North Pier and the Knuckle are included in Year 40, based on present erosion rates in the entrance channel. With raised estuary embankments, tidal flow rates and associated erosion are not expected to increase significantly. The new South Pier will dissipate wave energy and reduce associated scour of the channel bed. Therefore, it may not be necessary to replace the North Pier before Year 50.

Commented [AS4]: This section has not yet been finalised due to the following outstanding issues:
- Proposal to narrow the channel upstream of Dunwich Creek to be discussed further with HMC.
- Capital and maintenance costs for fenders to new South Pier, and future replacement of fenders to N Pier are TBC.
- Timing and cost of works to replace north Pier to be discussed further with NAC.
-

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If the HMC decide to go ahead with dredging of the shoal bank, this could be undertaken in advance of works to the South Pier or as part of a combined package of work. If the dredging is to be undertaken in advance, then a Marine Licence application would need to be prepared as soon as possible, for which sediment sampling and analysis and an environmental assessment will be required.

It is recommended that the following works are undertaken to the Blyth Estuary flood embankments, also dependant on securing the required funding. These works are a lower priority than replacing the South Pier:

- The estuary flood embankments to the Town Marshes, Robinson's Marsh, Tinker's Marsh and Reydon Marsh are raised to provide a 1 in 100 per year standard of protection, allowing for climate change (assuming a medium emissions scenario).
- A 250m long reinforced spillway should be constructed within the embankment to Tinker's Marsh, with a crest level of 2.0mODN. The location of this spillway would be confirmed during the design phase, considering the local topography.
- The existing flood embankments would be retained, with works undertaken to raise the crest level and increase the embankment width on the landward side.

Development of the design for the proposed works to the harbour and the estuary defences will need to consider the following issues:

- An assessment of the economic benefits of the proposed scheme is expected to be required to support funding applications for the proposed project. This would need to be progressed before detailed design can progress.
- Constraints on funding could require further consideration of alternative lower-cost solutions, such as phased implementation of the proposed improvements to the estuary defences.
- The alignment of the rock breakwater, particularly at the mouth of the harbour entrance channel, should be optimised during detailed design in terms of the wave conditions within the entrance channel, the requirements for navigation (e.g. transition from open sea to entrance channel), and any benefits that minor changes to the breakwater alignment could have for future flow rates in the entrance channel. The existing wave and tidal models can be used for this analysis.
- If the rock groyne option is taken forward, the design of this structure should be optimised in terms of position and size, considering flow velocities around the structure and the risk of scour;
- Options to retain the South Pier in place and maintain navigation as far as possible during construction of the breakwater should be considered as part of the design of the works.
- An Environmental Impact Assessment (EIA) will be required to assess the environmental impacts of the proposed works and identify appropriate mitigation measures.

Next Steps

The following tasks will be required to progress the delivery of the proposed Investment Plan:

- Initiation of relevant Council processes for the proposed capital works;
- Assessment of funding options and affordability;
- Cost / Benefit assessment, recognising the requirements of the funding applications;
- Environmental assessments, and preparation of information required for planning and other consents applications;
- Detailed design of all proposed works; and
- Planning for future maintenance and investigations, e.g. repeat bathymetric surveys.

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Table 2: Summary of assessment of options for the future management of Southwold Harbour and the estuary defences

Scenario / Issue	Do Nothing	Maintain Integrity of Present-day defences	EA Strategy	Raise all banks (1:100+CC SOP)	Raise N banks only (SMP policy)	Raise downstream banks + spillway	Raise banks + rock groyne to narrow the channel	Tidal barrier
Harbour structures	S Pier fails (<5 years), restricts harbour access.	Rock breakwater to replace South Pier (Option H6). Works to North Pier may be needed Year 30 – Year 50. **Cost: £11.5M**						
Flood risk (Southwold/ Walberswick)	Increased flood risk to 29 properties	Flood risk remains on extreme events when banks are overtopped. Secondary defences could be provided.	Secondary defences provided.	Addresses future flood risks.	Tinkers / Robinsons Marsh banks allowed to fail. Secondary defence required for Walberswick (£0.7M).	Requires bank/wall to Walberswick (£0.7M).	Addresses future flood risks. Rock groyne cost £1.1m.	Addresses future flood risks.
Flood risk to Harbour (peak flood levels)	240mm lower than 2013 event due to estuary flooding. South Pier failure affects access.	Increasing flood risk to harbour with sea level rise.	240mm lower than 2013 event.	190mm higher than 2013 event. Higher than all other options.	Comparable to present-day scenario. Increasing flood risk with sea level rise.	Comparable to present-day scenario. 220mm lower than bank raising alone.	110mm lower than bank raising alone. Narrow channel reduces peak water levels with dredging.	Addresses all future flood risks.
		Improvements to the condition of the Harbour Road, to be undertaken by harbour users. Costs TBC. Additional property resilience measures are likely to be needed in future.						No works required
Tidal flow in entrance (erosion & navigation risks)	Increase to 4.7 knots by 2070 (larger tidal prism).	3.0 knots by 2070. Peak flow on extreme events would be higher than if all banks are raised.	Increase to 4.7 knots by 2070 (larger tidal prism).	3.0 knots by 2070. Best case as tidal prism is minimised.	3.0 knots by 2070. Peak flow on extreme events would be higher than if all banks are raised.	3.0 knots by 2070, as for present-day defences. Peak flow on extreme events would be higher than if all banks are raised.	3.0 knots by 2070, as for raised banks.	Increase to 4.7 knots by 2070 - no works to flood banks
Cost of works to estuary defences	N/A	Emergency repair cost ~£500,000 for each 10m breach.	**£3.0M[7]**	**£16.3M**	**£10.5M**	**£15.7M**	**£15.4M**	**~£80M**
Other issues	Long-term realignment of coast.	Regular maintenance and repair of breaches required. Cost will increase with time.	Flooding of marshes, secondary defences.	-	Flooding of marshes, secondary defences.	Secondary defences, operational risks.	Navigation impact, change upper estuary behaviour?	-
Total Initial Capital Cost	**N/A**	**£13.5M**	**£16.2M**	**£28.3M**	**£20.5M**	**£31.2M**	**£28.5M**	**£70.2M**

[7] *Initial capital cost relates to construction of secondary defences only. Does not include for compensatory habitat (already acquired). Cost estimate given in StAR is £2.2m at 2007 prices. Increased by 36.6% to £3.0m to reflect inflation to September 2022.*

Commented [AS5]: Comments on format of the Summary Table are requested, as this may not be clear enough for people who are not familiar with the project.

Commented [AS6]: Risk of failure of N Pier to be added

Commented [AS7]: Discussion of the narrow channel option in this table does not fully cover the findings of the dredging assessment.

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Agenda Item 4

ES/1463

REPORT

Southwold Harbour Investment Plan

Assessment of Breakwater Culvert Options

Client: East Suffolk Council

Reference: PB9485-RHD-XX-XX-RP-X-0006

Status: Draft/0001

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Table of Contents

1 Introduction

A key recommendation of the Southwold Harbour Investment Plan is to replace the South Pier with a rock armour breakwater.

The existing South Pier incorporates ‘windows’ in the sheet piles, which enable a flow of water into the entrance channel from the south. The resulting interaction with waves moving along the entrance channel, and with the tidal flow in or out of the channel, is reported by harbour users to make it easier to navigate through the channel. This is understood to be particularly important during swell wave conditions.

A key objective for the Investment Plan is to sustain navigation conditions in the harbour entrance. To achieve this, the current recommendation is for large box culverts to be incorporated into the proposed rock breakwater, which would enable flow through the structure in a similar way to the existing windows (see Figure 1-1).

This innovative solution is considered to be technically feasible and is expected to have the desired effect. However, we have not identified any examples of the use of box culverts within a breakwater for this purpose. Therefore, additional tidal modelling is required to assess the performance of the proposed culverts, in terms of their influence on tidal currents within the harbour entrance channel, in comparison with the existing hydrodynamic conditions.

This Technical Note sets out the approach taken to assess this issue, the model results and conclusions, and the recommendations from this additional work.

Figure 1-1 – Proposed rock breakwater with box culverts

2 Approach

To review the performance of the proposed box culverts, we have undertaken the following activities:

a. Review of past projects and relevant technical literature to identify whether there are any examples of this type of solution being used elsewhere.

b. Review of the potential for wave penetration through the proposed culverts, and the potential impact on conditions in the entrance channel.

c. Review of the potential benefit of the proposed rock breakwater for wave energy dissipation, based on previous wave modelling.

d. Additional tidal modelling for the proposed rock breakwater with culverts (2 culvert arrangement options, 2 water level conditions).

e. Comparison of the additional modelling results with the previous modelling, considering the baseline conditions and solid South Pier options.

f. Presentation and discussion of the findings of the additional modelling at a stakeholder meeting.

g. Preparation of a Technical Note to summarise the findings of the additional modelling and any stakeholder comments. The main project report will also be updated to include the findings of this additional work.

3 Review of Existing Information

3.1 Examples of similar structures

The scenario at Southwold was shared with various colleagues with experience in the design and construction of rock armour breakwaters internationally. It has not been possible to identify any locations from our collective experience where a similar solution has been used. However, the discussion with colleagues did provide some useful comments on the benefits and constraints of the proposed solution, which are included in the subsequent discussion in this Technical Note.

3.2 Wave penetration through the proposed culverts

Incorporating open box culverts through the proposed rock breakwater would enable both waves and tidal flows to move through the breakwater into the entrance channel, with the aim of replicating the 'windows' in the existing structure. However, the culverts would be quite narrow, at approximately 3m, which means that a relatively limited amount of wave energy would be able to penetrate. Wave energy would be dissipated as waves move through the culverts, but wave-generated currents could be created.

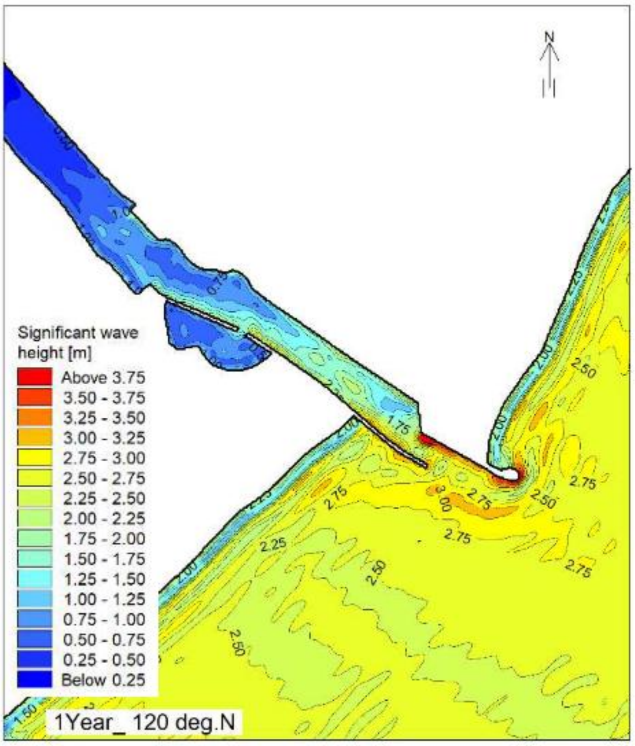
It is not possible to assess wave penetration through the proposed culverts using the existing wave model, as the culverts are too narrow compared to the model grid size. A 3-dimensional wave model would need to be used to represent the culverts as 'cuts' through the rock structure. This modelling could be undertaken as part of detailed design, if the proposal to incorporate culverts in the breakwater is taken forward. Such modelling could also be used to optimise the position and orientation of the culverts, considering the alignment of the breakwater and the prevailing wave direction. It would then be possible to either minimise or increase the amount of wave energy penetration and wave-generated currents, depending on the requirements for modifying conditions in the entrance channel.

3.3 Wave energy dissipation by proposed rock breakwater

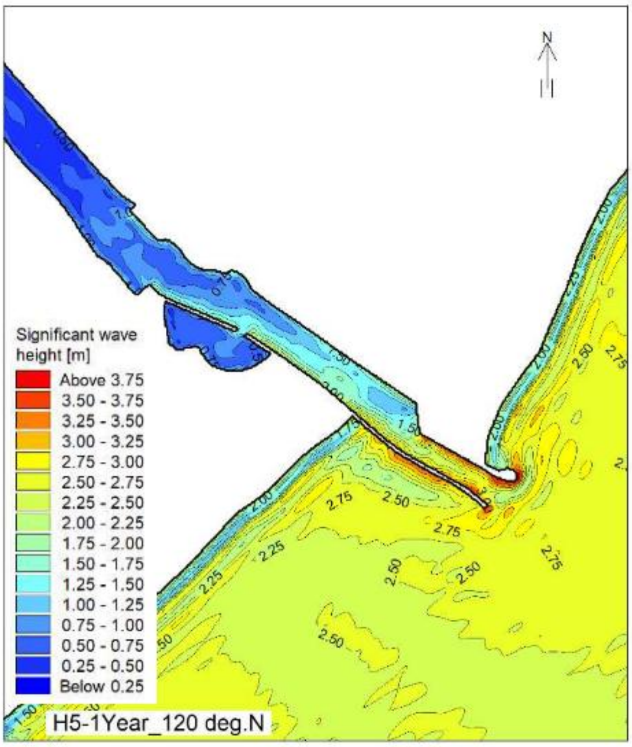
Figure 3-1 and **Figure 3-2** summarise the wave modelling results for 1-year return period waves from the 120 degree and 180 degree sectors, for various options for the future of the South Pier. It should be noted that a 1-year return period event represents a reasonably severe storm, so vessels are unlikely to be navigating the entrance channel during these conditions. These figures show that replacing the South Pier with a rock armour breakwater would significantly improve wave conditions in the entrance channel, as the rock armour will dissipate wave energy and reduce wave reflection.

The model results for the existing structure show that, for 1-year return period waves from the 120 degree sector, very disturbed wave conditions with waves of up to 2.75m are experienced along the middle of the channel over its full length. Potentially higher waves can occur close to the North Pier due to wave reflection. For waves from the 180 degree sector, the much higher waves mean that the variation in wave conditions within the channel is less obvious.

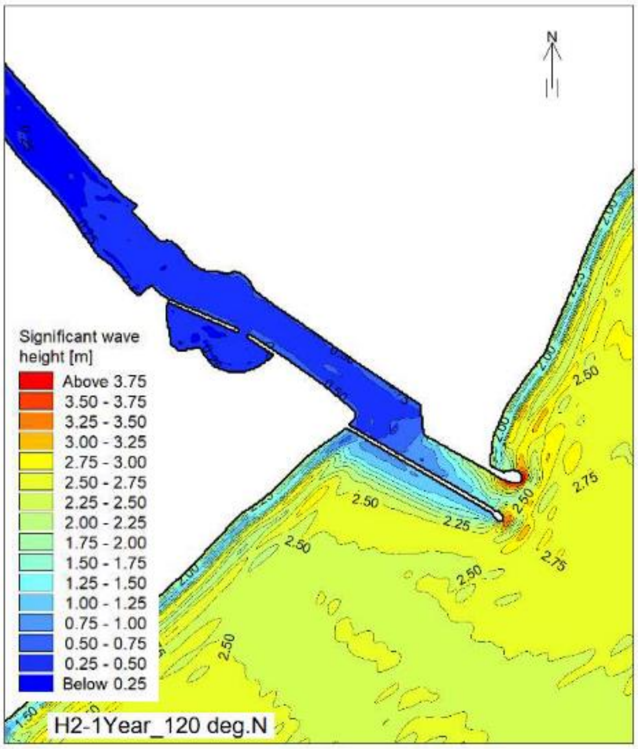
The model results for a vertical-walled South Pier (without the windows) show the increased wave reflection that would occur from the inner face of the South Pier. The model results for the 120 wave direction sector are compared in **Figure 3-1** below, as the differences are more apparent than for waves from the 180 degree sector. This figure further demonstrates the benefit of the windows in the existing structure for navigation into and out of the channel. An area of lower wave heights (approx. 2.25m) is shown at the mouth of the channel for the vertical-walled South Pier, with wave heights then increasing to about 2.75m as you move into the channel. For the existing structure, wave conditions within the channel are more disturbed over the length of the channel, so there would be less of a noticeable transition from lower waves at the mouth to higher (reflected) waves within the channel.



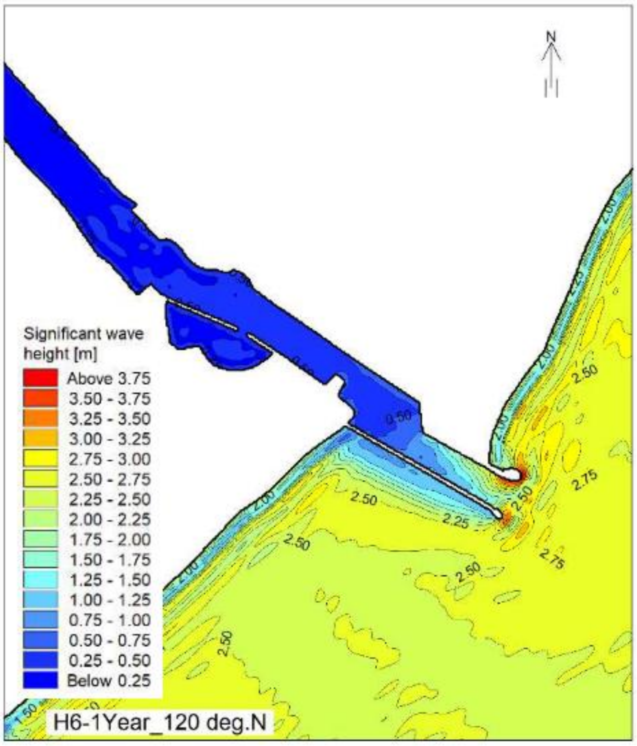
Existing South Pier, represented in wave model as an open structure above the cut-off level of the piles (bed level of model raised to the top of the piles).



South Pier replaced with vertical-walled structure.

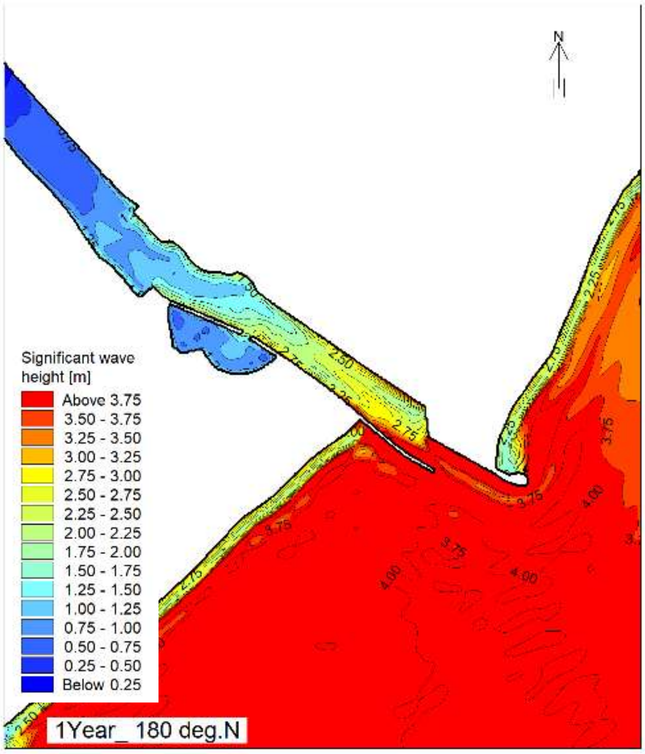


South Pier replaced with a rock armour breakwater.

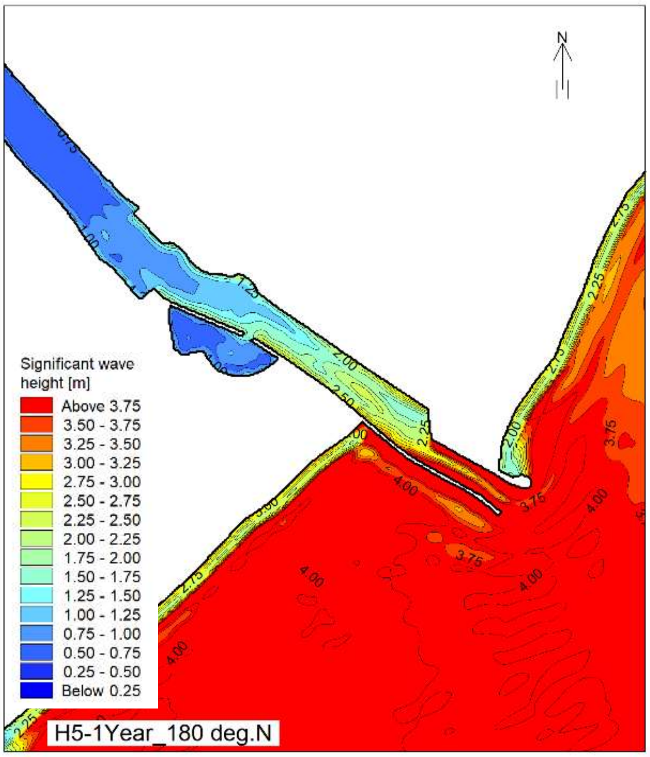


South Pier replaced with a rock armour breakwater, plus rock groyne opposite the North Wall.

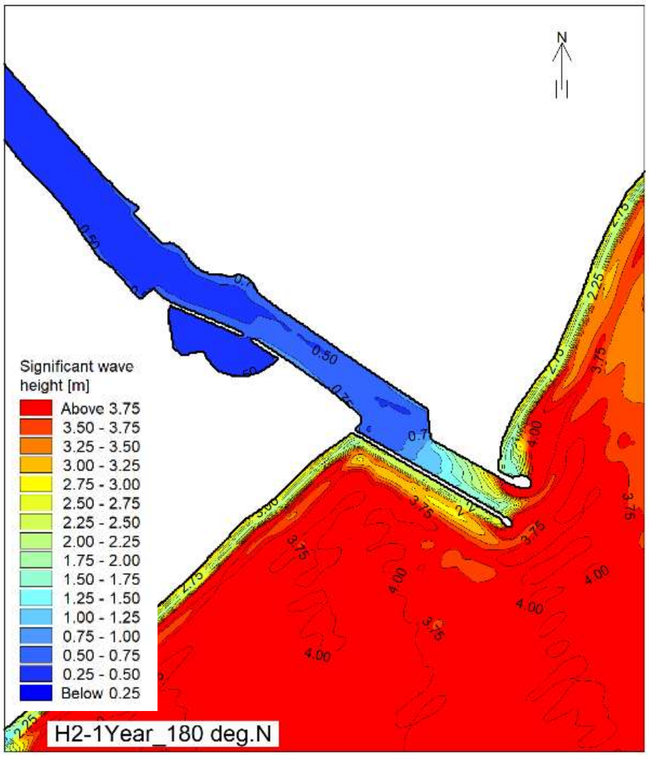
Figure 3-1: Comparison of wave conditions - options for replacement of South Pier, 1-year return period wave conditions from 120 degree sector



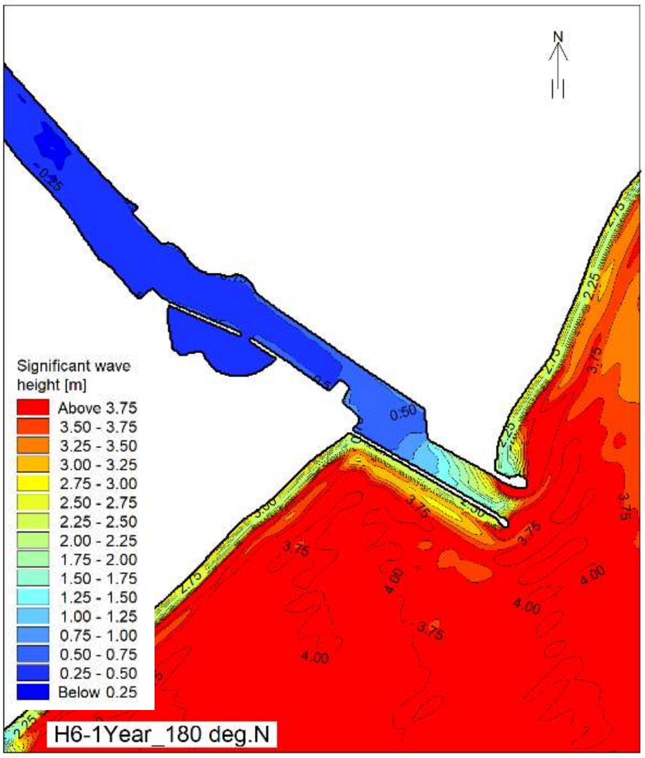
Existing South Pier, represented in wave model as an open structure above the cut-off level of the piles (bed level of model raised to the top of the piles).



South Pier replaced with vertical-walled structure.



South Pier replaced with a rock armour breakwater.



South Pier replaced with a rock armour breakwater, plus rock groyne opposite the North Wall.

Figure 3-2: Comparison of wave conditions - options for replacement of South Pier, 1-year return period wave conditions from 180 degree sector

With a rock armour breakwater, for waves from the 120 degree sector, wave heights in the entrance channel would reduce from about 2.5m at the mouth of the channel to less than 1.0m about halfway along the South Pier. For waves from the 180 degree sector the rock breakwater is even more effective in wave energy dissipation, reducing wave heights from about 3.75m at the mouth of the channel to less than 1.5m about halfway along the South Pier. This rapid change in wave conditions could be a constraint to navigation, as it could be difficult to move from the very disturbed wave conditions at the mouth of the channel into the calmer conditions within the channel, or vice versa when moving from the channel into the open sea. The change in wave conditions from the mouth to within the channel is expected to be less sudden for more typical day-to-day conditions.

The wave modelling results demonstrate that with a rock breakwater in place, the wave energy dissipation achieved due to the rock armour will significantly improve the conditions for vessels within the entrance channel. Therefore, it may not be necessary to further modify the conditions in the channel by introducing a cross-flow, such as is currently experienced from the windows in the South Pier, and which the proposed culverts aim to replicate.

There is a potential risk to navigation in relation to the relatively rapid transition from disturbed wave conditions outside the harbour entrance to much calmer conditions within the channel. The available wave modelling results are for a 1-year return period storm event, which is more severe than the typical conditions for navigation. Additional modelling would be required to better understand this issue for less severe wave conditions, as well as further discussion with harbour users.

If necessary, there are modifications that could be made to the design of the breakwater to reduce the rate of change in the wave height or to mitigate the impact on vessels. This might include reducing the crest level of the head of the breakwater so that some (limited) wave overtopping can occur, changing the shape of the harbour entrance, or altering the angle of approach by vessels. The further development of the design for the proposed rock breakwater should therefore consider this issue in some detail, including consultation with harbour users.

4 Additional Tidal Modelling

4.1 Approach to additional modelling

Additional tidal modelling has been undertaken to assess the impact of the proposed box culverts on tidal flows within the harbour entrance channel, by comparison with the model results for the existing situation (windows through the South Pier), and for a breakwater without windows or culverts.

The tidal model was revised to include a rock breakwater in place of the South Pier. Box culverts were incorporated within the breakwater, assumed to be 3m wide and 2m high and positioned at mid-tide, i.e. with the invert level set at 0.5m ODN. The culverts were aligned to 210 degrees, to limit wave penetration. Two options were modelled, with either 3 or 5 box culverts. The figures showing the model results show the location of the culverts.

Table 4-1 sets out the scenarios that have been considered for this assessment, including the conditions that were assessed in earlier phases of this project, as well as the new model runs. The previous model runs for a solid vertical-walled pier show what the tidal flows would be for a rock breakwater without culverts, as the different reflection characteristics of these two options are not relevant for the tidal model.

Table 4-1: Scenarios assessed using the tidal model

Option		Tide level (m ODN)	
Harbour entrance	**Estuary defences**	**1.49 (2020)**	**2.04 (RCP2.5, 2020)**
Present-day South Pier	Present-day defences (E0)	✓	✓
Solid South Pier (F1) / Rock Breakwater	Present-day defences (E0)	✓	✓
Rock breakwater with 3 box culverts	Present-day defences (E0)	✓	✓
Rock breakwater with 5 box culverts	Present-day defences (E0)	✓	✓

4.2 Model results

The tidal model results for the present-day harbour structures (**Figure 4-1**) show that the flow through the 'windows' in the South Pier does influence the tidal flows in the harbour entrance channel to some extent, with high flows shown adjacent to the inner face of the South Pier, for both the flood and ebb tide.

Figure 4-1 can be compared against the peak flow velocity with a solid, vertical-walled pier structure without the windows (**Figure 4-3**), which does not show the same high flows along the pier. A figure showing the difference between these two model runs is also provided (**Figure 4-4**), which shows that with a solid, vertical walled South Pier without windows the tidal flows along the centre of the channel would be slightly less (up to 0.4m/s) than they are at present. **Figure 4-2** to **Figure 4-4** show maximum flow velocity over the full tidal cycle, which typically occurs on the ebb tide.

The model results for the existing harbour entrance structures (**Figure 4-1**) show that the influence of the tidal flow through the windows in the South Pier does not extend very far into the entrance channel, as the high flow rates are concentrated close to the pier. In the centre of the entrance channel, it appears that tidal flows are dominated by the strong flood and ebb flows into and out of the Blyth estuary.

The tidal model results for the proposed rock breakwater with 3 culverts show high current speeds adjacent to the breakwater on the ebb tide (**Figure 4-5**). For this rock breakwater option, maximum current speeds in the centre of the channel are approximately 1.4m/s for the February 2020 tidal conditions, which is also the maximum current speed with the present-day harbour entrance structures, although the highest current speeds occur over a greater length of the channel in that scenario. Comparing the results for this option against the present-day conditions (**Figure 4-6**) shows the flow through the culverts on the flood tide, although not on the ebb tide, and that current speeds immediately adjacent to the South Pier could be up to 1.0m/s higher on the ebb tide compared to the present-day conditions. However, the flow through the culverts does not have a strong influence on flow velocities in the centre of the entrance channel.

The tidal model was also run with a higher water level condition (2.04mODN tide level) for this rock breakwater option (**Figure 4-9** and **Figure 4-10**), to assess the impact of the proposed culverts with higher flow velocities. Areas of high flow velocity are again visible adjacent to the breakwater, but do not extend into the centre of the channel. As for the lower water level, peak flow velocities immediately adjacent to the South Pier could be up to 1.2m/s higher with the rock breakwater and culverts, but in the centre of the channel the peak flow velocities would be comparable to present-day conditions (+/- 0.2m/s) for the same tide level.

The peak flow velocities for a rock breakwater with 5 culverts are shown in **Figure 4-7**. When more culverts are incorporated into the breakwater structure, the flow through the culverts means that the flows in the entrance channel would be slightly is closer to the present-day situation. This is more noticeable for lower water levels. The difference plots for both the 1.49mODN and 2.40mODN tide levels (**Figure 4-8** and **Figure 4-12**) show that current speeds in the entrance channel would be up to 0.2m/s higher for this breakwater option than with the present-day South Pier.

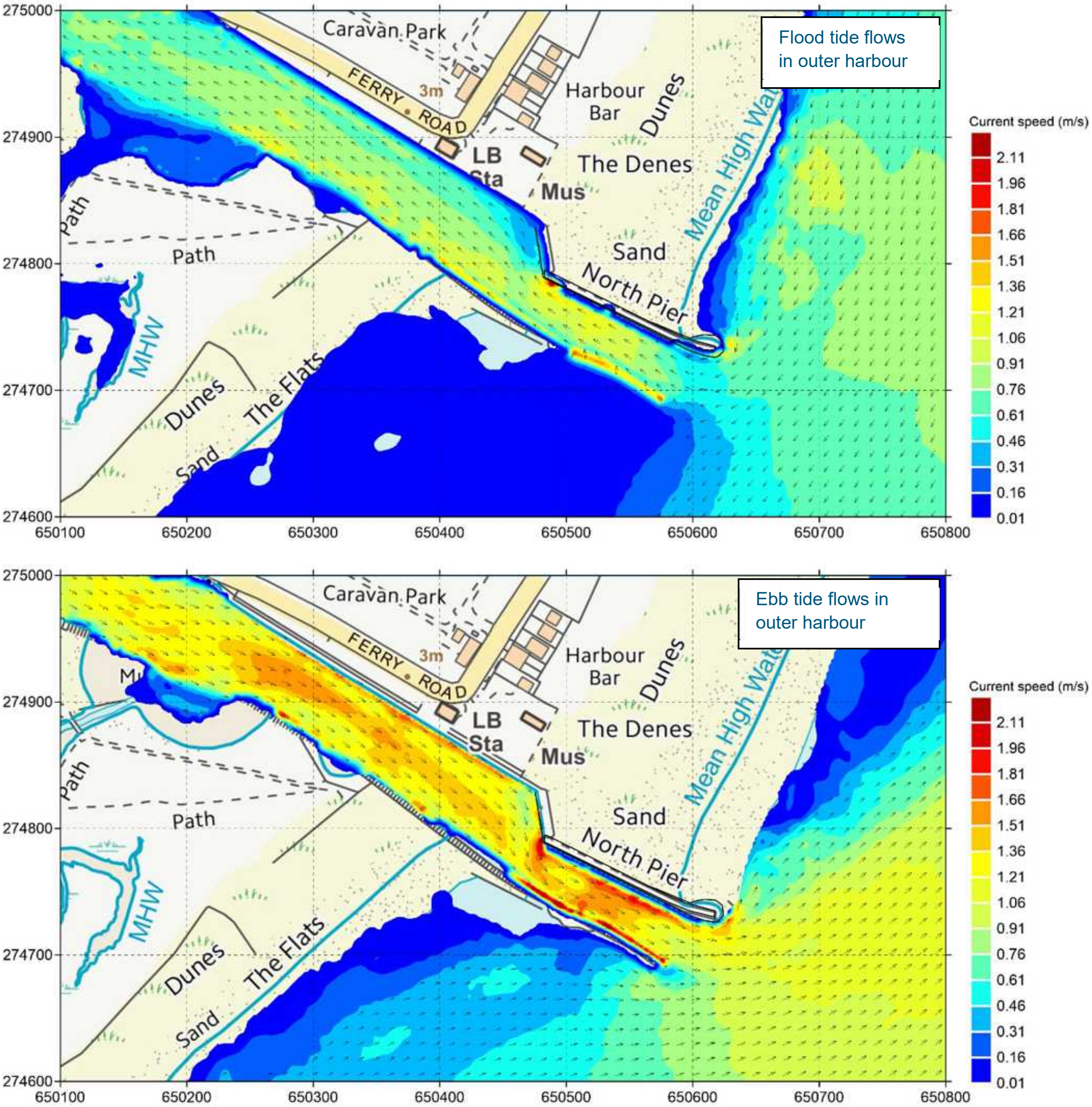


Figure 4-1: Spatial variation of peak flow velocity for present-day South Pier (with windows), Feb 2020 conditions

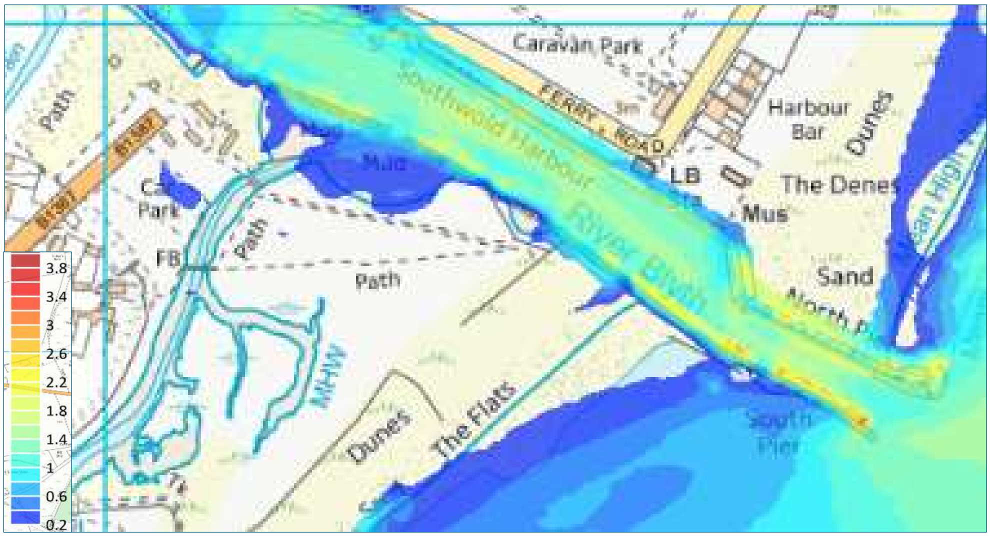


Figure 4-2: Maximum flow velocity in harbour entrance for vertical-walled South Pier (no windows), Feb 2020 conditions

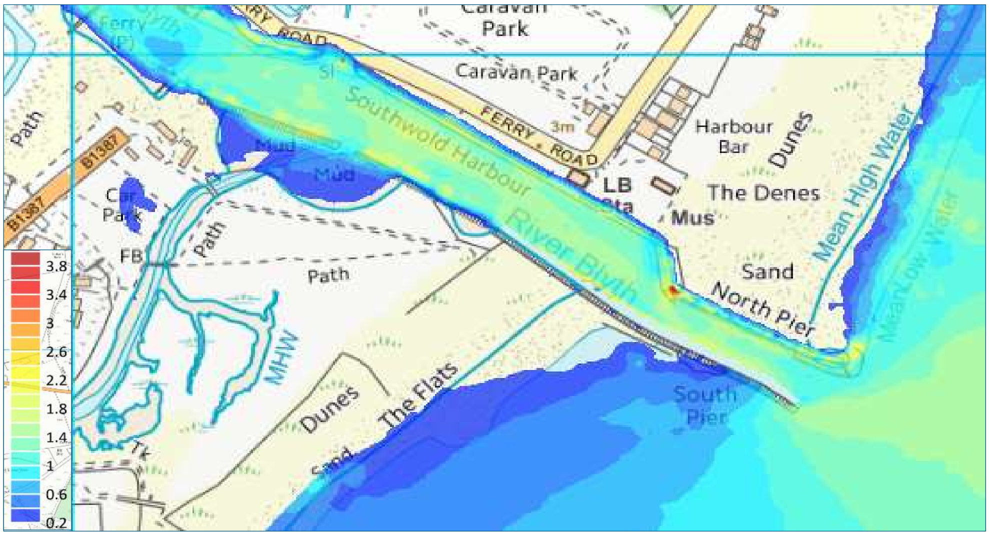


Figure 4-3: Maximum flow velocity in harbour entrance for vertical-walled South Pier (no windows), Feb 2020 conditions

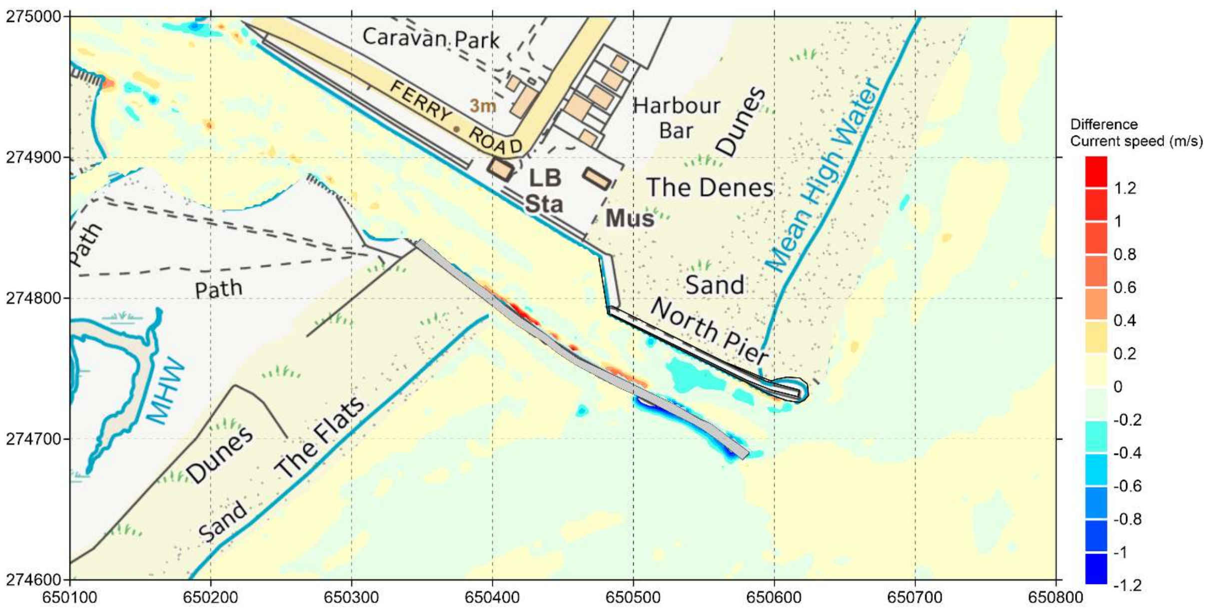


Figure 4-4: Difference in maximum flow velocity for solid South Pier (no windows) compared to present-day structure (with windows), Feb 2020 conditions

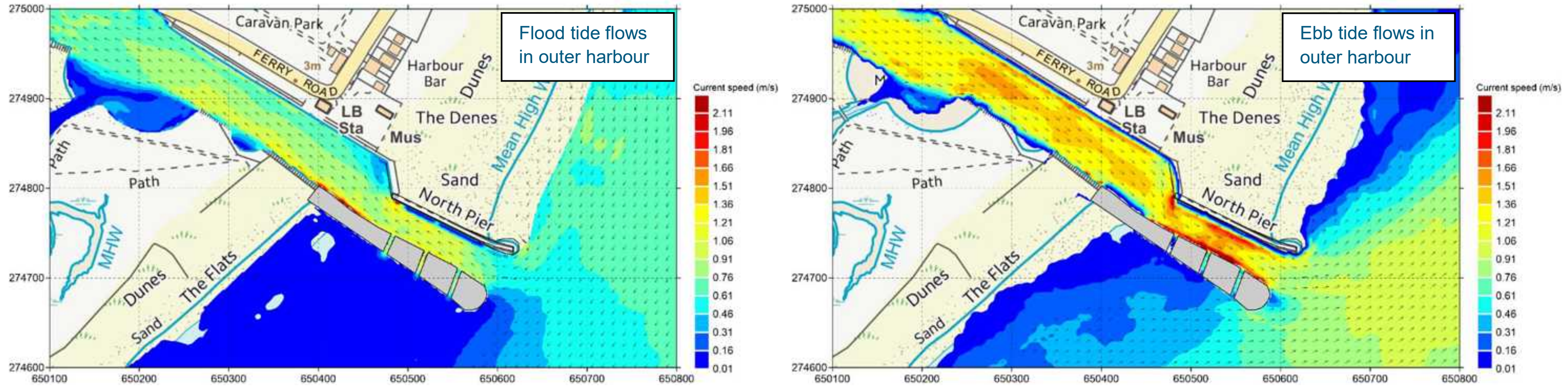


Figure 4-5: Spatial variation of peak flow velocity for rock breakwater (3 culverts), Feb 2020 conditions

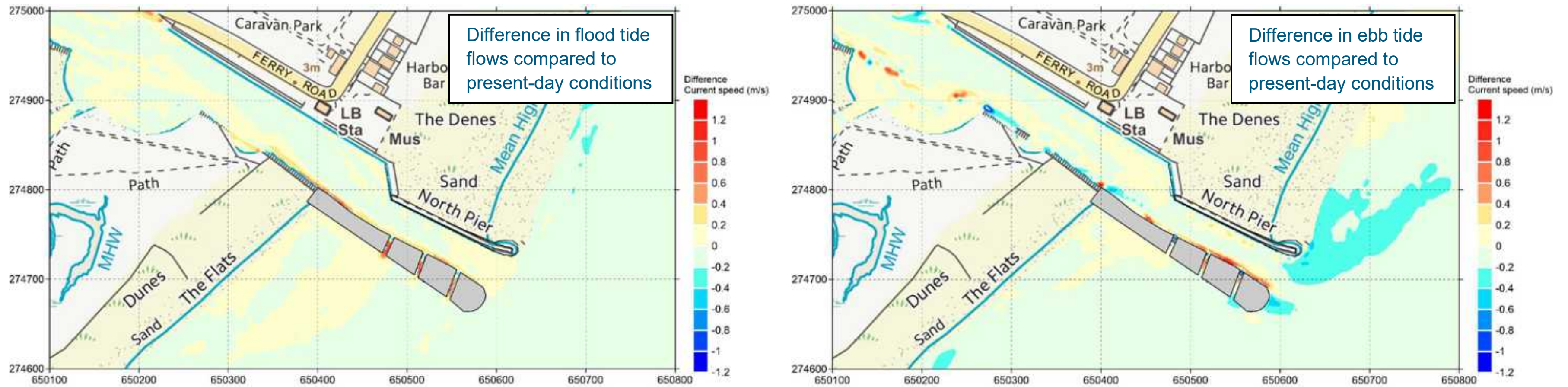


Figure 4-6: Difference in peak flow velocity for rock breakwater (3 culverts) compared to present-day structure, Feb 2020 conditions

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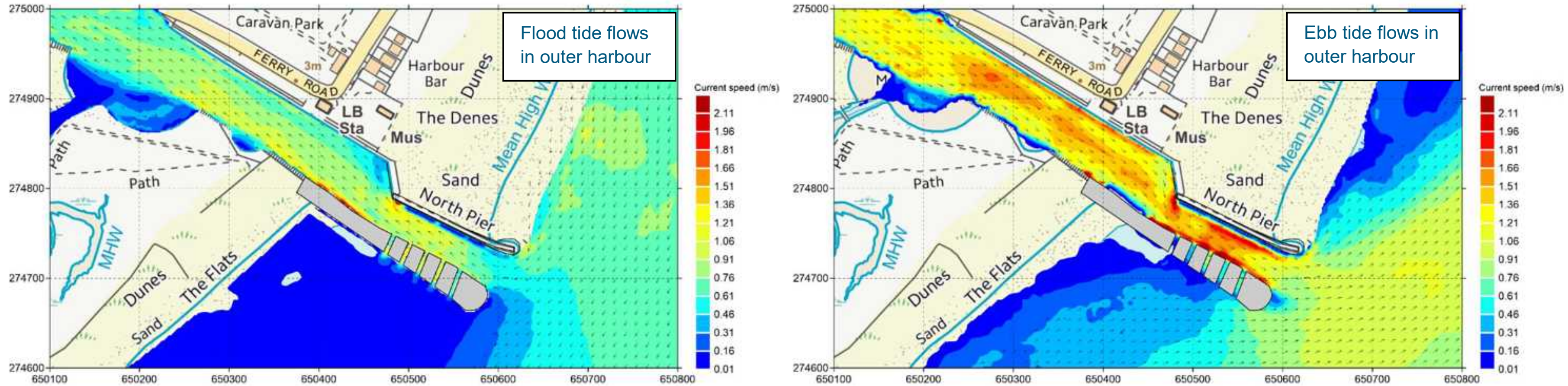

Figure 4-7: Spatial variation of peak flow velocity for rock breakwater (5 culverts), Feb 2020 conditions

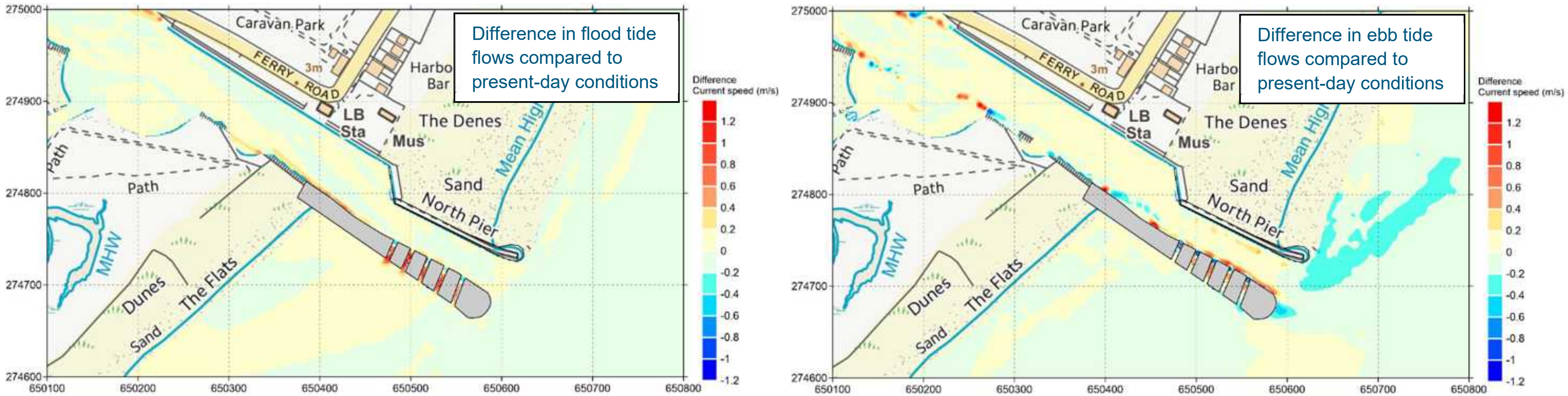

Figure 4-8: Difference in peak flow velocity for rock breakwater (5 culverts) compared to present-day structure, Feb 2020 conditions

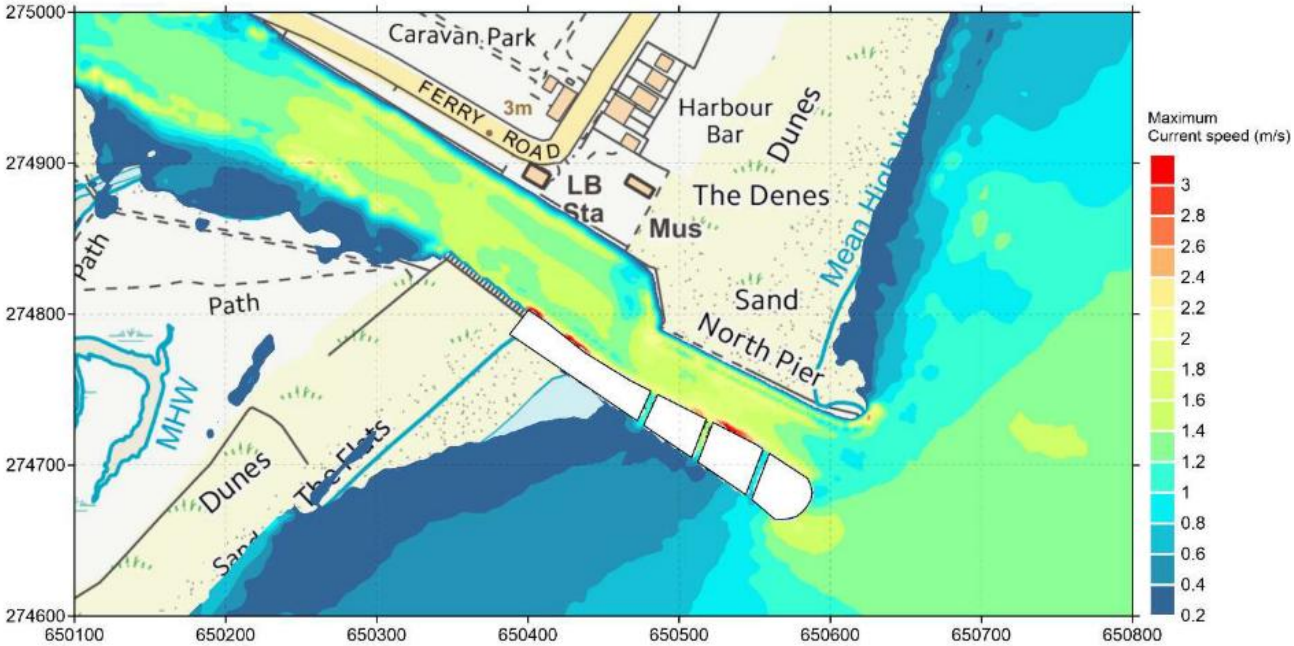

Figure 4-9: Maximum flow velocity in harbour entrance for rock breakwater (3 culverts), 2.04m tide level

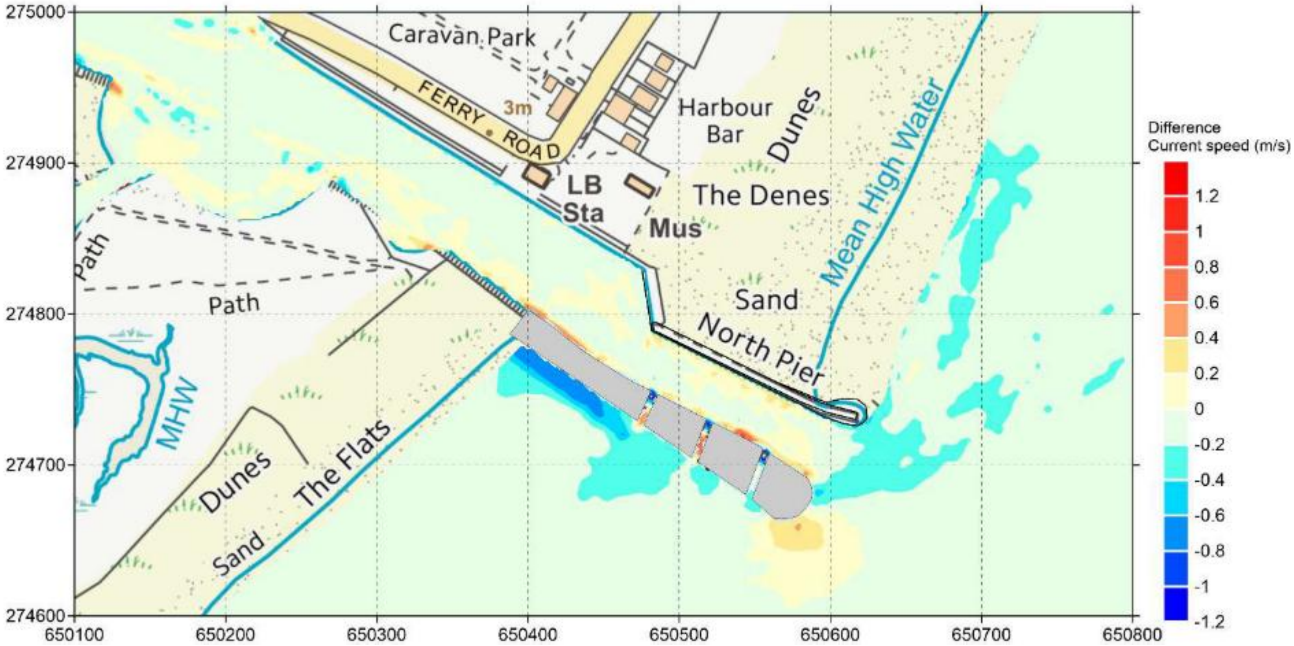

Figure 4-10: Difference in maximum flow velocity for rock breakwater (3 culverts) compared to present-day structure, 2.04m tide level

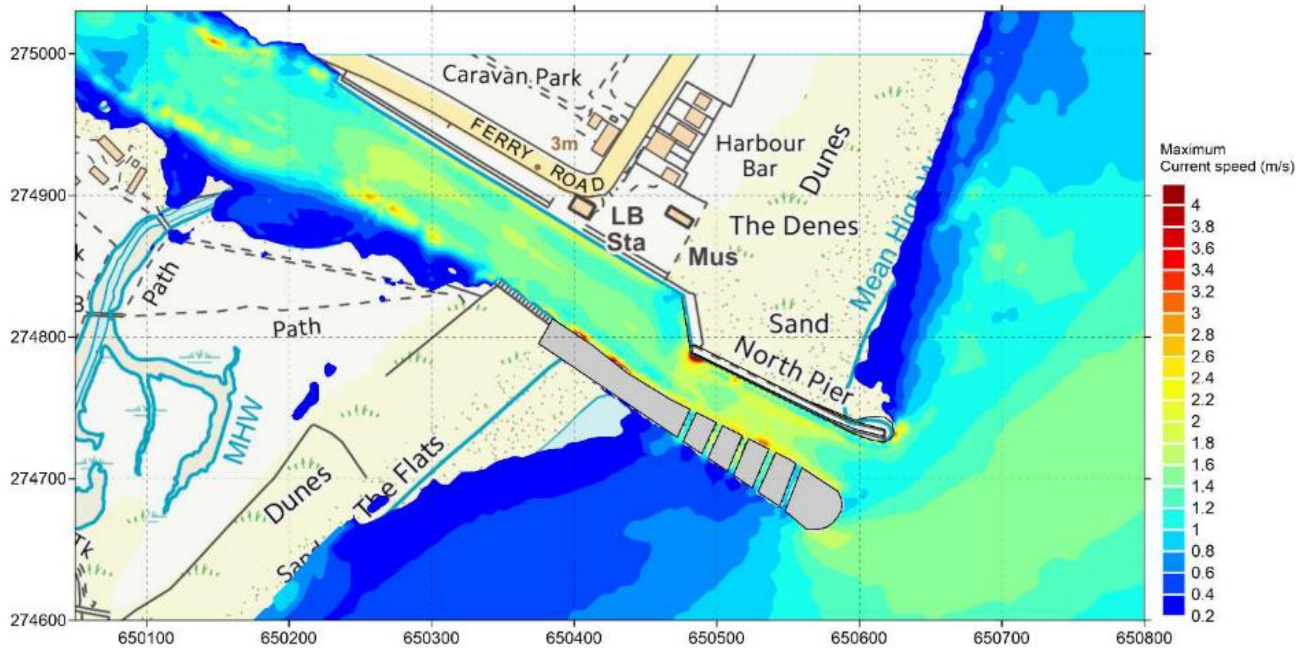

Figure 4-11: Maximum flow velocity in harbour entrance for rock breakwater (5 culverts), 2.04m tide level

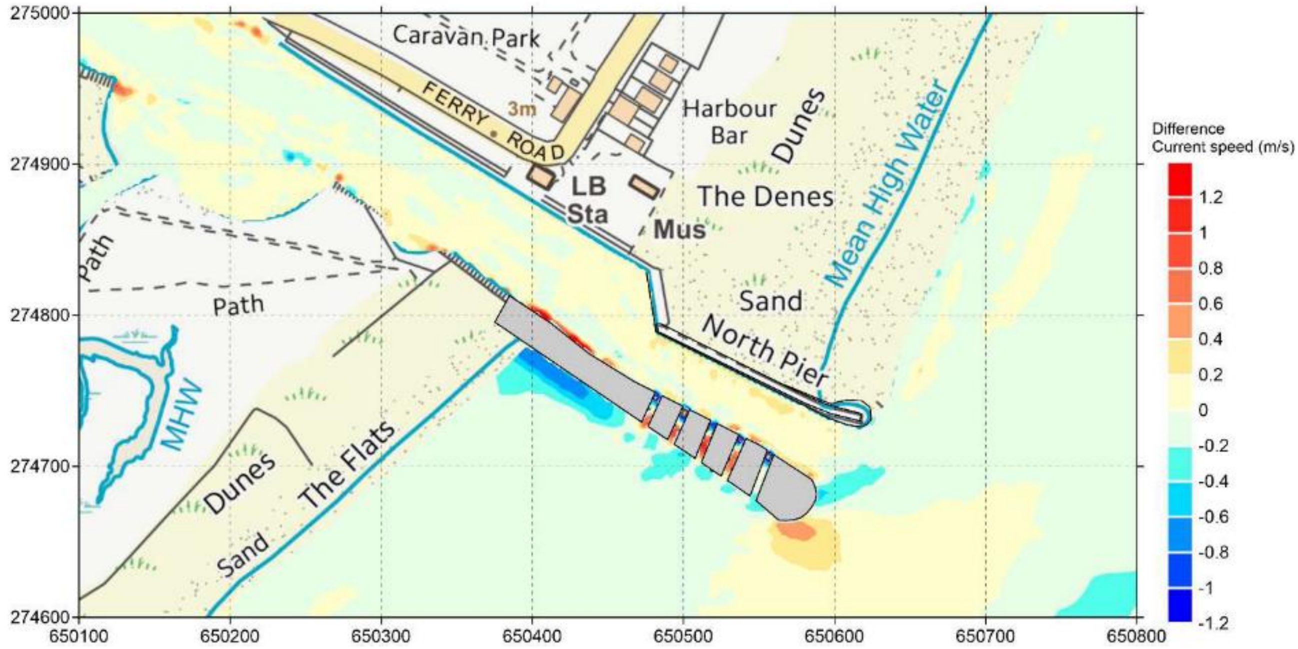

Figure 4-12: Difference in maximum flow velocity for rock breakwater (5 culverts) compared to present-day structure, 2.04m tide level

5 Conclusions

A series of box culverts are proposed to form part of the rock armour breakwater which is currently recommended to replace the South Pier at Southwold. The aim for these culverts is to replicate the 'windows' in the existing South Pier, which enable waves and tidal flows to penetrate into the harbour entrance channel. This additional assessment as part of the development of the Southwold Harbour investment Plan has assessed the likely hydraulic performance of the proposed box culverts, considering:

- Wave penetration through the box culverts;
- Wave energy dissipation in the harbour entrance channel due to the proposed rock armour breakwater; and
- Tidal flow through the box culverts.

Whilst the proposed box culverts would dissipate wave energy, wav-generated currents could occur, with waves and tidal flows moving through the culverts resulting in intermittent jets of water into the channel. It is not possible to quantify this wave penetration using the existing wave model, although this could be done as part of detailed design using a 3-dimensional wave model, which could also be used to optimise the position and orientation of the culverts.

The tidal model results show that both the existing 'windows' in the South Pier and the proposed culverts create cross-flows into the entrance channel. Higher current speeds are shown in the model results close to the South Pier structure, but these flows appear to have only a limited influence on the overall flow conditions compared to the diurnal tidal flows in and out of the estuary. The cross-flows are slightly more apparent over the full channel width for lower tidal levels.

The wave modelling results show that replacing the South Pier with a rock armour breakwater would significantly improve the wave conditions within the entrance channel, as the rock armour will dissipate wave energy and reduce wave reflection. With a rock armour breakwater, wave heights in the entrance channel are shown to reduce quite rapidly from disturbed conditions at the mouth to relatively calm conditions (>60% reduction in wave height) from about halfway along the South Pier, for 1-year return period wave conditions. The reduction in wave reflection achieved with a rock armour breakwater means that a cross-flow would no longer be necessary in terms of reducing wave reflection.

Comparing the wave conditions experienced with the existing South Pier structure to those that would occur with a vertical-walled structure without any windows demonstrates the benefits of the windows for limiting wave reflection and the potential build-up of swell waves running directly along the vertical wall. The relatively disturbed conditions that currently occur in harbour entrance channel are understood to benefit navigation into and out of the channel, because there is a more gradual change in wave conditions from disturbed through the channel to calmer at the North Wall.

Based on the wave modelling results that are available for review as part of this assessment, there may be a risk to navigation due to the rapid reduction in wave heights from the mouth of the harbour entrance channel into the channel itself. It could be difficult to move from the disturbed wave conditions at the entrance into the calmer conditions within the channel, or vice versa when moving from the channel into the open sea. This risk may not be so great for less severe wave conditions when vessels are more likely to be navigating the harbour entrance. This issue would need to be addressed in the design of the breakwater, irrespective of whether culverts are to be incorporated in the breakwater.

Considering the wave and tidal modelling results together in the context of the proposed rock armour breakwater and associated culverts, the overall conclusion is that the culverts would be of limited benefit to improving navigation conditions in the channel. Flow through the culverts has limited influence on the overall tidal flows in the channel, and the wave energy dissipation achieved by the rock breakwater reduces the impact of reflected waves. There is also the risk that tidal flow or wave penetration through the culverts could be experienced by vessels as a strong jet of water.

6 Recommendations

Based on the conclusions of this assessment, a rock armour breakwater continues to be the preferred option to replace the South Pier. However, we now recommend that the breakwater is designed without the inclusion of box culverts. This recommendation is subject to discussion of the conclusions and recommendations of this report with harbour users in February 2023.

The design of the mouth of the harbour entrance channel should optimise conditions for navigation into and out of the channel. Additional wave modelling should be undertaken for less extreme wave conditions, to fully understand any risks to navigation from the transition from disturbed conditions at the harbour entrance to calmer conditions within the channel. Any residual risk should be addressed in the design, informed by consultation with harbour users.

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REPORT

Southwold Harbour Investment Plan

Assessment of Dredging Option

Client: East Suffolk Council

Reference: PB9485-RHD-XX-XX-RP-X-0005

Status: Draft/0001

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Date / initials:	TBC

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Appendices

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1 Introduction

A high bank of sediment has built up close to the Southwold Harbour entrance channel, which restricts navigation and mooring at the North Wall, as shown in Figure 1-1below. Following discussions during the stakeholder meetings held in March and September, the Harbour Management Committee (HMC) is keen to explore whether it would be possible to dredge this sediment, with the aim of enabling increased mooring at the North Wall.

This report sets out the assessment that has been undertaken in order to develop a better understanding of the benefits and constraints of the proposed dredging, including:

1. The impact of removing the sediment on tidal flows at the North Wall and in the entrance channel;
2. The impact on wave conditions at the North Wall and further upstream;
3. Whether the proposed dredging could be undertaken as maintenance operations or would be considered to be capital works;
4. Whether ongoing maintenance dredging is likely to be needed;
5. Potential beneficial uses of any dredged material;
6. Any licence requirements for the proposed dredging; and
7. Any impacts on or from the dredging proposals due to other options proposed for the Southwold Harbour entrance, e.g. the proposed 'narrow channel' option.

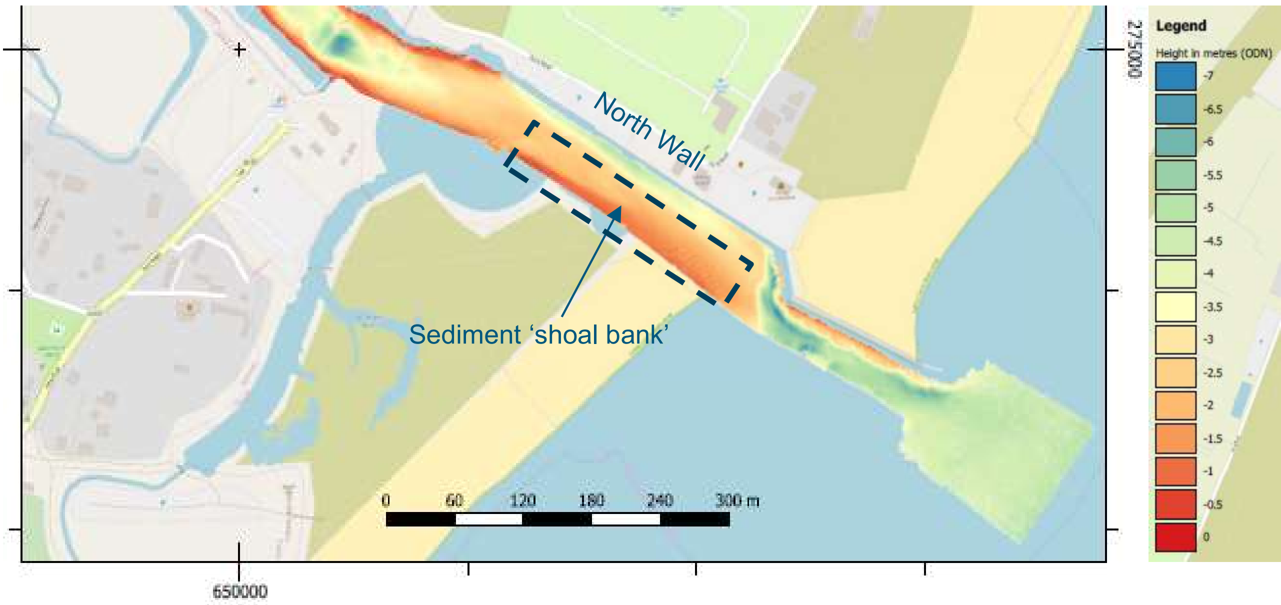

Figure 1-1 – Bathymetry of Southwold Harbour entrance (2020)

2 Approach

To review the benefits and constraints of dredging the shoal bank opposite the North Wall, we have undertaken the following activities:

a. Initial review of expected benefits and constraints of dredging the shoal bank, and preparation of a benefits and constraints note, issued to stakeholders for comment.
b. Review of historic evidence of shoal bank development.

c. Review of existing wave and tidal modelling results in the context of the dredging proposals.
d. Carry out additional Mike21 tidal modelling for a modified channel bed to represent the proposed dredging.
e. Review and update the sediment transport assessment, to include geomorphological review of potential future sedimentation of the outer harbour area, with and without dredging, and an assessment of whether the shoal bank is likely to re-establish in the future.
f. Review the requirements for consents / licences and comment on delivery programme.
g. Present and discuss the findings of the additional modelling and analysis at a stakeholder meeting.
h. Prepare a Technical Note to summarise the findings of the additional modelling, analysis and consultation. Update the main project report to include the findings of this additional work.

3 Dredging Option

3.1 Historic Evidence of Shoal Bank Development

There is a long history of issues with sediment blocking the entrance to Southwold Harbour, which has resulted in many changes to the location of the mouth of the River Blyth and the harbour entrance, with records dating back to medieval times[1]. Historically, several attempts were made to find a sediment 'free' entrance by trial-and-error relocation of the river mouth. The first seawards projecting pier was built in 1750, most likely with the aim of reducing shingle infill, and was largely successful. The North and South Piers push the harbour entrance into deeper water, partly restricting the alongshore sediment transport pathway. The Piers also confine the ebb tidal flow, causing it to exit more rapidly than if it were the natural river outfall. The high flow speeds act to flush the entrance of sediment.

However, blockages of the harbour entrance have continued with the piers in place. Records showing that the harbour mouth was dredged 13 times 1805 and 1818. Sediment deposition in the early 19th century may have been aggravated by the reclamation of 12km^2 of saltmarsh which reduced the tidal prism and associated tidal flow velocities. The 1971 article by Robert Simper, titled 'The Southwold Saga', states:

"The trouble is that on an on-shore N.E. gale, shingle is piled up across the harbour mouth and there is not a current strong enough to scour it away."

The sediment accumulation that developed on both the north and south sides of the harbour entrance in 1987 is shown in **Figure 3-1** and **Figure 3-2**. No similar issues have occurred in the last 20 years, which suggests that tidal flow speeds are usually sufficient to keep the entrance channel clear.

The sediment bank shown in **Figure 3-2** is the area of interest for this assessment. It is located opposite the North Wall, immediately upstream of the Knuckle, extending along the southern side of the channel towards the Dunwich Creek entrance. Often referred to as the 'shoal bank', whilst it is not currently as large as in this photo, it is still present. The shoal bank is reported by harbour users to affect the local hydrodynamic behaviour, with swell waves building over this shallow area. The high sediment bank can also cause incoming waves to break in this area.

[1] Ref: The history of Southwold, by John Winter and George Bumstead, BBC, Suffolk, 24.10.2014: (http://www.bbc.co.uk/suffolk/content/articles/2005/07/05/coast05_walks_john_winter_feature.shtml), and Ref: "The Southwold Saga" by Robert Simper, 22 January 1971 (incomplete reference).

Anecdotal evidence varies around how the shoal bank formed:

- change in tidal flow velocities and directions following construction of the Knuckle, resulting in an area of lower flow velocity opposite the Knuckle, and the deposition of shingle;
- flow from the Dunwich Creek combining with flow in the main river channel, resulting in disturbed flow patterns immediately downstream and an increase in the potential for sediment deposition;
- a one-off release of sediment from the Dunwich Creek entrance, possibly when the timber piling was installed in this area;
- ongoing deposition of sediment carried by flows from the Dunwich Creek; and
- material from offshore shingle banks driven into the harbour entrance during north-easterly storms.

It is likely that all of these scenarios have contributed to the establishment of the shoal bank. Once a build-up of sediment has begun it supports its own growth as wave heights and flow velocities decrease in the reduced water depths.

The presence of this bank of sediment means that the navigation channel into the inner harbour is forced to the north, close to the North Wall. This means that there is relatively limited space available for boats to berth at the North Wall, as it would restrict access for other vessels.

Figure 3-1: Sediment accumulation, north side of harbour, 1987

Figure 3-2: Sediment accumulation, south side of harbour, 1987

3.2 Review of Harbour Bathymetry

The local bathymetry within the harbour, as recorded by the February 2020 hydrographic survey, is shown in **Figure 3-3**. Furthermore, **Figure 3-4** compares the 2020 survey with a previous survey undertaken in 2013 by the Environment Agency.

A comparison of the 2013 and 2020 bathymetric surveys shows that there has been relatively little change to the channel bed in the harbour entrance, and in the vicinity of the North Wall, during this 7-year period. The areas where the bed level is relatively lower or higher have not moved, including the area of the shoal bank. This is confirmed by anecdotal evidence from harbour users, so there is good confidence in both survey datasets.

A brief discussion is provided below of the comparison of the two surveys, for the outer part of the harbour (locations i. to vii. as indicated on **Figure 3-4**).

i. The North Pier is currently long enough to retain most beach material and sediment moving alongshore from north to south. Without the pier, sediment would move into the channel, as is known to have happened when the North Pier was shorter.

ii. At the mouth of the harbour, erosion of up to 1.5m (depth) has occurred.

iii. The channel bed level immediately adjacent to the seaward section of the South Pier (170m length) is 5.5m ODN. There has been up to 0.5m of erosion along the centre of the harbour entrance channel over the full length of the entrance since 2013.

iv. The channel bed level immediately adjacent to the landward section of the South Pier (100m length) is -2.0m ODN. In the centre of the channel where the North Pier meets the Knuckle, a small area of erosion of >2m is indicated. However, review of both surveys suggests that this is more likely to be due to errors in the 2013 survey, which did not record data over the full channel width in this area.

v. Sediment deposition of up to 0.5m is shown upstream of the Knuckle on both sides of the channel. The bank of sediment located on the southern side of the channel extends from opposite the Knuckle towards the Dunwich Creek entrance.

vi. Erosion of up to 1m is shown over the full channel width adjacent to the North Wall. This may indicate an ongoing trend of erosion of 0.1-0.2m/year, but further monitoring would be needed to confirm this.

vii. Seaward of the Walberswick Ferry, there may be ongoing erosion of up to 0.5m.

In reviewing the survey data, we have considered the significance of any changes. In general, only change of the order of +/-0.5m or greater is likely to indicate an ongoing trend in the sedimentation within the harbour area. The main area of change is from the harbour entrance to the north end of the North Wall, in the centre of the channel. For this area, an ongoing trend of erosion of 0.1-0.2m per year is indicated, but this would need to be confirmed by future monitoring.

In terms of the shoal bank opposite the North Wall, comparison of the bathymetric surveys in **Figure 3-4** indicates that this could be gradually extending or migrating to the south, towards the entrance channel, although with a reduction in the crest level of the bank of about 0.5m since 2013.

This potential change in the shoal bank has been considered further by reviewing the change in the bed level for three cross sections in this area, based on survey data from 2013, 2015 and 2020. This comparison is provided as **Figure 3-5**, and confirms the 0.5m reduction in bed level since 2013. The cross sections in **Figure 3-5** show that the width of the bank can vary (e.g. 1-2m increase in width between 2013 and 2015), although in 2020 the bank width was comparable to that recorded in 2013. This data does not indicate any noticeable southerly movement of the shoal bank.

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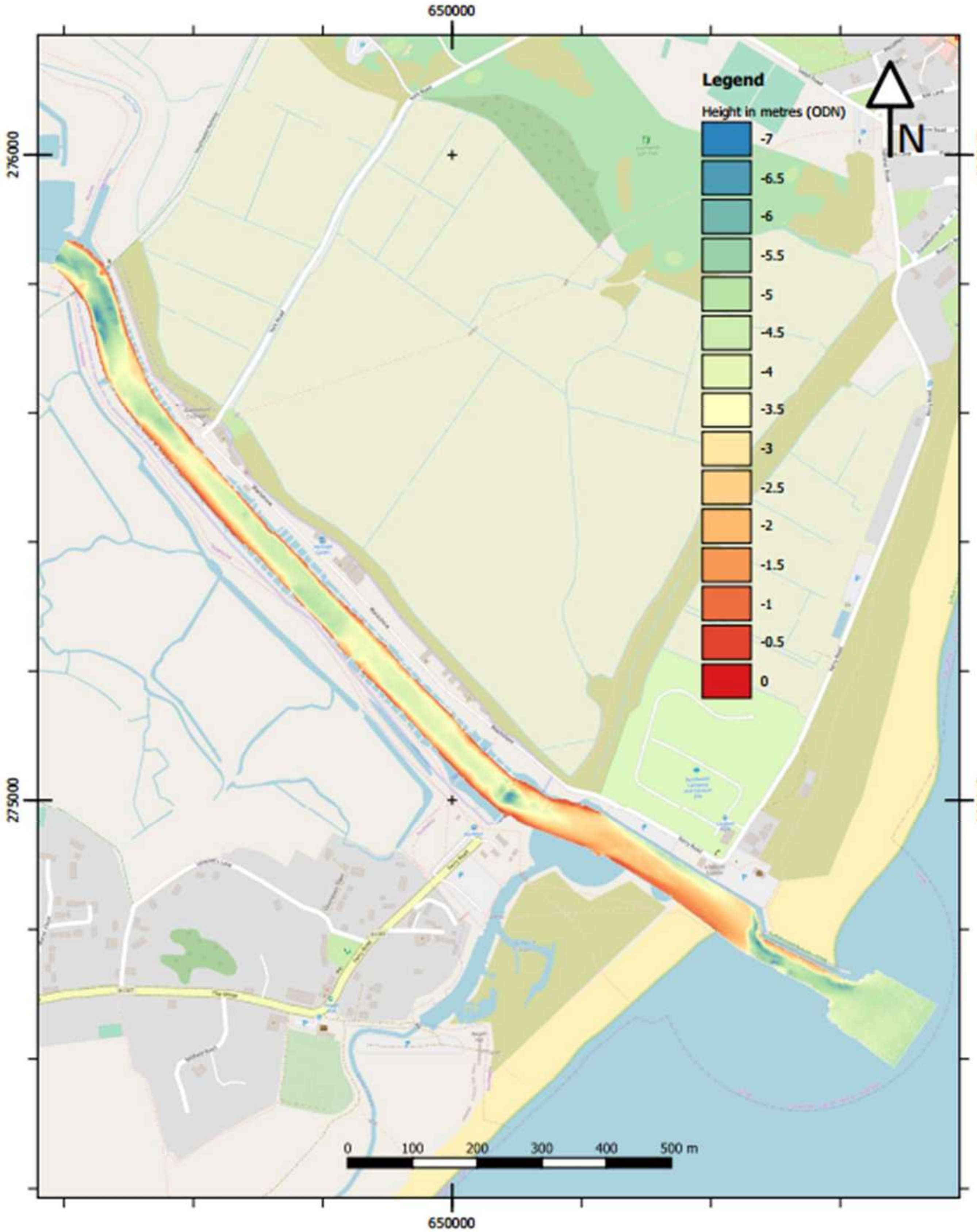


Figure 3-3: Bathymetric survey of Southwold harbour, February 2020

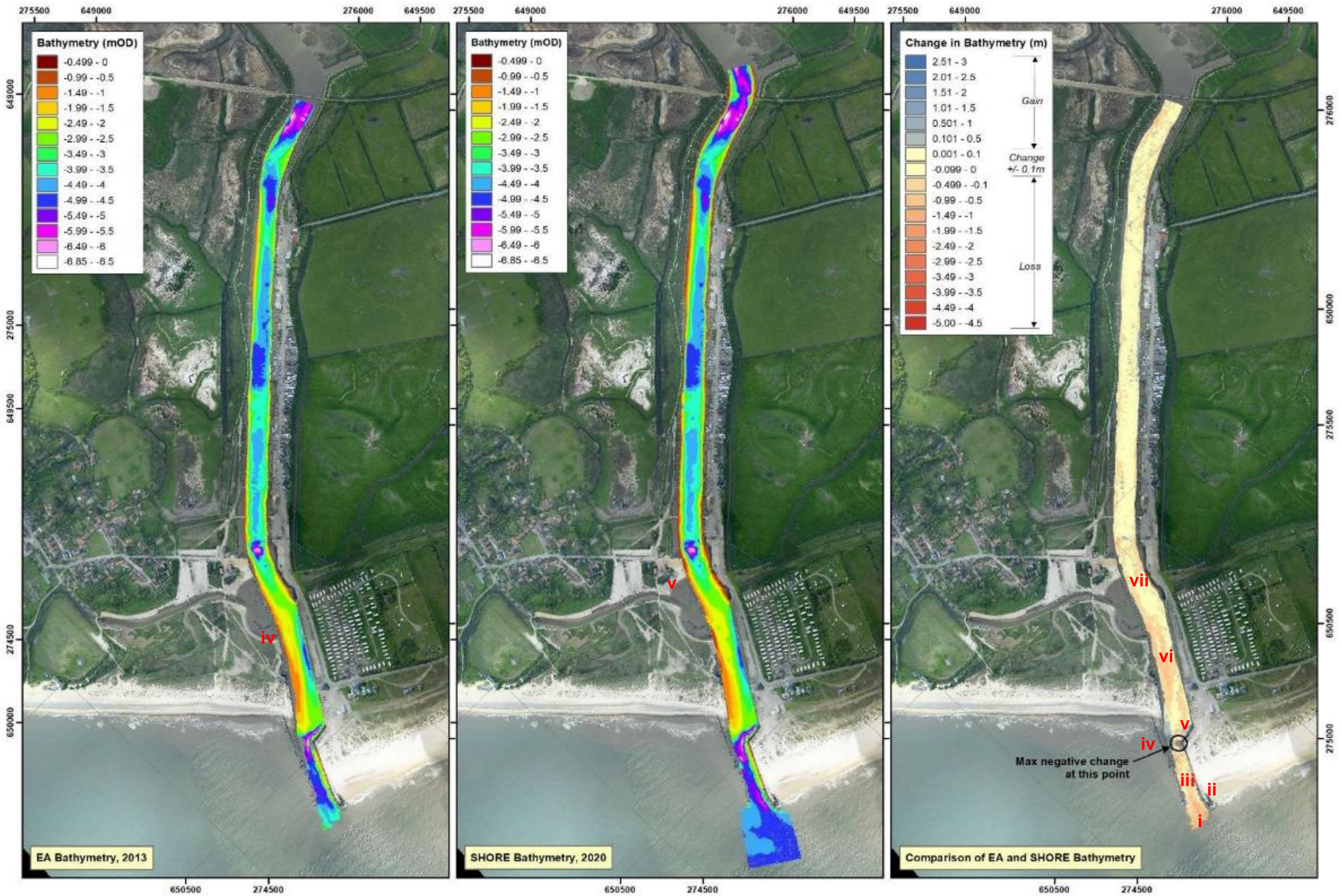


Figure 3-4: Comparison between the 2013 and 2020 bathymetric survey

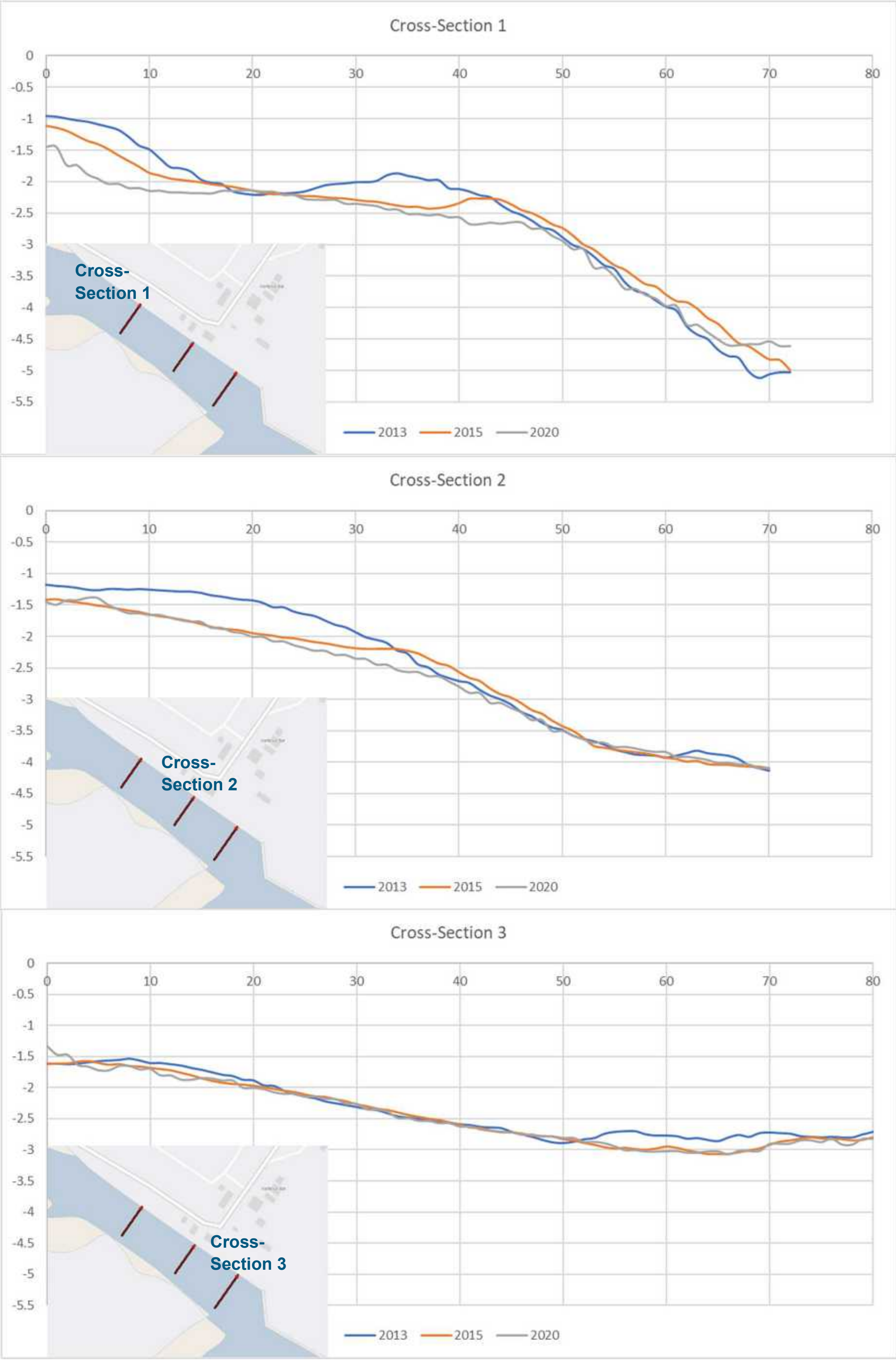


Figure 3-5: Comparison between 2013, 2015 and 2020, for 3 cross sections (see inset location plans)

3.3 Summary of Dredging Proposals

The presence of the shoal bank opposite the North Wall has resulted in the navigation channel into Southwold Harbour running close to the wall, which restricts the space available for mooring vessels. Wave conditions at the North Wall would improve following construction of the proposed rock breakwater, and the HMC is keen to take this opportunity to increase mooring at the North Wall. Therefore, the HMC is keen to explore whether it would be possible to dredge or otherwise remove the shoal bank sediment.

A required depth of dredging has not been stated; however, it is expected that the channel bed level would be reduced over the full length of the North Wall to at least the current minimum depth of the navigation channel, which is -3.0mODN. For the purposes of the additional tidal modelling, a worst-case dredged channel level of -4.0mODN has been assumed.

The anecdotal evidence of areas of hard material within the channel bed should be recognised in the assessment of the dredging proposals. This material is thought to be concrete from historic construction works. The shoal bank is understood to be formed of compacted shingle, so could be difficult to remove.

3.4 Initial Review of Benefits and Constraints of Dredging

An initial review was undertaken of the potential benefits and constraints of the proposal to dredge the bank of sediment opposite the North Wall, which was included in a Technical Note (**Appendix A**) that issued to the Harbour Management Committee and the Project Stakeholder Group for comment. The initial assessment of benefits and constraints is provided in is provided in **Table 3-1**, whilst the stakeholder comments are summarised in **Table** 3-2.

Considering the stakeholder comments alongside the initial assessment of the benefits and constraints of the dredging proposals, the potential benefits and constraints of the proposals are recognised by the harbour users. The comments made by the stakeholders will be considered in this assessment.

Table 3-1: Initial review of benefits and constraints of dredging of shoal bank

Benefits	Constraints
Relatively low capital cost for initial dredging.	Capital cost of initial dredging.
Increased navigable width in outer harbour, improving access to inner harbour.	Shoal bank could rebuild, so ongoing maintenance dredging may be required.
Stability of shoal bank (2013-2020) suggests that maintenance dredging may not be necessary.	Licence may be required for capital and/or maintenance dredging, with associated requirements for environmental assessment (cost and time impacts).
More space at North Wall for vessel mooring.	Further works to North Wall may be required to enable safe mooring.
Flow rates could reduce at the North Wall due to the increase in channel cross section.	Changes to flow rates and directions at the North Wall could impact on navigation.
Dredged material could be reused in the works to replace the South Pier, or infill eroded areas behind South Training Arm.	Flow rates and directions may increase in the Entrance Channel, affecting navigation.
	Wave disturbance may increase in the inner harbour (upstream of the North Wall), as deeper water could maintain larger waves.
	Reports of very hard material being present within the channel bed, which could impact on cost of dredging and ease of disposal.

Table 3-2: Stakeholder comments on dredging proposals

Issue	Comment

Impact on wave and sediment conditions in harbour entrance	Need to understand how the dredging would affect other parts of the entrance in terms of sediment movement and swell.
Impact on navigation conditions	It would allow easier navigation into the harbour and allow us to carry out the additional works necessary to bring the North Wall into use for the mooring of larger vessels.
Dredged depth	What draft vessels are you hoping to assist – what will be the dredged depth?
Requirement for maintenance	Need to understand how likely it is that the dredging will need to be maintained.
Cost of dredging	On a day to day basis the harbour seems to work pretty well so is the (potentially ongoing cost) worth it?
Impact on Walberswick beach	How will this affect the protection to the Walberswick beach?

3.5 Review of Previous Wave Modelling

Additional wave modelling has not been undertaken as part of this assessment, so the previous wave modelling results have been considered against the proposals for dredging of the shoal bank.

The water depth within Southwold harbour is typically of the order of 5m. For this water depth, waves with a height of about 2m would not break. However, the water depth is much less over the shoal bank, where there is 2-3m water depth at Mean High Water Springs, so waves do break in this area. Anecdotal evidence also suggests that wave heights can build as they move over the shoal bank, particularly swell waves from the 90 to 120 degree direction sectors.

The wave modelling results for the present-day conditions show higher wave energy close to the shoal bank (red box in **Figure 3-6**) compared to elsewhere in the outer harbour. If the shoal bank was removed before works are undertaken to replace the South Pier, then wave heights would no longer build over the bank and break in the shallow water. Removing the shoal bank would increase the exposed height of the vertical structures on the south side of the channel, increasing wave reflection and therefore wave heights at the North Wall. The deeper water in the outer harbour would also be able to sustain larger waves.

If the South Pier was replaced with a rock breakwater, wave energy in the outer harbour and at the North Wall would reduce significantly, as shown in **Figure 3-6**. As such, the shoal bank would have much less influence on wave conditions in the harbour. With a rock breakwater in place, removal of the shoal bank would not be expected to affect the wave conditions in the harbour.

3.6 Review of Previous Tidal Modelling

The previous tidal modelling did not assess flow behaviours with the shoal bank removed. The tidal modelling results have therefore been reviewed in the context of the proposals for dredging the shoal bank.

Figure 3-7 shows the peak flow rates on the flood and ebb of a spring tide, recorded as part of the hydrographic survey in February 2020. This shows the lower flow velocities over the shoal bank, where the channel bed is higher. Over the bank, the flow directions are generally perpendicular to the channel, with the direction of flow being more variable closer to the North Wall, as flows are diverted around the shoal bank and the Knuckle. The highest flow velocities are observed in the deepest part of the channel.

Present-day conditions, 1-year wave from 120 deg	Rock breakwater, 1-year wave from 120 deg

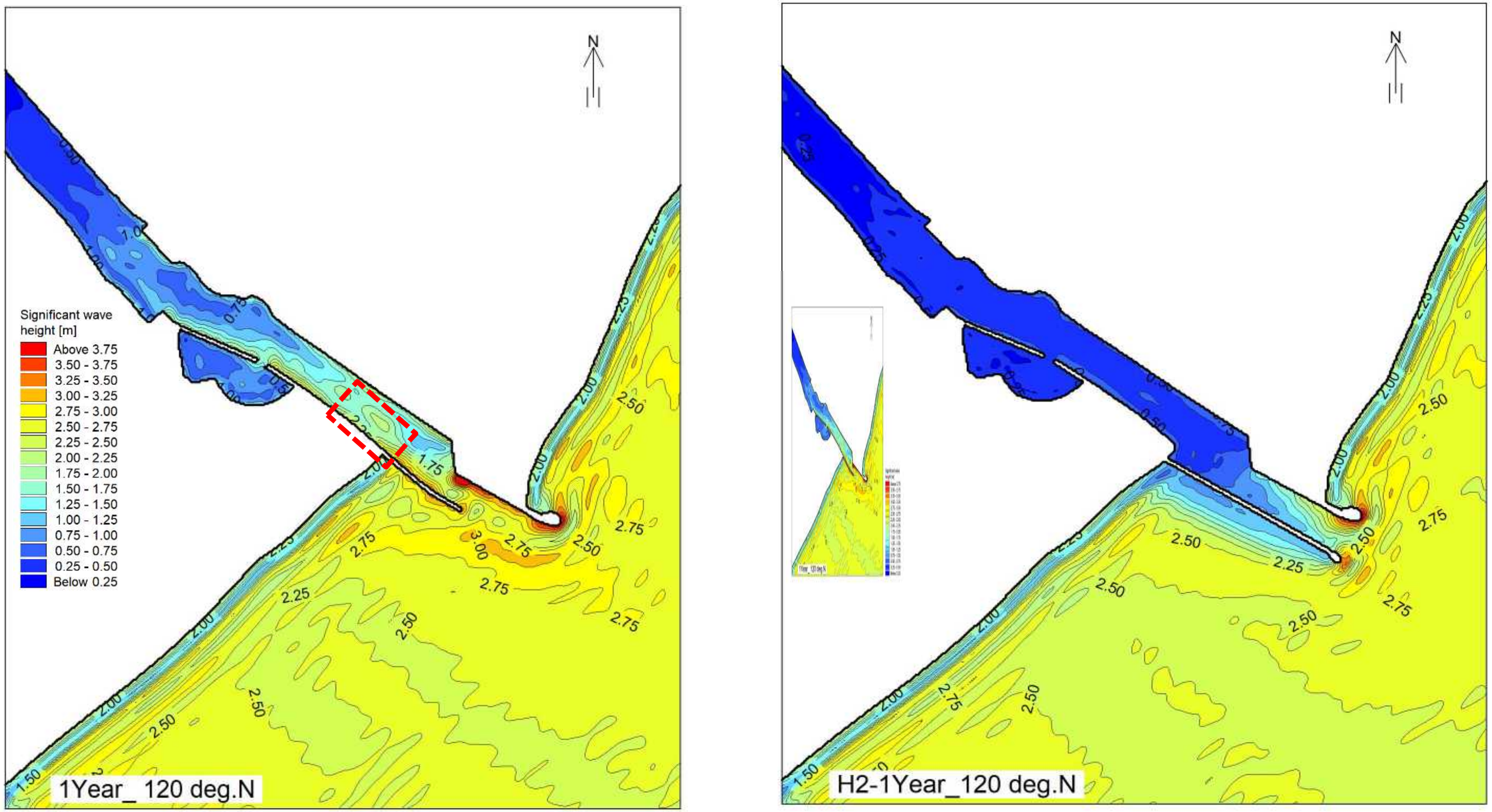
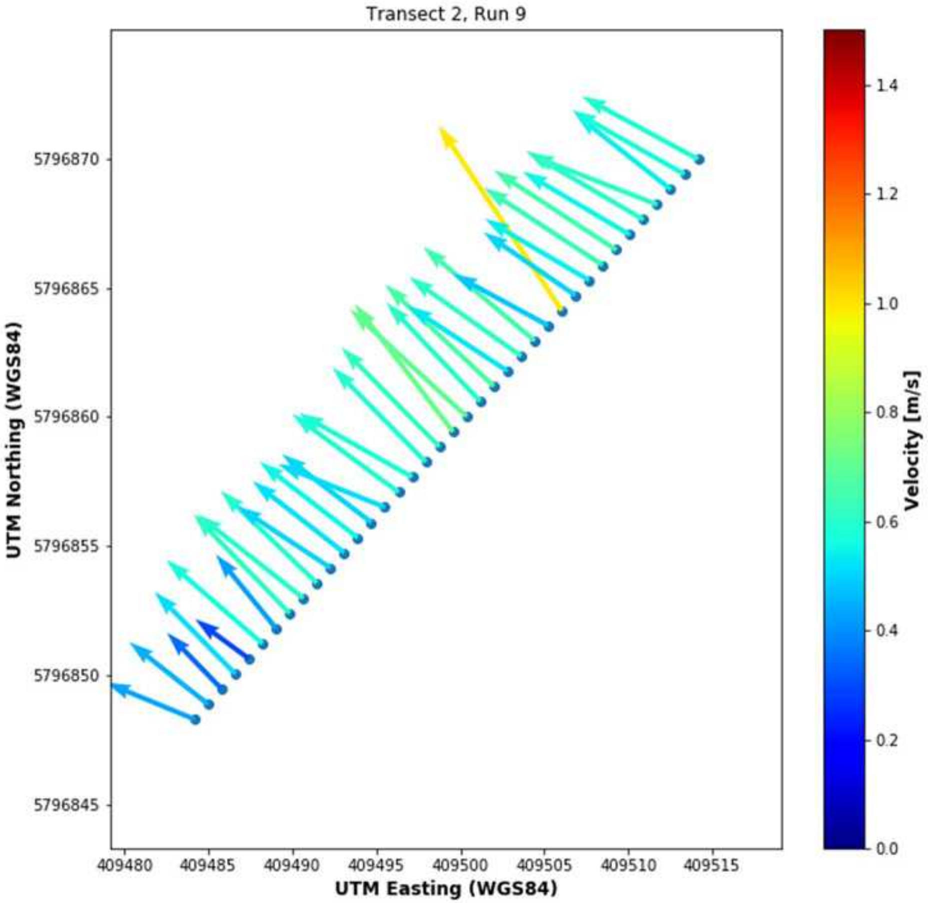


Figure 3-6: Example of wave modelling results for present-day harbour entrance structures and rock breakwater option

Peak flow on flood tide	Peak flow on ebb tide



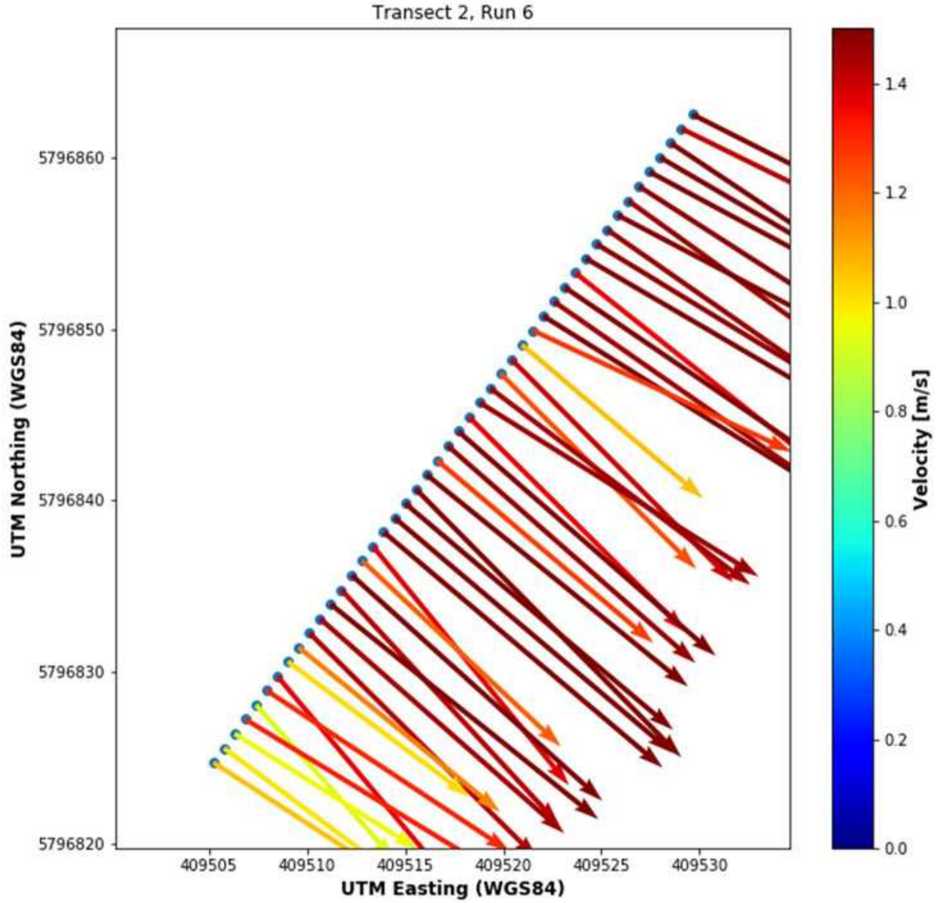


Figure 3-7: Peak flow rates (Spring tide) – Transect 2 (location of shoal bank)

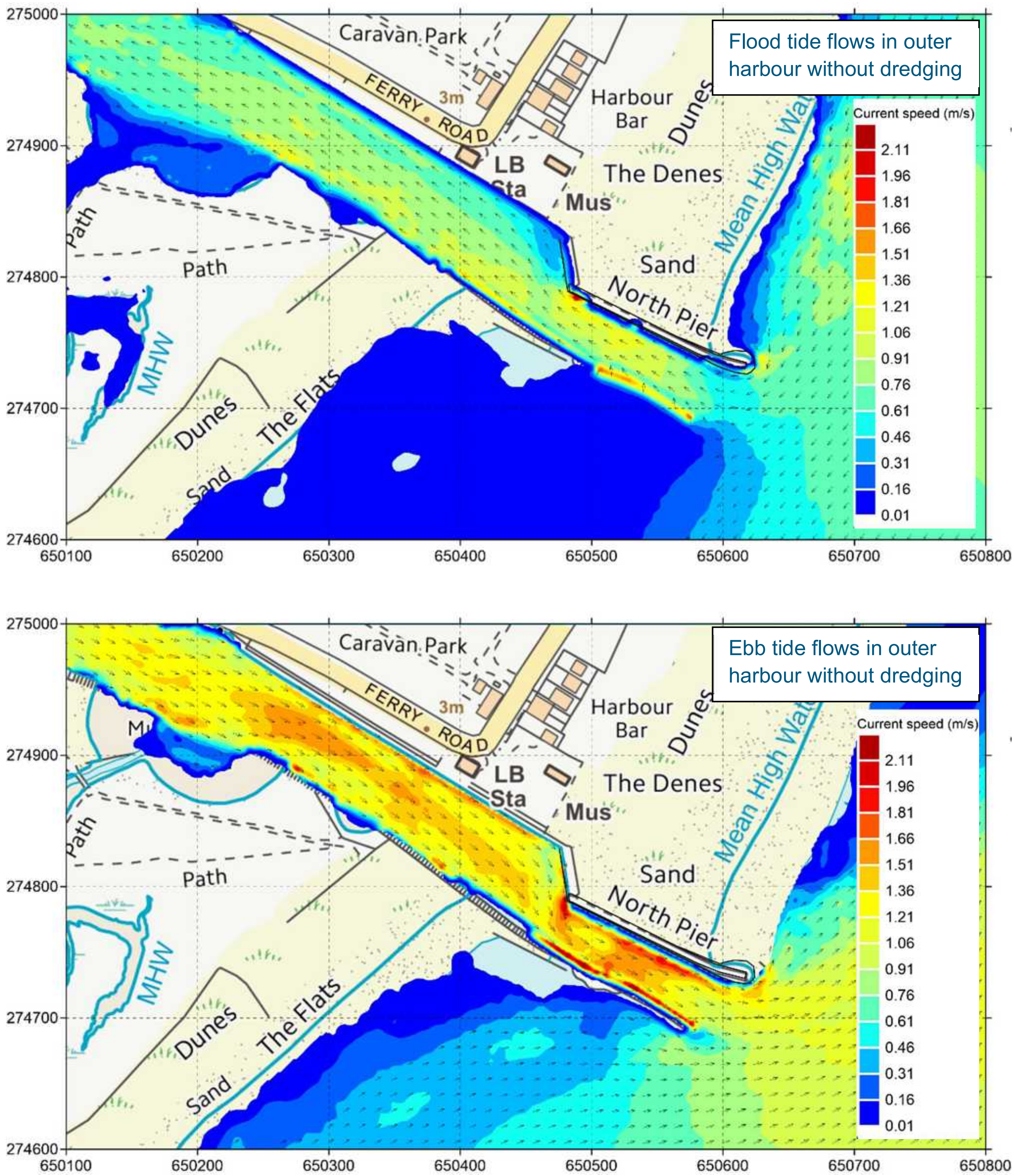


Figure 3-8: Peak flow velocity and direction for present-day defences without dredging, December 2013 conditions

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Figure 3-8 shows the present-day peak flow velocities and directions in Southwold Harbour on a flood and ebb tide, for the February 2020 conditions. From this figure, it can be seen that the peak flow on the ebb tide is lower over the higher bed levels of the shoal bank, compared to flow velocities along the centre of the channel past the North Wall. **Figure 3-8** also shows how flow directions change as the channel widens at the Knuckle, and lower flow velocities near to Dunwich Creek as discharge from the creek disturbs flows in the main channel.

The predicted increase in peak flow velocity for the Do Nothing scenario (**Figure 3-9**) would be expected to increase the rate of erosion of the shoal bank. The changes in channel bathymetry discussed in **Section 3.2** show erosion of the shoal bank between 2013 and 2020, which could reflect an increasing tidal prism or increased storminess during that period. If the estuary defences were to be raised, peak flow rates would reduce during extreme conditions (**Figure 3-9**), which could result in growth of the shoal bank.

An initial assessment of the potential impacts of the removal of the shoal bank on tidal flow patterns was undertaken as part of the preparation of the draft project report, which can be summarised as follows:

- An area of lower flow rates would be expected where the shoal bank is currently located, due to flow around the Knuckle and outflows from Dunwich Creek.
- If the shoal bank was to be removed, the bathymetry would need to be monitored in case of future sediment accumulation, which could require maintenance.
- Further modelling was recommended to assess the impact of dredging on flow rates in the vicinity of the North Wall. This additional modelling has now been undertaken to inform the preparation of this report.

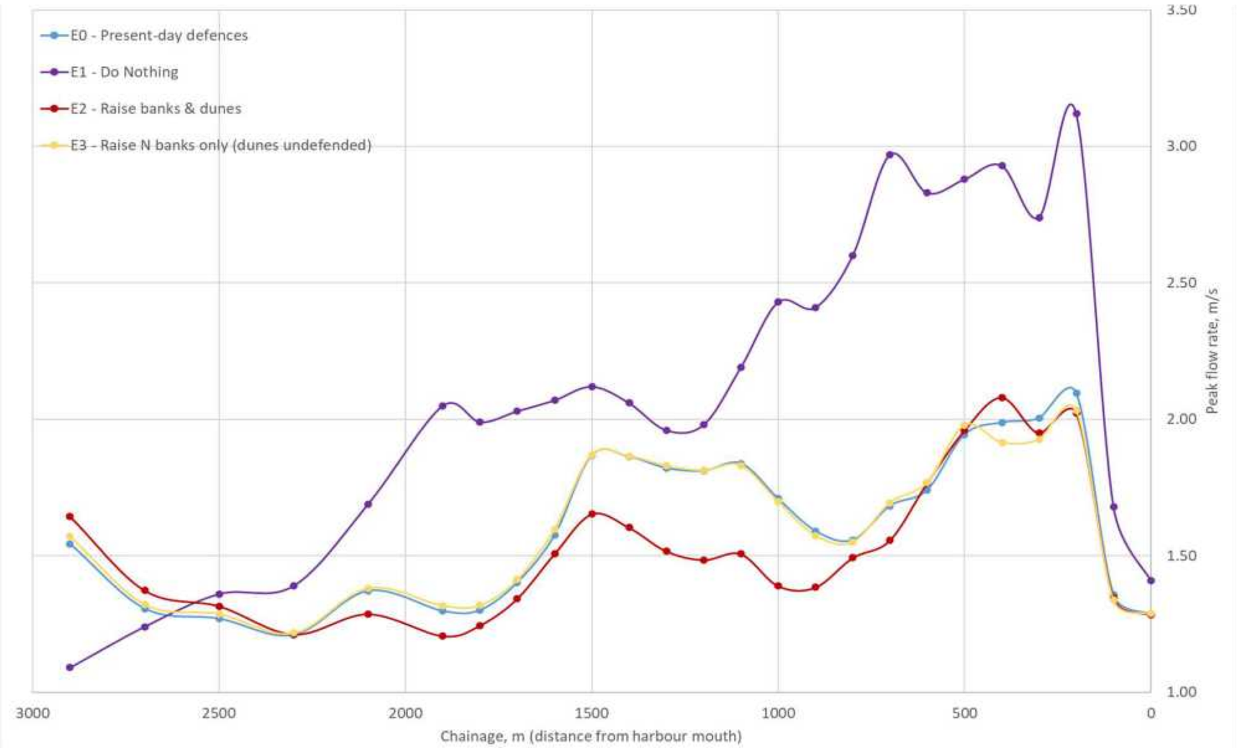

Figure 3-9: Change in peak flow rate along river channel, December 2013 conditions

4 Narrow Channel Option

4.1 Description of Narrow Channel Option

Following discussions with harbour users, an additional option has been assessed, where the river channel would be narrowed by constructing a short rock groyne on the south side of the channel. By extending the narrowed channel of the harbour entrance further upstream, the volume of water entering the estuary would be constrained, reducing peak water levels in the harbour. The rock groyne would also limit the penetration of swell waves into the inner harbour. This option could be combined with any of the other management options for the estuary defences and harbour structures.
This option is described further in Appendix E of the main report.

The Technical Note that was prepared for the stakeholder group (**Appendix A**) included details of the proposed narrow channel option. Four potential locations were proposed for the rock groyne to narrow the channel, as shown in **Figure 4-1,** with each location having different benefits or constraints. The initial assessment of benefits and constraints is included in **Section 4.2 Error! Reference source not found.**, as well as the stakeholder comments on the proposed option.

The previous wave and tidal modelling assessed a narrow channel option with a rock groyne located opposite the North Wall, near to the Lifeboat Station (approximately Location 2 in **Figure 4-1**), and the results of this modelling are discussed in **Sections 4.3 and 1.1.** The additional tidal modelling that has been completed to inform this assessment is discussed in **Section 6**.

4.2 Initial Assessment of Benefits and Constraints

An initial review was undertaken of the potential benefits and constraints of the proposal to extend the narrow channel further into the harbour. This assessment was provided in the Technical Note that was issued to the stakeholder group (**Appendix A**) and is provided in **Table 4-1**. The stakeholder comments on this option are summarised in **Table 4-2**.

Considering the stakeholder comments alongside the initial assessment of benefits and constraints shows that opinions are split about whether the channel should be narrowed. The review of the wave modelling and the additional tidal modelling will consider locations 1, 2 and 4 for the rock structure.

Table 4-1: Initial review of benefits and constraints of narrow channel option

Benefits	Constraints
Modelling shows that peak water levels would be lower in the inner harbour if a rock structure was constructed in the outer harbour (modelling undertaken for location 2).	Increased tidal flows around the rock structure, affecting navigation and with a risk of scour of the channel bed which could affect the foundations for the North Wall.
	Navigation impacts of narrowed channel.
Position of rock structure may help with vessel turning, particularly for locations 1 and 2.	Rock structure reduces the space available for mooring at the North Wall, particularly for locations 2 and 3.
The rock structure would limit the penetration of swell waves into the inner harbour by absorbing wave energy.	Access to lifeboat station restricted, particularly for location 2.
Sediment accumulation to either side of the rock structure could improve stability of both the rock structure and the adjacent South Training Arm.	Sediment may accumulate either side of the rock structure, which could further restrict navigation and require maintenance dredging.
Increased flow rates around the rock structure could limit any sediment accumulation.	

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Table 4-2: Stakeholder comments on narrow channel option

Issue	Comment
Potential location of a rock groyne structure to extend the narrow channel	Position 1.5 seems optimum, i.e. half way between positions 1 and 2.
	Position 1 appears to provide the greatest length of dock wall with a lower wave height and would provide a lower surge flood level to the Fisherman's Compound, RNLI shed, Caravan Park and Ferry Road.
	Positions nearer the harbour entrance give the biggest potential benefit so position 1 seems best.
	I believe that the constraints outweigh the benefits and would consider the only possible location for a rock structure to be location 4, to bring the benefits to the inner harbour without restricting our longer term plans for the development of the harbour facility.

4.3 Review of Previous Wave Modelling

The previous wave modelling included an option with a rock groyne incorporated into the outer harbour to narrow the channel, located opposite the North Wall near to the Lifeboat Station. This option also assumed that a rock breakwater would be constructed to replace the South Pier. The model results for this option are provided in **Table 4-3**, compared with the results for the present-day conditions and for a rock breakwater without the narrowed channel, for three locations within Southwold Harbour. **Figure 4-2** provides an example of the wave modelling results for 1-year return period waves from the 150 degree direction sector.

These results show that the construction of a rock groyne to narrow the channel near to the Lifeboat Station would improve wave conditions in the harbour entrance, immediately upstream of the rock groyne (Dunwich Creek area) and at the upstream moorings, for waves from all direction sectors. If the channel was narrowed further upstream, e.g. north of Dunwich Creek (location 4 in **Figure 4-1**), then the rock groyne structure would be expected to have less influence on wave conditions downstream of the structure, i.e. at the harbour entrance and the Dunwich Creek area.

Table 4-3: Wave modelling results for narrow channel option (1-year wave conditions)

Layout	Layout	Hm0 (m) due to waves from Offshore Direction (deg.N)							
		0	**30**	**60**	**90**	**120**	**150**	**180**	**210**
Harbour entrance	H0: Present-day Baseline	0.7-1.0	0.8-1.2	0.6-1.0	0.6-1.4	1.0-2.2	1.0-2.6	1.5 -3.5	1.3-3.3
	H2: Rock Breakwater	0.5-0.6	0.6-0.8	0.4-0.6	0.4-0.7	0.4-0.7	0.4-0.8	0.6-0.8	0.4-0.6
	H6: Rock breakwater + narrow channel	0.4-0.6	0.5-0.8	0.3-0.5	0.3-0.6	0.3-0.6	0.4-0.7	0.5-0.8	0.3-0.6
Dunwich - Walberswick	H0: Present-day Baseline	0.5-1.5	0.6-1.8	0.5-1.4	0.5-1.3	0.7-1.8	0.7-2.0	1.0-2.3	0.7-2.1
	H2: Rock Breakwater	0.4-0.9	0.4-0.9	0.3-0.7	0.4-0.7	0.4-0.7	0.4-0.8	0.4-0.8	0.4-0.6
	H6: Rock breakwater + narrow channel	0.5-0.6	0.6-0.8	0.4-0.6	0.4-0.7	0.4-0.7	0.4-0.8	0.6-0.8	0.4-0.6
Upstream Moorings	H0: Present-day Baseline	0.3-0.5	0.3-0.6	0.3-0.7	0.3-0.6	0.3-0.7	0.3-0.7	0.6-0.9	0.4-0.7
	H2: Rock Breakwater	0.3-0.4	0.3-0.4	0.2-0.3	0.2-0.3	0.2-0.3	0.2-0.3	0.3-0.4	0.2-0.3
	H6: Rock breakwater + narrow channel	0.2-0.3	0.2-0.3	0.2-0.3	0.2-0.3	0.2-0.3	0.2-0.3	0.2-0.3	<0.25

Figure 4-1: Potential locations for rock structure to extend the narrow entrance channel

Present-day, 1-year wave from 150 deg	Rock Breakwater, 1-year wave from 150 deg	Rock breakwater + narrow channel, 1-year wave from 150 deg

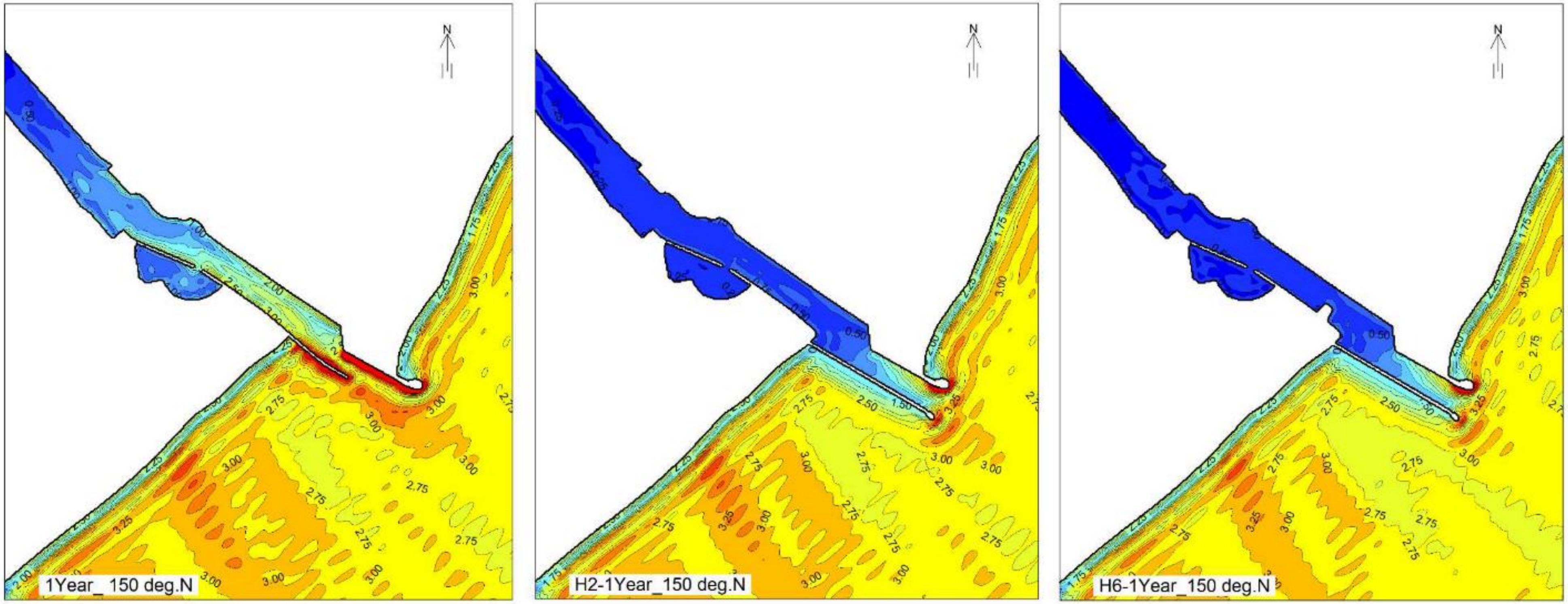

Figure 4-2: Comparison of wave modelling results showing benefits of narrowed channel option

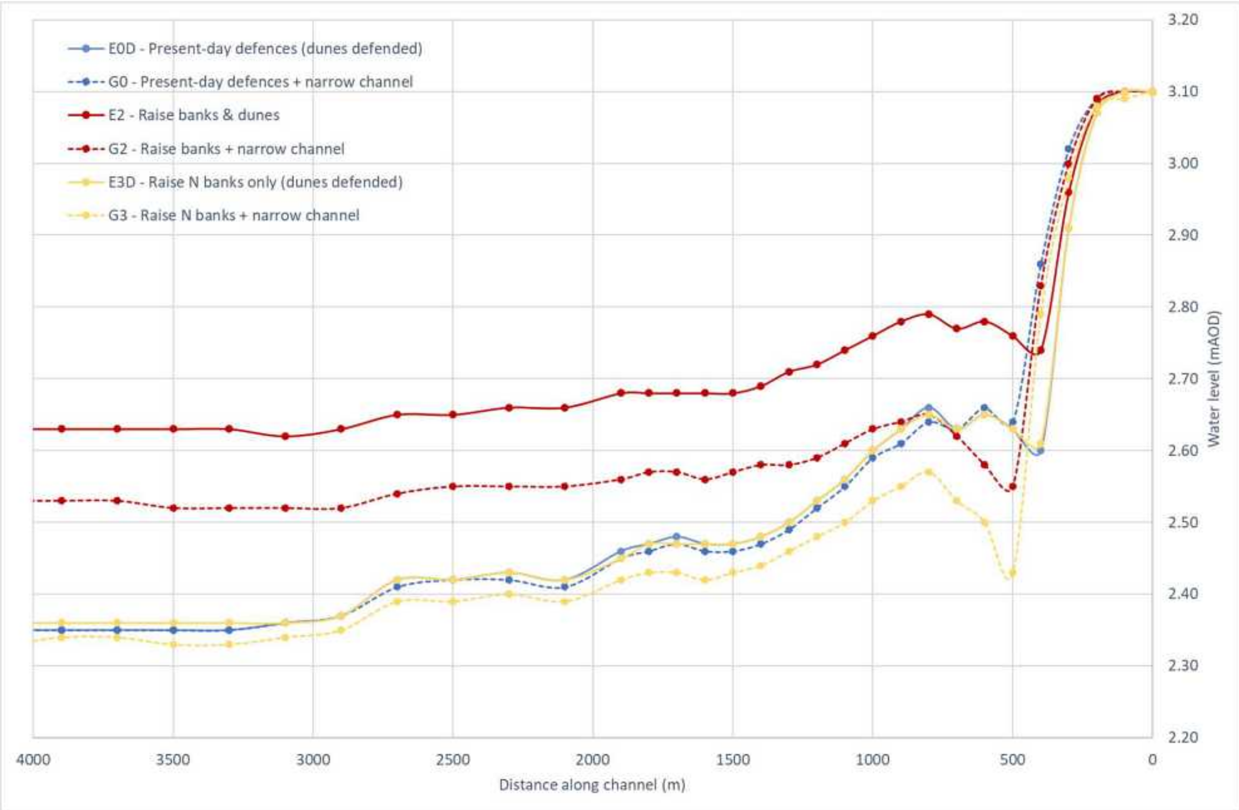

Figure 4-3: Change in peak water level along river channel with narrow channel, December 2013 conditions

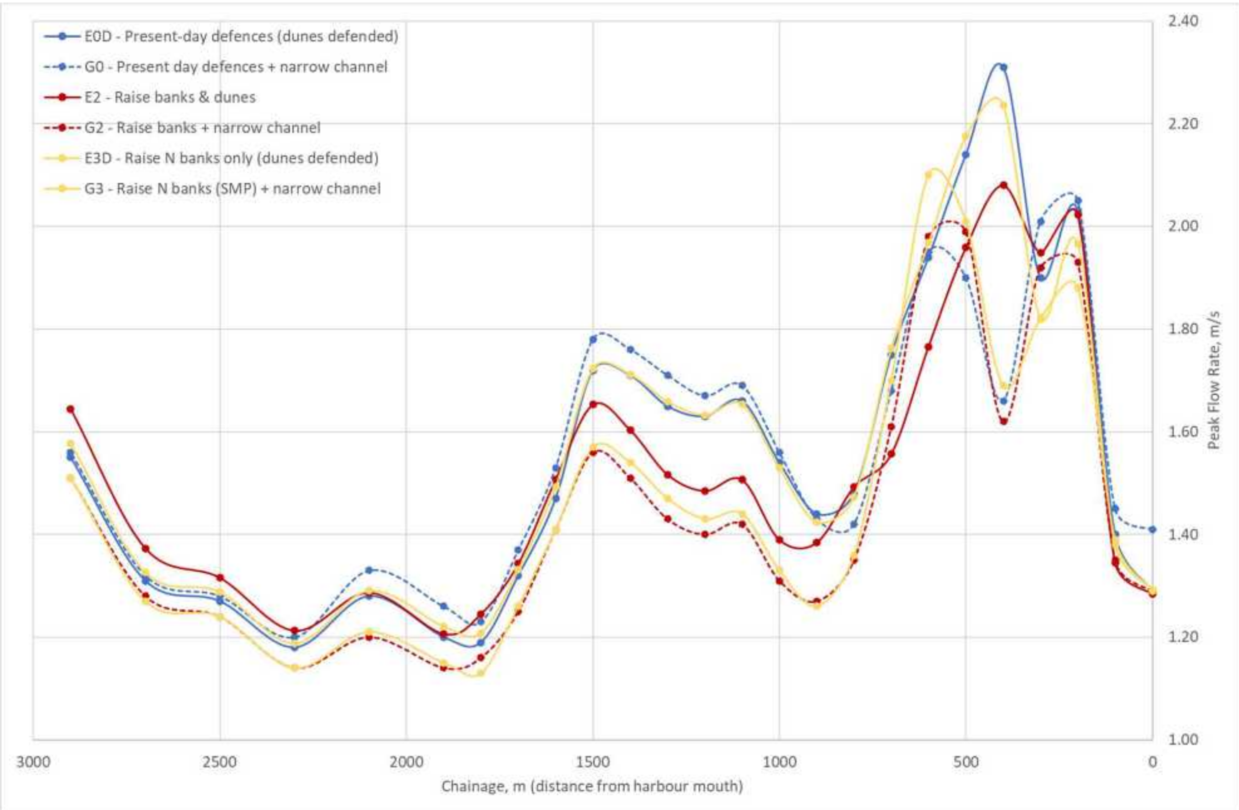

Figure 4-4: Change in peak velocity along river channel with narrow channel, December 2013 conditions

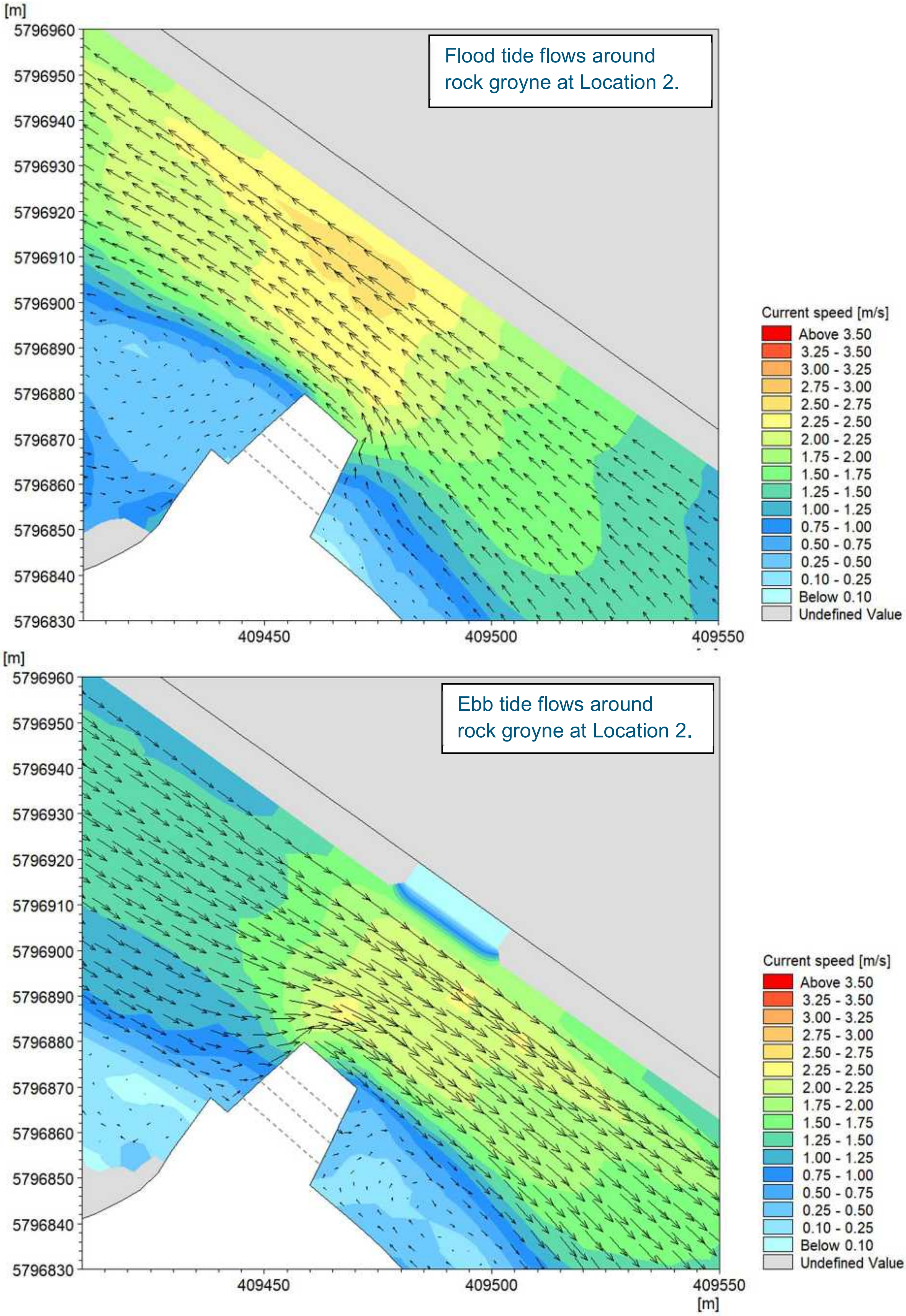

Figure 4-5: Peak flow velocity and direction around the rock groyne structure (narrow channel option), December 2013 conditions

Raised estuary defences, 2013 conditions	Raised estuary defences and narrowed channel, 2013 conditions

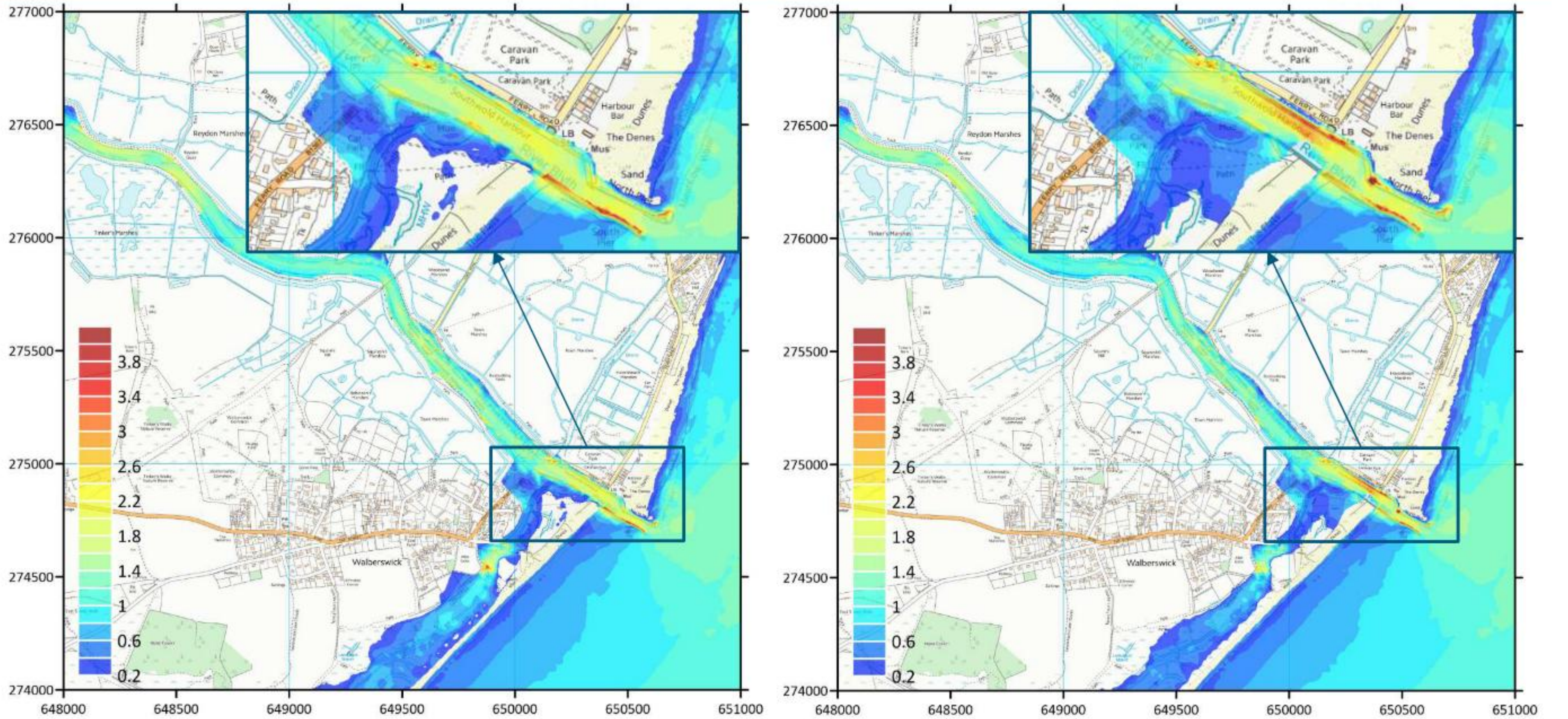

Figure 4-6: Peak flow velocity for raised estuary defences with/without narrow channel option, December 2013 conditions

4.4 Review of Previous Tidal Modelling

The previous tidal modelling included an option with a rock groyne incorporated into the outer harbour to narrow the channel, located opposite the North Wall near to the Lifeboat Station. The narrow channel option was modelled for the present day estuary defences, and for raised estuary embankments.

The modelling results (**Figure 4-3**) show that if the channel was to be narrowed opposite the North Wall, combined with raising the estuary defences, the peak flood levels at the Blackshore (chainage 1500m) for the December 2013 conditions would be reduced by 110mm compared to raising the defences alone. If the existing defences were unchanged (option E0), narrowing the channel would reduce peak flood levels by only 10mm.

In terms of peak flow velocities with the December 2013 conditions (**Figure 4-4** and **Figure 4-6**), if the embankments were raised and the channel narrowed opposite the North Wall, peak flow rates in the entrance channel would be reduced by about 0.1m/s compared to embankment raising alone. Peak flow rates further upstream are also reduced. The model results showed that peak flow velocities would increase in the vicinity of the rock structure with a narrowed channel (**Figure 4-5**).

5 Additional Tidal Modelling

5.1 Approach to Additional Modelling

Additional tidal modelling has been undertaken to assess the impact of the proposed dredging on tidal flows within the harbour entrance channel.

The tidal model was revised to set the channel bed level at -4mODN over the length of the North Wall, to represent the proposed dredging/removal of the shoal bank. Further model runs were also set up with various combinations of the potential management solutions for the harbour entrance structures and estuary defences, plus the narrow channel option (2 possible locations). **Table 5-1** summarises the model runs that have been undertaken, including relevant previous model runs that have been used for comparison.

Table 5-1: Tidal model runs completed to inform assessment of dredging proposals and narrow channel option

Option			Model run ref.	
			Tide level (mODN)	
Harbour entrance	Estuary defences	Dredging	1.49 (2020)	3.1 (2013 event)
Present-day defences	Present-day defences	No dredging	E0	E0
Present-day defences	Present-day defences	Dredged to -4mODN	**D1**	D2
Breakwater	Present-day defences	No dredging	F0	F0
Breakwater	Present-day defences	Dredged to -4mODN	**D3**	D4
Present-day defences + narrow channel (v1)	Present-day defences	No dredging	G0	G0
Breakwater + narrow channel (v1)	Present-day defences	Dredged to -4mODN	**D5**	D6
Breakwater + narrow channel (v2)	Present-day defences	No dredging	-	C2
Breakwater + narrow channel (v2)	Present-day defences	Dredged to -4mODN	-	C3

The tidal modelling results are provided in **Appendix B** (Peak Water Levels), **Appendix C** (Peak Flow Velocities), and **Figure 5-1** to **Figure 5-3** below.

5.2 Peak water levels

Figure 5-1 compares the peak water levels along the channel for the various options for the harbour entrance structures, with and without dredging. **Table 5-2** gives the peak water levels at key locations in the harbour and further upstream, and **Table 5-3**Table 5-3 compares these peak water levels with the present-day conditions for the December 2013 surge event.

Table 5-2: Summary of peak water levels for dredging options, December 2013 conditions

Option			Peak water level (m)				
Ref.	Harbour entrance structures	Dredging	Entrance channel (200m)	Lifeboat Station (400m)	Dunwich Creek (600m)	Blackshore Cottages (1500m)	Upstream of Bailey Bridge (2500m)
E0	Present-day defences	No dredging	3.07	2.60	2.65	2.47	2.42
D2	Present-day defences	Dredged to -4mODN	3.08	2.82	2.83	2.54	2.48
F0	Breakwater	No dredging	2.68	2.62	2.62	2.45	2.41
D4	Breakwater	Dredged to -4mODN	2.71	2.79	2.79	2.48	2.45
G0	Present-day defences + narrow channel (Location 2)	No dredging	3.09	2.86	2.66	2.46	2.42
D6	Breakwater + narrow channel (Location 2)	Dredged to -4mODN	2.87	2.92	2.66	2.47	2.40
C3	Breakwater + narrow channel (Location 4)	Dredged to -4mODN	2.80	2.77	2.79	2.38	2.35

Table 5-3: Comparison of peak water levels with present-day peak water levels, December 2013 conditions

Option			Change in peak water level (m)				
Ref.	Harbour entrance structures	Dredging	Entrance channel (200m)	Lifeboat Station (400m)	Dunwich Creek (600m)	Blackshore Cottages (1500m)	Upstream of Bailey Bridge (2500m)
D2	Present-day defences	Dredged to -4mODN	+0.01	+0.22	+0.18	+0.07	+0.06
F0	Breakwater	No dredging	-0.39	+0.02	-0.03	-0.02	-0.01
D4	Breakwater	Dredged to -4mODN	-0.36	+0.19	+0.14	+0.01	+0.03
G0	Present-day defences + narrow channel (Location 2)	No dredging	+0.02	+0.26	+0.01	-0.01	0.00
D6	Breakwater + narrow channel (Location 2)	Dredged to -4mODN	-0.20	+0.32	+0.01	0.00	-0.02
C3	Breakwater + narrow channel (Location 4)	Dredged to -4mODN	-0.27	+0.17	+0.14	-0.09	-0.07

For the existing South Pier and estuary defences, dredging the shoal bank would increase peak water levels by about 20cm in the outer harbour and by up to 10cm through the Blackshore for the December 2013 event conditions. The shoal bank currently acts to extend the narrowed channel upstream of the harbour entrance, so removal of this sediment would allow more water to flow into the estuary, raising peak water levels.

If the South Pier was replaced with a rock breakwater, peak water levels through the entrance channel are reduced by up to 40cm, because the rock breakwater constrains the entrance channel more than the existing South Pier (the additional flow through the windows in the pier would be removed). There is a slight reduction in peak water levels at the Blackshore and further upstream with a breakwater. Dredging of the shoal bank with a breakwater in place would increase peak water levels by about 20cm in the outer harbour, but only by a few centimetres further upstream compared to present-day peak water levels for the December 2013 event conditions. Including a narrowed channel as well as the breakwater and removal of the shoal bank increases peak water levels upstream of the narrowed section but reduces the peak water levels further upstream by about 5cm (option D6 compared to option D4).

Figure 5-2 compares the peak water levels for two alternative locations of a narrowed channel (Locations 2 and Location 4, **Figure 4-1),** which shows that Location 4 performs slightly better than Location 2 in terms of peak water levels further upstream, although the difference is less than 5cm.

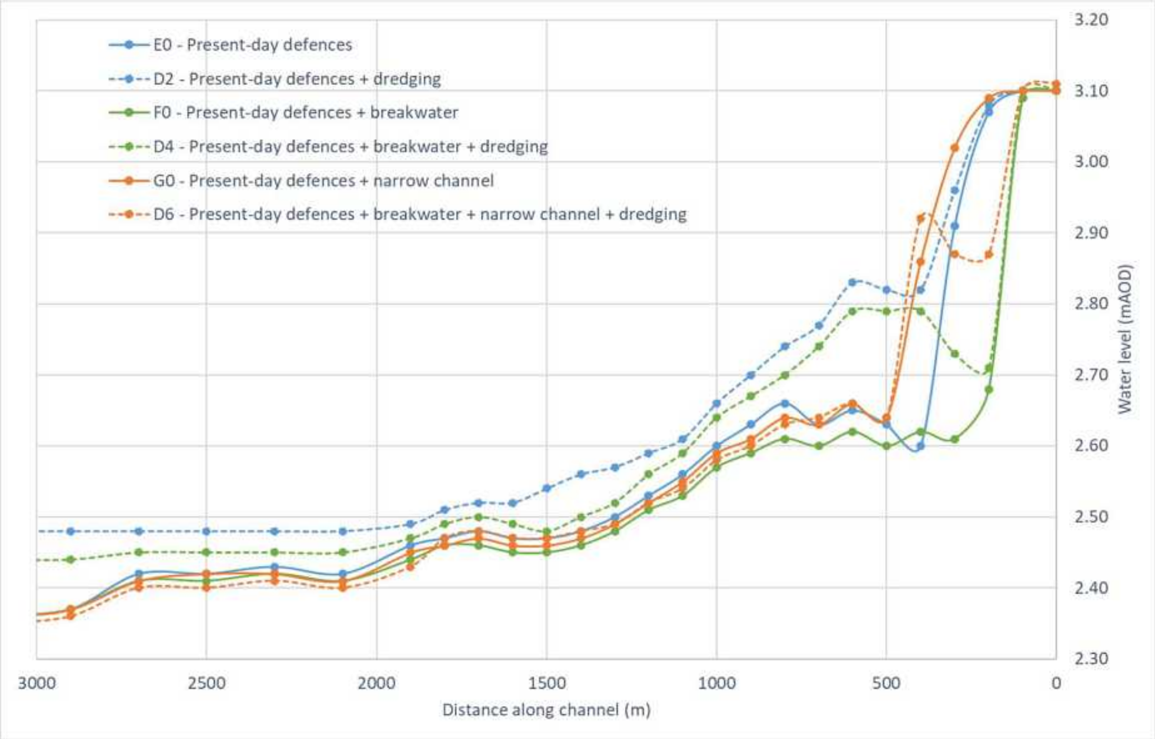

Figure 5-1: Peak water level with dredging, December 2013 conditions

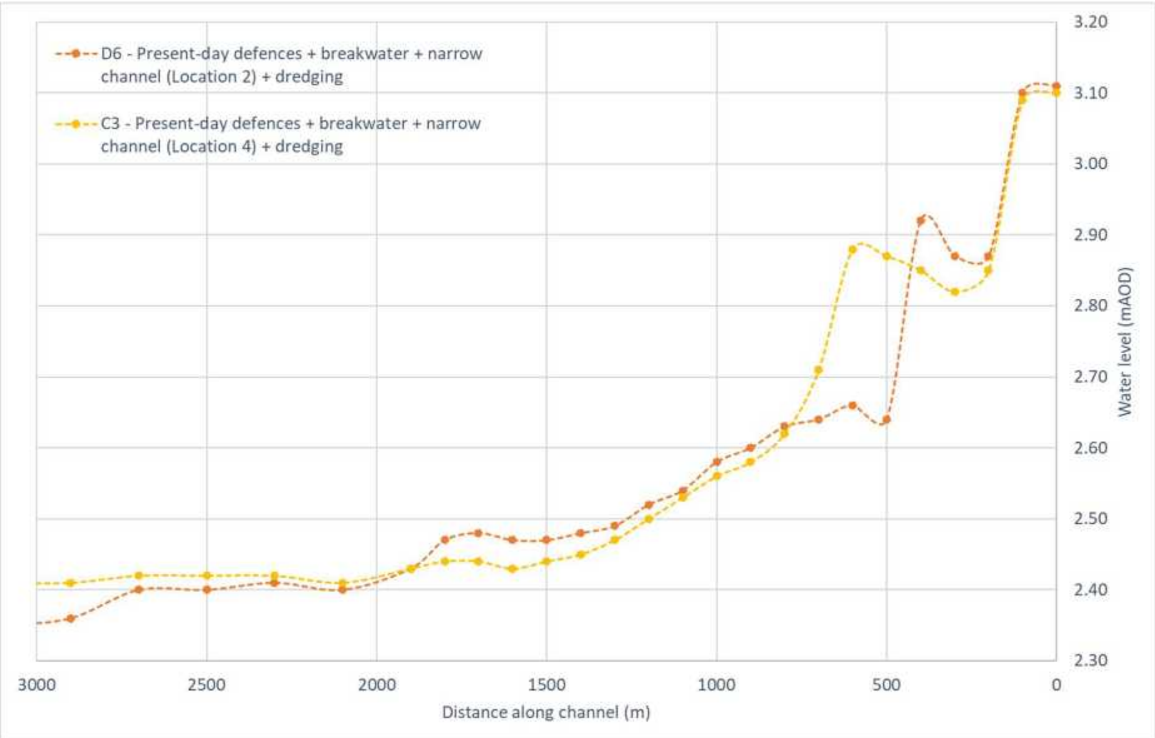

Figure 5-2: Peak water level for narrow channel options, December 2013 conditions

5.3 Peak flow velocities

Figure 5-3 and **Figure 5-4** show that with the existing South Pier and estuary defences, dredging the shoal bank would decrease peak flow velocities through the outer harbour by up to 0.5m/s for the February 2020 conditions and by 0.4m/s for the December 2013 surge event conditions. This is due to the increased channel cross section with the removal of the shoal bank. Further upstream, peak flow velocities would increase due to the increase in the tidal prism, although the increase would be less than 0.1m/s for both water level conditions.

Replacing the South Pier with a rock breakwater would result in an increase in peak flow velocities within the entrance channel, because the breakwater constrains the surge tide flow more than the existing South Pier. Further upstream, peak flow velocities are reduced because the more constrained entrance channel reduces the amount of water flowing into the estuary, and therefore limits the peak flow velocities. The influence of the breakwater on peak flow velocities is much less for lower water levels.

If the shoal bank is dredged with a rock breakwater in place, peak flow velocities along the North Wall would be up to 0.6m/s lower than with the breakwater but without dredging, for both the February 2020 and December 2013 conditions. Upstream of the North Wall, peak flow velocities for the December 2013 event conditions would be up to 0.3m/s higher than with a breakwater but without dredging. For the February 2020 conditions, peak flow velocities would be about 0.1m/s higher.

Including a narrowed channel as well as the breakwater and removal of the shoal bank reduces peak flow velocities by up to 0.3m/s upstream and downstream of the narrowed section for the December 2013 conditions (option D6 compared to option D4). For this option with the February 2020 conditions, peak flow velocities in the outer harbour reduce by only 0.1m/s compared to the conditions without the narrow channel (option D5 vs option D3) .

Figure 5-5 to **Figure 5-7** show the spatial variation in peak flow velocity in the outer harbour on the flood and ebb tides for the various dredging options with the February 2020 conditions, which are representative of a 1-year return period event (worst-case operational conditions). The peak flow velocities on the ebb tide are also compared with the present-day conditions. These figures further demonstrate that dredging would have limited impact on flow conditions in the entrance channel, but reduces peak flow velocities along the North Wall.

The reduction in flow velocities in the outer harbour with dredging could result in an increased rate of sediment deposition compared to present day conditions.

5.4 Flow directions

Figure 3-8 shows the spatial variation and direction of the peak flow velocities for the present day conditions. Comparing this figure with **Figure 5-5** to **Figure 5-7** shows that the dredging proposals would not have a significant impact on flow directions. However, any change in flows could be more noticeable to harbour users, as with dredging, the flows will be more consistent over the full width of the channel, rather than the faster flows being concentrated in the existing narrow navigation channel close to the North Wall.

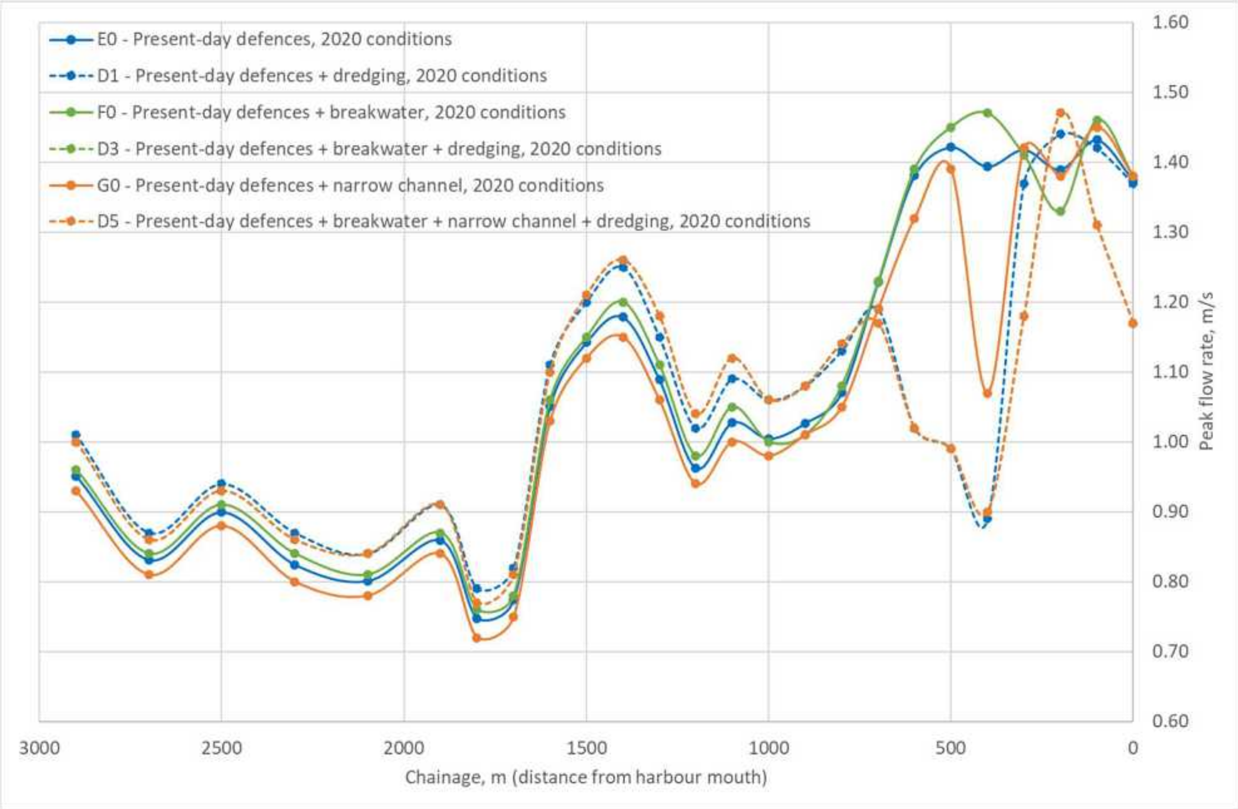

Figure 5-3: Peak flow velocities with dredging, February 2020 conditions

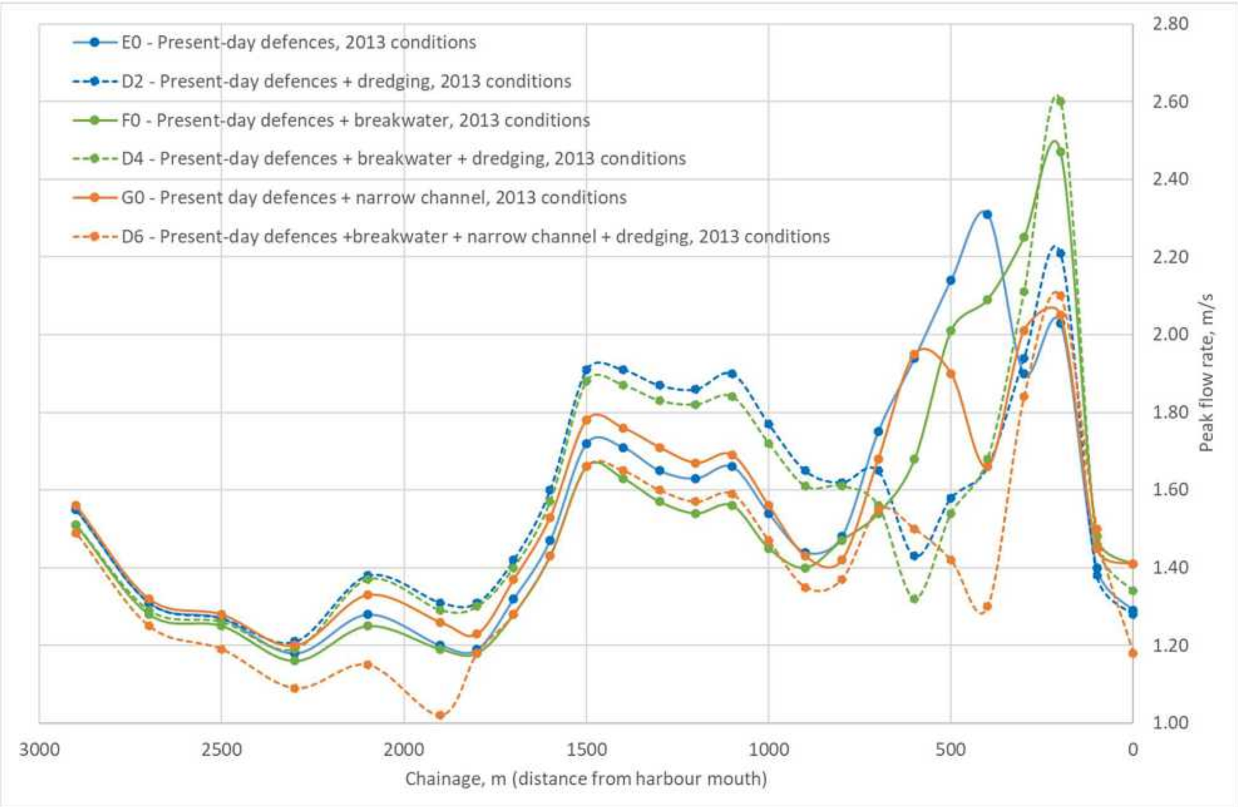

Figure 5-4: Peak flow velocities with dredging, December 2013 conditions

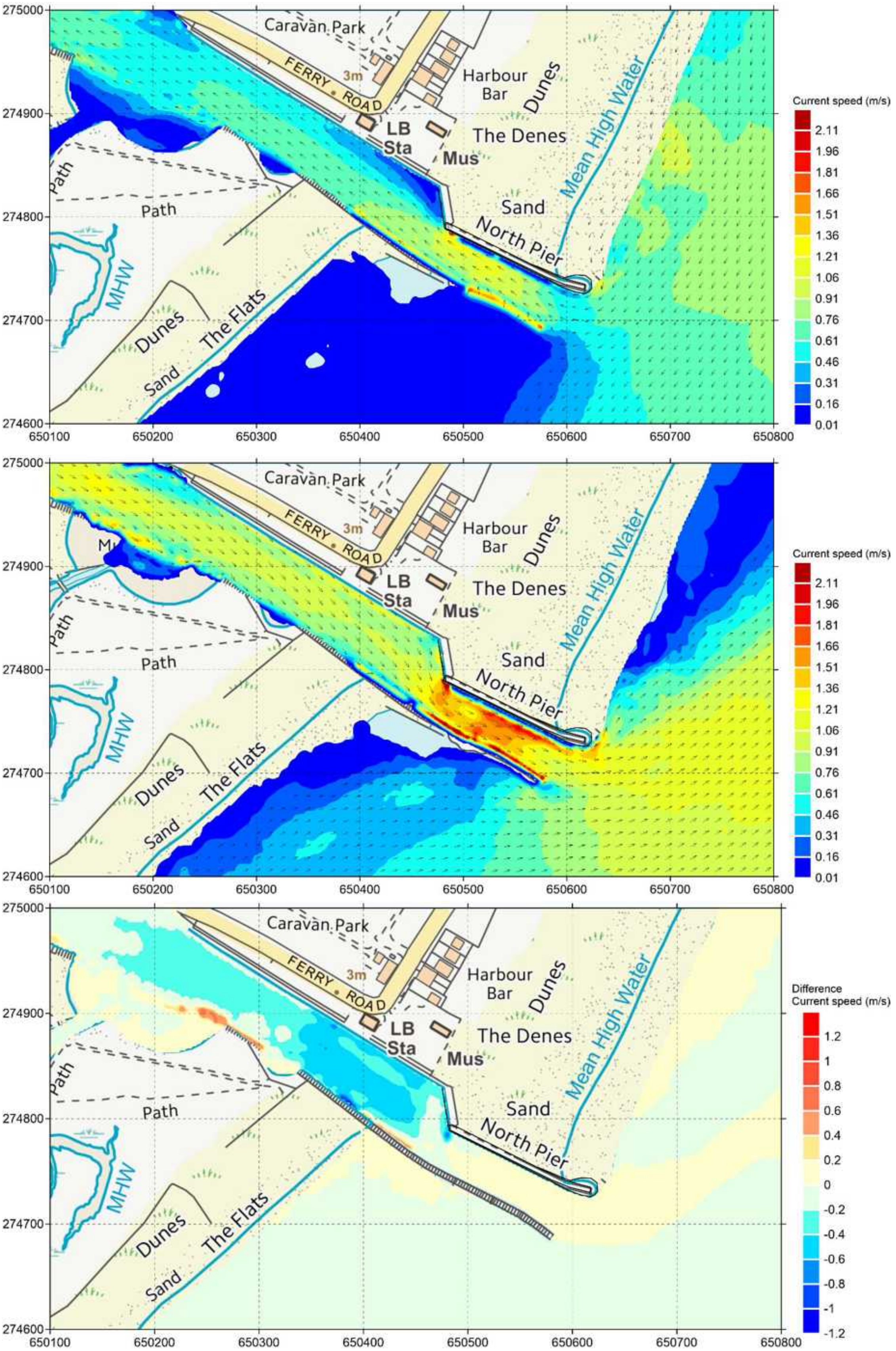

Figure 5-5: Spatial variation and direction of peak flows, Present-day defences with dredging, February 2020 conditions

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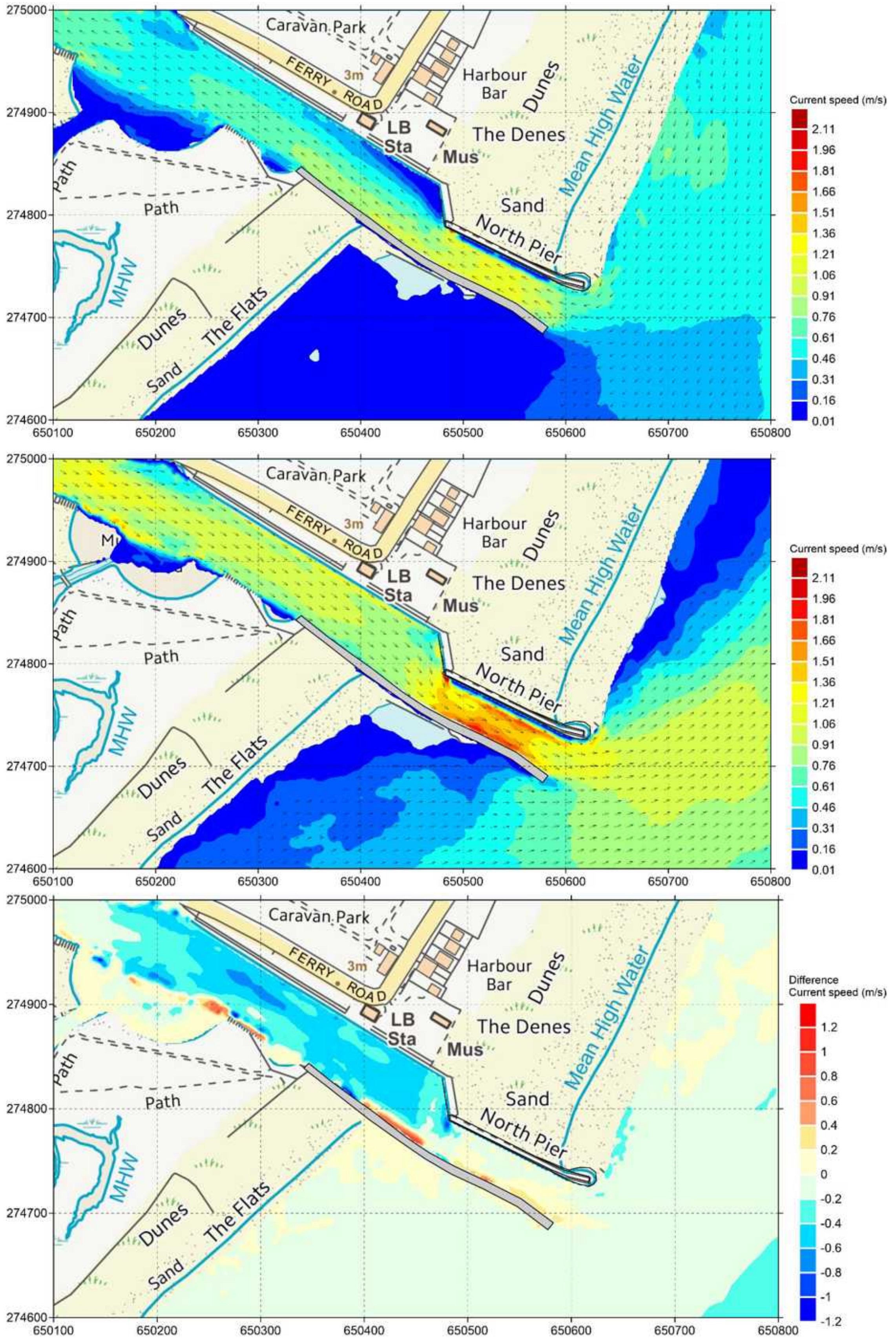

Figure 5-6: Spatial variation and direction of peak flows, breakwater with dredging, February 2020 conditions

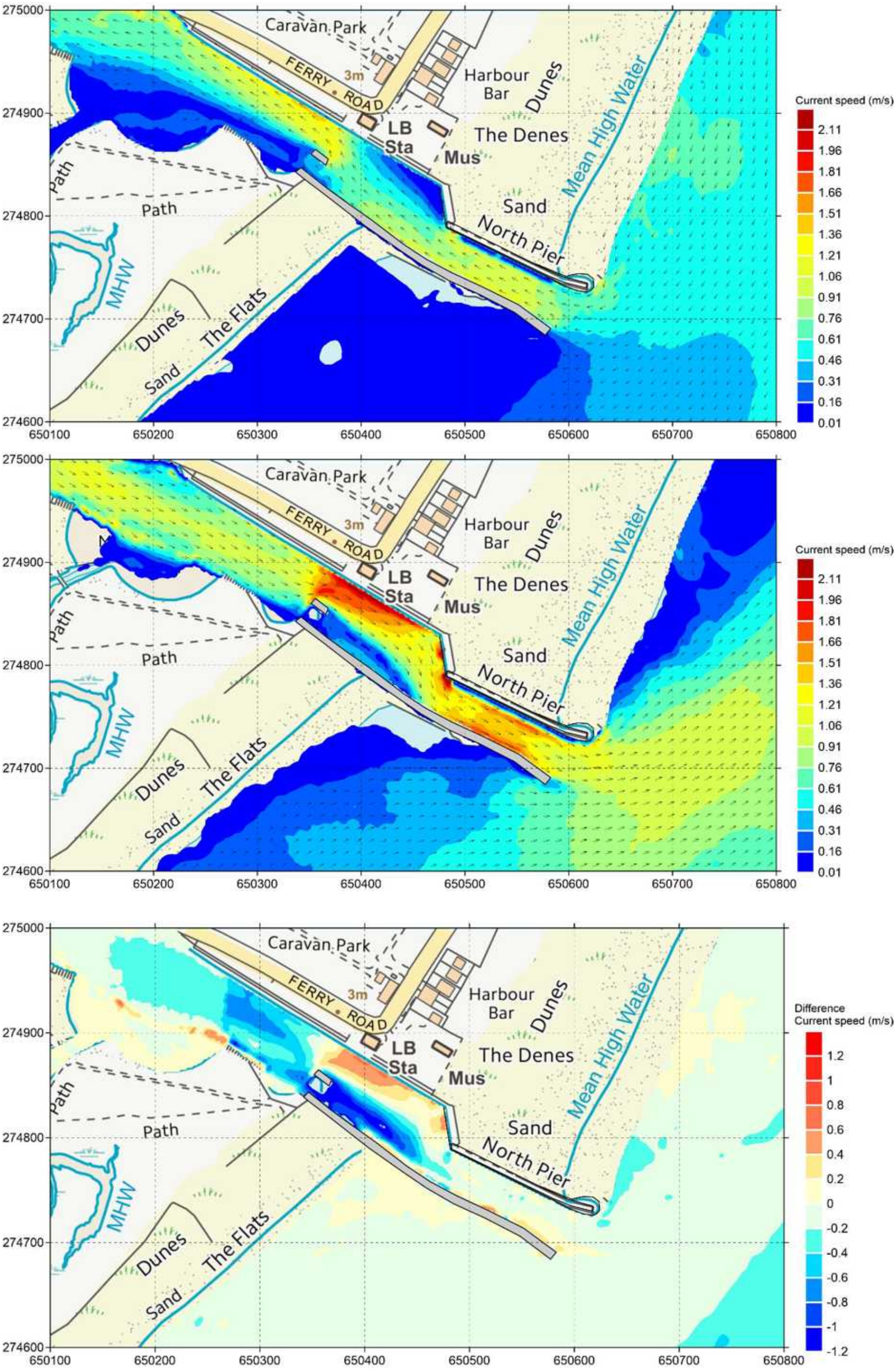

Figure 5-7: Spatial variation and direction of peak flows, breakwater and narrow channel with dredging, February 2020 conditions

6 Consent Requirements

Section 75 of the Marine and Coastal Access Act 2009, as amended, provides exemptions to a marine licence for certain dredging activities where:

a) the activity is undertaken by or on behalf of a harbour authority, and
b) the activity is authorised by, and carried out in accordance with, any legislation listed below:
    a. any local Act,
    b. any order under section 14 or 16 of the Harbours Act 1964 (c. 40),
    c. any order under section 1 of the Harbours Act (Northern Ireland) 1970 (c. 1 (N.I.)), or
    d. section 10(3) of that Act.

The following conditions also need to be met:

a) the activity involves the relocation of sediments inside surface waters;
b) the activity is for the purpose of:
    a. managing waters or waterways;
    b. preventing floods;
    c. mitigating the effects of floods or droughts; or
    d. land reclamation; and
c) it is proved to the satisfaction of the appropriate licensing authority for the area in which the activity is to be undertaken that the sediments are not hazardous waste.

Whether East Suffolk Council, as Statutory Harbour Authority for the lower section of the tidal River Blyth, is exempt from requiring a marine licence will depend upon whether they have existing powers to do so. Should powers exist, sediment sampling will still be required to prove to the satisfaction of the appropriate licensing authority (the Marine Management Organisation (MMO)) that the sediments are not hazardous. Where powers do not exist, a marine licence will be required for dredging and/or disposal.

It is understood that dredging has not been carried out at Southwold within the past 10 years and therefore, based on guidance from the Marine Management Organisation[1], any dredging proposed for navigational purposes or channel clearance would be defined as capital dredging works.

The application process for a marine licence is defined in the Marine pages of www.gov.uk[2]. An environmental assessment should be undertaken to consider the potential effects of the proposed dredging and disposal activities on the marine environment.

For the proposed dredging works, it may be possible to re-use the sediment within the harbour, so that disposal offshore is not required. For example, the dredged shingle could be used to infill areas of erosion, such as on the landward side of the South Training Arm, or to fill areas of scour in the channel (e.g. near to the Walberswick Ferry or the Bailey Bridge). Whilst beneficial use is preferred over offshore disposal, this these activities still require approval.

A further option would be to undertake the dredging alongside the construction of the proposed rock breakwater, using the material as fill material to the proposed rock breakwater, or placing it against the toe of the structure to reduce erosion risk. In this case dredging and disposal would be related to a construction project and therefore the Environmental Impact Assessment (EIA) Regulations will apply.

Sediment sampling and analysis will be needed to inform the nvironmental assessment. The hydrographic survey completed in 2020 included suspended sediment sampling, plus samples of sea-bed sediments taken from various locations within the harbour, but no samples were taken from the shoal bank. Samples

[1] *Dredging - GOV.UK (www.gov.uk)*
[2] *The marine licence application timeline - GOV.UK (www.gov.uk)*

will need to be collected throughout the dredge depth. The number and location of samples and analysis would need to be undertaken in accordance with the requirements of the MMO.

7 Assessment of Potential Impacts of Proposals

Table 7.1 summarises the benefits and constraints of the proposals to dredge the shoal bank opposite the North Wall, and to narrow the channel in the outer harbour, considering the various key issues for both scenarios. The conclusions and recommendations based on this assessment are set out in **Sections 8 and 9** respectively.

8 Conclusions

The removal of the shoal bank would have a minor benefit for wave conditions in the vicinity of the North Wall if the South Pier was not replaced. If the South Pier is replaced with a rock breakwater, then the bathymetry in the outer harbour, including any changes to the shoal bank, would have limited influence on wave conditions, because wave energy will be dissipated by the rock breakwater. Narrowing the channel would further reduce wave penetration into the inner harbour.

The presence of the shoal bank influences peak water levels upstream, as the shoal bank acts to narrow the channel and limit the volume of water that flowing into the estuary. If the shoal bank was to be removed, peak water levels in the outer harbour would be approx. 20cm higher on an extreme event similar to 2013. At the Blackshore, peak water levels would be less than 10cm higher. Narrowing the channel with the construction of a rock groyne would replicate the effect that the shoal bank currently has on upstream water levels, reducing peak water levels upstream.

Flow velocities over the shoal bank are less than in the deeper part of the channel at present due to the reduced water depth and the shape of the Knuckle which influences the direction and speed of flow. The influence of the Knuckle on flow directions and velocities would continue with removal of the shoal bank, but this would be less pronounced as flows would no longer be ‘squeezed’ past the bank. Removing the shoal bank would result in a reduction in peak flow velocities past the North Wall, but a slight increase in peak flow velocities further upstream. With a narrow channel, flow velocities upstream are slightly reduced.

Construction of a rock groyne structure to narrow the channel immediately upstream of Dunwich Creek (Location 4 in **Figure 4-1**) would have fewer constraints for navigation than a rock groyne positioned at Location 2 and would achieve slightly lower peak water levels. Due to increased flow velocities around the structure, there would be a risk of scour of the channel bed in this area. Sediment would be expected to accumulate to either side of the structure, which could partially mitigate the scour risk.

If the shoal bank was removed, some deposition of sediment in the vicinity of the existing shoal bank would be expected in the future, as flow velocities and directions would continue to be influenced by the shape of the channel at the Knuckle. The future rate of sediment deposition is difficult to quantify, as it depends on the frequency of storm events from the North East, and the volume of sediment discharged from Dunwich Creek, which is hard to measure as the shallow depth of the Dunwich Creek channel restricts access for hydrographic survey

A Marine Licence would be required in order to undertake the proposed dredging, as maintenance dredging has not been undertaken to the harbour within the past 10 years. This would require environmental assessment, supported by sediment sampling and analysis for samples taken from the shoal bank. Based on current assessment timescales for Marine Licence applications by the MMO, this process could take 6 months to 1 year.

9 Recommendations

Removing the shoal bank located opposite the North Wall would improve conditions for navigation in the outer harbour and increase space for mooring at the North Wall. Dredging would not change conditions in the entrance channel. Flow velocities in the outer harbour would be reduced, and the impact on upstream flow velocities would be limited. However, there would be negative impacts on water levels further upstream.

If dredging was to be undertaken, construction of a rock groyne to narrow the channel would mitigate the impacts on peak water levels. A location upstream of Dunwich Creek is preferred for the narrowed channel, however, further discussion with stakeholders is required regarding any constraints associated with the construction of a rock groyne at this location.

A marine licence application, supported by an environmental assessment and sediment sample analysis, would need to be completed to enable the shoal bank to be removed.

Regular bathymetric surveys would be needed to monitor future channel depths and any requirement for maintenance dredging.

Table 7.1: Assessment of benefits and constraints of proposed dredging and narrow channel options

Issue	Benefits	Constraints	Assessment
Wave conditions	With a rock breakwater, any changes to the shoal bank would have limited influence on wave conditions, because wave energy would have been dissipated by the rock armour. Narrowing the channel, with or without dredging, would reduce wave penetration into the inner harbour.	If the shoal bank was removed before the South Pier is replaced, wave heights would no longer build or break in the shallow water. More wave energy could progress into the inner harbour if waves do not break over the shoal bank. Removing the shoal bank could increase wave reflection from the south side of the channel, causing higher waves at the North Wall. The deeper water in the outer harbour would be able to sustain larger waves.	Removal of the shoal bank is expected to increase wave heights in the outer harbour if dredging is undertaken before the South Pier is replaced. After replacement of the South Pier with a rock breakwater, dredging the shoal bank would have minimal impact on wave disturbance in the outer harbour and entrance channel, because wave energy would be dissipated by the breakwater.
Peak water levels	Removal of the shoal bank would allow more water to flow into the estuary, raising peak water levels by about 20cm in the outer harbour and by up to 10cm through the Blackshore for the December 2013 event conditions. Upstream water levels are less with a rock breakwater in place but would be a few centimetres higher than present day conditions.	Narrowing the channel in the outer harbour as well as dredging the shoal bank reduces peak water levels upstream by about 5cm compared to the option with a breakwater + dredging, Peak water levels at the Blackshore would be comparable with present-day conditions.	The shoal bank currently acts to extend the narrowed channel upstream of the harbour entrance, so removal of this sediment would allow more water to flow into the estuary, raising peak water levels in the outer harbour and further upstream. Narrowing the channel in the outer harbour would replicate the effect that the shoal bank has on constraining flows, so peak water levels upstream would be comparable with the present day conditions. A rock groyne at Location 4 is slightly better for peak water levels compared to Location 2.
Peak flow velocities	**D**redging the shoal bank would decrease peak flow velocities through the outer harbour by up to 0.6m/s due to the increase in channel cross section. Dredging has limited impact on flow velocities in the entrance channel. Including a narrowed channel as well as the breakwater and removal of the shoal bank	Through the Blackshore and further upstream, peak flow velocities would increase by up to 0.3m/s compared to the present day with a rock breakwater plus dredging of the shoal bank. With a rock breakwater in place, dredging would increase peak flow velocities upstream of the North Wall by up to 0.3m/s for the December 2013 event conditions. For the	Dredging the shoal bank would reduce peak flow velocities in the outer harbour for all options. Peak flow velocities would increase further upstream as the tidal prism would increase, unless the channel is narrowed by a rock groyne.

Issue	Benefits	Constraints	Assessment
	reduces peak flow velocities by up to 0.3m/s upstream and downstream of the narrowed section (December 2013 conditions). Peak flow velocities in the outer harbour reduce by 0.1m/s for the February 2020 conditions.	February 2020 (operational) conditions, peak flow velocities would be only 0.1m/s higher.	
Flow directions	The dredging proposals are not expected to have a significant impact on flow directions.	Any change in flows could be more noticeable to harbour users, as with dredging the flows will be more consistent over the full width of the channel, rather than the faster flows being concentrated in the navigation channel close to the North Wall.	Whilst a change in flow patterns would be experienced by harbour users following removal of the shoal bank, this is not expected to be significant.
Channel bed erosion and/or sediment deposition	The dredging proposals would not have a significant impact on erosion of the channel bed in the entrance channel. Sediment accumulation to either side of a rock groyne to narrow the channel could improve stability of both the rock groyne and the adjacent South Training Arm.	The reduction in flow velocities in the outer harbour with dredging could result in an increased rate of sediment deposition. Therefore, the shoal bank could re-establish in the future. It is difficult to predict the rate of sediment deposition as this would also depends on the frequency of storm events that could drive sediment into the harbour, and discharge from Dunwich Creek. For a narrowed channel, the increased flow velocities around the structure could result in scour of this part of the channel, with a risk of undermining the foundations to the North Wall. Sediment would also be deposited on either side of the structure which may need to be removed in future.	The shoal bank could re-establish in the future and could require maintenance dredging. Channel bed levels should be monitored to determine the requirement for maintenance dredging, or scour around a narrow channel structure.
Navigation and mooring	The navigable width of the outer harbour would be increased, improving access to inner harbour and creating more space at North Wall for vessel mooring. A rock groyne at Location 2 may help with vessel turning.	If a rock groyne is installed to narrow the channel, this would restrict navigation, which could be more difficult due to faster flows around the structure. Access to the Lifeboat Station could be restricted, particularly for a rock groyne at Location 2. Without a narrowed channel, there could be increased wave disturbance in the inner harbour. Further works to North Wall may be required to enable safe mooring.	Removing the shoal bank would increase space for mooring at the North Wall, and the width of the navigation channel, assuming the shoal bank does not re-establish. A narrowed channel would increase navigation constraints. Narrowing the channel at Location 4 would be preferable to Location 2 in terms of minimising the constraints on navigation and mooring.

Issue	Benefits	Constraints	Assessment
Consent requirements	A marine licence is unlikely to be required for any future maintenance dredging, but this would need to be confirmed with the MMO.	The proposed dredging is likely to be defined as capital dredging works because dredging has not been carried out at Southwold within the past 10 years. Therefore, a marine licence will be required, supported by an environmental assessment to consider the potential effects of the proposed dredging and disposal activities on the marine environment. Sediment sampling and analysis in accordance with the requirements of the MMO will be needed to inform the environmental assessment.	A Marine Licence is likely to be required to enable the proposed dredging. The application and assessment process for a licence could take 6 months to 1 year.
Undertaking the proposed dredging	The capital cost for initial dredging would be relatively low. Dredged material could be reused in the works to replace the South Pier, or infill eroded areas behind South Training Arm, although an environmental assessment would be required for this.	Hard material may be present within the channel bed, which could impact on cost of dredging and ease of disposal.	Subject to obtaining the relevant consents for undertaking the proposed dredging, these works should be straightforward. Sediment samples will be required to inform the Marine Licence application, which would provide useful information for planning the works.

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Backed by expertise and experience of 6,000 colleagues across the world, we work for public and private clients in over 140 countries. We understand the local context and deliver appropriate local solutions.

We focus on delivering added value for our clients while at the same time addressing the challenges that societies are facing. These include the growing world population and the consequences for towns and cities; the demand for clean drinking water, water security and water safety; pressures on traffic and transport; resource availability and demand for energy and waste issues facing industry.

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EASTSUFFOLK COUNCIL

Southwold Harbour Management Committee

Work Programme

23 February 2023	• Royal HaskoningDHV report
9 March 2023	• Standard Operating Procedures • Update from the Working Groups • Update from the SAG • Work Programme •
July 2023	• Election of Chairman and Vice Chairman for 2023/24 • Co-opted Members Term of Office – Richard Musgrove and David Gledhill • Business Plan • Update from the Working Groups • Update from the SAG • Work Programme •

Other matters:

Report from ABP Mer on Harbour Audit (timeline to be confirmed)

An informal Annual Meeting needs to be convened once a year, with SAG Members being invited.

To review the post of Southwold Harbour and Asset Manager once in post for a year.

Updated 14 November 2022