PORT OF DOVER

CLIMATE CHANGE ADAPTATION REPORT 2015

Contents

1.0 Introduction

The Port of Dover's Climate Change Adaptation Report (2015) has been undertaken in response to the Department for Environment, Food and Rural Affairs', (Defra) request, under their Adaptation Reporting powers, for a report on progress in planning for climate change. As a statutory undertaker and a critical service provider, the Port actively engages in this process as a commitment to ensure a robust approach is maintained towards providing a resilient part of the United Kingdom's and Europe's transport infrastructure. This updated report follows the first Climate Change Adaptation Report (2011) and reviews the mitigation and adaptation measures proposed to improve the Port's resilience to climate change.

1.1 Background

The Climate Change Act (2008) conferred powers to the Secretary of State to direct certain "reporting authorities" to produce reports which evaluate their risks from climate change and to provide details of their adaptation strategy towards these risks. The Adaptation to Climate Change (ACC) cross-government body highlighted the Port of Dover as being a significant provider to the UK economy, handling 2.5 million freight vehicles and £100 billion of trade. The Dover Harbour Board (DHB), as the responsible body for the Port of Dover, falls under the definition of "reporting authorities" and therefore was required to pass on to government a Climate Change Adaptation Report. This was submitted by DHB, in March 2011, in accordance with the direction from the Secretary of State. This report contained:

a) An assessment of 2011's current and predicted impact of climate change in relation to the reporting authority's functions;
b) A statement of the reporting authority's proposals and policies for adapting to climate change in the exercise of its functions and the time-scales for introducing those proposals and policies.

In meeting this requirement, DHB followed guidance issued by Defra, supplemented by a risk assessment framework developed by Cranfield University and the Environment Agency's supplementary guidance. The report was developed to meet this reporting requirement by documenting the Climate Change Risk Assessment process that was carried out. Information was provided on the function of DHB; the approach undertaken to assess the risks of climate change on the organisation; a summary of those risks and the proposals which were to be taken forward in order for DHB to adapt.

A second round of voluntary reporting has been requested by Defra, using their Adaptation reporting powers, providing an update on the progress made since 2011, the first round of adaptation reporting. This document updates the information in the first report, and will help the government understand the level of capacity to adapt in the sector. Assessments have been carried out using the probabilistic output data of the United Kingdom's Climate Projections 2009 (UKCP09) for both rounds of reporting. The information provided will inform the next government Climate Change Risk assessment to be published in 2017 and the update of the National Adaptation Programme thereafter.

2.0 Organisational Structure and Function

2.1 Overview of Dover Harbour Board

DHB was established by Royal Charter in 1606 and entrusted with the administration, maintenance and improvement of the harbour at Dover. Subsequent statutes have amended the terms of the Charter but its responsibilities remain substantially the same.

DHB is an independent statutory body governed by unique Acts of Parliament and controlled by an independent board of eight members. It is subject to national legislation and a number of port related statutory instruments. The Trust Port status means there are no shareholders and funds generated are reinvested in the Port for the benefit of its customers and other stakeholders. It also puts funding into the Port of Dover Community Fund to support the local community.

DHB supplies services to the ferry, cruise and cargo operators who use the Port of Dover as well as their customers. Other stakeholders include statutory authorities (such as UKBF, Police aux Frontieres, Kent Police), other port users (such as concessionaires), property tenants, freight agents, marina users and the local community.

The Port of Dover is one of the busiest international ferry ports in the world, the busiest in Europe and the second busiest UK cruise port. The core business is the roll-on/roll-off ferry operation supported by other commercial activities, including cruise, cargo and marina. Trade at the Port consists of freight and tourist vehicles, ferry and cruise passengers and conventional deep-sea cargoes.

There are currently two ferry operators providing cross-Channel services to Calais and Dunkirk with around 20,000 vessel entries per year. Dover is one of Europe's most important ports, with 98 per cent of its freight traffic by weight either originating in or destined for the EU. Trade has increased since 2011 and within the last two years freight traffic has grown by 20%. Dover now handles £100 billion of trade per annum.

A wealth of additional information about the Port of Dover can be found on the website at www.doverport.co.uk

DHB's management and administration structure is divided into six divisions; Operations and Harbour Masters, Technical and Engineering Services, Finance, Corporate Administration, Strategy and Risk Management and Business Development, reporting directly to the Chief Executive Officer. There are approximately 300 staff across these divisions which can fluctuate according to seasonal requirements of some services.

DHB is the land owner of the Port and operates the ferry and cruise terminals and the marine side of the cargo terminal. The landside of the cargo terminal is operated by a third party – George Hammond PLC. Stevedoring, mooring and cargo handling services are operated predominantly by third parties.

The Organisation provides appropriate infrastructure for delivery of its services according to statutory and regulatory obligations and requirements.

2.2 Main Shipping Activities

The Port facilities at Dover are split into two locations: the Eastern Docks and the Western Docks. The Eastern Docks are located to the East of the town centre. They are the primary focal point for the ferry operation and the current location of the cargo terminal. The Western Docks are located to the South West of the town centre. They consist of freight clearance, two terminals for cruise liners which are used for grain exports out of season and a marina. A bunker barge also operates at the Port, to provide the vessels with low sulphur fuel.

2.3 Statutory Functions

The statutory functions of DHB can be found in local acts of parliament, such as the Dover Harbour Consolidation Act 1954 and the Dover Harbour Act 1963, as well as general statute relating particularly to harbours such as, the Harbours, Docks and Piers Clauses Act 1847 and the Harbours Act 1964.

Douglas et al. (1997) describes, in general terms, the statutory functions of a Harbour Authority as follows;

i. "*the provision and maintenance of harbour facilities, i.e., quays, wharves, etc;*
ii. *navigational safety functions, including lighting and buoying the harbour, the removal of wrecks and other obstructions and maintenance dredging;*
iii. *regulating activities of other persons in the harbour including, in particular, regulating the movement and berthing of ships in the harbour by means of directions and by-laws and licensing dredging and the construction of works in the harbour by other persons;*
iv. *carrying out harbour operations including, in particular, cargo-handling activities;*
v. *the provision of a pilotage service; and*
vi. *of increasing importance, the prevention of pollution and nature conservation*."

In this case DHB is the landowner and has jurisdiction over the waters within the harbour walls and up to 1 nautical mile from them. Therefore functions i to ii and function vi are carried out within this area. The conditions of the Port's pilotage service require any vessel greater than 50m in length or with over 12 passengers on board to be brought in to the harbour by a DHB pilot or a Pilotage Exemption Certificate (PEC) holder. PECs are issued by DHB following an examination and a ship handling review and are revalidated every 5 years. Some cargo handling services are offered by DHB but the majority are carried out by third parties who are licensed to operate within the harbour or lease a quayside from DHB. There is no statutory requirement to maintain certain types of shipping and cargo handling operation within the harbour. The types of facility available and the contractual arrangements surrounding them therefore remain commercial decisions.

2.4 Mission, Aims and Objectives

DHB has developed the following Mission Statement, Commitment and Vision, associated objectives and guiding principles:

Our Business Mission

Our mission is to apply our skills and experience to develop a growing, vibrant and commercially focused business that contributes to our community and to the economic interests of our Nation.

Commitment and Vision

The commitment is to be the best port in the world for the benefit of our customers and community.

Long-term corporate objectives

- To manage, maintain and continually develop our financially and operationally robust and profitable business.
- To maintain and improve financial performance within a sound framework, generating investment capital to deliver our business mission and objectives.
- To make best use of our available capacity.
- To plan and develop our infrastructure to meet the needs of both our customers, present and future, and our community.

Plan objectives 2014 - 2016

- To develop our growth and value agenda, start to deliver an expanding business.

- To maintain our momentum in securing and further developing our highly skilled, technical and professionally focused organisation.
- To further enhance our reputation as one of the UK's most commercially successful and well managed port authorities.
- To maintain and improve our port infrastructure over time and deliver additional revenue opportunities and protect port capacity for when it is needed.
- To develop and enhance our growing national and international reputation, links and relationships by offering consultancy services on a commercial basis to other organisations and governments.
- To continuously develop and improve our safety and environmental management culture and performance.
- To ensure that we develop our service levels such that they meet the agreed needs of customers, both internal and external, and deliver improved levels of customer satisfaction.

Our guiding principles

- We seek to improve and maintain the facilities and levels of service offered to all our customers, we aspire to become the best port in the world.
- We intend to grow and add value to the Port business and to hand on to future generations a thriving organisation and a modern and efficient infrastructure.
- We will facilitate competition where it is in the best interest of the consumer and improves consumer choice.
- We place responsible safety and security management at the core of our activities ensuring a safe environment for all those who work in or visit the Port of Dover.
- We will seek to provide for environmental sustainability in the management of existing assets and in all future developments, lowering our ecological footprint and delivering on our environmental responsibilities.
- We will market and promote the Port of Dover and the work of the Dover Harbour Board to a wider public both nationally and, where it is in our interests, internationally, to government, the EU and any other agencies and bodies we wish to influence or whose decisions and actions affect our organisation.
- We are committed to closely following the guidance on consultation, transparency of reporting and accountability detailed in Modernising Trust Ports Second Edition.
- We aspire to excellence in business efficiency, continuously improving our business processes, policies and the management of our resources.
- We will always endeavour to be a good neighbour to our community.

3.0 Major Port Projects and Development Plans since 2011

In the 2000's, DHB was the first port to undertake Master Planning. The work showed that the Port of Dover's Eastern Docks roll-on roll-off ferry terminal was nearing capacity and in need of renovation. With rapidly growing freight traffic figures, a 30 year Master Plan for development of the Western Docks was created and the Dover Harbour Revision Order 2012 was approved. A substantial amount of renovation work within the Eastern Docks, including berth refurbishments and the introduction of a traffic management system coupled with an increase in ship size has significantly increased the capacity of the Eastern Docks but the long term need for further capacity is imperative to the resilience of UK trade flows. The projects below are ongoing as part of this process to meet the capacity requirements.

Traffic Management Improvement (TMI) Project

TMI is part of an £85 million upgrade programme focused on the Eastern Docks. This project has been co-financed by the European Union as part of the Trans-European Transport Network. The physical works for the TMI project will, when completed, improve the resilience of the Port operation. It will also, as required, help manage the throughput of

traffic within the confines of the Port and reduce congestion on the external road network through a new holding area with a capacity to hold up to 220 freight vehicles (equivalent to almost four kilometres of traffic).

Dover Western Docks Revival

Dover Harbour Board is pursuing a major opportunity acting as a catalyst for the wider regeneration of Dover. The Port has recently committed to investing up to £120 million in phase one of the Dover Western Docks Revival project, the Dover Harbour Board's single biggest ever investment. Having successfully achieved Government approval in 2012 to develop the Western Docks, the Port could create over 600 new jobs for Dover and safeguard another 140 positions by developing a new cargo terminal and port-centric distribution facility. This would revive the Western Docks, create a dedicated ferry terminal in the Eastern Docks with further opportunity to increase holding capacity for freight vehicles, protect long term port capacity and enable the transformation of the waterfront with the creation of a new marina. Sustainability is being incorporated into this project through the aim of gaining a CEEQUAL award and is currently striving for excellence. CEEQUAL is the evidence-based sustainability assessment, rating and awards scheme for civil engineering, infrastructure, landscaping and the public realm, and celebrates the achievement of high environmental and social performance.

4.0 Climate Change Risk Assessment Scope

Risk can be described as follows:

"…risk is the threat that an event will adversely affect the ability to achieve objectives. It arises as much from the likelihood that something good will not happen as it does from the threat that something bad will happen" (Turnbull).

Or alternatively:

"Risk is the effect of uncertainly on objectives" (ISO 31000:2009).

"Major disruption to operations arising from bad weather, industrial action or other factors," is cited as one of the major risks to the long term primary objective: *"To maintain and continually develop our vibrant, financially and operationally robust and profitable business."*

Weather is therefore a key consideration of DHB operations and therefore the changing weather patterns associated with climate change will have an effect on our operations.

4.1 Functions Impacted by Climate Change

Adverse weather can cause timetabling delays and in certain more extreme cases port closures. This in turn leads to a loss of revenue and could affect the Port's ability to function as a robust transport node. With the future expected to bring wetter winters, higher sea levels and possibly more stormy conditions a thorough risk assessment has been carried out to ensure that the necessary steps are taken for effective adaptation.

Table 4.1 sets out in broad terms how the high level statutory functions (as described in section 2.3) are currently affected by the weather and the broad trends that could be expected in the future due to climate change. It demonstrates that all but one of our statutory functions are currently impacted by the weather and therefore have the potential to be affected by climate change. As part of operating a weather sensitive facility DHB has in place a number of thresholds above which operations cannot be continued or known problems arise. These are also outlined in Table 4.1. The only change since 2011 is

improvements to the efficient operating temperature for refrigerant units, from 30° to 34°C. This positive change is due to upgrades made by DHB to the equipment as part of the maintenance and renewal programme to equipment in the Port. The Port has an annual 5% energy reduction target and the upgrade programme contributes to achieving this.

Table 4.1: Weather Effects on Statutory Functions.

Statutory Function	Current Weather Impacts	Potential Future Impacts	Known Thresholds
Maintenance of harbour facilities	High winds, storms and storm surges cause flooding and damage to infrastructure.	Potential for increased storminess to increase the frequency and severity of damage to infrastructure.	Overtopping of the Admiralty Pier occurs at wind speeds of 37 knots and above. Storm surges greater than 8m cause flooding to the car parks around the marina. Vessels cause damage to berths in wind speeds of over 45 knots from a South South Westerly and West South Westerly direction or swells of over 1.5m.
Navigational safety functions	High winds and storms can cause timetabling delays, damage to navigational aids and in certain cases port closures. Fog can cause timetabling delays.	Potential for increased storminess and more days of fog could lead to an increase in the frequency and severity of delays and an increased frequency of port closures.	The Port is closed during sustained wind speeds above 55 knots from a South South Westerly and West South Westerly direction.
Regulating activities of other persons in the harbour including, in particular, regulating the movement and berthing of ships in the harbour by means of directions and by-laws and licensing dredging and the construction of works in the harbour by other persons	High winds from a West South Westerly or South South Westerly direction can lead to berth closures. Pushing operations by the tug become limited in high energy seas and the dredger is unable to go to sea to spoil. High winds and stormy conditions can delay engineering works.	Potential for increased storminess could limit operations and engineering works more often and lead to increased delays.	The Port is closed during sustained wind speeds above 55 knots from a South South Westerly and West South Westerly direction. Damage is caused during pushing operations in swells greater than 1.5m. Tug operations switch to towing lines. The Dredger cannot go to sea to spoil in swells greater than 1m.
Carrying out harbour operations including in particular cargo-handling activities	High winds prevent crane operations and refrigerant units become less efficient at maintaining temperature in extremely hot weather.	Potential for increased storminess to limit crane operations leading to delays. Potential for temperatures sensitive areas to not be maintained at the correct temperature.	Harbour cranes cannot be operated in winds of 44 knots greater. Road mobile cranes are more sensitive to wind and vary according to crane type and location. Operations are therefore closed down in winds upwards of 37 knots. The cranes are able to stand in winds of up to 60 knots. Refrigerant units become less efficient in temperatures of greater than approximately 34°C.
Provision of pilotage	High winds from a West South Westerly or South South Westerly direction can lead to port closures and curtail pilotage.	Potential for increased storminess could limit operations more often.	The Port is closed during sustained wind speeds above 55 knots from a South South Westerly and West South Westerly direction. Pilotage is suspended at wind speeds greater than 40 knots, but can be lower for piloting some vessels.
Prevention of pollution and nature conservation.	Not impacted by weather.	No change is foreseeable.	

4.2 Stakeholders, Interdependencies and Community

The stakeholders of the Port of Dover can be categorised in the following way:

Transport Operators and Infrastructure Providers
The Port of Dover is a key part of the trans-European transport network (TEN-T). As a transport node, the Port is a core port connecting the UK and continental Europe. The transport connection between UK and Europe also relies heavily on the hinterland infrastructure, the vessels operating out of the Port and the sister ports on the continent and their hinterland infrastructure. There are therefore a number of key stakeholders which make up the transport network such as shipping operators, Highways England and other ports.

Statutory Bodies
There are a number of stakeholders operating within the Port who are required in order to maintain a legal operation such as UK Border Force and Police Aux Frontieres.

Customers
The customers of the Port of Dover include ships and shipping operators that use the Port and the Heavy Goods Vehicles (HGVs), cars and passengers that use the ships. In addition marina customers comprise berth holders and overnight visitors.

Tenants
The Port of Dover has over 300 tenanted spaces. These range from water sports providers to cold stores, food villages, shopping centres and workshops to office spaces.

Community
The close proximity of Dover town and environmentally designated areas to the Port of Dover means that local people and many organisations have a strong interest in port operations and developments.

DHB organise many community events to engage with the community and its stakeholders at various levels.

Table 4.2 outlines the extent to which weather affects the interaction between DHB and each stakeholder type in order to determine whether the impact of climate change on that stakeholder needs to be assessed.

Table 4.2: Stakeholder interaction impacts

Stakeholder	Impact of Climate Change
Transport Operators and Infrastructure Providers	There is an integral link between the successful operation of the Port of Dover as a transport node and the successful operation of other parts of the transport network. It was therefore important that the impacts of climate change on the rest of the transport network were assessed as part of this process.
Statutory Bodies	Weather does not currently inhibit the interaction of these statutory bodies with DHB operations and therefore it is not expected that the impacts of climate change will need to be assessed.
Customers	Weather may affect the preferences of customers and change market drivers. This has been explored as part of this assessment.
Tenants	Weather does not currently inhibit the interaction of these stakeholders with DHB and therefore it is not expected that the impacts of climate change will need to be assessed.
Community	Weather does not currently inhibit the interaction of the local community. However, it is recognised that weather can cause congestion in the local road networks. This relationship is therefore included in this process through the assessment of climate change impacts on the interaction between the Port and the transport operators and infrastructure providers.

Customers, transport operators and infrastructure providers are therefore the key stakeholders for consideration. They include the following:

- Ferry operators;
- Highways England;
- Kent Highways Services;
- Berth holders in the marina;
- George Hammonds (stevedores) and;
- Cruise operators.

Although the impacts of climate change on the other stakeholders do not need to be assessed, it is recognised that the changes to port policies, operations or developments that arise from this assessment may have an impact on the interaction with that stakeholder. These changes will however be dealt with in the same way as any other change to port policy, operation or infrastructure and the affected stakeholders would be consulted through the normal channels.

5.0 Climate Change Assessment

5.1 Assessment Methodology

UKCP09 was used as the current main source of data for the predicted changes in climate that are expected to be experienced in Dover, both in 2011 and in the 2015 Adaptation Reports. The User Interface Tool was used to produce a customised set of probabilistic projections for the Dover locality (see Appendix 1). This allowed the most local grid square available to be used for each climate variable that was analysed, therefore providing the most detailed data possible for the assessment.

UKCP09 provides projection information for 3 different scenarios of high, medium and low carbon emissions based on different projections of worldwide economic growth and reliance on fossil fuels. As identified in section 3.1 the operations of Port of Dover are weather sensitive. It was therefore decided that the high emissions scenario would be used to determine the impact of climate change on the organisation as this gave the greatest change in weather patterns. It is considered that if the greatest change in weather can be adapted to, through a managed adaptive approach, then a change of smaller magnitude would be accounted for within that approach.

Where available, data was collated for the high emissions scenario for the years 2020, 2050 and 2080. This allowed the risk assessments to take into account when each climate variable may start to have an impact on the operation so that risks that would take a long time to adapt to could be taken into account.

Where probabilistic projection for a climate variable was unavailable from UKCP09, information of general trends were obtained. As there is no probabilistic information of what those changes may be and the associated time frame, the risk assessment is more vague about the level of risk that will be experienced and when this risk will become an issue.

In round one of reporting (2011), the impacts of the predicted changes on the activities of the Port of Dover were assessed through a series of workshops with each key department: *Operations*, *Engineering Services* and *Commercial and Support Services*. Attendees at the workshop brought their own specific set of expertise allowing the assessment to take into account the effects of climate change on a variety of disciplines whilst using experts that had the best local knowledge of the operation of the Port of Dover. Attendees included: Harbour Masters; pilots; operational managers and directors; health, safety and environmental experts; mechanical, electrical and development engineers; buildings and estates managers; commercial managers; financial and insurance experts; and human resources managers.

A further series of workshops was undertaken in 2015 with the same key departments. The workshops covered the following topics;

Current effects of weather	Compare the view of the statutory functions and thresholds of 2011 to 2015.
Effect of Climate Change	Analyse the risks from 2011 to check their validity and more threats or opportunities if required.
Mitigation and Adaption	Analyse 2011 mitigation measures and possible adaption measures. Report on; • progress and changes • monitoring and evaluating • interdependencies • barriers, opportunities and benefits

5.2 Quantifying Risk

The method used by DHB to quantify risk has changed since the first Climate Change Adaption report in 2011 and therefore both methods used have been outlined below in the following sections.

The level of risk resulting from climate change was assessed in 2011 using the same methodology that was used to assess all risks affecting the Port. This allowed the Climate Change Risk Register to feed directly into the Corporate Risk Register, incorporating it into the normal risk processes of DHB as outlined in section 8. It also allowed all risks affecting DHB to be comparable, thus ensuring that the correct risks are prioritised and the right investment decisions are made, see Appendix 2 for the full 2011 Climate Change Risk Matrix.

Each effect is assigned a quantitative value of gross risk and residual risk. Gross Risk is the unmitigated threat. It is a theoretical risk as it assumes that no mitigation is delivered which is a highly unlikely scenario but is useful in understanding the value of the mitigating activities. Residual risk is the risk that remains after mitigation measures are in place. It is this level of risk that is finally accepted by the organisation.

As the climate change risk register is not only dealing with the known impacts of current conditions but also the predicted impacts of future conditions, the risks have been separated out into 2 scenarios: "Present Day" and "Future."

In order to make this clear, the measures taken to reduce risk have also been separated out into these 2 scenarios and can be defined as follows:

- **Mitigation measures** are the measures that are already undertaken to reduce the threat of weather to the organisation.
- **Adaptation measures** are the measures that will need to be taken to reduce the threat of the changes to the weather systems in the future as a result of climate change.

Therefore within the Climate Change Risk Assessment, only mitigation measures only are taken in to account when calculating the Present Day residual risk but mitigation and adaptation measures are taken in to account when calculating the Future residual risk.

Risk is calculated by considering:

- the *probability* of that effect occurring; and
- the *severity* of the effect.

5.2.1 Risk Method used in 2011

Using experience and knowledge of DHB and its operating environment, the categories financial, reputation, service and safety were used to quantify the severity and probability of each effect.

The following calculation was then used to determine an overall value of risk.

Risk = Severity x (Probability + 2)

Each risk was then prioritised and colour coded based on its overall quantitative value. Red and amber risks are the high priority risks. Yellow and green risks are much lower priority (see table 5.2).

Severity					
Major	*4*	12	16	20	24
Moderate	*3*	9	12	15	18
Minor	*2*	6	8	10	12
Insignificant	*1*	3	4	5	6
	Multiplier	*3*	*4*	*5*	*6*
Probability		Rare	Unlikely	Possible	Likely

Table 5.2: Calculation of risk 2011.

An assessment of risk was carried out for each weather effect in the "present day" scenario and the high emissions scenario at a date in the future at which it was determined that the change in risk would be significant.

5.2.2 Risk Method used in 2015

The risk methodology used for the Corporate Risk Register has changed since 2011, from a 4x4 risk matrix of probability and severity, shown above in section 5.2.1, to a 5x5 risk matrix (shown below) using the categories financial loss, service delivery, safety/injury, legality, reputation and environment to quantify the likelihood and severity of each event. As the 2011 Climate Risk Matrix was written to feed into the Corporate Risk Register the 2015 Adaptation Report needed to do the same, therefore the matrix was rescored using the 2015 methodology before it was reviewed in the workshops.

Horizon = 5 years		**Likelihood** ---------->				
Severity ^		L1 = (1 + 2) = 3	L2 = (2 + 2) = 4	L3 = (3 + 2) = 5	L4 = (4 + 2) = 6	L5 = (5 + 2) = 7
	S5 = 5	**15**	**20**	**25**	**30**	**35**
	S4 = 4	**12**	**16**	**20**	**24**	**28**
	S3 = 3	**9**	**12**	**15**	**18**	**21**
	S2 = 2	**6**	**8**	**10**	**12**	**14**
	S1 = 1	**3**	**4**	**5**	**6**	**7**

Low Risk	Moderate Risk	Substantial Risk	High Risk

5.3 Evaluating Our Adaptation Options

Adaptation to climate change could be approached in 2 different ways:

Managed adaptive approach – allows for adaption in the future and is appropriate where changes can be managed through multiple interventions.

Precautionary approach – necessary where future adaption may be technically unfeasible or too complex.

DHB took the view that managed adaptive was the appropriate approach in most cases to ensure that investment is not wasted on over-adaptation. Therefore the majority of adaptation measures that were identified follow this approach. A precautionary approach is useful, however, when developing large pieces of infrastructure as it is often more cost effective and produces a better outcome if the appropriated features are incorporated at the design stage instead of undertaking retrofitting at a later date. In this instance, climate change impacts are assessed as part of the environmental impact assessment or appraisal of any major project. As this Risk Assessment process is mainly associated with the current activities of DHB, the approach discussed, both in the 2011 report and the 2015 update, is predominantly a managed adaptive one.

Each 2011 adaptation measure that was identified had been analysed within an Appraisal Matrix to determine if it is appropriate for the purpose of adaptation in accordance with the Defra Guidance. Each measure was assessed against the following factors and the overall outcome used to determine which measures should be prioritized.

a) Effectiveness
b) Efficiency
c) Equitability
d) Sustainability

The assessment allowed DHB to make a judgment on which measures would be most effective, whilst taking in to account the uncertainties of the projections by allowing a flexible approach. Within the Appraisal Matrix, the adaptation measures associated with each risk were numbered in order of preference for implementation, shown in the High Priority Adaptation Measures. This is shown in appendix 4, as the overall approach of DHB is managed adaptive, the mitigation measures should be implemented in order of preference, with less preferred measures only being implemented when it is recognized that the more preferred measures are not mitigating the climatic risk.

In 2015 the Climate Change workshops reviewed the progress on measures proposed in the 2011 report and reviewed them as per Defra guidance on effectiveness for;

- Achieving beneficial outcomes
- Mitigating climate change risks
- Increasing the organisation's readiness to respond and recover from impacts
- Contributing to sustainable development.

In the case of measures that had not been implemented reasons for these were discussed and recorded. The following chapters explain the risks and adaptations that are the highest priorities for DHB.

6.0 Storminess

6.1.1 The effects of storms

High winds and stormy seas are the most impacting weather parameters on the operation of the Port of Dover. Severe weather affects the safety of navigation and can lead to timetabling delays and in certain conditions port closures. The effect on the operation is mainly due to the sea state which is not only a function of wind speed but also wind direction. Winds of above 45 knots from a South South Westerly to West South Westerly direction have the worst effect on the Port. In swells of greater than 1.5m fender damage can be caused by berthing vessels and

the ship to shore interface of cruise and cargo vessels can be compromised. Manoeuvering within the harbour becomes more difficult, traffic uplift is reduced and the potential for a marine incident increases.

This risk is mitigated by increased use of the tugs to aid vessel manoeuvering and to maintain the ship to shore interface. In extreme conditions, the Duty Harbour Master will close the marine side of the Port if he deems the conditions unsafe for operations. DHB has a Port Marine Safety Code which specifies the provisions under which the Harbour Master operates. The General Directions state within *Section 8, Weather and Tidal Restrictions* that the Port will be closed in the following conditions:

Table 6.1: Conditions for port closure.

Wind Direction	Wind Speed	Swell Height	Damage to Berth
SSW	Sustained Above 55 Knots	1.5m	Can occur to all berths when wind speed is over 45 knots.
WSW	Sustained Above 55 Knots	1.5m	Can occur to all berths when wind speed is over 45 knots.

Closing the marine side of the Port mitigates the risk of a marine incident but leads to a loss of revenue due to missed sailings. This effect is most pronounced in the cruise operation where port closures or severe weather could inhibit a cruise call altogether.

As a major transport node within a wider Trans European network, closing the Port in order to mitigate the risk of a navigational incident creates a number of knock-on consequences which in themselves create their own risks. Ships can anchor or lay by in safe areas to shelter from the weather. However, vehicles travelling to board the ferries will continue their journey to the Port and provisions need to be made to accommodate them in order to keep the local road network operational. The landside facilities of the Port will continue to fill up until capacity is reached at which point traffic will start to queue on the approach roads.

During times of prolonged delay, a proven contingency plan may be put in place. Operation Stack involves closing part of the M20 motorway to store Heavy Goods Vehicles (HGVs) heading to either Eurotunnel or the Port of Dover. This limits the congestion experienced on the local road network and allows traffic to be called forward as space becomes available. The manning required to achieve a successful Operation Stack requires the services of port staff and Kent police and has cost and resourcing implications for the organisations involved.

Storms and high winds can lead to berth damage from vessels as mentioned above but can also lead to flooding and damage to piers and buildings from wind and wave action. The Port closely monitors weather predictions as a normal part of operations and uses a storm warning system to ensure that weather sensitive assets are secured in time. A post storm inspection regime checks that any damage is picked up and dealt with appropriately. A good maintenance plan also helps to keep the effects to a minimum and insurance is used to share the liability. This problem could however be exacerbated as extreme weather can constrain maintenance and repair work. This in itself is overcome by good planning of maintenance and project work to reduce the risk of delays.

6.1.2 The potential effects of increased storminess

It is believed that the potential for increased storminess which is expected to be a result of climate change can continue to be mitigated through the proven management plans and programmes that are already in place at the Port. It is however recognized that increased resources will be needed to cope with any increase in regularity and intensity of storm events, which, if not accounted for in financial planning, would lead to an increase in costs. The St Jude's storm, 6th December 2013, caused flooding at Dover Cruise Port and evidenced the potential risks of storm events and subsequent insurance claims.

The increased pressure that may be experienced by certain key members of staff, such as tug crews and maintenance teams has been mitigated by modifying the working hours and contractual arrangements to meet the change in demand. These measures have been taken as a result of monitoring the working practices and recognizing when a change in process is needed.

If storm damages were increased for the UK as a whole this could lead to an increase in insurance premiums. These would be minimized as far as possible through our current processes of good risk management, negotiations and investigating the most cost effective insurance pathway, which could involve self-insuring, although this is not required at present.

In 2011, after detailed analysis of the affects of storm events on the Port of Dover it was concluded that adaptation could be achieved through our current work practices and the proposals to increase capacity, which are underway.

6.1.3 Changes and Progress

DHB continually looks to improve and update facilities to increase the resilience of the Port to all factors which could cause operational delays. The Port development projects, detailed in section 3.0, will aid climate change adaptation as they are consistently aligned to meet demand under the circumstances experienced. Traffic management improvements are almost complete in the Eastern Docks, to deliver increased landside capacity. The Western Docks plans will further increase port capacity on both the marine and landside. By moving cargo operations out of the Eastern Docks ferry terminal more landside space will be created for the ferry operation. The cargo operation will also no longer be space constrained allowing the business to develop. New longer berths will provide improvements in navigation and a better wave climate to ensure operations can be maintained for as long as possible in inclement conditions. As reported in 2011, a climate change assessment was carried out for this specific project as part of the Environmental Impact Assessment to improve future resilience against storm and flood risk.

Many of the Port buildings are old and some are listed buildings which have low levels of thermal efficiency. Increased wind speeds could lead to a reduction in the thermal efficiency of these buildings and require an increase in energy use. Following analysis of the key areas for improvements, Harbour House was identified. Improvements have already been implemented to this building such as secondary double glazing, improved insulation and installation of a zonal thermostatically controlled heating system. DHB has in place a number of programmes to reduce energy and has successfully reduced its actual carbon footprint on an annual basis since 2006 by over 26%. A Buildings Energy Management System (BEMS) is used to monitor the energy use of port buildings. Any improvements that were needed to combat the reduced thermal efficiency that might be experienced would be picked up by the monitoring programme and delivered through our energy saving initiatives.

Since 2011 the Port has been working hard to reduce the impacts of queuing in Dover prior to the implementation of Operation Stack. The Traffic Management Improvement (TMI) project outlined in section 3.0, increases the vehicle capacity of the Port by 220 freight vehicles, reducing congestion on the external road network. New traffic management measures (Dover TAP) were implemented on the A20, Dover approach road, by Highways England (in conjunction with the Port of Dover) on the 8th April 2015 as part of an assessment aimed at reducing congestion through Dover during busy traffic times. This combined approach to managing the traffic volumes aims at reducing the impact on the road network and the local community. This is currently being closely monitored.

A key area where the knowledge and preparation for risk has improved is that of flood resilience. At the Port of Dover digital terrain models have been created to allow production of updated inundation maps; using 8.0m, 8.5m and 9.5m (above chart datum) inundation events, these new models give an improved height accuracy from previous data allowing inundation events to be better forecast. The highest ever recorded tide is 7.49m. Flood resilience has been strongly incorporated into development plans outlined in section 3.0, Port Projects and Development Plans. Work is in progress on topographic and bathymetric surveys to allow further modelling of flood events using enhanced wave modelling data, tidal information and fluvial flows for the River Dour. Much of this work has been completed in liaison with the Environment Agency and feeds into the East Coast Ramsgate and Hythe Coastal inundation model with the results expected in 2016, these projects will culminate in an interactive PDF inundation map data that will be shared with all relevant authorities.

In collaboration with the cruise contractor, changes have been made to the parking arrangements for the Cruise Terminals to avoid the areas identified as potentially at risk of flooding. The Engineering Dept. has protected or raised electrical infrastructure where appropriate and the revised inundation maps have been consulted for any proposed installations.

Charging mechanisms, linked to increased costs associated with pressures on certain resources, were not considered of immediate concern in 2011 as they had a relatively short implementation time for changes. They remain unchanged as the monitoring of resource cost and use has not indicated that charging changes are required at present, although if this situation changes the system is flexible enough to adapt quickly, in consultation with the relevant parties.

6.2 Snow events and precipitation

6.2.1 The current effects of snow events and precipitation

Severe snow events can have a serious effect on the resilience of the UK transport system. Within the Port of Dover the internal road network is kept passable and the risk of slips and trips is minimized through effective planning, a robust gritting policy and regular weather reports. Under ramp heating has been constructed in essential areas to help keep them snow and ice free.

Although port operations may be reduced so that effective snow clearance of essential infrastructure takes priority, it is extremely unlikely that the Port would ever have to close due to snow. Snow clearance and salting is now undertaken by one of the Port contractors, reducing the chance of disruption and the need for DHB staff involvement. This resilience to snow fall means that the Port of Dover can be expected to deal with significant numbers of additional passengers moving to the Port from other modes of transport that are less resilient. Airport and Eurostar closures lead to an influx of foot passengers. Under normal operational conditions the main ferry users are HGVs and tourist vehicles with relatively few foot passengers. Facilities therefore have to be realigned to cope with this change in user demand. This is dealt with through detailed contingency plans, which involve on call staff, emergency supplies of heaters, blankets etc. and through strong relationships with other organizations that may be involved, such as bus and train companies. Weather alerts are shared at tactical meetings with local government agencies and other operators. Transport operators will also cascade information on potential transport network problems to the Port.

6.2.2 The potential effects of changes in snow events and precipitation

The expected increase in snow events has the potential to lead to stock shortages in certain supplies such as grit and heating/fuel oil and could lead to increased pressure on staff availability if the length of time that snow events have a serious effect is extended. Contingency plans are also regularly reviewed and revised and increases in their stock requirements, modifications to equipment and staff training would be delivered as part of this process.

Our charging system does not currently take into account emergency events which lead to a high influx of passengers. If these types of events were to increase, the charging system would have to be reviewed to ensure that the increase in cost was reflected.

The Port has never been heavily affected by flooding in the past because the essential infrastructure is mainly located on reclaimed land which has an extremely low potential for a fluvial flood event, although the flooding caused by the St Jude's storm in 2013 has increased awareness of flooding.

The drainage within the Port has been designed and constructed to the relevant drainage standards and until now has never been breached due to a rain event. However, within the high emissions scenario the increase in winter precipitation becomes significant by the year 2050. This significant increase, coupled with the long lifetimes associated with drainage infrastructure, makes this an area that may require further consideration. In the interests of developing a managed adaptive approach, investment in new infrastructure would not be made until it is considered necessary. It is expected that drainage design standards in the future would reflect this change in precipitation and a programme of retrofitting to meet this standard would be developed.

There is also a level of concern that increased flooding in other areas has the potential to contaminate the potable water supply to the Port, which in turn would affect the potable water which is supplied to the ships. A regular testing regime is undertaken by Affinity Water, the water supplier, and monitored by Port Health to ensure that potable water standards are being maintained. It is assumed that water providers would be adapting to meet the pressures of the changing climate in order to maintain their service level. DHB has the potential to develop its own resilience to this issue through water filtering systems if the potable water service was compromised. This would not be a carbon efficient option however, and would not be implemented unless absolutely necessary.

The expected decrease in summer precipitation becomes significant in the high emissions scenario by the year 2050 and this has the potential to affect water supplies. DHB is not big consumers of water for its own operations; it does however provide a significant amount of water to the vessels that visit the Port. In the future, if there is a shortage of supply, this service would put a greater demand on the Port's water supplier. Currently, cargo and cruise vessels are charged for their water usage based on the amount used but ferries and marina berth holders have water included as part of their berthing fees. The infrastructure is in place to monitor the water usage of these customers but is currently not used as part of the charging mechanism. If the price of water were to increase significantly the charging mechanism would be changed to pass this cost on to the customer. This would defer the risk from DHB and would lead to a change in attitude by the end user resulting in a reduction in consumption of UK water resources – the ferries are the biggest water consumers in the Port and have the potential to bunker in our sister ports in France.

Within the Port there is potential to increase the use of grey water. These measures would always be considered when undertaking port projects to ensure they incorporate the principles of sustainability. As water becomes scarcer, the cost effectiveness of these solutions may increase and a case would be made for implementation.

6.2.3 Changes and Progress

Plans have been implemented to provide a larger grit store at the Port and working partnerships are being utilized for snow clearance to reduce the reliance on DHB staff for snow clearing. Two road ramps are currently heated and this has been reviewed as sufficient.

In the project development of the Western Docks, flood modelling and inundation maps have been carried out, as detailed in section 6.1.3, *Storminess, Changes and Progress* and these consider the flood risk from increased precipitation, including input from the River Dour which exits through the Wellington Dock.

After detailed analysis of the effects of precipitation on the Port of Dover it is concluded that some investment in adaptation measures is likely to be required but the need for this investment only becomes significant in 2050. No immediate action is required other than the current activities outlined above. After analysing the effects of snow events, it is considered that the extra investment that is currently being made is appropriate.

6.3 Fog

6.3.1 The current effects of fog

Fog can affect the safety of navigation and as a result leads to delays in shipping. Where fog lasts for a long period of time the delay to the shipping timetable means that the shipping uptake may not meet the traffic demand resulting in other traffic management measures. Mitigations to reduce the risk of an incident help to maintain shipping operations at an appropriate volume. Measures include: high visibility lights, enhanced radar systems, the direction of the Port's Vessel Traffic Information Service and the Port Marine Safety Code and training for crew on how to deal with fog.

6.3.2 The potential effects of increased fog

If incidents of fog become more severe and longer lasting as a result of climate change there is little more that can be done to mitigate this problem and the delays caused by these types of events may get worse. These may be dealt with through Operation Stack and other traffic management and capacity measures.

6.3.2 Changes and Progress

The high visibility lighting has been installed and the radar enhancement to Port Control is budgeted for 2017. These improvements will improve visibility and safety both on the land and marine operations. Mitigation and adaptation measures against traffic congestion that is associated with shipping timetable delays have been discussed earlier in section 6.1.3 *Storminess, Changes and Progress*.

6.4 Storm Surges and Sea Level

6.4.1 The current effects of storm surges and sea level

The Port infrastructure provides the facilities on the quayside for people and vehicles to board vessels. On the ferry berths, link-spans provide the ship to shore interface by connecting a ramp to a ship over which vehicles can travel. On the cruise berths and on some ferry berths, passenger access ramps are used to provide a walkway from the quayside to the vessel. Link spans and passenger access ramps are either free floating or can be moved up and down to meet the decks of different vessels at different states of the tide. Currently at extreme low and extreme high water some of the link spans and passenger access ramps cannot be used as they cannot be raised or lowered enough to provide a safe interface with the vessel. Some of the ferry berths are therefore closed over high and low water during extreme tides and loading operations cannot be undertaken at the cruise terminal. This is over such a short period of time that it is not an issue and the changes are accommodated into the timetable.

The flooding that occurs around the Wellington Dock has the potential to be worse during a storm surge event than it has been previously. From a tidal surge in 2013, flooding occurred to the Wellington Dock, marina, the inner harbours, Eastern Docks vehicle assembly lanes, car parks and closed the swing bridge beside the Marina which has raised the need for improved flood risk knowledge.

During storm surges, penstock valves are used to close the drainage in the Eastern Docks to prevent the system back filling. As storm surges are predictable events, notification of a storm surge leaves plenty of time for the penstock valves to be closed and for any areas at risk of flooding to be cleared.

6.4.2 The potential effects of rising sea level

As sea level is expected to rise, the duration of berth closures would increase over the high water but decrease over the low water. However, link spans and passenger access ramps only have a 30 year life span and so will be replaced with spans and ramps that could cope with the new tidal range as part of the normal replacement programme which is already underway.

6.4.3 Changes and Progress

Flood resilience planning is being incorporated into design plans for the Dover Western Docks aiming to improve the flood defences around the Wellington Dock, heighten the quay walls and to develop a new dock gate system, to retain storm surges and prevent flooding. Improved understanding of our flood risk is part of this process and is outlined in section 6.1.3 *Storminess, Changes and Progress*.

Linkspans and berth improvements have been underway since 2004 and sensor activated self locking mechanisms on the free floating fingers, are reducing the amount of bridge movements to adjust to vessel height and provide energy savings and improved safety. Vertical ladders were used for crew access to vessels and these have been replaced by articulated walkways that go to an angle of 20° to improve safety. The berth refit programme will

conclude with the last berth in 2016. These improve the resilience to tidal height changes both for the long term and also during weather events.

6.5 High Summer Temperatures

6.5.1 The current effects of high summer temperatures

Cooling and refrigeration units are used to provide temperature control in the following areas:

- server rooms for the IT system;
- storage areas for temperature sensitive commodities, such as palletized fruit;
- Comfort cooling in some of the office space.

The specification of the unit chosen is determined using a cost benefit analysis. A unit which remains efficient at higher temperatures costs more and that cost has to be balanced against the costs associated with the effects of the peak temperatures that may go above that efficiency threshold within the lifetime of that unit. Using this rationale, a unit that remains efficient during peak temperatures is more critical in temperature controlled stores or server rooms than in office space.

Temperature control in the Port is maintained using units which have a lifespan of approximately 15 years. The older units on site become less efficient above 28˚C but the newer models now remain efficient up to 34˚C, which is an increase from 30°C in 2011.

6.5.2 The potential effects of rising summer temperature

As summer maximum temperatures are expected to rise as a result of climate change this will need to be accounted for in the cost benefit analysis when procuring new cooling units. Units of higher specification may be required in the more critical areas such as the temperature controlled stores and the server rooms. Reviews are currently underway to assess the server room sizes and the associated cooling requirements, as room size reductions could lower the energy usage on cooling.

6.5.3 Changes and Progress

As the older air conditioning units come to the end of their lifespan they are replaced with modern units with the higher efficient operating threshold and the replacement programme is almost complete. This has benefits for energy consumption reduction. The Information Technology department is assessing the server room sizes and the associated cooling.

7.0 Uncertainties and Assumptions

7.1 Uncertainties

Within this risk assessment there are different levels of uncertainty associated with different climatic factors.

This risk assessment for 2011 and 2015's reports are based on the UKCP09 projections which for some climatic factors provided probabilistic outcomes for the Dover area. Where this is the case, the outcomes are available for 3 different scenarios of high, medium and low emissions. The high emissions scenario is assessed within the report but the scenario that is realised will depend on population growth and future reliance on fossil fuels. Within each scenario there is a wide range of outcomes creating the typical probability bell curve for each climatic factor. The results presented to management when making this assessment comprised the 10^{th}, 50^{th} and 90^{th} percentile of the probability curve providing a median outcome and a range which the outcome was "very unlikely" to be outside of.

However, there is uncertainty about the level of emissions and therefore the level of alignment with the high emissions scenario which has been assessed. There is uncertainty whether the climatic outcome associated with that emissions scenario will be within the "likely" ranges expressed. There is also an inherent uncertainty in using a

model to replicate the Earth's systems as the model can only be based on the best current understanding of the system which is likely to improve over time.

There are some factors which are less understood and therefore their projections are associated with a greater level of uncertainty. The factors of greatest importance to the operation of the Port of Dover are the areas that have less detail within their projections, such as storminess (including the potential to be electrical), wind speed, and critically direction and fog. All of these have a bearing on DHB's operations and costs but probabilistic, time specific projections are unavailable so there is less certainty about when these factors may need to be taken into account in business planning.

There are some climatic factors that affect DHB operations for which there is little or no information such as wind direction, which affects sea conditions, and sunshine hours, which affects lighting requirements.

The time frames associated with climatic change are extremely long when compared with business models and decisions about commercial operations. Therefore the activities and commercial priorities of DHB are likely to change significantly and may not necessarily be affected by the climatic factors in the way that is currently predicted.

7.2 Assumptions

This adaptation programme is developed on the assumption that the climate projections produced by UKCP09 are correct. However, it is recognised that there are uncertainties within this postulation and a managed adaptive approach has been developed to provide the flexibility to overcome this and ensure that an appropriate level of investment is made into the Port's adaptation options.

There are also some key assumptions that reflect the Port's interdependencies with other parties. It is expected that the UK government will continue to prioritise its winter resilience programme in order to retain a functional transport system during snow events. It is presumed that Highways Authorities, Sewerage Undertakers and Utility providers will also be adapting to climate change in order to maintain their level of service delivery. It is also assumed that building standards and regulatory requirements will be modified as necessary to align with the changing climate.

It is assumed that trade patterns and resource demand between UK and continental Europe that are the basis for DHB's operations will be unaffected by climate change.

8.0 Barriers to Adaptation

Barriers were identified in the risk workshops alongside any adaptation measures suggested. Risk specific barriers can therefore be found in the risk matrix for 2011 and 2015, in appendices 2 and 3. This section provides a general overview of the barriers that were identified in 2011 and gives their current status where changes have been seen.

8.1 Staff Relations

Some adaptation measures involved modifying working processes and staffing levels to meet peak demand for certain types of services. These changes were implemented fairly smoothly with contractual changes providing greater flexibility in availability of staff.

8.2 Cost

Some adaptation measures require investment in infrastructure which must be justified. It is also recognised that adaptation through management processes could lead to an overall increase in costs, (e.g. due to increased maintenance or on call pay) which if not managed appropriately, could have some implications for cash flow. A managed adaptive approach remains and the requirement for a sound financial justification reduces the potential for over adaptation, keeping costs to a minimum and sound monitoring of expenses ensures that cash flow is maintained.

8.3 Control and Interdependencies

This risk assessment considered the interdependencies of DHB with its key stakeholders as identified in section 4.2; customers and transport providers. It also considered the dependency on suppliers. The risks that climate change poses to these interdependencies are detailed within the risk matrix and section 6 and form a considerable part of the risk that is posed to the organisation, as a transport node. It is key to this assessment and the future operations of the Port of Dover that the hinterland infrastructure and national utility providers are adapting to maintain their service delivery also. Delivery of these adaptions is not within DHB's control.

8.4 Knowledge

As discussed in section 7.0 there is a lack of knowledge surrounding some of the climate variables that are most significant to the Port operations. This affects the extent to which adaptation measures can be planned. Knowledge of flood risk has increased since 2011 through project work which is still underway.

8.5 Technological/Managerial solutions

It is possible that further adaptive solutions will be found with technological advances and changes in organisational structure.

8.6 Carbon

DHB has reduced its carbon footprint of their operation by over 26% since 2006 and it is expected that pressure to continue this trend will only increase in the face of climate change as the UK moves forward as a low carbon economy. This requirement constrains some adaptation options which have high energy requirements. The adaptation options with high energy demands are therefore the least favoured and will only be implemented if absolutely necessary and in the most energy efficient manner practicable.

9.0 Monitoring and Evaluation

DHB has a mature Risk Framework that has been developed to be consistent with the requirements of ISO31000: Risk Management Principles and Guidelines in order to integrate the process of managing risk into the organisation's overall governance, strategy and planning. The Risk Framework is broken down into varying levels in order to tailor it to the interest levels of all members of the organisation. High level corporate risks are broken down into more detailed risks which sit with different working areas. Each risk is assigned a leader who is empowered to review the level of that risk and the results of any mitigation actions and report back to management on any changes or effects. In this way the responsibility is put into the hands of the mitigators and mitigating actions can be undertaken at various levels within the organisation embedding risk management into all processes.

This is carried out in conjunction with DHB's Risk Management Plan as outlined in section 9.1.

9.1 DHB Risk Management Plan

The following Policy Statements are made available to all DHB staff via the intranet system and the staff handbook and outline the risk management responsibilities associated with all types of organisational risk, including climate change risk.

Policy

Dover Harbour Board will identify and manage its risks in order to maximise the opportunities for the Port and minimise risk to its employees, assets and business. The risk management discipline will form a fundamental part of all the activities of the organisation and the culture of effective risk management will be continuously developed and reviewed.

Responsibility

General - everyone is responsible for the effective management of risk. All employees are responsible for identifying potential risks within their area of activity and for notifying management of such risks. Management is responsible for developing and implementing plans to reduce the negative effect of risks. The Board is responsible for ensuring that appropriate resources, including those required for training and development, are available at each level of staff to ensure the successful implementation of this risk management policy. In particular:

Individuals should:

- Understand their obligation to be aware of risk,
- know that they are accountable for risk that they control or influence,
- understand how they can play a part in the continuous improvement of risk management,
- understand that effective risk management is a key part of the organisation's culture and everyone's day-to-day work, and
- report systematically and promptly to management any perceived new risks or failures of existing control measures.

Heads of Department and Business Managers will:

- Establish performance measures which allow them to monitor the key business activities in the context of progress towards their business and service objectives,
- identify risks, including new risks, which require control systems to be established,
- develop control measures to manage the risks which fall into their area of responsibility,
- develop mitigating or contingency plans to minimise or respond to risk events which occur notwithstanding the controls that may be in place,
- be aware of the possible effects that their risks may have on other business areas and the effects that risks in other areas may have on them,
- report promptly and directly to senior management any perceived new risks or failures of existing control measures. It should be noted that any sudden and significant deterioration in an adverse risk rating to a red net level requires immediate reporting to a director who may determine that the activity should be suspended temporarily pending further investigation,
- encourage a culture of risk awareness amongst their teams, and
- champion the embedment of risk management in all of their procedures and activities.

Risk Leaders will:

- Carefully assess all risks assigned to them, consulting with colleagues and specialist advisors where appropriate,
- form a view as to the effectiveness of the associated control and mitigation measures and report systematically to the Risk Compliance Manager, and
- report promptly and directly to executive management and the Risk Compliance Manager any perceived new risks, failures of existing control measures or inadequacy of mitigating or contingency plans.

Directors and General Managers will:

- Promote risk awareness within their areas of responsibility,
- develop risk management objectives in their areas of responsibility,
- champion the embedment of risk management into the day to day activities of their reporting teams,
- determine the organisation's appetite for risk at operational, technical, project and component business stream level,
- establish the assessment matrix and its gradation levels,
- advise the Board on strategic risk tolerance and risk management policies,
- report exposure to high-rated risks and all strategic risks to the Board, and
- ensure that risk management, in the sense of both the business case and the delivery plan, is incorporated at each stage of a project.

The Board (incorporating the responsibilities delegated to its Audit Committee)

- has responsibility for determining the strategic direction of the organisation by setting clear objectives for management,
- is ultimately responsible for Dover Harbour Board's systems of risk management and internal control,
- will set appropriate policies,
- will set the tone of risk appetite and determine the Board's tolerance for adverse strategic risk and limits of exposure,
- will seek regular assurance that the risk management system is working effectively as part of its evaluation of systems of internal control
- will report performance to stakeholders and regulators as required.

The General Manager, Strategy and Risk Management will:

- Act as the primary champion of risk management at strategic level,
- set policy and strategy for risk management,
- co-ordinate the various functional activities which advise on risk management issues for DHB,
- prepare Board reports on risk and co-ordinate the strategic risk reporting to the Board and Audit Committee.

The Risk Compliance Manager will:

- Maintain custody of the risk registers,
- understand and link all non-financial risk processes throughout the organisation,
- administer the risk management review process using ISO31000 and its associated guidance standards as the model of good practice,
- prepare monthly reports on risk,
- highlight weaknesses in risk management and control processes.

In addition to the above general responsibilities for certain groups or teams, there is a number of teams or individuals with specific risk management responsibilities:

Internal Audit will:

- Provide robust independent assurance that the risks, key management objectives and core systems are being appropriately managed,
- understand and link all risk processes throughout the organisation,
- assess the efficiency and effectiveness of the assurance processes,
- identify gaps and possible overlaps in assurance provided,
- report significant issues related to the processes for controlling the activities of Dover Harbour Board, including potential improvements to those processes, and provide information concerning outstanding actions not completed within agreed timescales which arise from our internal audit reviews.

The General Manager, Corporate Administration will:

- Ensure that contracts of employment/job descriptions contain appropriate risk management responsibilities as a core competence,
- ensure that risk management is emphasised in induction training, appraisals and the staff handbook,
- facilitate risk management training for staff at all levels, and
- ensure that risk management forms a part of the management training and development programme.

The Financial Controller will:

- Ensure that risk management is embedded in the financial and budgeting processes, and
- understand and link all financial risk processes throughout the organization.

9.2 Embedding Climate Change Risks

The Climate Change Risk Framework feeds into DHB's Corporate Risk Register and will lie beneath the corporate risk:

"Major disruption to operations arising from bad weather, industrial action or other factors"

As with all other risks, each risk will be assigned an owner and a leader and a regular review of all risks will be carried out. This will include a review of any changes to projections, thresholds and interdependencies which may change as a result of mitigation, further monitoring, modification of equipment, assets or processes. The regularity of the review of each risk will depend on the level of residual risk.

Through the review and reporting process, DHB continues to look out for new risks associated with climate change and remove risks that no longer apply, continuously improving the Climate Change Risk Register within the context of the overall risk framework. Mitigation and adaptation measures are assessed on their cost effectiveness and their ability to meet the criteria set out in section 5.3. Options that allow flexibility in meeting adaptation needs will be viewed preferably to allow for the uncertainties that are inherent to the climate change projections.

When the risk matrix was reviewed with the Risk Compliance Manager, against the corporate risk register, some risks that were no longer considered valid were removed; others were combined as they overlapped sufficiently to be assessed as the same risk. The subsequent risk review process, through workshops and meetings with key staff, enabled discussion and assessment of the 2011 matrix resulting in the revised Risk Matrix 2015, appendix 3. A benefit of this process is that it has ensured that staff actively engage with climate change mitigation and adaptation and evidence of progress is recorded, outlined in Section 6, under *Changes and Progress* and in the review of the High Priority Measures, appendix 4.

9.3 Evaluation of the Risk Matrix and High Priority Measures

The review of the Climate Change Risk Matrix (appendix 3) has illustrated that DHB is at less risk from climate change than earlier calculated and recorded in 2011 (appendix 2). There is a reduction in the number of risks shown that would be categorised as high priority from 24 to 13, a reduction of 46%, but it must be considered that this is partially due to the methodology changes for scoring risk now used by DHB.

As expected, some mitigation and adaptation measures have naturally occurred as an intrinsic part of the normal maintenance, renewal and upgrades to the infrastructure at the Port. The method for project approval and management has been improved so proposed projects now have a sponsor, from a relevant department, who is driving projects. These go through a rigorous review process, by various parties including by the Environmental Team, so questions will be raised to ensure resilience against climate change risk has been considered.

Good progress has been shown in the High Priority Measures (appendix 4) with 35% of the recommended adaptation measures having been implemented, with a further 25% currently underway or partially improving resilience.

10.0 Summary

The actions taken since the first report in 2011 have been effective at reducing risk and improving knowledge of climate change for the Port of Dover. The reporting process has proved useful in providing an opportunity to refresh knowledge and raise awareness of climate change, with all workshops well attended, involving active engagement.

Effects of weather on activities and assets continue to be closely reviewed and assessed by the Port of Dover and the risks have been incorporated into the Corporate Risk Register. In 2011, the Climate Change Adaptation Report considered that existing flexible management programmes would be able to adapt to climate change risks associated with the climate projections for the next 20 years, with risks not significant until the 2050 scenario. Recent increases in business and operational drivers have shown how the Port needs to maintain adaptability and is capable of this, maintaining a strong part of the UK's transport infrastructure. Current development projects are already looking forward, incorporating resilience to a higher level, working with our community and partners to ensure we continue to use an adaptive approach towards climate change.

Appendix 1: Climate Change Projections for Dover

Projections have been obtained from UKCP09 User Interface and are presented in the table below in the following format:

X = Median or 50th percentile
(Y-Z) (10th percentile – 90th percentile)
OR
average change
(range outside of which the outcome is very unlikely to be outside of)

Table 2.1 Predictions for High Emissions Scenario

	Temperature				Precipitation			Percentage change in Relative Humidity				Relative Sea Level Rise (95%ile)
Year	Increase in Winter mean	Increase in summer mean	Increase in summer mean daily max	Increase in summer mean daily min	Change in annual mean	Change in winter mean	Change in summer mean	Dec/Jan/Feb	Mar/Apr/May	Jun/Jul/Aug	Sep/Oct/Nov	
2020	1.4°C (0.5-2.2)	1.5°C (0.5-2.8)	2°C (0.6-3.8)	1.7°C (0.6-3)	0% (-5-6)	7% (-4-20)	-4% (-26-18)	-0.1% (-1.3-1.1)	-1.4% (-5-1.9)	-2.1% (-10.3-6.3)	-0.8% (-3.4-1.7)	0.177m
2050	2.5°C (0.9-3.8)	3.1°C (1.1-5.2)	4.3°C (1.2-7.4)	3.4°C (1.2-5.7)	0% (-6-6)	19% (1-40)	-19% (-43-16)	-0.1% (-2.1-1.5)	-2.8% (-8.3-1.4)	-5.2% (-17.3-6.1)	-1.6% (-5.5-1.6)	0.403m
2080	3.7°C (1.4-5.7)	4.9°C (1.4-8.1)	6.7°C (1.4-11.5)	5.4°C (1.4-9.1)	1% (-7-9)	30% (4-67)	-29% (-57-13)	0% (-2.9-2.2)	-3.6% (-12.3-3.2)	-7.8% (-24.6-7.6)	-2.4% (-8.3-2.3)	0.678m

Appendix 2: Climate Change Risk Matrix 2011

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
6	Change in mean precipitation in summer time.	A shortage of water supply.	Large amounts of water are required for vessels. This puts greater demands on our supplier.	0	0	0	2050	4	3	20	DHB monitor the water usage of all vessels. DHB have an Energy and Water Policy in place and run and associated initiatives to reduce water consumption.	DHB would pass on increasing water charges to the tenants and vessels and change the charging mechanism to reflect water use. Investigate the potential for vessels to obtain their water supply in France to reduce the pressure on UK resources. Increase the use of grey water within the port. Investigate the potential for a desalination plant.	The infrastructure required for the use of grey water has to be cost effective. A desalination plant would require a large capital expenditure and would use large amounts of electricity.	0	0	0	2	3	10
21	Increase in snow events	Bad weather, snow and ice causing traffic disruptions within the port.	Internal roads, lanes and ramps become impassable and unusable.	2	4	12	2020	3	4	18	Gritting and snow clearance. Bad weather planning. Gritting policy. Weather reports direct from met office.	Planning to have a larger grit store, experimenting with blowers. Bring in outside help from local service providers for snow clearance. Plan to maintain the heating system in the ramps and investigate the potential to install more.	Heating system infrastructure has to be cost effective.	1	4	6	2	4	12
22	Increase in snow events	Severe weather closing other modes of transport creating extra pressure and costs to the port operation	Airports, Eurotunnel being closed due to weather conditions. The port has to modify operations to account for the resultant change in transport modes and travel patterns.	2	3	10	2020	3	4	18	Contingency plans. Extra staff on-call. Relationships with bus and train companies. Emergency supplies (blankets, heaters).	Modify charging mechanisms to reflect costs. Overflow space made available for foot passengers.	Cost of on call staff. Cost of emergency supplies.	1	3	5	1	4	6
26	Increased fog	Delays in the ferry timetable due to poor visibility.	Leads to delays and operation stack. Currently affects operations 2-3 weeks per annum.	2	4	12	?	3	4	18	High visibility lights, enhanced radar systems. Port control measures. Training for ship staff to work in the fog. Port marine safety code.			1	4	6	2	4	12

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
28	Increased storminess/wind speed	Severe weather leading to port closure/operation stack.	Police manning roundabouts/operation stack, loss of revenue.	2	4	12	?	3	4	18	Port marine safety code. Operation stack procedures. Good relations with Kent police.	Traffic Management Improvement project to increase capacity within the Eastern Docks. Terminal 2 project to increase capacity. External buffer zone to hold waiting traffic.	Cost of development projects. Planning constraints.	1	4	6	2	4	12
7	Change in winter mean precipitation.	Contamination of potable water service caused by flooding	Risk controlled by service provider.	3	1	9	2050	3	3	15	DHB currently have a testing regime in place and are notified through Kent area health authority. There is also a regime for sanitizing any new modifications that are put in place. Ferries have sterilisation systems on board.	Apply pressure to the water provider to maintain service levels. Protect our own supply via filtration.	Our water supply is not fully under our control, as it is provided to us by the supplier. The cost of infrastructure for filtration can be very high and has the potential to use large amounts of energy.	2	1	6	2	2	8
8	Change in winter mean precipitation.	Flooding of the port due to inadequate draining facilities	Increased precipitation could potentially flood drains causing pollution and lack of access. Service ducts and tunnels would also become flooded.			0	2050	3	3	15	DHB presently use the correct design standards for drains to mitigate for any potential flooding due to precipitation.	Increase the drainage capacity inline with future design standards.	Infrastructure can be very costly, however this can be reduced via a manage adaptive strategy that would bring drainage up to new design standards incrementally.	0	0	0	2	2	8
25	Increase in snow events/Change in mean precipitation in winter time.	Severe weather causes stock shortages in key supplies.	e.g. salt, grit, heating oil.	2	3	10	2020	3	3	15	Hold a stock of grit and heating oil.	Increase the size of stocks.	Cost of storage infrastructure.	1	3	5	2	3	10
41	Increased storminess/wind speed	Financial results affected by more costs and less revenue	More costs due to increased expenditure on overtime and maintenance and less profit due to less sailings.	1	1	3	?	3	3	15	Take account in forecasting and managing costs. Includes eastern docks not cruise terminals.	Modify charging mechanisms to reflect costs.	Customer objections.	1	1	3	1	2	4

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
1	Storm surge.	Flooding around the Wellington Dock.	A storm surge greater than 8m would cause the Wellington Dock to over spill and flood the surrounding area. No current operational risk but precludes development in this area which reduces the opportunity for making a profit from this asset.	4	1	12	now	4	1	12	Plans are currently in place to enable works to heighten quay walls and develop dock gates that can keep out storm surges to prevent flooding.		Cost of infrastructure. Planning permission (listed buildings in the docks).	4	1	12	2	1	6
2	Increased storminess/wind speed	Flooding on the Admiralty Pier.	Waves over spilling the Admiralty Pier can occur during high water, with gale force 8 and above winds.	1	4	6	2050	2	4	12	Flood defences are fitted on the Admiralty Pier in winter season, it is also non operational during the winter season. If the pier is used weather limitations are put in place.	There is potential to improve the flood defences that are currently put in place. This will only be taken forward if it becomes cost effective.	Cost of infrastructure.	1	3	5	1	3	5
11	Increased storminess/wind speed	Restricted work and work opportunities	Highs winds can restrict work opportunities such as maintenance duties and project development and some operational duties.	1	4	6	?	2	4	12	DHB ensure good planning is conducted to avoid bad weather when programming works.	DHB would increase current measures, and look into introducing more flexible hours, such as annualised hours. With more outdoor work taking place in the summer months.	Staff may resist negotiations of terms and conditions to change their hours.	1	4	6	1	4	6
12	Increased storminess/wind speed	Increased storm damage and corrosion	Increased winds brings more storminess causing damage to buildings and marine structures.	1	4	6	?	2	4	12	DHB have in place a storm warning system. Prior to a storm vulnerable structures are fixed down. There is a post storm inspection and regime, to check on all structures. The organisation is heavily insured towards this risk. Hydraulics research with HR Wallingford means there is a catalogue of information available on how storms can affect the port.	Upgrade buildings and structures to meet design standards.	Assuming design standards are modified to adapt to climate change. Increased demand on maintenance staff.	1	3	5	1	3	5

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
15	Increased storminess/wind speed	Reduced thermal efficiency of buildings	Increased winds can cause drafts in poorly insulated buildings reducing the thermal efficiency of the building and costing more to heat it.	1	4	6	?	2	4	12	DHB carry out general maintenance and monitor the energy use of buildings. We also have in place an Energy Monitoring scheme across the port, to continuously identify areas for improvement and investments are made annually to deliver improvement projects.	The implement of improvement projects would be carried out when they become cost effective through the normal energy saving initiatives.	Many of the old buildings that have a poor thermal efficiency are also listed buildings, which can limits the types of works that can be carried out and increases the costs.	1	3	5	1	3	5
18	Sea level rise.	Low and high tide affecting passenger access operations at the cruise terminal and span operations at the ferry berths.	The passenger access walkways and the link spans on some berths cannot be operated safely at all states of the tide. Operations are therefore not carried out on these berths over extreme low and extreme high waters.	1	4	6	2050	2	4	12	Close the berth until the tide turns. Manage the operation through other berths during this time.	Engineer the problem out as part of the general upgrade of equipment. The lifespan of berths being 25 years.	Cost of infrastructure	1	3	5	1	3	5
20	Change in mean precipitation in winter time.	Snow and icy conditions creating costs to cover labour, plant and grit.	Snow clearing operations require on call staff and can lead to overtime and associated costs.	1	4	6	2050	2	4	12	The cleaning contractor is used to carry out gritting functions in place of sweeping which cannot be done in snow conditions. This utilises staff who are already being paid. Staff and tenants responsible for clearing their own areas.	Update contractual arrangements to define responsibilities and reduce the burden on DHB.	Contractual negotiations.	1	3	5	1	3	5
30	Increased wind speed.	Parting of vessel from ship-shore interface	Safety risk. Affects cruise and cargo vessels in gale force 7-8 and/or 2m swell. Rarely affects ferry operations. Gale force 8-9 before problems experienced.	1	3	5	?	2	4	12	Use tugs. Put out extra moorings. Use alternative berths which are more sheltered. Vessels use engines to stay in berth.	Planned berths are aligned to give the best wave climate possible for the local conditions. More tugs and/or bigger tugs.	Cost of purchasing tugs. Increased crewing requirement.	1	3	5	1	4	6
31	Increased wind speed.	Enhanced operational commitments affects crewing arrangements.	Long continuous use of the tugs leads to problems with the crewing arrangements. The maritime working directive limits work to 14 hours. The problem is exacerbated when two tugs are required.	1	4	6	?	2	4	12	Use on-call tug crew to provide break.	Create a different shift pattern.	Negotiations with staff.	1	4	6	1	4	6

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
34	Snow events/Change in mean precipitation in winter time.	Ice causing slips/trips	Health and safety concern.	2	4	12	?	2	4	12	Gritting and snow clearance. Bad weather planning. Gritting policy. Weather reports direct from met office.	Planning to have a larger grit store, experimenting with blowers. Bring in outside help from local service providers for snow clearance. Plan to maintain the heating system in the ramps and investigate the potential to install more.	Costs of investment in ramp heating and high energy use.	1	4	6	1	4	6
35	Increase in summer max temperature	Increase pressure on cooling in temperature sensitive areas.	Refrigerant units become less efficient above 28˚C for older units and 32˚C for newer units. Cooling to a specified temperature is important in the temperature controlled stores, computer server rooms and in the berth pump houses.	1	4	6	?	2	4	12	Maintain a suite of refrigerant units that can meet the majority of circumstances.	Increase the specification of refrigeration units to meet the temperature demands and maintain the required temperatures. Upgrade equipment to less temperature sensitive solutions as technology improves. This can be done through the normal upgrade programme due to the lifespan of the equipment in relation to the temperature changes expected.	Availability of technological solutions. Increased cost of improved specification systems. High energy requirements of cooling.	1	4	6	1	4	6
37	Increased storminess/wind speed	More insurance claims to cover affects.	Property, employer liability and public liability insurance could be affected.	1	4	6	?	2	4	12	Good risk management practices.			1	4	6	1	4	6
38	Increased storminess/wind speed	Higher insurance premiums	As more claims are processed UK wide the cost of insurance will increase as will the excess.			0	?	2	4	12	Good risk management practices. Negotiate suitable excess. Liability limitations.	Continue with the same. Potentially self-insure.	Cost	0	0	0	1	4	6
39	Increased storminess/wind speed	Cash flow affected by unexpected costs.	Increased costs to fix damages and cover overtime.	1	4	6	?	2	4	12	Insure sufficient funds by good planning.	Continue with the same.	Lack of information to allow good planning.	1	2	4	1	3	5

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
40	Increased storminess/wind speed	Cruise vessels unable to call due to conditions or delayed in departure.	Loss of cruise call revenue, disruption of service to customer, increase costs.	2	3	10	?	2	4	12	Tug assistance makes operations possible in difficult conditions to an extent. Monitor the weather and shift operations where possible to avoid bad weather. Liaise with the cruise customer to	More tugs/bigger tugs.	Cost of purchasing tugs. Cost of additional crewing requirements.	1	3	5	1	4	6
9	Increased storminess/wind speed	Damage to marine navigational equipment used by Port Control.	Marine navigational equipment such as (HADCP/VTMS/Tide Gauge) can be damaged due to large wind and wave action.	1	3	5	?	2	3	10	Maintain a stock of spare parts for maintenance of equipment. Back up systems on certain areas.	Continue with the same.		1	2	4	1	3	5
10	Increased storminess/wind speed	Disruption to hydrographic surveying regime and dredging regime.	Disrupted hydrographic regime would cause a delay in information to the dredger reducing the accuracy of dredging operations. Dredging cannot be carried out in high swells as the dredger has difficulty accessing the disposal site. This leads to siltation of the harbour.	1	1	3	?	2	3	10	Monitor the weather and arrange dredging and hydrographic operations around inclement weather. Prioritise dredging and hydrographic operations in good weather where possible. Prioritise to ensure key areas are surveyed and dredged.	Continue with the same. Potentially increase resource to allow hydrographic and dredging operations to be prioritised further.	Cost of additional staffing.	1	1	3	1	1	3
24	Change in mean precipitation in winter time.	Snow and ice preventing employees getting to work.	Lack of staff for operational roles. Increased pressure on staff in attendance.	1	2	4	2050	2	3	10	Contingency planning to bring staff in. On call staff to provide cover. Business continuity planning.	Continue with the same.		1	1	3	1	1	3
13	Increased storminess/wind speed	Beach erosion.	Heavy winds creating large swell could lead to an increase in beach erosion. Which has the potential to undermine marine structures such as the Admiralty Pier.	1	1	3	?	2	2	8	Regular surveys and maintenance of marine structures.	Continue with the same. Apply additional sea defence measures if necessary.		1	1	3	1	1	3
14	Change in winter mean precipitation.	Cliff erosion.	More precipitation causing freeze-thaw erosion may lead to increased cliff erosion. A big potential for danger and disruption.	1	1	3	2020	2	2	8	Regular surveys and cliff protection works.	Continue with the same.		1	1	3	1	1	3
16	Increased wind speed.	Disrupted electricity supply due to weather damage.	Stormy conditions causing damage could lead to a loss in power from the grid supply.	1	1	3	?	2	2	8	System of generators to allow key operations to continue.	Generator upgrade currently in planning to improve resilience further.		1	1	3	2	2	8

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
23	Snow events/Change in mean precipitation in winter time.	Snow and ice affecting approach routes.	Reduces traffic flow to the port.	1	2	4	2050	2	2	8	Outside of DHB control.	Government winter resilience programme.	Outside of DHB control.	1	2	4	2	2	8
36	Snow events/Change in mean precipitation in winter time.	Extreme conditions leading to staff absence, extra work and excess passengers causes staff to take time away from their core roles.	Potential to miss an important deadlines, commercial opportunity.	2	2	8	?	2	2	8	Business continuity planning.	Continue with the same.		2	1	6	2	1	6
3	Increase in daily mean summer time maximum temperature.	Higher utility costs for cooling	Hotter days could cause more money to be spent on cooling.	1	4	6	2050	1	4	6	Energy saving initiatives to improve efficiency and investigate the potential for renewables.	As costs increase more measures become cost effective.	Costs of investment in new technology/solutions .	1	4	6	1	4	6
4	Increase in summer max temperature	Uncomfortably warm offices.	Temperatures above 28˚C in un-air-conditioned offices causes complaints and decreasing productivity. Offices without any air-conditioning may not be rented off the organisation.	1	3	5	2050	1	4	6	Air conditioning is currently placed in areas of significant solar gain and where other options are less feasible.	Awareness training on keeping cool without the need for air con. Significant justification for installing air conditioning in new areas would be needed. Potential to investigate external blinds/reflective glass, and changing the occupancy of building to move people to cooler areas.	Awareness training maybe ignored. Cost of introducing external blinds/reflective glass. Negotiations about moving office spaces.	1	3	5	1	3	5
5	Increase in summer max temperature	Sunburn to staff.	Increased temperatures could cause more cases of sunburn during the summer.	1	3	5	2080	1	4	6	Personal Protective Equipment (PPE) is available, offering protection from sunburn. Occupational health department assists with any health issues. During summer months education on preventing sun burn is sent out. Risk assessment in place concerning working in the sun.	Increase current mitigation measures.		1	2	4	1	2	4

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
17	Sea level rise/storm surge.	Failure of ramps and berths in the marina.	A sever storm surge coupled with a significant rise in sea level could cause the ramps and berths in the marinas to fail.			0	2050	2	1	6	N/A	Modify design to cope with expected storm surges.	Cost of investment.	0	0	0	1	1	3
29	Increased wind speed.	Commercial opportunities associated with wind farms increase.	Potential for our own and for developing facilities to service the wind farm industry.			0	?	2	1	6	N/A	Maintain awareness of commercial opportunities and cost effectiveness of using wind generation ourselves.	Planning constraints.			0	2	1	6
32	Increased storminess/wind speed.	Damage to customers property.	Vehicles and vessels stored in the port	1	2	4	?	1	3	5	Insurance. Prepare for the weather through monitoring and storm warning systems. Good communications with customers where possible.	Continue with the same.		1	2	4	1	2	4
27	Increased storminess/wind speed.	Loss of reputation as the last mode of transport standing.	Increased port closures due to storminess may lead to a loss of reputation as a reliable transport node and could cause some customer diversion.	1	2	4	?	1	2	4	Maintain operations in as many conditions as possible. Provide good customer service in times of delay.	Continue with the same.		1	1	3	1	1	3
33	Increased storminess/wind speed.	Damage to floating craft/ equipment.		1	2	4	?	1	2	4	Insurance. Prepare for the weather through monitoring and storm warning systems.	Continue with the same.		1	2	4	1	2	4
19	Increase in daily mean summer time maximum temperature.	Tarmac broken through heat softening		1	1	3	2080	1	1	3	Concrete used on areas where vehicles are turning. Asphalt only used on low impact areas. Regular resurfacing programme to maintain road surfaces in good condition.	Continue with the same.		1	1	3	1	1	3

Appendix 3: Climate Change Risk Matrix 2015

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
16	Increased wind speed.	Disrupted electricity supply due to weather damage. Power cuts	Stormy conditions causing damage could lead to a loss in power from the grid supply.	3	4	18	?	3	5	21	System of generators to allow key operations to continue.	Generator upgrade currently in planning to improve resilience further.		1	4	6	1	5	7
6	Change in mean precipitation in summer time.	A shortage of water supply.	Large amounts of water are required for vessels. This puts greater demands on our supplier.	1	1	3	2050	4	3	20	DHB monitor the water usage of all vessels. DHB have an Energy and Water Policy in place and run and associated initiatives to reduce water consumption.	DHB would pass on increasing water charges to the tenants and vessels and change the charging mechanism to reflect water use. Investigate the potential for vessels to obtain their water supply in France to reduce the pressure on UK resources. Increase the use of grey water within the port. Investigate the potential for a desalination plant.	The infrastructure required for the use of grey water has to be cost effective. A desalination plant would require a large capital expenditure and would use large amounts of electricity.	1	1	3	2	3	10
1	Storm surge.	Flooding around the Wellington Dock.	A storm surge greater than 8m would cause the Wellington Dock to over spill and flood the surrounding area. No current operational risk but precludes development in this area which reduces the opportunity for making a profit from this asset.	4	2	16	now	4	3	20	Plans are currently in place to enable works to heighten quay walls and develop dock gates that can keep out storm surges to prevent flooding.		Cost of infrastructure. Planning permission (listed buildings in the docks).	4	1	12	2	1	6

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
21	Increase in snow events	Bad weather, snow and ice causing traffic disruptions within the port.	Internal roads, lanes and ramps become impassable and unusable.	3	3	15	2020	3	4	18	Gritting and snow clearance. Bad weather planning. Gritting policy. Weather reports direct from met office.	Planning to have a larger grit store, experimenting with blowers. Bring in outside help from local service providers for snow clearance. Plan to maintain the heating system in the ramps and investigate the potential to install more.	Heating system infrastructure has to be cost effective.	2	3	10	2	4	12
22	Increase in snow events	Severe weather closing other modes of transport creating extra pressure and costs to the port operation	Airports, Eurotunnel being closed due to weather conditions. The port has to modify operations to account for the resultant change in transport modes and travel patterns.	2	3	10	2020	3	4	18	Contingency plans. Extra staff on-call. Relationships with bus and train companies. Emergency supplies (blankets, heaters).	Modify charging mechanisms to reflect costs. Overflow space made available for foot passengers.	Cost of on call staff. Cost of emergency supplies.	2	3	10	2	4	12
26	Increased fog	Delays in the ferry timetable due to poor visibility.	Leads to delays and operation stack. Currently affects operations 2-3 weeks per annum.	2	4	12	?	3	4	18	High visibility lights, enhanced radar systems. Port control measures. Training for ship staff to work in the fog. Port marine safety code.	Traffic Management Improvement project to increase capacity within the Eastern Docks		1	4	6	2	4	12
28	Increased storminess/wind speed	Service delivery ro-ro. Severe weather leading to port closure/operation stack. Berths untenable traffic queuing. Uplift capacity reduces	Police manning roundabouts/operation stack. Traffic disruption and air quality decreases.	3	3	15	?	3	4	18	Port marine safety code. Operation stack procedures. Good relations with Kent police/Highways Agency. Tug assistance to vessels.	External buffer zone to hold waiting traffic.	Cost of buffer zone conflicts with DHB investment to regenerate town.	3	3	15	2	3	10

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
40	Increased storminess/wind speed	Service delivery cruise and cargo. Vessels unable to call due to conditions or delayed in departure.	Loss of call revenue, disruption of service to customer, increased costs. Perception by vessel owners that Dover is comparatively more exposed.	3	3	15	?	3	4	18	Tug assistance makes operations possible in difficult conditions to an extent. Flexible working hours. Liaise with the cruise customer to deliver the best service and issue weather warnings.	More tugs/bigger tugs.	Cost of purchasing tugs. Significant difficulty in recruiting specialist skills	2	3	10	1	4	6
5	Increase in summer max temperature	Sunburn to staff.	Increased temperatures could cause more cases of sunburn during the summer.	1	4	6	2080	3	4	18	Personal Protective Equipment (PPE) is available, offering protection from sunburn. Occupational Health department assists with any health issues. During summer months education on preventing sun burn is sent out. Risk assessment in place concerning working in the sun.	Increase current mitigation measures.		1	2	4	3	2	12
8	Change in winter mean precipitation.	Flooding of the port due to inadequate draining facilities	Increased precipitation could potentially flood drains causing pollution and lack of access. Service ducts and tunnels would also become flooded.			0	2050	3	3	15	DHB presently use the correct design standards for drains to mitigate for any potential flooding due to precipitation.	Increase the drainage capacity inline with future design standards.	Infrastructure can be very costly, however this can be reduced via a manage adaptive strategy that would bring drainage up to new design standards incrementally.	0	0	0	2	2	8

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
7	Change in winter mean precipitation.	Contamination of potable water service caused by flooding	Risk controlled by service provider.	3	1	9	2050	3	3	15	DHB currently have a testing regime in place and are notified through Kent area health authority. There is also a regime for sanitizing any	Apply pressure to the water provider to maintain service levels. Protect our own supply via filtration.	Our water supply is not fully under our control, as it is provided to us by the supplier. The cost of	2	1	6	2	2	8
25	Increase in snow events/ Change in winter mean precipitation.	Severe weather causes stock shortages in key supplies.	e.g. salt, grit, fuel oil.	2	3	10	2020	3	3	15	Hold a stock of grit and fuel oil.	Increase the size of salt and grit stocks, source fuel oil by sea.	Cost of storage infrastructure.	1	3	5	2	3	10
41	Increased storminess/ wind speed	Financial results affected by more costs and less revenue	More costs due to increased expenditure on overtime and maintenance and lower revenue due to fewer sailings.	2	1	6	?	3	3	15	Take account in forecasting and managing costs. Includes eastern docks not cruise terminals.	Modify charging mechanisms to reflect costs.	Customer objections.	1	1	3	1	2	4
20	Change in winter mean precipitation.	Snow and icy conditions creating costs to cover labour, plant and grit.	Snow clearing operations require on call staff and can lead to overtime and associated costs.	2	4	12	2050	2	4	12	The cleaning contractor is used to carry out gritting functions in place of sweeping which cannot be done in snow conditions. This utilises staff who are already being paid. Staff and tenants responsible for clearing their own areas.	Update contractual arrangements to define responsibilities and reduce the burden on DHB.	Contractual negotiations.	1	4	6	1	4	6

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
34	Snow events/Change in winter mean precipitation.	Ice causing slips/trips	Health and safety concern.	2	4	12	?	2	4	12	Gritting and snow clearance. Bad weather planning. Gritting policy. Weather reports direct from met office.	Planning to have a larger grit store, experimenting with blowers. Bring in outside help from local service providers for snow clearance. Plan to maintain the heating system in the ramps and investigate the potential to install more.	Costs of investment in ramp heating and high energy use.	2	4	12	2	4	12
12	Increased storminess/wind speed	Increased storm damage and corrosion	Increased winds brings more storminess causing damage to buildings and marine structures. Increased costs to fix damages and cover overtime.	2	3	10	?	2	4	12	DHB have in place a storm warning system. Prior to a storm vulnerable structures are fixed down. There is a post storm inspection and regime, to check on all structures. The organisation is heavily insured towards this risk. Hydraulics research with HR Wallingford means there is a catalogue of information available on how storms can affect the port.	Upgrade buildings and structures to meet design standards.	Assuming design standards are modified to adapt to climate change. Increased demand on maintenance staff.	2	3	10	1	3	5
15	Increased storminess/wind speed	Reduced thermal efficiency of buildings	Increased winds can cause drafts in poorly insulated buildings reducing the thermal efficiency of the building and costing more to heat it.	1	4	6	?	2	4	12	DHB carry out general maintenance and monitor the energy use of buildings. We also have in place an Energy Monitoring scheme across the port, to continuously identify areas for improvement and investments are made annually to deliver improvement projects.	The implement of improvement projects would be carried out when they become cost effective through energy savings, backed by enhanced capital allowances.	Many of the old buildings that have a poor thermal efficiency are also listed buildings, which can limit the types of works that can be carried out.	1	3	5	1	3	5

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
31	Increased wind speed.	Enhanced operational commitments affects crewing arrangements	Long continuous use of the tugs leads to problems with the crewing arrangements. The Maritime Working Directive limits work to 14 hours. The problem is	1	4	6	?	2	4	12	Use on-call tug crew to provide break. Flexible working hours	Consider recruiting additional staff.	Significant difficulty in recruiting specialist skills.	1	4	6	1	4	6
37	Increased storminess/wind speed	More insurance claims to cover effects. Higher insurance	Property, employer liability and public liability insurance could be affected. As more claims are processed UK wide the cost of insurance will increase as will the excess	1	4	6	?	2	4	12	Good risk management practices. Negotiate suitable excess. Liability limitations.	Continue with the same.		1	4	6	1	4	6
30	Increased wind speed.	Parting of vessel from ship-shore interface. Health and safety risk	Safety risk in gale force 7-8 and/or 2m swell.	1	3	5	?	2	4	12	Put out extra moorings. Use alternative berths which are more sheltered. Vessels use engines to stay in berth. Retro-fitting ro-ro berths with self-supporting fingers.	Planned berths are aligned to give the best wave climate possible for the local conditions.		1	3	5	1	4	6
18	Sea level rise.	Low and high tide affecting passenger access operations at the cruise terminal and span operations at the ferry berths.	The passenger access walkways and the link spans on some berths cannot be operated safely at all states of the tide. Operations are therefore not carried out on these berths over extreme low and extreme high waters.	2	2	8	2050	2	3	12	Close the berth until the tide turns. Manage the operation through other berths during this time.	Engineer the problem out as part of the general upgrade of equipment. The lifespan of berths being 25 years.	Cost of infrastructure potentially including the vessels.	1	3	5	1	3	5

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
24	Change in winter mean precipitation.	Snow and ice preventing employees getting to work.	Lack of staff for operational roles. Increased pressure on staff in attendance.	1	2	4	2050	2	3	10	Contingency planning to bring staff in. On call staff to provide cover. Business continuity planning.	Continue with the same.		1	1	3	1	1	3
14	Change in winter mean precipitation.	Cliff erosion.	More precipitation causing freeze-thaw erosion may lead to increased cliff erosion. A big potential for danger and disruption.	1	3	5	2020	2	3	10	Regular surveys and cliff protection works.	Continue with the same.		1	3	5	1	3	5
23	Snow events/Change in winter mean precipitation.	Snow and ice affecting approach routes.	Halts/reduces traffic flow to the port.	1	3	5	2050	2	3	10	Outside of DHB control. Liaison with Highways Agency	Government winter resilience programme.	Outside of DHB control.	1	3	5	2	3	10
9	Increased storminess/wind speed	Loss of function of Port Control due to damage to marine navigational equipment and/or inaccessibility	Marine navigational equipment such as (HADCP/VTMS/Tide Gauge) can be damaged due to large wind and wave action.	1	3	5	?	2	3	10	Maintain a stock of spare parts for maintenance of equipment. Back up systems on certain areas.	Continue with the same.		1	2	4	1	3	5
10	Increased storminess/wind speed	Disruption to hydrographic surveying regime and dredging regime. Restricted work and work opportunities and maintenance etc. delays project	Disrupted hydrographic regime would cause a delay in information to the dredger reducing the accuracy of dredging operations. Dredging cannot be carried out in high swells as the dredger has difficulty accessing the disposal site. This leads to siltation of the harbour.	1	1	3	?	2	3	10	Monitor the weather and arrange dredging and hydrographic operations around inclement weather. Prioritise dredging and hydrographic operations in good weather where possible. Prioritise to ensure key areas are surveyed and dredged. DHB ensure good planning is conducted to avoid bad weather when programming works.	Continue with the same. Potentially increase resource to allow hydrographic and dredging operations to be prioritised further. DHB would increase current measures, and look into introducing more flexible hours, such as annualised hours. With more outdoor work taking place in the summer months.	Cost of additional staffing.	1	1	3	1	1	3

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
32	Increased storminess/wind speed.	Damage to customers property, flooding on the admiralty pier.	Vehicles stored in the port. Waves overtopping the Admiralty Pier can occur during high water, with gale force 8 and above winds.	2	3	10	?	2	3	10	Insurance. Prepare for the weather through monitoring and storm warning systems. Flood defences are fitted on the Admiralty Pier in winter season. Flood plan updated. Use alternative storage areas.	Continue with the same. Inundation maps completed to 8.5-9m above high tide. There is potential to improve the flood defences that are currently in place. This will only be taken forward if it becomes cost effective.	Cost of infrastructure.	1	3	5	1	2	4
36	Snow events/Change in mean precipitation in winter time.	Extreme conditions leading to staff absence, extra work and excess passengers causes staff to take time away from their core roles.	Potential to miss an important deadlines, commercial opportunity.	2	2	8	?	2	2	8	Business continuity planning.	Continue with the same.		1	2	4	1	2	4
13	Increased storminess/wind speed	Beach erosion. Scouring action will undermine marine structures	Heavy winds creating large swell could lead to an increase in beach erosion. Which has the potential to undermine marine structures such as the Admiralty Pier.	1	1	3	?	2	2	8	Regular surveys and maintenance of marine structures.	Continue with the same. Apply additional sea defence measures if necessary.	Capital investment unlikely to be justified on grounds of preservation of amenity alone.	1	1	3	1	1	3
17	Sea level rise/storm surge.	Failure of ramps and berths in the marina.	A severe storm surge coupled with a significant rise in sea level could cause the ramps and berths in the marinas to fail.	2	2	8	2050	2	2	8	N/A	Modify design to cope with expected storm surges.	Cost of investment.	0	0	0	1	1	3

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
29	Increased wind speed.	Commercial opportunities associated with wind farms increase.	Potential for our own and for developing facilities to service the wind farm industry.			0	?	2	1	6	N/A	Maintain awareness of commercial opportunities and cost effectiveness of using wind generation ourselves.	Planning constraints. Cost of buffer zone conflicts with DHB investment to regenerate town.			0	2	1	6
3	Increase in daily mean summer time maximum temperature.	Increase pressure on cooling in temperature sensitive areas. Higher utility costs for cooling	Refrigerant units become less efficient above 28˚C for older units and 32˚C for newer units. Cooling to a specified temperature is important in the temperature controlled stores, computer server rooms and in the berth pump houses. Hotter days could cause more money to be spent on cooling.	1	4	6	2050	1	4	6	Energy saving initiatives to improve efficiency and investigate the potential for renewables. Maintain a suite of refrigerant units that can meet the majority of circumstances.	Increase the specification of refrigeration units to meet the temperature demands and maintain the required temperatures. Upgrade equipment to less temperature sensitive solutions as technology improves. This can be done through the normal upgrade programme due to the lifespan of the equipment in relation to the temperature changes expected. As costs increase more measures become cost effective.	Availability of technological solutions. Increased cost of improved specification systems. High energy requirements of cooling. Costs of investment in new technology/solutions.	1	4	6	1	4	6
4	Increase in summer max temperature	Staff welfare in uncomfortably warm offices.	Temperatures above 28˚C in un-air-conditioned offices causes complaints and decreasing productivity. Offices without any air-conditioning may not be rented off the organisation.	1	4	6	2050	1	4	6	Air conditioning is currently placed in areas of significant solar gain and where other options are less feasible.	Awareness training on keeping cool without the need for air con. Significant justification for installing air conditioning in new areas would be needed. Potential to investigate external blinds/reflective glass, and changing the occupancy of building to move people to cooler areas.	Awareness training maybe ignored. Cost of introducing external blinds/reflective glass. Negotiations about moving office spaces.	1	3	5	1	3	5
27	Increased storminess/wind speed.	Loss of reputation as the last mode of transport standing.	Increased port closures due to storminess undermine the ability to handle £100 billion of UK/European trade and influxes of passengers from elsewhere.	1	2	4	?	1	2	4	Maintain operations in as many conditions as possible. Provide good customer service in times of delay.	Continue with the same. Studies to improve the resilience of berths.	Fragility of regional infrastructure - road and rail.	1	1	3	1	1	3

Risk Number	Climate Projection	Risk Description	Details of Risk Including Any Thresholds	Gross - Present Day			Gross - Future (Based on the timescale when the change becomes significant)				Current Mitigation Measures	Adaptation Measures	Barriers to Adaptation	Net - Present Day			Net - Future (Based on the timescale highlighted)		
				Severity	Probability	Risk Overall	Timescale	Severity	Probability	Risk Overall				Severity	Probability	Overall	Severity	Probability	Overall
33	Increased storminess/wind speed.	Customer service risk. Damage to floating craft/ equipment.		3	2	12	?	1	2	4	Insurance. Prepare for the weather through monitoring and storm warning systems.	Continue with the same.		3	1	9	3	2	12
19	Increase in daily mean summer time maximum temperature.	Tarmac broken through heat softening		1	2	4	2080	1	2	4	Concrete used on areas where vehicles are turning. Asphalt only used on low impact areas. Regular resurfacing programme to maintain road surfaces in good condition.	Continue with the same.		1	1	3	1	2	4

Appendix 4: Evaluation of High Priority Adaptation Measures

Risk ID	Adaptation measure	2011 Order of overall preference	Implemented Actions				
			Progress on implementation	Assessment to which actions have mitigated risk	Benefits /challenges experienced	Further or new actions planned	Timescale for further new action
2	There is potential to improve the flood defences that are currently put in place.	1	New innundation maps have been made to identify areas at greatest risk at an increased 9.5m above chart datum. Flood risk modelling has been completed in conjunction with Royal HaskoningDHV UK and this has been incorporated in Dover Western Docks Revival Project, currently at the planning stage. This plan proposes improved flood defences and new locks gates using the 1 in 100 year risk scenario. Changes have been made to parking arrangements in the Cruise Terminal and some electrical installations have been protected or moved.	Knowledge of our vulnerabilities are increasing and development plans are looking at ways to become more resilient against flood risk. Changes to parking arrangements will make us less liable to insurance claims and associated rises in premiums	The results of the modelling work will produce an interactive PDF inundation map data that will be shared with all relevant authorities.	Improved flood defences subject to planning approval.	Modelling work will be complete by 2016. Dover Western Docks Revival work is part of a long term project which is at the planning stage at present.
6	Water charges will be passed on to tenants and users.	1	Water charges have not been passed on to ferries but water metering and monitoring of usage is in place. If water shortages or price increases were to occur tariffs would be reviewed accordingly.			None at present but flexibility remains to allow for changes to be made.	As required
	Investigate the potential for vessels to obtain their water supply in France.	2	Primarily a matter for ferry operators, this has not been investigated at present.	N/A		None	
	Increase the use of grey water in the port	3	It has been assessed as not viable at present on cost and practicality grounds.	N/A		To be incorporated in new development plans	At planning stage - timescale not available at present
	Investigate the potential for a desalination plant.	4	This has not been investigated further due to the high energy requirements, carbon related increases and economic costs that a desalination plant would cause.	N/A	Cost and energy usage prevents desalination becoming an option at present	None	

Risk ID	Adaptation measure	2011 Order of overall preference	Implemented Actions				
			Progress on implementation	Assessment to which actions have mitigated risk	Benefits /challenges experienced	Further or new actions planned	Timescale for further new action
7	Apply pressure on the water provider.	1	Good relationships have been established with Affinity Water, the water provider, and regular water testing is still in place. Advance notice of water cuts is given and the back up reservoirs would be used.	N/A		None	
	Protect our own supply via filtration.	2	The water quality is checked weekly and sanitisation occurs to all new infrastructure installed. Investments have been made to water supply hoses on linkspans to ensure they are not capable of contamination from back siphoning.	Water supply is protected from back siphoning.		None	
8	Increase drainage capacity inline with future design standards.	1	No changes have been made to drainage at present.	N/A		None	
11	Introduce more flexible hours, such as annualised hours. More outdoor work taking place in the summer months.	1	Contractual rights for employees regarding hours have changed, which are more flexible to cope with periods of demand. Weather is monitored and the shifts are adapted accordingly.	More flexibility in available staff to repond to weather events through contractural changes.	More available staff to respond in severe weather events	None	

Risk ID	Adaptation measure	2011 Order of overall preference	Implemented Actions				
			Progress on implementation	Assessment to which actions have mitigated risk	Benefits /challenges experienced	Further or new actions planned	Timescale for further new action
12	Upgrade buildings and structures to meet design standards	1	Storm warning system unchanged. Pre and post inspection regime has been improved. Feeder systems have been renewed on berths. A 4 year programme will be completed in 2015 to protect the infrastructure from vessels.	The infrastructure will be more resilient following the upgrade progamme	Cost is part of the ongoing upgrade and refit programme of the port to maintain a high level of service	Completion of current works	
15	Improvements to buildings that are less thermally efficient.	1	Secondary double glazing and thermostatic radiator valves installed in Harbour House	Reduced energy losses in the building.	Problems have been encountered with the energy monitoring systems.	None	
18	Engineer berths to new tidal regime as part of upgrade programme	1	Berth designs have been changed from 8.5m to 9.5 m above chart datum for future use. Vertical ladder access has been replaced with articulated walkways to improve safety and resilience. Free floating fingers on the bridge access to vessels allow self levelling to accommodate vessel movements and maintain a safe access	Berth accessibility has improved for staff and self levelling allows for tidal changes.	Safety aspects have improved with this adaption. Self levelling fingers reduce bridge movements and the associated energy use.	Completion of current works	Expected 2016
20	Update contractual arrangements to define responsibilities and reduce the burden on DHB.	1	Use of the contractors to clear snow has proved effective and provided a good service	New arrangements for snow clearance are working well and reducing the impact of snow on roads and footpaths	Extra staff are available from the contractor without taking operational staff away from duties	None	

Risk ID	Adaptation measure	2011 Order of overall preference	Implemented Actions				
			Progress on implementation	Assessment to which actions have mitigated risk	Benefits /challenges experienced	Further or new actions planned	Timescale for further new action
21 and 34	Increase grit store	1	A larger grit store was been put in place in 2013.	Snow events are uncommon but preparedness has improved.	More salt is available to treat roads and paths	None	
	Bring in help from local service providers for snow clearance	2	Snow clearance is now part of the services provided by the cleaning contractor. Snow blowers were purchsed but were inadequate.	New arrangements for snow clearance are working well and reducing the impact of snow on roads and footpaths	Extra staff are available from the contractor without taking operational staff away from duties	None	
	Maintain the heating systems in the ramps	3	Ramp heating systems has been maintained and a thermal survey has been carried out to check operation	Current service has been maintained to provide clear routes		None	
	Investigate the need for more ramp heating systems	4	Currently the two heated ramps provide sufficient facilities in the case of snow and there is no evidence to warrant implementation of more heated ramps.	N/A		None	
22	Modify charging mechanism to reflect costs.	1	There has not been evidence to support a change in charging mechanisms at present. Analysis of layby of vessels in bad weather has shown there has not been an increased demand for these services which would support changes.	N/A		None	
	Overflow space made available for foot passengers	2	Due to the traffic management improvement (TMI) project work this is not possible at present.	N/A	Fewer buildings available due to current project work	To be reviewed when current project has concluded	

Risk ID	Adaptation measure	2011 Order of overall preference	Implemented Actions				
			Progress on implementation	Assessment to which actions have mitigated risk	Benefits /challenges experienced	Further or new actions planned	Timescale for further new action
25	Increase the size of stock	1	Grit store increase has been successfully implemented. Agreement has been made with the fuel oil suppiers to store a reserve offsite	Supply risk not totally mitigated as road network may prevent access. Exploring renewable energy sources could reduce the reliance on transported fuel oil.	Supply of fuel oil by bunker barge may need to be explored - DHB has long used the low-sulphur fuel which is now also supplied to ferries.	None at present	
26 and 28	Traffic Management Improvement project to increase Eastern Docks capacity	1	TMI due to be completed by the end of 2015. High visibility lighting has been installed and radar enhancement to Port Control is budgeted for 2017.	TMI will facilitate increases storage of an extra 220 freight vehicle in the eastern docks.	This will reduce traffic and congestion on local roads and increase the capacity of the port.	Radar enhancement to Port Control	Expected 2017
	Terminal 2 project to increase capacity	1	Project is moving forward with the Dover Western Docks Revival since the approval of the Harbour Revision Order.	In progress	as above	Incorporated into new development plans	
	External buffer zone to hold waiting traffic	3	New A20 traffic management measures were implemented by Highways England on the 8th April 2015 as part of an assessment aimed at reducing congestion through Dover during busy traffic times.	Results will follow the assessment period	This may provide improvements to air quality in parts of Dover as well as ensure routes remain clear for the local community.	Will be announced following the review of the assessment period by Highways England	

Risk ID	Adaptation measure	2011 Order of overall preference	Implemented Actions				
			Progress on implementation	Assessment to which actions have mitigated risk	Benefits /challenges experienced	Further or new actions planned	Timescale for further new action
30	Berths under development are aligned to give the best conditions.	1	Existing berths have had improvements made during the refit programme such as free floating fingers on the linkspans to adjust to tide height changes. For the proposed berths wave modelling has been completed by HR Wallingford to assist with the new berth designs to make them more resilient, balanced against acceptable down times for the business which has been assessed as 60-100 hours per annum. Orientation of the berths and material type is incorporated in the design.	Berthing operations will have health and safety risks reduced.	Berthing time for vessels will be reduced as will the need for tug assistance.	Completion of current works	Expected 2016
	More/bigger tugs	2	These have been proposed but have not moved forward at present.	N/A	Cost	Proposal has not moved forward at present	
31	Create a different shift pattern for the tug crews.	1	This has been implemented and has been in operation since 2012, with a change to contractual rights. Greater flexibility in working hours has enabling use of a stand by crew when the day crew have exhausted their regulated hours.	More available staff to repond to tug support required during weather events through contractural changes for flexible hours.	Greater availability of staff	None	
35	Increase the specification of refrigerant units to meet temperature demands.	2	Installation of newer units has been part of an ongoing programme since 2012. They have been replaced on a cost basis re their potential energy savings. This is near completion.	Units now work efficiently at higher operating temperatures	Energy reduction benefits	Completion of current works. Review of server room sizes.	By 2016
	Upgrade equipment to less temperature sensitive solutions.	1	as above			as above	

Risk ID	Adaptation measure	2011 Order of overall preference	Implemented Actions				
			Progress on implementation	Assessment to which actions have mitigated risk	Benefits /challenges experienced	Further or new actions planned	Timescale for further new action
38	Self-insure	1	There has been an insurance fee reduction which means there is no need to self - insure. The maintenance programme has reduced claims.	N/A		None	
40	More/bigger tugs	1	These have been proposed but have not moved forward at present.	N/A	Cost	Proposal has not moved forward at present	
41	Modify charging mechanisms to reflect costs	1	There has been no need to amend charging mechanisms at present but flexibility is present if this changes.	N/A		None at present but flexibility remains to allow for changes to be made.	As required

References

Douglas, R. P. A., Green, G. K., Lane, P. and Peto, M. 1997. *Douglas and Green on The Law of Harbours, Coasts and Pilotage*. LLP limited.

The International Organization for Standardization. 2009. ISO31000: Risk Management – Principles and Guidelines. Switzerland.

UKCP09. 2009. Available at: http://ukclimateprojections.defra.gov.uk [Accessed: February - August 2010]

Dover Harbour Board 2011. *Climate Change Adaptation Report, March 2011*