REPORT

Climate Change Adaptation Report

ARP4 Update

Client:	Peel Ports Group
Date:	December 2024
Reference:	Reproduced from PC4268-RHD-XX-XX-RP-X-003

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Executive Summary

Background

This report provides Peel Ports Group's response to the request from Defra to provide a voluntary update to their Climate Change Adaptation Reports (CCAR), in accordance with the Adaptation Reporting Power under the Climate Change Act 2008. CCARs were first submitted by Peel Ports in 2011 for the Mersey Docks and Harbour Company Ltd. (MDHC) and the Port of Sheerness Ltd. (PoSL). A combined update report was provided for the voluntary ARP third round (ARP3) in 2021.

Peel Ports has proactively addressed the recommendations of its previous CCARs. For this update the previous CCARs and related work completed since 2021 have been reviewed against the latest Defra guidance. This report:

- Provides an update on progress in the management of climate risk, including governance of climate risk management and how the recommendations from the ARP3 report have been addressed.
- Focusses on the core Statutory Harbour Authority and Competent Harbour Authority responsibilities of the MDHC and the PoSL, but also considering how the wider port operations might impact on those responsibilities.
- Reviews and updates the previous climate change risk assessments, recognising the timelines and scenarios referred to in the ARP4 Guidance.
- Considers interdependencies with the wider port operations and with third parties.
- Provides case studies summarising work undertaken to progress understanding and management of climate change risks.

Progress since ARP3

Since 2021, awareness of climate change issues and the need to take action has gained momentum within Peel Ports. Clear strategy, governance and management processes have been embedded. Actions undertaken to address uncertainties in the previous risk assessment include:

- Completion of a high-level Climate Change Risk Assessment (Screening Assessment), to improve understanding of risks to all ports and inform financial disclosure reporting. The 2023 Screening Assessment reviewed physical climate change risks to all port infrastructure and operations, using the latest UKCP18 data and considering a range of future scenarios and timescales. For the Port of Liverpool, 27 priority risks, categorised as High or Extreme in the next 50 years, were identified.
- Generation of an Adaptation Action Plan for the Port of Liverpool, based on a site-specific review of issues and consequences, has reduced the number of priority risks from 27 to 21. The 2023 Screening Assessment and the Local Adaptation Plan include adaptation measures to address the priority risks, including defining requirements for data collection, monitoring and assessment of critical threshold levels.
- Evaluation of the potential for cascading failures between interlinked natural and socioeconomic systems is addressed, including impacts on commercial operations that can affect the SHA and CHA functions.
- Completion of case studies demonstrating investments made to improve climate risk understanding, covering: i) Adaptation Action Plan development; ii) University of Birmingham interdependencies research; iii) use of satellite data to inform dredging; and iv) development of a Marine Biosecurity Plan.
- Staff engagement and capacity building through the development of this report and review of the previous risk assessments.

Improved Understanding of Risks and Challenges

The physical climate change risks to assets and operations at the MDHC and the PoSL have been identified for each climate hazard. The likelihood of occurrence and level of impact was assessed for each risk to determine risk severity in accordance with a defined matrix. The assessment considered financial risk valuations where available, otherwise a qualitative assessment was undertaken.

The ARP3 report identified 22 potential impacts on core SHA and CHA responsibilities for the MDHC and the PoSL. The risk assessment table provided in this report now includes 30 risks, covering 42 of the specific risks identified in the full risk assessment spreadsheet. Where the same impact could occur due to multiple climate hazards, risks have been combined. The key risks are summarised below.

- **Marine Infrastructure and Systems:** These 13 risks reflect the importance of the port infrastructure for effective operations. Risks relating to sea level rise, increased storminess and high temperatures are Low (2) to Moderate (3) in mid-century, increasing to High (4) or Extreme (5) by 2100 for RCP4.5 and RCP8.5. Risk ratings are generally unchanged compared to ARP3.

  Flooding risks are well understood and have a high confidence rating. There is less confidence in the risk assessments relating to high temperatures and storms due to data uncertainties and the need for improved understanding of how assets could be affected.

  The highest priority risk is the potential for uncontrolled opening and structural damage to lock gates. Failure of the gates could have significant impacts on operation of the ports, affecting SHA responsibilities and commercial operations.

- **Marine operations, including pilotage and navigation:** Eight risks to marine operations are included, which may occur due to sea level rise, increased storminess and high temperatures. These risks are rated as Low (2) to Moderate (3) in the mid-century, increasing to Moderate (3) to Extreme (5) by 2100.

  Risks due to sea level rise and increased storminess have been assessed with high confidence because these hazards and the expected impacts are well understood. Lower confidence is assigned to impacts on operational windows, because the thresholds for impacts and the associated consequences are yet to be confirmed.

- **Dredging and disposal:** Three risks relate to dredging and disposal, resulting from sea level rise, increased storminess and temperature changes, which could have potentially long-term impacts on delivery of SHA duties regarding pilotage and navigation, conservancy and protection of the natural environment. The risks are assessed as Moderate in the mid-century, increasing to Moderate (3) to High (4) by 2100. The confidence rating for these risks is Low to Medium because of uncertainties relating to how climate change will affect hydrographic and biological conditions.

- **Natural Environment, including Pollution:** Four risks could impact on the natural environment, due to sea level rise and increased storminess causing flooding (resulting in pollution) or damage to natural habitats, with the potential for long-term impacts on delivery of SHA duties, and operational and reputational impacts. These risks are assessed as Low (2) to Moderate (3) in the mid-century and may increase to Moderate (3) to High (4) by 2100.

- **Interdependent and cascading risks:** These two risks relate to impacts on water users from changes in water chemistry and biology and impacts on the wider transport network affecting access. The confidence in this assessment would be improved by better understanding of the climate projections, the associated impacts, and the resilience plans of the infrastructure operators.

Mitigation measures to better understand and address all risks include regular inspection, monitoring of weather/climate data and recording impacts occurring during extreme events, including operational downtime. Specific assessments of failure risk and relevant threshold levels are recommended for

some infrastructure assets, to inform planning for replacement or improvement and to update operational plans. Interdependent risks will be managed by continuing to engage with the responsible authorities.

Gaps in the risk assessment have been identified, as follows:

- **Lack of certainty** due to data adequacy and understanding of the vulnerability of affected assets and operations. It is expected that confidence in the climate change projections will increase over time.
- **Quantified data:** Improved data relating to costs, downtime or other impacts on SHA responsibilities would enable quantification of the risk assessment, supporting the business case for investment in resilience. Critical thresholds above which an impact is expected to occur also needs to be defined. The benefits of understanding this data in the context of climate resilience is understood, and Peel Ports intends to progress the recording of downtime and economic losses for future extreme weather events.
- **Interdependencies:** More specific engagement with utilities, local authorities and the Highways Agency in relation to their risks and resilience planning would help to achieve an improved understanding of the interdependent risks, particularly for the PoSL. Further engagement on climate risk management is also needed with tenants and adjacent landowners.

Adaptation Action Plan

Based on the work undertaken since the ARP3 submission in 2021, Peel Ports has developed an improved understanding of the adaptation actions needed to address their priority risks. Local Adaptation Action Plans are being developed based on the ARP4 Guidance, focusing on the following priority areas with the aim of reducing the risk rating for all priority risks to Moderate (3) or lower by 2100.

- Governance and management processes
- Further assessment of risks and impacts
- Identification and implementation of adaptation solutions
- Data and monitoring
- Contingency planning
- Communication and capacity building
- Evaluation and learning from incidents

Recently completed and ongoing actions are summarised on the following page.

Action	Type of Action	Financial Year	Status
Establish Climate Change Steering Group	Governance	July 2021	Complete
Appoint Group Head of Sustainability		Feb 2022	Complete
Establish ESG Committee		March 2022	Complete
Develop ESG Strategy		March 2023	Complete
Complete risk screening for all port clusters	Risk Assessment	March 2023	Complete
Financial Disclosure Reporting	Governance, Risk Assessment	2023	Complete
University of Birmingham Assessment of Interdependent Climate Change Risks	Risk Assessment, Capacity Building	2023	Complete
Marine Biosecurity Action Plan	Governance, Capacity Building, Action Planning	2024	Complete
Develop Local Adaptation Plan (Port of Liverpool), including coastal flooding risk assessment and Climate Risk GIS	Governance, Management Processes, Risk Assessment, Action Planning, Capacity Building	2025	Complete
Local Adaptation Plan (PoSL)		Mid-2025	Ongoing
Local Adaptation Plan (other port clusters)		End 2025	Ongoing

Conclusion

This ARP4 update demonstrates that Peel Ports is committed to proactive climate change adaptation and has embedded a clear strategy, governance and management processes for the management of climate change risks. The Group is integrating best practices and innovative solutions to ensure the resilience of its port operations. This report demonstrates the significant progress that has been made since 2021 in addressing gaps in climate risk understanding and clarifying the further actions that are required. As such, it sets a strong foundation for planning cost-effective, outcome-focused adaptation measures.

1 Introduction

1.1 Background

The Climate Change Act 2008 set a framework for the UK to achieve its long-term goals of reducing greenhouse gas emissions and to ensure steps are taken towards adapting to the impact of climate change. The Adaptation Reporting Power introduced under this Act provides for infrastructure operators and public bodies to report to Defra on how they are addressing current and future climate impacts.

Under the Adaptation Reporting Power (ARP), ports with responsibilities as Statutory Harbour Authorities (SHAs) including the Peel Ports Group (Peel Ports) were directed by the Secretary of State in 2010 to undertake climate change risk assessments (CCRAs). Peel Ports prepared and submitted their first Climate Change Adaptation Reports (CCAR) for the Mersey Docks and Harbour Company Ltd. (MDHC) and the Port of Sheerness Ltd. (PoSL) in 2011. Peel Ports did not submit CCRAs in the voluntary ARP second round (ARP2), but a combined update report was prepared for the subsequent voluntary ARP third round (ARP3). Peel Ports has proactively addressed the recommendations of these previous CCRAs, and this progress is discussed in **Section 2.0**.

Defra has again reached out to those ports with SHA responsibilities to provide an update to their CCRAs. Voluntary ARP Round 4 (ARP4) submissions have been requested by the end of December 2024, with the aim of meeting the following objectives of the UK Government:

- Support the integration of climate change risk management into the work of SHAs.
- Build government understanding of the level of preparedness to climate change at sectoral and national levels.
- Inform government's climate change risk assessment (CCRA4) and national adaptation plan.

This report comprises the Peel Ports response to the invitation to prepare a voluntary ARP4 submission. The previous ARP reports and related work completed by the Group since the ARP3 submission have been reviewed against the latest Defra guidance (ARP4 Guidance). This report sets out a review of the climate change risks identified in the previous reports and provides an update on the progress of Peel Ports Group in the management of these risks.

1.2 Organisational Profile

1.2.1 Peel Ports

As the second largest port group in the UK, Peel Ports handles over 70 million tonnes of cargo every year. This climate change adaptation report covers the Mersey Docks and Harbour Company Ltd. (MDHC) and the Port of Sheerness Ltd. (PoSL), which are the Group's two largest English ports, handling in excess of 10 million tonnes annually. The other English ports are Heysham, Great Yarmouth, the Manchester Ship Canal and the Humber Bulk Terminal.

Peel Ports, through MDHC and PoSL, is the Statutory Harbour Authority (SHA) and the Competent Harbour Authority (CHA) for both of these harbour areas. As SHA, Peel Ports is responsible for the management of navigational safety, the protection of the marine environment, and for all of the Group's

marine services, including pilotage, aids to navigation, tugboat operations, hydrographic surveying, dredging and vessel traffic services for ships and craft using the port.

MDHC's SHA area covers the Port of Liverpool including Liverpool and Birkenhead Docks, the approaches to the Manchester Ship Canal and the Port of Garston, illustrated in **Figure 1-1.** The SHA limits for PoSL extend from Allington Lock on the River Medway near Maidstone to a distance approximately five miles offshore into the Thames Estuary, as shown in **Figure 1-2**.

The CHA responsibilities, under the 1987 Pilotage Act, require MDHC and PoSL to provide pilotage within their areas of jurisdiction. It should be noted that risks to pilotage are considered by this report but are not necessarily undertaken within the same area of jurisdiction as the SHA.

Peel Ports is a commercial operator with other facilities in the northwest and across the UK. As such, MDHC and PoSL undertake a range of activities and operations. For this report, these wider duties have also been considered, in the context of the potential impact on the SHA and CHA responsibilities.

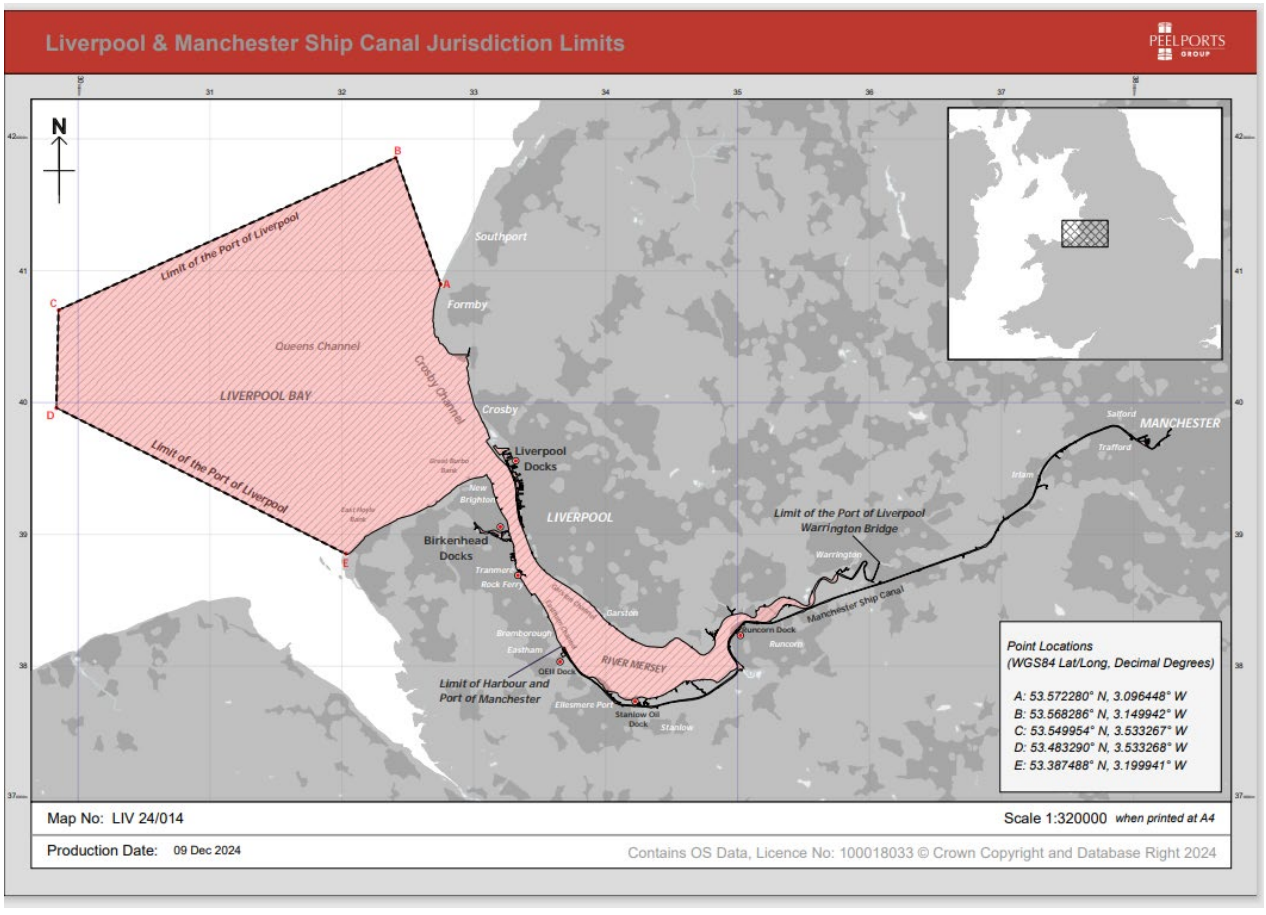


Figure 1-1: SHA area for the Mersey Docks and Harbour Company Ltd

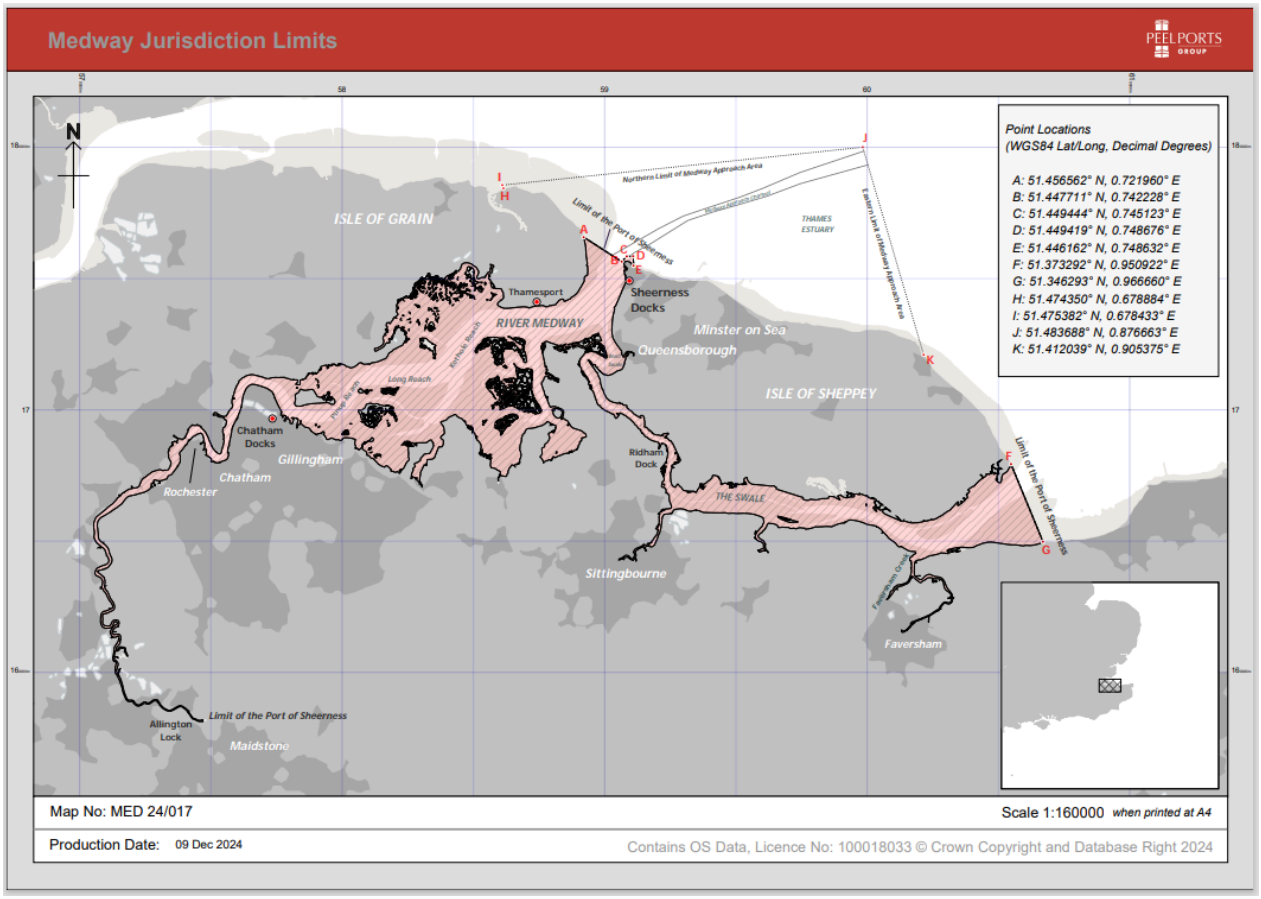


Figure 1-2: SHA area for the Port of Sheerness Ltd

1.2.2 Strategy, Governance and Management

Peel Ports understands its responsibility to minimise the environmental impact of its operations. The company continues to adapt its operations to provide sustainable, efficient port services, helping meet the needs of the future, and invests in ways to achieve this.

'Enabling the Future'[1] sets out the company's 5-year Environment, Sustainability and Governance (ESG) Strategy, which combines 12 commitments covering four of the UN's sustainable development goals[2]. Peel Ports also has a comprehensive Enviro 365 framework, establishing environmental management as a core business value, and the company's Environmental Policy includes statements relevant to the organisation's commitment to achieving climate resilience.

An annual ESG Plan is in place, which has a range of actions and targets for the year across a broad cross-section of environmental areas, with regular reporting against environmental performance parameters to the ESG Governance Committee. A strategic objective within this plan is that the climate change adaptation risk assessment will be developed into a prioritised action plan by 2025.

[1] *EnablingTheFuture (peelports.com)*

[2] *THE 17 GOALS | Sustainable Development*

Since ARP3, Peel Ports has made good progress with improving its governance relating to climate resilience. A Climate Change Policy has now been adopted, which states the Group's commitment to becoming a net zero port operator by 2040 at the latest. The policy makes the following statements relating to climate resilience and adaptation:

- Maintain focus, visibility and direction on climate change issues relevant to our business through the Climate Change Steering Group;
- Integrate climate change considerations into the business as a whole, for the purposes of adaptation and mitigation;
- Work with our current supply chain partners on these subjects, encouraging them to innovate and propose new products and services that acknowledge the requirements to adapt to and mitigate climate change impacts;
- Understand and report on our climate change risks and opportunities in order to ensure business resilience as conditions change; and
- Consider the use of nature-based solutions and adaptive management.

A Climate Change Steering Group (CCSG) has been formed and is chaired by the Managing Director Ports Services (MDPS). A Group Head of Sustainability has been appointed to support the MDPS integrate sustainability and climate risks & opportunities into business processes. The CCSG includes leaders from across the business and has the aim of driving progress in climate change adaptation and mitigation based on the working streams shown in **Figure 1-3.**

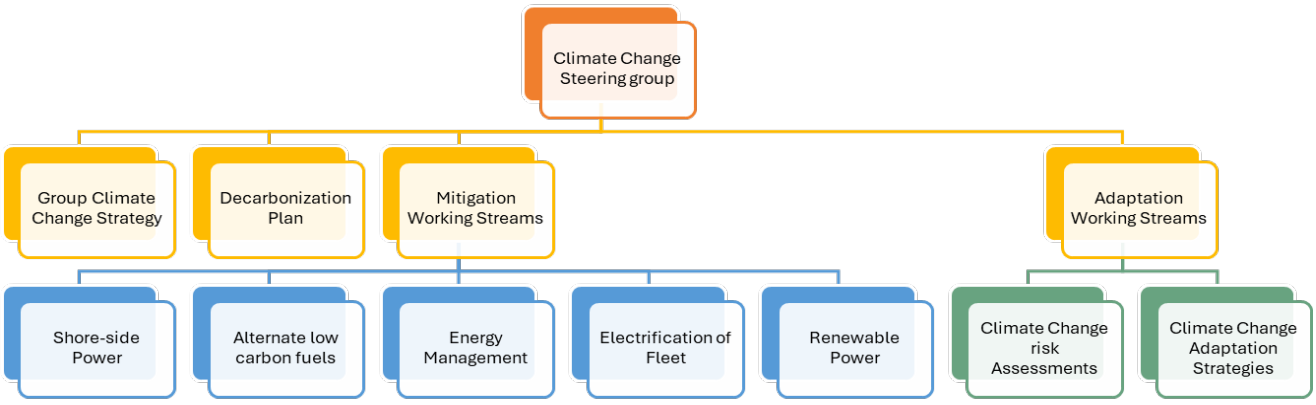


Figure 1-3: Climate Change Steering Group - structure and associated workstreams

The Group Marine Environmental Department develops and oversees the delivery of good environmental practice in relation to marine activities, ensuring local Marine Teams can meet their statutory responsibilities and comply with relevant marine environmental legislation.

The ongoing work to undertake climate change risk assessments and develop Local Adaptation Plans for all ports has broadly followed the relevant steps from the four-stage methodology described in the PIANC guidance 'Climate change adaptation planning for ports and inland waterways' (2020)[3] and considering the guidelines set out in ISO 14090 (2019) and ISO 14091 (2020). The national and international policy context for the 2023 Climate Change Risk Assessment for all ports is set out in the report for that project.

[3] *Climate Change Adaptation Planning for Ports and Inland Waterways - Pianc*

1.3 This Report

1.3.1 What's covered?

This adaptation report focusses on the following core SHA and CHA responsibilities of the MDHC and the PoSL, considering the wider port operations and how these might impact on those responsibilities.

- Conservancy, pilotage and vessel traffic services for ships and craft using the port
- Maintenance of navigational channels, moorings, lights and buoys
- Provision of hydrographic, tidal and other information, and
- Protection of the natural environment.

The geographical coverage of the report is shown by **Figure 1-1** and **Figure 1-2**.

The ARP4 Guidance recommends that organisations assess their climate risks based on the latest data. This report reviews and updates the climate change risk assessments undertaken for ARP3 in 2021, and the subsequent high-level Climate Change Risk Assessment (Screening Assessment) which was completed for all ports to inform statutory financial disclosure reporting (in accordance with the TCFD framework). For the Port of Liverpool, a Local Adaptation Action Plan has also been developed which has incorporated a more detailed site-specific review of the risks for that site. These risk assessments were all completed using the most recent UKCP18 climate projections data, considering a range of future scenarios and timescales. This ARP4 report also recognises the additional timelines and scenarios referred to in the ARP4 Guidance.

To provide relevant information for CCRA4, Defra have also requested that risks due to interdependencies are considered in greater detail than for previous ARP submissions. These types of risks, e.g. due to potential climate change impacts on the local and regional transport and utilities networks, were discussed in the ARP1 and ARP3 submissions. Upstream and downstream interdependencies with third-party organisations are considered explicitly in this review, as well as the interdependencies between SHA and CHA responsibilities and the wider port operations. **Section 2.3** includes a case study of a project to assess port interdependencies which was undertaken for Peel Ports by the University of Birmingham.

This report also includes a review of progress against the adaptation measures and monitoring recommended by the ARP3 report and provides brief case studies summarising work that has been undertaken since the previous ARP submission to progress the understanding and management of climate change risks.

Following this Introduction, this report is presented in three further sections. ***Section 2 – Progress since ARP3*** summarises the actions that have been undertaken since 2021, including relevant cases studies. ***Section 3 – Improved Understanding of Risks*** sets out the approach taken to the review of the risk assessment and summarises the findings, including identification of any gaps and discussion of interdependent risks. **Section 4 – *Adaptation Action Plan and Implementation*** summarises the approach being taken by Peel Ports to address the identified risks, identifying specific actions that are ongoing or recently completed.

1.3.2 What's not covered?

This report only addresses the physical climate change risks to the MDHC and the PoSL. Whilst the CCSG has overseen the completion of the Screening Assessment which assessed physical climate change risks for all Peel Ports sites across the UK and Ireland to inform financial disclosure reporting, this voluntary update report does not cover all ports.
Peel Ports has also commissioned an assessment of climate change transition risks, to better inform the Group's financial disclosures in accordance with the TCFD framework. This work is ongoing and therefore it is not included in this report.

This report summarises the actions that are currently ongoing to address the identified climate change risks for the MDHC and the PoSL. Comprehensive site-specific Adaptation Action Plans are in development for all ports and covering all port operations, including SHA and CHA responsibilities. These plans have been aligned with the ARP4 Guidance (Annex H, Action Logging and Monitoring), but are not reproduced in full here because they have a broader scope.

2 Progress since ARP3

2.1 Overview of ARP3 risk assessment

The ARP3 report submitted to Defra in December 2021[4] was prepared by Peel Ports and covered the MDHC and PoSL SHAs, focussing on the core SHA and CHA responsibilities.

The report broadly followed the four-stage methodology described in the guidance 'Climate change adaptation planning for ports and inland waterways' (PIANC, 2020). Climate change projections for parameters and processes relevant to the SHA and CHA responsibilities were obtained for the mid-term (30-50 years) and long-term (50-80 years) timeframes and for a range of climate change scenarios, to reflect the range in 'most likely' to 'plausible worst case' scenarios. The adequacy of the available data for the purposes of the risk assessment was assessed.

An initial high-level, likelihood-and-consequence review was completed, and an internal workshop held to discuss potential impacts categorised with a risk rating of 'Moderate' or 'High', which confirmed 22 priority impacts relating to the core SHA responsibilities. These impacts were subject to further assessment, and short term and possible longer-term responses were identified. The following impacts were categorised as 'High' risk:

- **Uncontrolled opening and possible structural damage to lock gates** due to sea level rise, extreme high-water levels/water level variation, overtopping, or extreme waves, impacting navigational safety and the loading / movement of products.
- **Structural damage to bollards** with vessel alongside due to overtopping or extreme waves.
- **Increased dredging and disposal requirements** if climate change affects sedimentation patterns.
- Berthing, quaysides and **marine operations compromised more frequently by overtopping** due to sea level rise and storms.
- **Reduced ability to board and recover pilots** due to more frequent extreme wave conditions or change in fog characteristics (Medway only).
- **Physical damage to protected habitats** resulting from erosion, deposition, submergence, etc. due to changes in sea level, storms or high flow rates.

The ARP3 report identified the following uncertainties and barriers to adaptation:

- Differences in the adequacy of the climate change projections on which the risk assessment is based, which was reflected in the level of confidence attributed to the individual risk ratings.
- The need for additional local monitoring and data collection to improve confidence and inform decision making, including local trends in relevant climate parameters or processes; data on the condition and performance of physical assets; and information about the characteristics, costs and consequences of extreme events.
- Some critical thresholds were yet to be established.
- The challenges in making a robust business case for major investment outside existing capital or maintenance programmes.

[4] *port-of-sheerness-mersey-docks-and-harbour-company-climate-change-adaptation-report-2021.pdf*

- More consideration needed to be given to the potential for cascading failures between interlinked natural and socioeconomic systems and sub-systems.
- The need to continue to strengthen engagement with staff, build capacity and mainstream climate change considerations across all departments.

2.2 Actions to improve understanding of risks

Since the submission of the ARP3 report in 2021, awareness of climate change issues and the need to take action has continued to gain momentum within Peel Ports, including establishing and embedding the clear strategy, governance and management processes described in **Section 1.2.2.** Various actions have been undertaken to address the uncertainties identified by the ARP3 report, which are described below.

A high-level Climate Change Risk Assessment (Screening Assessment) was commissioned to improve the understanding of physical climate change risks to all ports and inform the Group's financial disclosure reporting. The 2023 Screening Assessment reviewed the physical climate change risks to all port infrastructure and operations, rather than solely focusing on the SHA and CHA responsibilities. The latest UKCP18 data was used to inform the assessment, considering a full range of future scenarios and timescales from the short term to the far future. The 2023 Screening Assessment identified 27 priority risks, defined as those risks categorised as High or Extreme in the long-term timeframe (50 years, i.e. to 2073).

Subsequently, to improve local ownership of material considerations within the risk assessment, and enable proactive planning of mitigation measures, an Adaptation Action Plan has been developed for the Port of Liverpool. As a precursor to the development of this plan, a more detailed site-specific review has resulted in an improved understanding of the issues and consequences, which has reduced the number of priority risks from 27 to 21. The understanding of the requirements for risk management and mitigation has also been improved, which means that appropriate solutions are more likely to be resourced and implemented.

The 2023 Screening Assessment and the Adaptation Action Plan for the Port of Liverpool include the adaptation measures needed to address the identified priority risks. **The requirements for data collection and monitoring and further assessment to define critical threshold levels are more clearly defined by these documents.** In addition, the identification of priority risks and the improved understanding of the consequences of climate change impacts on port operations (including some financial analysis) will support the future development of business cases for investment in monitoring and other adaptation measures.

The potential for cascading failures between interlinked natural and socioeconomic systems and sub-systems has been recognised in the updated risk assessments. **Cascade effects to and from the port's hinterland are considered**, as well as those occurring within the port boundaries. In particular, this report now addresses the physical climate change impacts on the commercial operations of the ports which can affect the SHA and CHA functions, which were not included in the ARP3 report. A case study is included in **Section 2.3** summarising a report prepared by the University of Birmingham to inform understanding of interdependent climate change risk at the Port of Liverpool[5].

[5] *Syeda Anam Hashmi, Emma Ferranti, Jan Brooke and Andrew Quinn (2024) Assessing Interdependent Climate Change Risks in the Port Sector: A report to help inform understanding at the Port of Liverpool. Summary of key findings of University of Birmingham 2023 report to Peel Ports Group.*

The development of this report and the previous risk assessments has also benefitted staff engagement and capacity building, with further workshops, site visits and meetings with operational teams. Whilst it is recognised that climate change considerations are not yet mainstreamed in all operational processes across all departments, the Local Adaptation Plan has identified the requirements to achieve this.

2.3 Best practice case studies

The case studies on the following pages demonstrate investments that have been made by Peel Ports since ARP3 to improve understanding of climate change risk.

CASE STUDY: Development of a Local Adaptation Plan for the Port of Liverpool

An Adaptation Action Plan has been developed to provide a framework for the ongoing management of physical climate change risks to the Port of Liverpool. The plan, which acts as a pilot for future plans for the Group's other ports, has been developed with the aim of addressing the following strategic priorities:

- Use of the Screening Assessment outputs to inform development of the Local Adaptation Plan, focusing on the usability of the report for the individual port.
- Engagement with the local team to develop an Adaptation Plan that will be owned and implemented by the port.
- Improved understanding of the local risks due to physical climate hazards and help them to move forward with addressing those risks.
- Identification of practical solutions, which are risk-based and data driven.
- Inclusion of an appropriate timeline for implementing the identified resilience measures.
- Provision of GIS-based outputs to support future delivery of the Plan and monitoring of improvements.
- Development of a common structure which establishes how all ports need to be working in the context of climate risk.
- Setting of corporate standards for resilience so that compliance can be demonstrated over time.
- Consideration of recognised standards, e.g. ISO 14091.
- Establishment of a process which supports a learning from events approach relating to the impacts of physical climate change hazards, enabling the delivery of long-term resilience.

The Local Adaptation Plan report includes a review of existing processes capability and capacity, at group level and locally. The risk assessment is summarised for the Port of Liverpool and has been updated from the 2023 Screening Assessment based on more in-depth local assessment and discussions with the local operational teams. The Adaptation Action Plan is set out, with a supporting spreadsheet based on the ARP4 Guidance. The Adaptation Action Plan includes actions relating to:

- Governance and management processes
- Assessment of risks and impacts
- Implementation of Adaptation Solutions
- Monitoring of weather and climate change
- Progress evaluation and audit

Based on the findings from the development of the Local Adaptation Plan, an overarching Strategy is also in preparation. This will set out the principles of climate change risk management and adaptation for Peel Ports and be applicable to all ports. Local Adaptation Plans are to be prepared for all other port clusters in the UK and Ireland by the end of 2025.

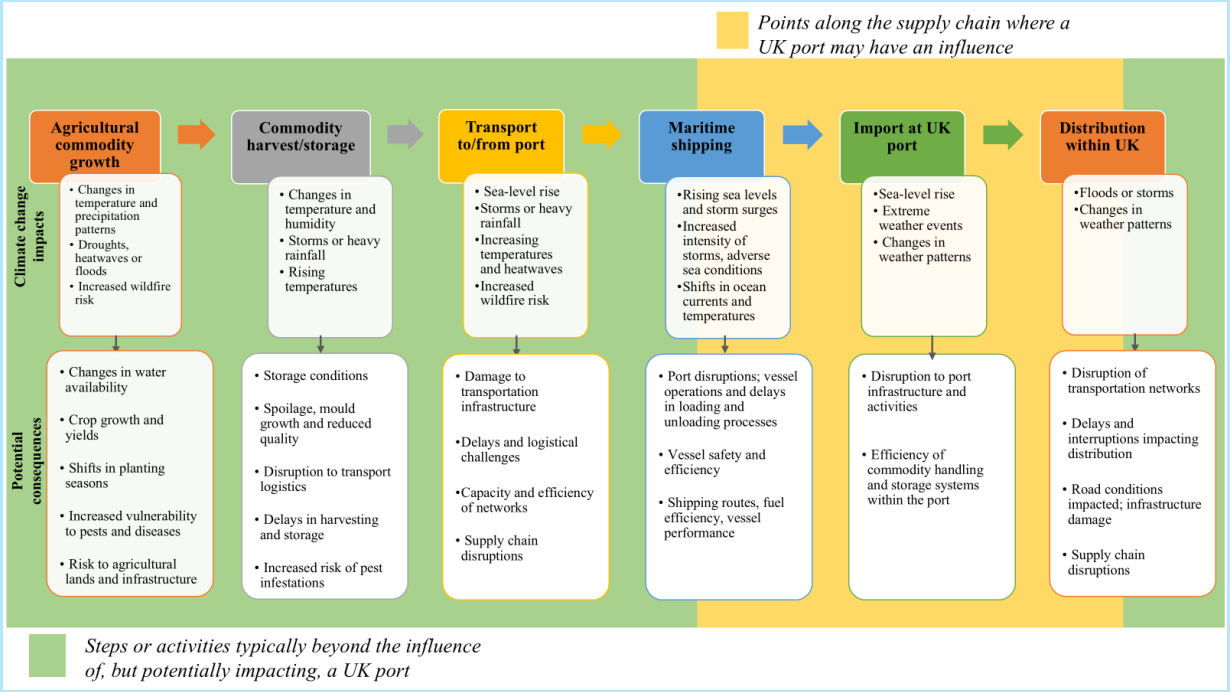
CASE STUDY: Climate change interdependencies[5]

Peel Ports' ARP3 report highlighted the need to identify, assess, and plan to respond to interdependent climate change-related risks. During 2023, Peel Ports therefore worked with the University of Birmingham on a project supported by an EPSRC IAA funding grant. The project aim was to improve understanding of how port operations could be impacted – directly or indirectly – if utilities and services (such as power, water supply, flood defence), inter-connected transport systems (road, rail, water), and/or wider supply chains are impacted by the changing climate. A particular focus was on exploring situations in which critical climate change adaptation decisions sit with third-party organisations. Understanding the nature and significance of such risks, including potential cascading effects and their possible consequences for port operations, is vital to effective adaptation planning.

The investigation identified functional, physical, spatial, economic, institutional and social interdependencies, ranging from the 'obvious' local dependence of certain port operations on the supply of power, water or telecommunications by third-party providers, to wider supply chain impacts. On the latter, both the degree of resilience of local and international transport networks, and the influence of other climate-related physical and socio-economic changes, were demonstrated to have potential implications for levels of preparedness and for the sustainability of certain port activities.

To assist with the identification of different supply chain risks, the study developed an interdependency mapping methodology. This enables the port to understand the potential cascading consequences of physical impacts, including those associated with extreme events. Responses can thus be identified in areas where the port has an influence.

Beyond this, as illustrated on the figure below, port customers may face other challenges as a result of the changing climate. While such challenges represent a less immediate risk than the effects of extreme weather events on port utility and service providers, they are important in the medium to long term because they are typically outside the influence and control of port operators. The methodology therefore also provides a useful tool to help inform future business planning.



CASE STUDY: Use of satellite data to inform dredging activities

A UK-first collaboration between Peel Ports, the National Oceanography Centre (NOC) and Channel Coastal Observatory (CCO) is using satellites to monitor coastal changes in a bid to create safer shipping navigation channels.

In a project funded by UK Space Agency Small Business Research (SBRI), the NOC is using its patented coastal mapping technology to support Peel Ports in building targeted dredging operations across the Mersey and Medway estuaries. This will provide greater insight into future changes to the marine environments – including those associated with the changing climate – around two of the UK's most important waterways. Peel Ports will use the data to ensure safer access to the Port of Liverpool and Port of Medway for arriving ships.

Traditionally, marine observation and maintenance is carried out using environmental surveys and annual dredging programmes, which come at high cost and provide limited data. The coastal mapping capabilities developed by the NOC will provide Peel Ports with accessible data which maps marine features, including challenging intertidal areas that see the most changes. As a result, Peel Ports will be able to identify issues, including trends in sediment dynamics that are potentially caused by climate change-related factors, and take action, where appropriate more quickly and effectively than before.

Gary Doyle, Group Harbour Master at Peel Ports: *"Like any statutory harbour authority, we have a duty to provide accurate timely navigational information. Understanding the dynamics across our sites, and publishing accurate information, is vitally important to us and all those who rely on the waterways under our responsibility. We are constantly evaluating new technologies and this project will provide information on adding an additional flexible asset to our inventory. It will also allow us to assess what impact it will have in support of our marine decarbonisation and adaptation plans.."*

Christine Sams, Head of Research Engagement, NOC: *"This collaboration is something that has never been done in the UK before and we are excited to provide valuable insight into the areas in which Peel Ports operates in. Not only will it give them a comprehensive overview of the Mersey and Medway estuaries, but it will also support Peel Ports to develop proactive dredging and maintenance strategies which will deliver a safer shipping environment for everyone."*

Charlie Thompson, Director, CCO: *"Using satellites is an evolution on traditional survey methods with the potential to bring unparalleled data that can inform the actions required when reviewing coastal maintenance of challenging intertidal areas. We're looking forward to supporting Peel Ports and the NOC to deliver this project."*

The SBRI's funding for this project came from its Unlocking Space for Business initiative, which offers applicants a share of £2m to combine terrestrial technologies with satellite data for transport, logistics, and financial services.

Buoy marking the edge of the Port of Liverpool approach channel, in its charted position, immediately after a severe storm, April 2024.

CASE STUDY: Development of Marine Biosecurity Plan

Climate change is altering natural abiotic conditions, reducing the resilience of native species to invasions and increasing the temperature range, enabling invasive non-native species (INNS) to establish and thrive in marine environments. The 2021 Progress Report to Parliament by the Climate Change Committee[6] highlighted INNS as a priority risk to terrestrial, freshwater, and marine habitats and species. The changing climate is likely to increase the extent and abundance of many INNS, making stressed habitats more vulnerable to invasion and disease[7]. Some scientists suggest that increased local management of INNS is critical to prepare for climate change[8].

In addition to threatening native biodiversity, some invasive non-native species pose a risk to port operations: compromising infrastructure integrity or operational efficiency for example by burrowing in riverbanks; fouling intakes and outfalls; or smothering equipment. The presence of such species in dredged sediment can also constrain disposal options. A heavily fouled vessel berthing in a new location could trigger a spawning event, significantly increasing the presence of INNS and therefore operational risks. With projections of rising sea temperatures, the impact on species establishment may become more profound, making ports in cooler regions more vulnerable to INNS invasions and serving as stepping stones for their spread[9].

In order to reduce some of the climate risks associated with INNS Peel Ports have produced a Marine Biosecurity Plan. This contains practical measures that can be implemented to reduce the risk of species transfer from day-to-day marine operational activities. Marine Biosecurity information notes have also been produced for common activities around the port and list best practice biosecurity measures that should be followed by both port and third-party operatives. Biosecurity conditions have also been added to some marine contracts. These measures help to reduce the likelihood of INNS transfer from marine operational activities and therefore reduce the marine biosecurity risk across our Statutory Harbour Authority areas.

[6] *2021 Progress Report to Parliament - Climate Change Committee*

[7] *NNSS. The Great Britain Invasive Non-Native Species Stratergy DRAFT . s.l. : DEFRA, 2022.*

[8] *Amherst, University of Massachusetts. Why Confronting Invasive Species is One of the Best Ways to Prepare for Climate Change, ECO Environment coastal and offshore. [Online, accessed 07-06-2022].*

[9] *BIMCO, International Chamber of Shipping. Biofouling, biosecurity and hull cleaning. Witherbys, 2022.*

3 Improved Understanding of Risks and Challenges

3.1 Approach to Review of Risk Assessment

To inform the preparation of this ARP4 report, the risk assessments completed for the 2023 Screening Assessment and the Local Adaptation Action Plan for the Port of Liverpool have been reviewed against the ARP3 report, to ensure that this report reflects the significant progress in the understanding of physical climate change risks that has been developed by Peel Ports since 2021. The updated risk assessment presented below therefore incorporates those risks to the wider port operations which may have a consequential or cascade impact on the SHA and CHA responsibilities to the MDHC and the PoSL. Risks to commercial operations that do not impact on statutory responsibilities are not included in this report.

The 2023 Screening Assessment and the update as part of the development of the Local Adaptation Action Plan for the Port of Liverpool were completed based on the process described in the PIANC guidance, as for the previous ARP reports. However, the focus of the recent risk assessment updates was different in that they considered the full commercial operation of the ports, including all landside and marine assets and operations.

The physical climate change risks to assets and operations at the MDHC and the PoSL were identified for each physical climate change hazard. The likelihood of occurrence (**Table 3-1**) and level of impact (**Table 3-2**) was assessed for each of the identified climate change risks, to determine the severity of risk (**Table 3-3**) resulting from the various combinations of likelihood and impact, as shown by the risk matrix presented in **Table 3-4.** Where a financial valuation of the risk was available, this was taken into account in the assessment of the level of impact, otherwise a qualitative assessment was undertaken.

Table 3-1: Risk Likelihood

Likelihood Rating	Description	Approx. average annual probability (AEP) of occurrence [return period]
5. Almost certain	The event is likely to occur numerous times in the timeframe under consideration	20% [1 in 5 years]
4. Likely	The event is likely to occur on several occasions in the timeframe under consideration	5% [1 in 20 years]
3. Moderate	The event is likely to occur on limited occasions in the timeframe under consideration	2% [1 in 50 years]
2. Unlikely	The event is likely to occur once in the timeframe under consideration	1% [1 in 100 years]
1. Very unlikely	The event is not expected to occur during the timeframe under consideration	0.1% [1 in 1,000 years]

Table 3-2: Level of Impact (Consequence)

Impact Rating	Description
5. Catastrophic	Permanent damage to the receptor requiring replacement of a major asset or resulting in a severe lasting effect on the port's ability to operate, and/or very significant adverse effect to the surrounding environment requiring remediation and restoration.
4. Major	Extensive damage to the receptor requiring major repairs and maintenance, or resulting in a significant impact on port operations, and/or significant adverse effect to the surrounding environment. Impact on operations is out with accepted risk profile but is not long-term.
3. Moderate	Limited damage to the receptor requiring maintenance or minor repairs or resulting in a limited short-term impact on port operations, and/or adverse effect to the surrounding environment. Impact on operations is within accepted operational risk profile.
2. Minor	Small and localised damage to the receptor and/or potential for slight adverse effect to the surrounding environment. Repair / maintenance costs can be managed within existing operational budgets.
1. Insignificant	No damage to the receptor. No adverse effect on the surrounding environment. No additional costs.

Table 3-3: Severity of Risk

Risk Severity	Description
5. Extreme	The hazard creates an **Extreme** risk where a *Catastrophic* impact would occur with a *Moderate* likelihood, or where a *Major* impact is almost certain. The impact to the business would be very significant, these risks may not be insurable and could be too large for the business to manage if the risk occurred. The risk should be examined in more detail to better define and quantity it. Plans should be developed to either reduce the likelihood to the hazard to *Unlikely* or to reduce the scale of the impact through adaptation.
4. High	The hazard creates a **High** risk where *Moderate* impacts are *Almost Certain* or *Major* impacts are *Moderately* likely and a *Catastrophic* risk is *Unlikely*. The impact to the business would be significant but should be insurable or could be managed if it occurred. The risk should be examined in more detail to better define and quantify it. Plans should be developed to reduce the exposure of the business to this hazard.
3. Moderate	The hazard creates a **Moderate** risk, *Minor* impacts are *Almost Certain*, *Moderate* impacts are *Likely*, *Major* impacts are *Unlikely* and *Catastrophic* impacts are *Very Unlikely*. The risk would be manageable within planned operations and insurance. Further investigation would help to better define the risk and to develop proportionate plans to reduce the exposure of the business to this hazard.
2. Low	The hazard has between an *Insignificant* to *Moderate* impact that when combined with an *Insignificant* to *Moderate* likelihood presents a **Low** risk that could be easily managed. Some further investigation to confirm the risk level of this hazard and mitigation planning should be developed but with a reduced priority and level of detail proportionate to the scale of this risk.
1. Very Low	The risk from this hazard is **Very Low** as its *Very Unlikely* and the consequence is *Insignificant*. This hazard could therefore be scoped out from further plans. Periodic re assessment should be undertaken to ensure that new information hasn't changed the assessment of this hazard.

Table 3-4: Risk Matrix

Likelihood	Impact				
	1. Insignificant	2. Minor	3. Moderate	4. Major	5. Catastrophic
5. Almost certain	2. Low	3. Moderate	4. High	5. Extreme	5. Extreme
4. Likely	2. Low	3. Moderate	3. Moderate	4. High	5. Extreme
3. Moderate	2. Low	2. Low	3. Moderate	4. High	5. Extreme
2. Unlikely	2. Low	2. Low	3. Moderate	3. Moderate	4. High
1. Very unlikely	1. Very Low	2. Low	2. Low	3. Moderate	3. Moderate

The revised risk assessment developed for this report has considered the climate change scenarios set out in **Table 3-5**, recognising the ARP4 guidance. The present-day, mid-century and end-of century timeframes have been considered, which represents an improvement on the ARP3 risk assessment which considered potential changes to the 2070s, for a range of scenarios.

Table 3-5: Climate change scenarios[10]

Climate Change Scenario			Near term, 2021 – 2040		Mid-term, 2041- 2060		Long term, 2081 - 2100	
SSP	RCP	Description	Best estimate (°C)	Very likely range (°C)	Best estimate (°C)	Very likely range (°C)	Best estimate (°C)	Very likely range (°C)
1	2.6	*Low emissions, Net Zero by 2075*	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
2	4.5	*Emissions maintained to 2050, >2°C warming by 2100*	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
5	8.5	*Emissions triple by 2100, warming of >4°C by 2100*	1.6	1.2 to 1.8	2.4	1.9 to 3.0	4.4	3.3 to 5.7

A detailed risk assessment spreadsheet was developed to document the full assessment process, which includes 132 specific risks. In preparation of this report, the risk assessment spreadsheet has been revised to better reflect the ARP4 Guidance (Annex H) template, and to reflect the timelines and scenarios referred to in the ARP4 guidance. The full spreadsheet is not provided with this report because it also covers risks which only relate to the commercial operation of the ports, as well as risks with a low or moderate risk rating which are not currently a priority. A summary of the risk assessment is provided in **Appendix A**, presenting the priority risks relating to the core SHA and CHA functions.

The risks included in **Appendix A** cover all risks identified in the ARP3 report, plus any additional risks identified by the 2023 Screening Assessment which could affect the core SHA and CHA functions and which have an overall risk rating of either High (4) or Extreme (5). Risks identified by the ARP3 report which have a Moderate risk rating are included in the table. The risk rating is provided for the mid-century and end of century scenarios, for RCP2.6, RCP4.5 and RCP8.5. The ARP3 risk rating is provided for comparison, noting that the ARP3 report focused on the potential for climate change impacts to occur by the 2070s.

[10] *The IPCC Sixth Assessment Report (AR6) - Met Office*

Appendix A presents an overall risk rating appropriate for both the MDHC and the PoSL. There are some differences between the specific risk assessment ratings for the MDHC and the PoSL which reflect the local geography and differences in the specific operations undertaken at each site, as well as other differences due to the completion of the risk assessment for the Port of Liverpool in a greater level of detail than the Medway ports. In general, the risk ratings for the PoSL are expected to align with those for the MDHC after further assessment has been completed.

The identified adaptation measures associated with each risk are provided in the summary risk register in **Appendix A.**

3.2 Risk Assessment Review

The ARP3 report identified 22 potential impacts on core MDHC or PoSL SHA and CHA responsibilities. No significant opportunities associated with the changing climate were identified in relation to these responsibilities. The summary risk assessment table provided in **Appendix A** includes 30 risks, which cover 42 of the specific risks identified in the full risk assessment spreadsheet. Where the same impact could occur due to multiple climate hazards, these risks have been combined.

3.2.1 Marine Infrastructure and Systems

Appendix A includes 13 risks relating to marine infrastructure and systems, reflecting the importance of the port infrastructure for effective operations. Compared to ARP3, a further seven risks have been added. These additional risks relate to damage or access restrictions to critical buildings or infrastructure caused by flooding, storms or high temperatures which could affect the delivery of the SHA and CHA functions.

Risks relating to sea level rise, increased storminess and high temperatures are generally rated as low (2) to moderate (3) in mid-century, increasing to high (4) or extreme (5) by the end of the century under the RCP4.5 and RCP8.5 climate change scenarios. Risk ratings are generally unchanged compared to ARP3, although more information is now provided on how the risks are expected to vary with time and climate change scenario.

Risks associated with flooding have a high confidence rating because the likelihood and consequences are quite well understood. Confidence in the risk assessment for impacts due to high temperatures and storms is lower because of uncertainties in the climate projection data and the need to improve the understanding of how the assets would be affected. The confidence rating has been reduced for some of the risks previously identified in the ARP3 report, because it is considered that further information is needed about how the receptor would be affected (e.g. potential for structural damage due to extreme wave or wind conditions). There are also uncertainties in the expected rate of change in some climate conditions, e.g. warmer water temperatures causing biofouling of structures.

The highest priority risk to marine infrastructure relates to the risk of uncontrolled opening and potential structural damage to the lock gates for both MDHC and PoSL. The gates to the Gladstone Lock were replaced in 2023 at a cost of approximately £10 million. This investment has reduced the likelihood of failure up to 2050. The overall risk of failure of the lock gates is assessed as Moderate in the short to medium term based on the adoption of the identified mitigation strategy. In the longer term, there remains a risk of catastrophic failure of these and other gates at both ports, which could

have significant impacts on commercial operations and affecting SHA responsibilities. Mitigation measures to better understand and address this risk include regular inspection, monitoring of water levels and recording any impacts that occur during extreme events, including consequential impacts such as downtime. It is recommended that the risk of failure and relevant threshold levels are assessed for all gates, including the risk of failure of multiple gates at the same time. A managed adaptive plan should be developed for replacement or improvement if and when required.

Regular condition assessment, monitoring of relevant climate change data and recording of incidents due to extreme weather events is also a recommended action for all other risks to marine infrastructure and systems. Assessment of structural condition and threshold levels for impacts is also recommended, to improve the understanding of asset vulnerability, enable operational plans to be updated and to plan for the repair or replacement of structures.

3.2.2 Marine operations, including pilotage and navigation

Eight risks relating to marine operations are included in Appendix A, with the following risk added compared to ARP3:

- Extreme high temperatures affecting staff welfare, which is now included because the timescale for the risk assessment has been extended to the end of the century.

Risks to marine operations can result from sea level rise, increased storminess and high temperatures, and are mainly rated as low (2) to moderate (3) in the mid-century, increasing to moderate (3) to extreme (5) by the end of the century. Risk ratings are generally unchanged compared to ARP3, although more information is now provided on how the risks are expected to vary with time and climate change scenario.

The confidence rating for most of these risks is unchanged compared to ARP3. The confidence associated with impacts on berthing and marine operations from sea level rise and increased storminess has been increased to High because the climate projections for these hazards and the expected impacts are well understood. A lower confidence is assigned to potential impacts on operational windows, because although the hazard is well understood, the thresholds for impacts and the associated consequences are yet to be confirmed.

Monitoring of relevant climate change data and recording of incidents due to extreme weather events, including consequential impacts such as downtime is a recommended action for the risks to marine operations. This will inform updates to operational plans, considering the threshold levels at which operations should be suspended for reasons of safety and staff welfare. Regular monitoring of bathymetry is also recommended, as well as the review of dredging requirements to ensure that safe access can be maintained. The Marine Biosecurity Plan will continue to be followed, monitoring for presence of non-native species and liaising with regulators to agree mitigation measures if required.

3.2.3 Dredging and disposal

There are three risks relating to dredging and disposal, resulting from sea level rise, increased storminess and temperature changes. All of these risks were identified in the ARP3 report. The likelihood and consequence of these risks is assessed as Moderate in the mid-century, increasing to Moderate (3) to High (4) by the end of the century. These risks could have potentially long-term

impacts on delivery of SHA duties, relating to pilotage and navigation, conservancy and protection of the natural environment. The confidence rating for these risk remains as low to medium because of uncertainties relating to how climate change will affect hydrographic and biological conditions, so ongoing monitoring is recommended to track any changes and improve understanding, including staff awareness of potential reputational risks.

3.2.4 Natural Environment, including Pollution

There are four risks relating to the natural environment, including the potential for an increased risk of pollution, which were identified in the ARP3 report. These risks are due to sea level rise and increased storminess causing flooding (resulting in pollution) or damage to natural habitats. Temperature changes could affect the water chemistry resulting in changes to the characteristic biology and associated potential for the introduction or spread of invasive non-native species.
The likelihood and consequence of these risks is assessed as Low (2) to Moderate (3) in the mid-century and may increase to Moderate (3) to High (4) by the end of the century. These risks could result in environmental damage and may have long-term impacts on delivery of SHA duties, as well as wider operational and reputational impacts.

The development and implementation of the Marine Biosecurity Plan (refer to case study in **Section 2.3**) means that proactive management of these risks is in place. However, the confidence rating for these risk remains as low to medium because of uncertainties relating to how climate change will affect hydrographic and biological conditions. Ongoing monitoring is recommended to track any changes and improve understanding.

3.2.5 Interdependent and cascading risks

The two interdependency risks included in **Appendix A** relate to potential impacts on water users due to changes in water chemistry and biology, and climate change related impacts on the wider transport network affecting access to and from the ports.

The risk to water users is assessed to be low in the medium to long term. This risk rating has been reduced compared to ARP3 because the likelihood and consequence is currently considered to be relatively low compared to other risks. However, the confidence rating is low, which means that the risk rating could increase in future with better understanding of the relevant climate projections and the associated impacts.

Climate change impacts on the transport network could result in significant consequences for port operations, which may also affect the ability to deliver the core SHA and CHA functions. Due to the high consequences, the risk rating has been increased compared to ARP3 and is now assessed as Moderate (3) in the mid-century, increasing to High (4) at the end of the century. The confidence rating has been reduced to medium, because of the need to improve the understanding of the specific risks to the transport network, the resilience plans that the infrastructure operators have in place, and what this could mean in relation to port access.

The ARP3 report identified that there are risks to port operations relating to the utilities networks that supply the sites with gas, electricity and water. Whilst these risks are recognised as having potentially significant impacts on operations, they are not included in the ARP3 risk assessment tables or in this update because of the Moderate (3) long-term risk rating. This is due to the likelihood of occurrence

and a relatively good resilience of the ports against this risk, e.g. more than one power feed and the increasing installation of renewable energy sources.

The research project by Birmingham University will facilitate a more informed approach to the identification and assessment of interdependencies. Interdependent risks will be managed by continuing to engage with the responsible authorities and improving understanding of their resilience plans. This will inform improvements to the site emergency response plans. Staff awareness will be raised regarding potential reputational risks.

3.2.6 Identification of gaps in the risk assessment

Lack of certainty

As discussed in **Sections 3.2.1 to 3.2.5**, the level of confidence in the risk assessment varies, due to the adequacy of the climate change data and the understanding of the vulnerability of the affected assets, systems and operations.

It is not certain how climate change will manifest at a local level and there is low confidence in how climate change will affect certain parameters, such as storms and fog. Climate projections and techniques for monitoring and measuring the impact of climate change are undergoing a process of continuous improvement; for example there is now increased confidence in the projections related to extreme temperatures and extreme precipitation compared to the data used for the ARP1 risk assessment.

It is expected that the level of confidence in the climate change projections will increase over time. The UKCP climate projections data are regularly updated, with this risk assessment based on the most current dataset.

Quantified data on financial impacts and critical thresholds

Data relating to the potential costs, including due to downtime-related disruption, associated with climate change risks remains a gap in the assessment. For example, information about operational downtime due to flooding, extreme storms or heatwave events and the associated financial implications would enable better quantification of the risk assessment and would support the business case for investment in resilience. Data relating to navigation or pilotage restrictions or other specific impacts on SHA responsibilities would better demonstrate the high significance of these risks.

Relevant information is likely to be available from data already collected within the organisation. However, this data has not been collated or reviewed to evaluate its completeness and appropriateness to the quantified assessment of climate risk. It is currently difficult to map financial data related to repairs and reduced productivity against weather or climate events. The benefits of understanding this data in the context of climate resilience is now understood, and Peel Ports intends to progress the recording of operational downtime and associated economic losses for future extreme weather events in the near future.

Whilst the potential risk of flooding was quantified as part of the 2023 Screening Assessment and has been enhanced for the Local Adaptation Action Plan for the Port of Liverpool, these assessments have been undertaken at a relatively high level. Post-event data from large weather events, such as the extent and duration of inundation from storm tides and flooding, would be useful to validate the predicted flood extents.

For some of the potential impacts identified in **Appendix A**, the critical threshold above which an impact would be expected to occur or at which a risk becomes unacceptable has yet to be defined. This issue was identified in the ARP3 report and continues to be an action which needs to be progressed in the short term, particularly in relation to impacts associated with high temperatures and wind/waves, and the elevation of some critical infrastructure such as electrical control panels. Improved understanding of the condition and performance of physical assets and how this relates to their vulnerability to climate change would also enhance the risk assessment.

Interdependencies

This ARP4 update demonstrates the progress that has been made in the understanding of interdependencies and cascading risks within the port through the consideration of those risks associated with wider commercial operations which could affect the core SHA and CHA functions. In addition a partnership research project has been completed with the University of Birmingham to improve understanding of port infrastructure interdependencies (case study included in **Section 2.3)**.

Peel Ports continues to engage with relevant stakeholders for the wider area associated with the MDHC and the PoSL, particularly in relation to emergency planning for the Port of Liverpool, and flood protection (Environment Agency) and road access (Highways Agency and Local Authority) for Sheerness. More specific engagement with utilities, local authorities and the Highways Agency in relation to their own risks and adaptation and resilience planning would help to achieve an improved understanding of the interdependent risks. Further engagement is also needed with tenants and adjacent landowners to better understand the inter-related risks to and due to their operations.

Summary of progress in addressing gaps in the risk assessment

In summary, the work undertaken since ARP3 has made the following progress in addressing the previous gaps in the risk assessment:

- A strengthened risk assessment, including quantified assessment of flooding impacts, has improved the understanding of risk and supports the business case justifying future investment in data and monitoring.
- Governance established to enable risk management actions to be implemented.
- The updated risk assessment recognises internal cascade effects whereby impacts on wider port infrastructure and operations can affect the delivery of the core SHA and CHA functions.
- The University of Birmingham research project has improved the understanding of upstream and downstream interdependencies (refer to **Section 2.3**).
- Development of a Marine Biosecurity Plan (refer to **Section 2.3**) will support the management of climate change risks relating to the introduction or transfer of invasive non-native species.
- Improved clarity on the future requirements for data and monitoring relating to the SHA functions, identifying the local hydro-meteorological and oceanographic data needed to understand local trends.
- Identification and implementation of new approaches to monitoring, such as the use of satellite data to inform dredging requirements (refer to **Section 2.3**).

Short-term actions to address shortfalls and uncertainties

The following further improvements in addressing the shortfalls and uncertainties in the risk assessment are expected in the short to medium term based on actions which are already progressing or have been identified as a priority:

- The confidence assigned to the risk assessment for the MDHC is typically higher than for the PoSL, because of the more detailed investigations that have been completed for MDHC. Subject to any differences in local physical conditions and relevant operations, it is expected that the risk ratings for the PoSL will be comparable with those for the MDHC on completion of the Local Adaptation Plan for the Port of Sheerness.
- The development of Local Adaptation Plans for all ports in the UK and Ireland over the next year, beginning with the PoSL, will build capacity across the Group in the understanding of physical climate change risks and what needs to be done to address these, including site-specific requirements for data and monitoring to inform the understanding of consequences, and the identification of critical thresholds.

Depending on the solutions that are identified for each location, the next steps would be to develop proportionate management responses, taking an adaptation pathways approach. Adaptation pathways describe sequences of actions that can be implemented progressively, depending on how the future unfolds and how knowledge improves. These pathways can include the implementation of appropriate short-term, interim or temporary interventions while longer-term (and sometimes more complex and/or costly) responses are developed. This approach will enable the ports to take initial action to be taken while work to reduce uncertainty is ongoing.

4 Adaptation Action Plan and Implementation

The ARP3 report set out potential responses to climate change impacts that were expected to be required in the short-term, as well as options to be considered in the future depending on various factors, including further assessment and monitoring. Possible responses included not only physical/structural measures but also social/operational or institutional interventions, in line with the recommendations of the IPCC Adaptation Needs and Options report (IPCC, 2014). It was expected that some of the responses would be delivered via existing or new Standard Operating Procedures (SoPs) whilst others represent new actions or require supplementary activity such as additional monitoring.

The preparation of the 2023 Screening Assessment and the development of the Local Adaptation Plan for the Port of Liverpool has resulted in an improved understanding of the adaptation actions needed to address the priority risks, which has also clarified the objectives of Peel Ports for climate change risk management and adaptation. Local Adaptation Action Plans have been developed based on the ARP4 Guidance (Annex H, Action Logging and Monitoring), which links actions to the risks that they address and identifies the action owner and timeline for implementation.

Based on the Group's overall adaptation strategy, the Local Adaptation Action Plans focus on the following priority areas. The aim is that the identified actions will reduce the risk rating for all priority risks to Moderate (3) or lower for a climate change scenario of 2°C of warming by 2100.

- Governance and management processes
- Further assessment of risks and impacts
- Data and monitoring
- Identification and implementation of adaptation solutions
- Contingency planning
- Communication and capacity building
- Evaluation and learning from incidents

Recently completed and ongoing actions relating to the priority risks identified in this report are summarised in **Table 4-1.**

Table 4-1: Recently completed and ongoing actions

Action	Type of Action	Financial Year	Status
Establish Climate Change Steering Group	Governance	July 2021	Complete
Appoint Group Head of Sustainability	Governance	February 2022	Complete
Establish ESG Committee	Governance	March 2022	Complete
Develop ESG Strategy	Governance	March 2023	Complete
Complete risk screening for all port clusters	Risk Assessment	March 2023	Complete
Financial Disclosure Reporting	Governance, Risk Assessment	2023	Complete

Action	Type of Action	Financial Year	Status
Marine Biosecurity Action Plan	Governance, Capacity Building, Action Planning	2024	Complete
University of Birmingham Assessment of Interdependent Climate Change Risks in the Port Sector	Risk Assessment, Capacity Building	2024	Complete
Develop Local Adaptation Plan (Port of Liverpool)	Governance, Management Processes, Risk Assessment, Action Planning, Capacity Building	2025	Complete
Improved coastal flooding risk assessment (Port of Liverpool)	Risk Assessment	2025	Complete
Development of Climate Risk GIS (Port of Liverpool)	Risk Assessment, Capacity Building	2025	Complete
Local Adaptation Action Plan (PoSL)	Governance, Management Processes, Risk Assessment, Action Planning, Capacity Building	Mid-2025	Ongoing
Local Adaptation Action Plan (other port clusters)	Governance, Management Processes, Risk Assessment, Action Planning, Capacity Building	End 2025	Ongoing

Appendix A

Risk Assessment Summary Table

Risk ID [11]		Climate variable	Hazard	Risk description	Impact / receptors	Risk rating					Confidence		Mitigation measures	Risk following mitigation
ARP4	ARP3					ARP3	ARP4				ARP3	ARP4		ARP4
						2070s	2050s (RCP4.5)	2100 (RCP2.6)	2100 (RCP4.5)	2100 (RCP8.5)				2100s (RCP4.5)
Marine Infrastructure & Systems														
CF10	4.1.1	Sea level rise, storminess	Infrastructure / equipment failure	Extreme high-water levels result in uncontrolled opening and possible structural damage to lock gates. Severe damage could have significant operational impacts.	Navigation, Loading / Movement of Cargo, Marine Operations, Safety	H	4	4	4	5	High	High	Monitor water levels. Record impact of extreme events including consequential impacts e.g. downtime. Regular inspection. Assess structural condition and failure risk, including risk of combined failure of multiple gates. Develop adaptive management plan to improve / replace if required, considering alternative management approaches.	3
AvT6	4.1.2	Temperature	Changing environmental conditions	Warmer water temperatures leading to increased biofouling of dock, local structures, equipment, ladders, etc.	Maintenance Activities, Biodiversity, Cost	M	2	2	2	3	Medium	Low	Regular condition assessment, monitor biofouling and how this is changing. Review site-specific temperature sensitivity. Assess temperature thresholds for maintenance to reduce risk of biofouling.	2
Wa5	4.2.1	Storminess	Severe wave conditions	Severe wave conditions cause damage to structures (e.g. lock gates, piers, bollards with vessels alongside). Potential long-term operational impacts until damage is repaired.	Operational Efficiency, Safety, Cost	H	4	4	4	5	High	Medium	Record any damage incidents. Regular condition assessment. Assess risk of structural damage and review improvements required. Consider future conditions in design of replacement structures.	3
SL8, SL9	4.3.1	Sea level rise	Infrastructure/ equipment failure	Sea level rise, potentially resulting in a change in bathymetry, restricts access for maintenance or reading of monitoring/communications systems. Potential impacts on navigation safety if systems fail.	Maintenance Activities, Cost	M	2	3	3	3	High	Medium	Monitor bathymetry changes. Record any issues arising. Review potential impact of SLR on access. Revise operational plans if required.	2
OC3	4.3.2	Sea level rise, storminess	Sediment transport	Change in bathymetry compromising equipment configurations; impact on reading of equipment/ reliability of data. May require rapid and/or sustained response to maintain navigational safety.	Navigational Safety, General Operations	M	3	3	3	3	Low	Low	Monitor bathymetry changes. Record any issues arising. Review potential impact of climate change on bathymetry and equipment configurations. Revise operational plans if required.	3

*[11] Hazard Abbreviations used in Risk ID: **CF** (Coastal Flooding); **AvT** (Average Temperature Increase); **Wa** (Extreme Wave Conditions); **SL** (Sea Level Rise); OC (Other Chronic Risk); **FF** (Fluvial Flooding); **PF** (Pluvial Flooding; **R** (Change in Average Precipitation); **H** (Extreme High Temperatures); **D** (Drought); Wi (Extreme Wind Conditions); **AvW** (Increase in Average Wave Height);*

Risk ID [11]		Climate variable	Hazard	Risk description	Impact / receptors	Risk rating					Confidence		Mitigation measures	Risk following mitigation
ARP4	ARP3					ARP3	ARP4				ARP3	ARP4		ARP4
						2070s	2050s (RCP4.5)	2100 (RCP2.6)	2100 (RCP4.5)	2100 (RCP8.5)				2100s (RCP4.5)
CF3	4.3.3	Sea level rise, storminess	Coastal flooding	Coastal flooding causes damage to or failure of telemetry, MET, M&E, or physical systems and utilities (marine or terrestrial).	Navigational Safety, General Operations, Cost	M	3	3	3	3	Medium	Medium	Improve understanding of assets and their vulnerability. Record any incidents and consequential impacts. Make infrastructure more resilient e.g. raise control cabinets above flood levels. Assess supply chain for options. Focus on critical/hard to repair systems.	3
CF1, FF1, PF1, FF6, PF6, PF9, SL2, SL3, Wa1	N/A	Sea level rise, storminess	Coastal flooding, Severe Waves	Coastal/ fluvial/ pluvial flooding damages buildings/ infrastructure, including historic structures. Risk increased with sea level rise, extreme waves or if drainage is overwhelmed / tide locked.	Buildings / Infrastructure damage, General Operations	N/A	3	4	4	4	N/A	High	Record flood incidents and damage/ downtime. Undertake risk assessments for at risk structures. Improve building resilience. Change building use so it is less vulnerable. New buildings in locations not at risk. Assess site-specific overtopping risk. Review if overtopping protection is required. Improve understanding of combined flood risk / drainage capacity.	3
CF4, PF4, Wa1, SL2, R3	N/A	Sea level rise, storminess	Coastal flooding, Severe Waves	Coastal/ pluvial/ fluvial flooding or extreme rainfall damages electrical substations and/or service ducts causing damage to electrical infrastructure, power loss and major impact on IT systems and operations. Risk increased with sea level rise, extreme waves or if drainage is overwhelmed / tide locked.	General Operations	N/A	3	4	4	4	N/A	High	Record flood incidents and damage/ downtime. Improve understanding of vulnerability of electrical/IT assets to flooding. Assess site-specific overtopping risk and whether direct protection is required. Make infrastructure more resilient e.g. raise control cabinets above flood levels. Focus on most critical systems. Design replacement systems to deal with future flooding risk.	3
CF6, Wa1, SL2	N/A	Sea level rise, storminess	Coastal flooding	Coastal flooding restricts access within the port, causing operational downtime or affecting cargo movement. Risk increased with sea level rise, extreme waves or if drainage is overwhelmed / tide locked.	Loading / Movement of Cargo, General Operations	N/A	3	4	5	5	N/A	High	Record flood incidents and damage/ downtime. Assess transport routes against coastal flood risk, determine if protection is required. Understand safe depths for pedestrians and vehicles.	3

Risk ID [11]		Climate variable	Hazard	Risk description	Impact / receptors	Risk rating					Confidence		Mitigation measures	Risk following mitigation
ARP4	ARP3					ARP3	ARP4				ARP3	ARP4		ARP4
						2070s	2050s (RCP4.5)	2100 (RCP2.6)	2100 (RCP4.5)	2100 (RCP8.5)				2100s (RCP4.5)
													Review emergency management plans. Develop mitigation e.g. change layout.	
H3	N/A	Temperature	Overheating due to high temperatures	Extreme high temperatures affect the operation of lock gates or lifting bridges.	Infrastructure damage, General operations	N/A	3	3	4	4	N/A	Medium	Record any incidents and consequential impacts incl. downtime. Assess which assets could be affected by high temperatures and define threshold levels. Update safety / operational plans to account for temperature risks. Consider risk in design of replacement equipment.	3
H4	N/A	Temperature	Overheating due to high temperatures	Extreme high temperatures damage control/ telecoms infrastructure.	Infrastructure damage, General operations	N/A	3	3	4	4	N/A	Medium	Record any incidents and consequential impacts incl. downtime. Assess which assets could be affected by high temperatures and define threshold levels. Update safety/ operational plans to account for temperature risks. Consider risk in design of replacement equipment.	3
SL4	N/A	Sea level rise	Infrastructure/ equipment failure	Sea level rise, high tides and storms increase hydrostatic loading on infrastructure, increasing failure risk.	Infrastructure damage	N/A	3	3	4	4	N/A	Medium	Record any incidents and consequential impacts incl. downtime. Review structural stability and strength of retaining structures. Reflect impact of SLR in plans/design for replacement structures	3
D1	N/A	Precipitation, temperature	Drought	Extreme low water levels affects structural stability of quays. Potential long-term operational impact until damage is repaired.	Infrastructure damage	N/A	3	3	3	3	N/A	Medium	Record any incidents and consequential impacts incl. downtime. Review likelihood of extreme low water levels at a site level. Understand which structures are at risk of failure.	3

Risk ID [11]		Climate variable	Hazard	Risk description	Impact / receptors	Risk rating					Confidence		Mitigation measures	Risk following mitigation
ARP4	ARP3					ARP3	ARP4				ARP3	ARP4		ARP4
						2070s	2050s (RCP4.5)	2100 (RCP2.6)	2100 (RCP4.5)	2100 (RCP8.5)				2100s (RCP4.5)
													Plan for extreme low water levels in design of replacement structures.	
Marine Operations, including Pilotage & Navigation														
CF11	5.2.1	Sea level rise, storminess	Coastal flooding	Berthing, quaysides and marine operations compromised more frequently due to overtopping (sea level rise plus storms).	Marine Operations	H	3	4	5	5	Medium	High	Record any incidents and consequential impacts incl. downtime. Assess wave and overtopping risk to marine operations at a site level. Review operational plans considering thresholds for suspending operations.	3
Wa2, Wi1, Wi4, AvW3	5.2.2	Storminess	Severe waves	Severe wind and wave conditions impact on marine operations, including reduced operational windows (e.g. pilotage, docking/ berthing, ferry services, loading/ unloading).	Marine Operations, Pilotage, Navigation, Safety	H	3	4	4	4	High	Medium	Record any incidents and consequential impacts incl. downtime. Assess (future) wind and wave conditions and risk to marine operations at a site level. Review operational plans considering thresholds for suspending operations.	3
SL7	5.2.3	Sea level rise	Infrastructure/ equipment failure	Sea level rise reduces operational range of berthing infrastructure, slipways, ramps and pontoons.	Marine Operations	M	3	3	4	5	Medium	Medium	Record any incidents and consequential impacts incl. downtime. Review impact of SLR on berthing infrastructure. Plan for replacement where required.	3
OC8	7.1.1	Sea level rise, storminess	Sediment transport	Sea level rise / increased storminess changes the sedimentary regime/ bathymetry affecting navigation and access to marinas, etc.	Navigation	M	2	3	3	3	Low	Low	Monitor changes to bathymetry. Record any impacts on navigation or access. Review dredging requirements to maintain safe access.	2
OC7	7.1.2	Temperature	New invasive species	Changing climatic conditions result in introduction/spread of invasive alien species, with environmental impact.	Navigation, Conservancy, Biodiversity	M	3	4	4	4	Medium	Medium	Continue monitoring for presence of non-native species. Liaise with regulators to agree mitigation measures.	3

Risk ID [11]		Climate variable	Hazard	Risk description	Impact / receptors	Risk rating					Confidence		Mitigation measures	Risk following mitigation
ARP4	ARP3					ARP3	ARP4				ARP3	ARP4		ARP4
						2070s	2050s (RCP4.5)	2100 (RCP2.6)	2100 (RCP4.5)	2100 (RCP8.5)				2100s (RCP4.5)
				May have long-term impact on navigation/operations and reputational damage.										
H1	N/A	Temperature	Heatwave	Extreme high temperatures affecting staff welfare, requiring more frequent breaks, PPE etc.	Staff Welfare, General Operations	N/A	3	3	3	4	N/A	High	Record impacts of heatwaves including downtime. Formalise operational plans recognising requirements for staff welfare in high temperatures.	3
Wi3	N/A	Storminess	Severe winds	High winds cause ships to become lodged within canals or rivers, resulting in delays or blockages.	Navigation, Marine Operations	N/A	2	2	3	3	N/A	Medium	Record any incidents and consequential impacts incl. downtime. Review operational management plans, considering (future) threshold levels for suspending vessel movements.	3
D4	N/A	Precipitation, temperature	Drought	Drought can lead to water supply shortages, affecting the port's ability to provide essential services, e.g. fire protection, sanitation, vessel maintenance.	General Operations, Safety	N/A	2	2	3	3	N/A	Low	Record any incidents. Consider reducing high water usage activities during droughts. Investigate increased on-site water storage and recycling to improve resilience.	2
Dredging & Disposal														
OC4	5.1.1	Sea level rise, storminess	Sediment transport	Increased dredging and disposal requirements if changes in hydrographical conditions affect patterns of sedimentation. May require rapid/sustained response to maintain navigational safety. Disposal capacity may be limited, with additional impacts if this is exceeded.	Dredging, Navigation, Cost	H	3	4	4	4	Low	Low	Undertake regular bathymetric surveys and geomorphological reviews to identify any changing patterns. Consider sediment modelling if changes are noted. Improve understanding of disposal capacity constraints.	3
Wa4	5.1.2	Storminess	Severe wave conditions	Severe wave conditions limit operational windows for dredging or disposal.	Dredging, Navigation	M	3	3	3	3	Low	Medium	Record any incidents and consequential impacts incl. downtime. Assess (future) wave conditions and risk to marine operations at a site level. Review operational plans	3

Risk ID [11]		Climate variable	Hazard	Risk description	Impact / receptors	Risk rating					Confidence		Mitigation measures	Risk following mitigation
ARP4	ARP3					ARP3	ARP4				ARP3	ARP4		ARP4
						2070s	2050s (RCP4.5)	2100 (RCP2.6)	2100 (RCP4.5)	2100 (RCP8.5)				2100s (RCP4.5)
													considering thresholds for suspending operations.	
OC5	5.1.3	Temperature	New invasive species	Dredging disposal options compromised if warming increases presence of invasive non-native species in dredged sediment. May have long-term impact, on navigation/ operations and reputational damage.	Dredging, Navigation, Biodiversity, Cost	M	3	4	4	4	Low	Low	Continue sediment monitoring. Liaise with regulators to agree mitigation measures.	3
Natural Environment and Pollution														
CF5	6.1.1	Sea level rise, storminess	Coastal flooding	Coastal flooding causing damage to fuel stations / waste reception facilities, causing damage to infrastructure and/or environmental impacts. Requiring remediation, reputational impact.	Natural environment (pollution)	M	3	3	3	3	Medium	Medium	Record any incidents. Assess site facilities and potential for pollution migration. Consult with Local Authority, Environment Agency. Consider modifications to infrastructure to reduce risk of future impacts.	3
OC11	8.1.1	Sea level rise, storminess	Other	Physical damage to protected habitats (erosion, deposition, submergence) due to changes in sea level, extreme waves, storminess or high flow rates. Affecting statutory responsibilities and reputation.	Natural environment	H	3	3	3	3	High	Low	Continue monitoring. Stakeholder engagement, awareness to manage reputational risk. Explore habitat enhancement options.	3
OC12	8.1.2	Temperature	Other	Changes in characteristic biology due to increased water temperature resulting in changes to water chemistry (salinity, acidity) with potential for environmental damage.	Biodiversity	M	3	3	3	3	Low	Low	Continue monitoring. Stakeholder engagement, awareness to manage reputational risk.	3
OC7	8.1.3	Temperature	New invasive species	Changing climatic conditions result in introduction/spread of invasive alien species. Causes environmental damage and/or affecting ability to undertake HA Statutory Duties, with wider operational and reputation impacts.	Marine Operations, Biodiversity	M	3	4	4	4	Medium	Low	Continue monitoring. Liaise with regulators to agree mitigation measures. Awareness to manage reputational risk.	3
Interdependencies														

Risk ID [11]		Climate variable	Hazard	Risk description	Impact / receptors	Risk rating					Confidence		Mitigation measures	Risk following mitigation
ARP4	ARP3					ARP3	ARP4				ARP3	ARP4		ARP4
						2070s	2050s (RCP4.5)	2100 (RCP2.6)	2100 (RCP4.5)	2100 (RCP8.5)				2100s (RCP4.5)
OC10	7.1.3	Temperature	New invasive species	Potential health risks for water users associated with climate change-induced effects on water chemistry or biology e.g., algal blooms, jellyfish. Implications for environment and reputation.	Biodiversity, Safety (public)	M	2	3	3	3	Low	Low	Continue monitoring. Liaise with regulators to agree mitigation measures. Awareness to manage reputational risk.	2
CF7, FF8	7.2	Sea level rise, storminess	Coastal flooding	Coastal, fluvial or pluvial flooding causes (external) road/rail closure or damage, with impacts for movement of cargoes/ equipment/ people.	General Operations, Loading / Movement of Cargo	M	4	4	4	4	High	Medium	Assess flood risk to transport routes. Liaise with Highways and Rail Authorities and Environment Agency over their resilience plans. Develop plans to manage events e.g. keeping staff on site, alternative routes, emergency storage. Risk may be reduced with improved understanding and management plans but requires further assessment.	3