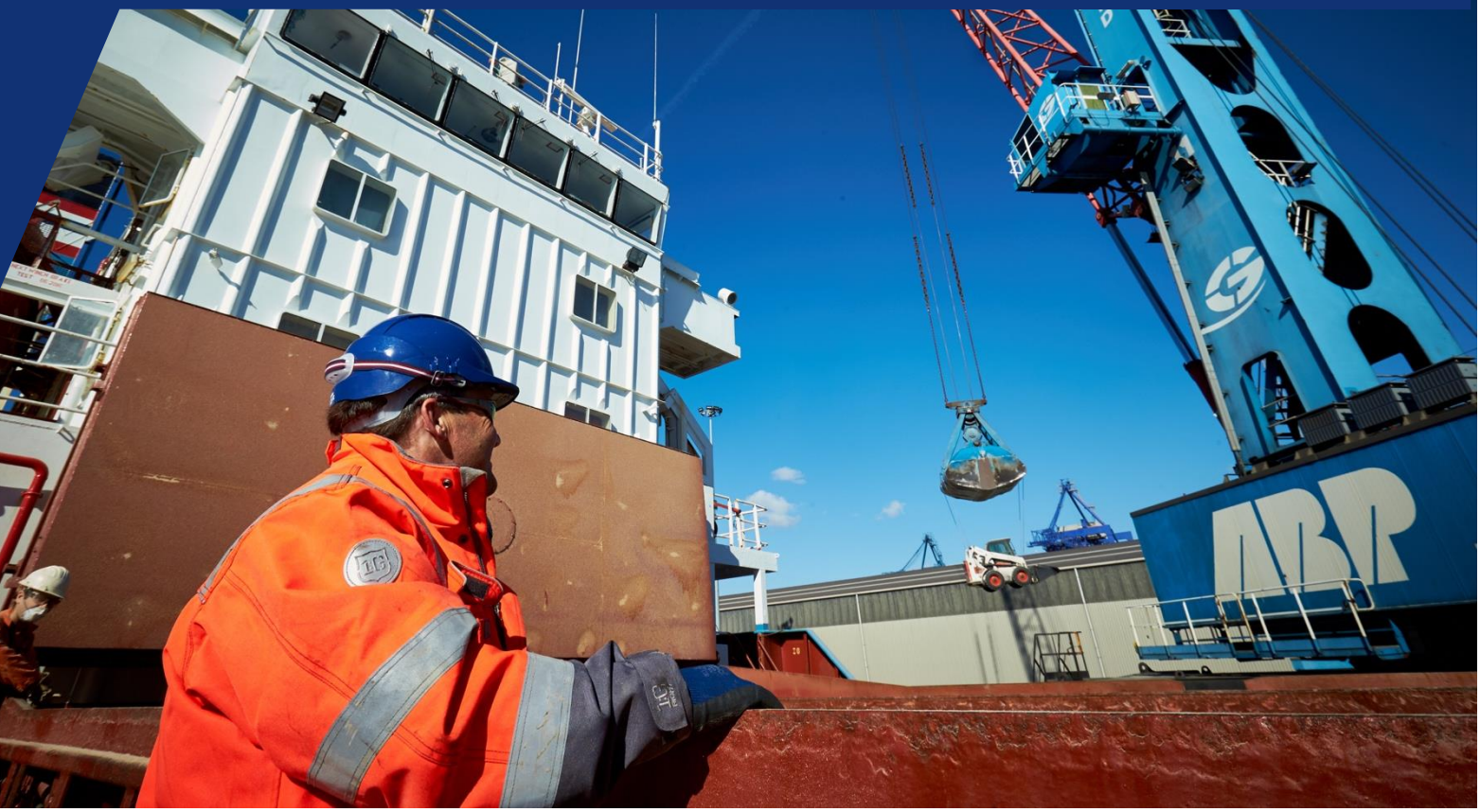


Climate Change Adaptation Report

2016 Update

July 2016

ABP | KEEPING BRITAIN TRADING

Contents

Non Technical Summary

ABP is the UK's leading ports group, owning and operating 21 ports around the UK and handling approximately handling over 92 million tonnes of cargo every year. As a result, we support over 84,000 jobs, generate 25% of UK rail freight and contribute over £5.6bn to the UK economy.

Our ports are: Ayr, Barrow, Barry, Cardiff, Fleetwood, Garston, Goole, Grimsby, Hull, Immingham, Ipswich, King's Lynn, Lowestoft, Newport, Plymouth, Port Talbot, Silloth, Southampton, Swansea, Teignmouth and Troon.

ABP has statutory functions as Harbour Authority for each of its 21 ports. ABP has been directed to report in relation to its role as Harbour Authority in the Humber and within the ports of Immingham, Hull and Southampton. Defra is updating its national climate change risk assessment and has requested voluntary participation in its second round of adaptation reporting. This document provides the voluntary update to ABP's original Climate Change Adaption Report (2011). It reviews climate change risk based upon the latest information and incorporates our more recent plans and programs to manage the increasing risk to engineering, dredging, Vessel traffic services and pilotage across the Humber, at Immingham, Hull and Southampton.

The key climate change risks that are considered likely to impact ABP functions are sea level rise, increased storm events, and temperature changes.

After reviewing the harbour authorities' functions and the key climate change risks the report concludes that the majority of potential impacts are currently considered to be of low risk with a small number of medium term risks. The key risks identified were related to our engineering and VTS functions and the projected impacts associated with sea level rise and flooding, temperature increases and storminess. We have documented the actions that are, and will be, taken to mitigate risks where possible so that that our marine functions are not significantly affected. The information collected as part of this report and the findings are used to inform the continuous process of review of our risk assessments and safe systems of work. The proposed risks and actions related to our statutory functions are embedded in our Marine Safety Management System.

Ports in the UK form an important part of our transport infrastructure. A small number of ports are extremely important and as such deemed critical national infrastructure, whose continued existence and contribution to trade underpins a significant amount of economic activity. ABP's 21 ports around the coast of Britain are estimated to contribute some £5.6 bn to the UK economy every year. Some ports are so strategically important that their existence essentially underpins a number of key societal needs, such as food, fuel and electricity generation.

Given that ports are wealth facilitators who also support the generation of significant amounts of tax revenue, we would suggest that a separate level of consideration should be given to ports and their hinterland industries, which reflects the largely hidden but nevertheless huge contribution they make to our standard of living. When viewed against their size and scope of activity, ports often support a proportionately greater amount of the nation's GDP. It would therefore seem reasonable for ports and industries, which have, by necessity, be located in coastal areas, be afforded a level of protected status when it comes to government considerations for flood risk management. Whilst we understand that residential areas command a priority when it comes to allocating funding, we would suggest that a more holistic approach should be adopted. In particular where a small number of industries employ large sections of the local workforce, it seems imprudent to disregard local industry, when the economic security of people depends upon industry and jobs to underpin all economic activity.

Introduction

Associated British Ports

ABP is the UK's leading ports group, owning and operating 21 ports around the UK and handling £150 billion worth of goods each year . We are the market leader in the sector, handling over 100 million tonnes of cargo every year. As a result, we support over 84,000 jobs, generate 25% of UK rail freight and contribute over £5.6bn to the UK economy every year.

ABP handles the largest vessels afloat, offers 87km of quay, 1.4 million square meters of covered storage, 1000ha of open storage and almost 5000ha of port land, including 900ha for development. We handle a huge range of different types of cargo, more than any other port group in the UK, and are investing over £1 billion in new facilities for our customers.

In addition to our own activities, we have interests in two UK container terminals moving over two million containers every year.

Our ports are: Ayr, Barrow, Barry, Cardiff, Fleetwood, Garston, Goole, Grimsby, Hull, Immingham, Ipswich, King's Lynn, Lowestoft, Newport, Plymouth, Port Talbot, Silloth, Southampton, Swansea, Teignmouth and Troon (see figure 1).

As well as excellent geographic coverage, our business benefits from a well-diversified cargo base. In addition, we work with a wide range of customers, usually under long-term contracts. Typically, our UK ports and transport revenue is earned from:

- Ships dues from vessels berthing at our ports;
- Goods dues (also known as wharfage or cargo dues) levied on the tonnage of goods passing over our quays;
- Handling services provided by ABP Stevedores;
- Charges to independent stevedores for working at our ports and hiring our equipment;
- Income from terminals we operate on behalf of other customers;
- Charges for storage or warehousing of cargo passing through our ports;
- Property rental and service income from the provision of land on our port estates;
- Pilotage charges for guiding vessels through estuary or harbour areas;
- Conservancy charges for the maintenance of safe and navigable waterways; and
- Value-added transport-related services.

ABP has statutory functions as Harbour Authority for each of its 21 ports. The main functions of a Harbour Authority are classified as:

- The provision and maintenance of harbour facilities, i.e. quays, wharves, piers, etc;
- The provision of navigational safety functions, including lighting and buoying the harbour, the removal of wrecks and other obstructions and maintenance dredging of navigational channels;
- The regulation of the activities of other persons at the harbour including, in particular, the movement and berthing of ships in the harbour by means of directions and byelaws, and licensing dredging and the construction of works in the harbour by other persons;
- The carrying out of harbour operations including, in particular, cargo-handling activities;
- The provision of a pilotage service; and
- Nature conservation and the prevention of pollution duties.

Climate change

It is important to highlight the importance of ports to the UK economy. Ports are our sole resilient and reliable link to the outside world and over 95% of international trade comes through our ports. Such is the importance of ports we are often included as nationally significant infrastructure and classified as a Category 2 Emergency Responder under the Civil Contingencies Act (2004).

Since the production of the original Climate Change Adaptation Report the UK has experienced some of the worst storms on record. Between December 2013 and March 2014 the UK experienced prolonged severe weather events that culminated in considerable coastal damage and widespread flooding. The overall impact of these events on businesses and the public has been substantial, highlighting the vulnerability of infrastructure and assets to storm surges and rising sea levels. The flood events witnessed over this period were estimated to cost insurance, small business and transport sectors a combined value of at least £2.5 billion (1).

Of most significance to ABP was the storm of the 5 December 2013 which brought a huge Atlantic surge, coupled with one of the highest tides of the year. The event brought about the most severe flooding of the winter along the east coast of England. The storm caused the shutdown of Scotland's rail network, loss of power to more than 100,000 homes and flooding to over 2,600 properties. Extensive flooding was experienced at the ports of Immingham, Hull and Lowestoft, with lesser flooding seen at the ports of Ipswich, Grimsby and Garston. Across the rest of the ports industry, flooding was also experienced at the Ports of Dover, Boston and Liverpool.

Our analysis of the tidal records shows that the water level at Immingham reached a level of 5.216m ODN, an equivalent of a 1 in 750 year storm! Despite emergency actions undertaken by port staff before, during and after the flood, the storm caused damage to critical infrastructure, assets and disrupted port operations. The port of Immingham was extensively flooded with 75% of the port area underwater at some point and port operations severely disrupted due to power and IT problems.

This flood event demonstrated the importance of resilience to port business operations as flooding at this scale presents a risk to life, causes damage to property and creates serious business interruptions (direct and indirect). Loss adjusters estimate overall direct losses for ABP at Immingham to be around £12m with the total overall cost to be much higher. However, taking into account the businesses in the port boundary which were also severely affected for several weeks or more, the costs of repairs for all tenants property and lost productivity is estimated to be circa £100m.

In addition to individual extreme weather events (i.e. storm surges), which pose an ongoing flood risk hazard to port operations, the ports industry is also facing serious environmental threats in the longer term through climate change. It is predicted that over the next 100 years, sea levels at the ports are likely to rise by as much as 0.75 m (even greater under more extreme scenarios). Climate change will also have an impact on weather patterns, likely increasing storm frequency and severity (e.g. surges) across the UK. As such, extreme events like that seen on the 5 December 2013 are likely to become more common and severe in the medium to long term, thus increasing the risk of flooding to critical port assets. Along with energy, transport and water supplies we face growing challenges in our ability to operate efficiently, service the economy and meet important social requirements.

Following the storms Richard Brown, Department for Transport (DfT) published his Transport Resilience Review in July 2014 (DfT, 2014[1]), identifying that the extreme weather had a considerable impact on UK transport systems. Specific to the ports industry, "an essential and unusually unseen part of the transport system", the review provided a number of recommendations, including:

- The review of flood protection provided to existing power, communication and IT infrastructure, with a view to improve flood resilience where necessary; and
- The Environment Agency and Met Office should work together to improve the granularity and accuracy of coastal flooding forecasts, involving complex modelling of a variety of factors. The

[1] DfT, 2014. Transport Resilience Review: A Review of the Resilience of the Transport Network to Extreme Weather Events. Department for Transport, July 2014. 168p. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335115/transport-resilience-review-web.pdf

ports should look to be involved with these improvements, ensuring the forecasts take account of known vulnerabilities and are suitably tailored to assess key impacts.

ABP has subsequently provided evidence to the 2015 Commons Select Committee Inquiry on 'Flooding: Cooperation Across Government[2]' along with several other national flood studies.

ABP welcomes the ongoing work of the Committee on Climate Change (CCC), which has highlighted 'flooding and coastal change risks to communities, businesses and infrastructure' as the top climate change risk with 'coastal infrastructures, particular ports, are at risk from rising sea levels and a consequential increase in the height of onshore waves and storm surges .' The CCC highlight that 'more action is needed' to 'manage the risk of cascading failures from interdependent infrastructure networks' as well as 'risks to infrastructure services from coastal flooding and erosion'[3].

We hope that recognition of the issues of critical infrastructure providers continues, along with a need for improved communication, information sharing and financial support.

Adaptation Reporting

The original Climate Change Adaptation Report (2011) was produced as a result of Directions to report in relation to ABP Harbour Authority areas in which more than ten million tonnes of cargo pass through per annum. These Directions were issued by the Department for Environment, Food and Rural Affairs (Defra) under the Climate Change Act 2008.

The Climate Change Act identifies a framework for the UK to reduce its greenhouse gas emissions and adapt to climate change. In summary the Act includes measures to set emissions reduction targets, produce annual reports, the creation of an independent advisory body, the ability to introduce an emissions trading scheme, and a procedure for looking at adaptation. Section 62 of the Act provides a power to direct statutory undertakers to report on climate change adaptation is created.

ABP has been directed to report in relation to its role as Harbour Authority in the following locations:

- Humber;
- Immingham;
- Hull; and
- Southampton.

Harbour Authorities handling over ten million tonnes of cargo per year have been put on the priority list as they are responsible for national infrastructure; vulnerable to the projected impacts of climate change; and because climate change adaptation requirements are not already covered in existing regulatory frameworks related to their functions.

The original report details the response to the Directions and was compiled using in-house expertise from each of the reporting authorities as well as input from several different central disciplines. ABP previously agreed with Defra that the most appropriate format to respond to the four Directions is a combined report. There are several reasons for this approach, with the most important being the similarity of risks between our Harbour Authority areas and the centralised management and co-ordination of risk and adaptation within ABP. The intention of the document was to inform the national climate change risk assessment which was being compiled by Defra.

Defra is updating its national climate change risk assessment and has requested voluntary participation in its second round of adaptation reporting. This document provides the voluntary update to ABP's original Climate Change Adaption Report (2011). It reviews climate change risk

[2] http://www.publications.parliament.uk/pa/cm201617/cmselect/cmenvaud/183/18304.htm
[3] UK Climate Change Risk Assessment 2017 Synthesis Report (CCC, 2016)

based upon the latest information and incorporates our more recent plans and programs to manage the increasing risk across the Humber, at Immingham, Hull and Southampton.

For ease of reference, much of the background information on ABPs functions as harbour authority, has not been reproduced here, and reference should be made to our original report (ABP, 2011). The functions that we consider to be affected by climate change and subject to this update are:

- Engineering – maintenance of infrastructure;
- Dredging – maintenance of safe navigational access to ports / berths;
- Hydrography – monitoring navigational depths and informing dredging operations;
- VTS / LPS operations – management of vessel movements;
- Pilotage – provision of pilotage service; and
- Nature conservation – carrying out of duties related to nature conservation.

ABP Harbour Authorities Directed to Report

Humber Harbour Authority

The Humber ports and terminals (see section below for full details) are seen as the region's engine for economic growth. They play an important role in the exploitation of new business opportunities, enable expansion into new markets and attract significant amounts of inward investment. The ports offer a major geographical advantage with unrivalled access into the UK. With excellent road and rail links, some 40 million consumers and over 60 per cent of the country's manufacturing capacity lies within a four-hour drive of the Humber. There are also excellent links to Europe with crossing times to the Continent as short as 10 hours.

Humber Estuary Services (HES), is the division of ABP through which ABP carries out its functions as the Competent and Statutory Harbour Authority for the Humber Estuary. The marine management of the Humber Estuary is the responsibility of the Harbour Master (Humber), who works closely with the Dock and Harbour Masters of other ABP and non-ABP ports and harbours within the estuary to ensure safe navigation for all vessels.

Its Vessel Traffic Services (VTS) operation handles some 37,000 shipping movements annually, of which nearly 21,000 require the services of one of our pilots and, because of the growth in trade, this figure is increasing year-on-year. The Humber CHA (pilotage area) extends from the seaward boundary shown in the appendix throughout the Humber Estuary and inland along the rivers Trent and Ouse.

HES provide the marine functions across the Humber Estuary. It is the Competent Harbour Authority (CHA) for the provision of Pilotage services; VTS Authority and Local Lighthouse Authority for the Humber.

HES is also responsible for the conservancy of the Humber Estuary, which involves the ongoing maintenance of safe and navigable channels for all vessels using the estuary. HES has a dedicated hydrographic survey team, which monitors the depth and location of channels in the estuary. The surveys allow regular publication of nautical charts, and notices to mariners to promulgate the changes in depths and channel alignments.

As the local lighthouse authority HES is responsible for marking channels and navigational hazards with buoys and other marks and lights. In the upper reaches of the estuary, the channel marker buoys are moved as often as every 14 days, based on the results of the hydrographic survey, to ensure channels are always correctly marked.

Hull Harbour Authority

Hull is situated on the north bank of the River Humber approximately 30 miles from Spurn Point. The Port of Hull is one of the UK's leading foreign-trading ports. The port has previously handled in excess of 12 million tonnes of cargo, with all-time record tonnages being handled during 2004 and 2005. The

port is a premier global gateway for international trade and is of national strategic importance to the UK. Hull is the UK's leading softwood timber port and is the only passenger port on the Humber Estuary, handling around one million passengers per year. Regular short-sea services operate to Europe, Scandinavia and the Baltic States and the port benefits from worldwide deep-sea connections. Our Rotterdam Terminal accommodates the new super-cruise ferries operated by P&O Ferries on the Hull-Rotterdam crossing. We directly employ around 500 people with the port employing around 5,000 people in total.

All vessels calling at Hull have to come through the Humber Harbour Authority area and the Hull Dock Master has a close working relationship with the Humber Harbour Master and HES. In addition to being the owner and operator of the Port of Hull, ABP is the Statutory Harbour Authority for the docks and jetties in the port.

The Dock Master, Hull, holds the statutory powers to control the movement of vessels within the port limits (which includes the riverside berths and jetties). The Harbour Master, Humber, via the VTS, controls the movement of all vessels transiting past the Port of Hull and has control of vessels arriving at, or departing from the port limits.

Independent stevedores licensed by ABP undertake general cargo activities on the port's common-user quays. Specific companies operate terminal facilities within defined leased areas while ABP itself operates a number of terminal areas (notably the Finland Terminal, All- Weather Terminal and the Hull Cold Store). Independent private companies undertake towage services in Hull. Other specialist departments within the local ABP port organisation include Engineering (maintenance activities and capital projects), Health & Safety, Personnel, Property, and Sustainable Development.

Immingham Harbour Authority

Immingham is a premier global gateway for international trade and is of national economic and strategic importance to the UK, handling about ten per cent of UK sea-borne trade. The Port of Immingham is the UK's largest port by tonnage and a vital part of the energy supply chain. Biomass flows through the port to Drax power station which generates 7 to 8% of our electricity. It is situated on the south bank of the River Humber approximately ten miles from Spurn Point. Continental Europe is less than 24 hours' sailing time from Immingham, making the port's potential market of more than 170 million people easily accessible to UK businesses. Beyond that, the rest of the world is accessible through well-established and proven routes. Immingham is a very diverse port operation, handling cargoes that include dry and liquid bulks, ro-ro and lo-lo unit cargoes plus break-bulk general cargo.

As with Hull, ABP Immingham is the Statutory Harbour Authority for the docks and jetties comprising the port. The Harbour Master Humber (HES) and Dock Master Immingham therefore have a very close working relationship. The Dock Master, Immingham, holds the statutory powers to control the movement of vessels within the port limits (which extend 200 yards beyond the berthing face of the riverside jetties) as well as, via VTS, controlling the movement of all vessels arriving at, transiting past, or departing from, the port limits.

Similar to Hull, independent stevedores licensed by ABP undertake general cargo activities on the port's common-user quays. Specific companies operate terminal facilities within defined leased or licensed areas. In addition, ABP operates a number of terminal areas (notably Humber International Terminal and Exxtor Terminal). ABP Hull also use the ABP specialist departments within the port.

Southampton Harbour Authority

Southampton is one of the UK's largest ports in terms of throughput handling around fourteen million tonnes of cargo per annum. Around 1.7 million cruise passengers per year have Southampton as their preferred choice of port for cruise holidays and we handle over 820,000 vehicles per year. ABP Southampton handles £40 billion worth of exports, making it the UK's number one export port. with its container, car and cruise operation and handles over one quarter of the UK's seabourne trade with non-EU countries by value (HM Revenue and Customs, 2014). Less than 100 miles from mainland Europe it has a sheltered, deep-water position on the south coast of England, resulting in minimum weather disruption to operations and minimum deviation from main shipping lanes, along with good inland transport connections.

In addition to being the owner and operator of the Port of Southampton, ABP is the Statutory Harbour Authority; Competent Harbour Authority for the provision of Pilotage services; VTS Authority; and Local Lighthouse Authority for Southampton.

The Harbour Master, Southampton, holds the statutory powers to control the movement of vessels within the harbour area. However, both the Competent Harbour Authority area and VTS areas covers the wider Solent. Southampton Harbour Authority area has over 70,000 shipping movements each year, of which more than 9,000 require the services of one of ABP's pilots.

In addition to the berths within ABP dock limits there are also the following terminals within the Harbour Authority Area, these are:

- Marchwood Sea Military Port; owned by the Ministry of Defence and operated by the Solent Gateway Ltd.;
- ExxonMobil Marine Oil Terminal, Fawley; one of the busiest independent marine oil terminals in Europe; and
- BP Oil Terminal, Hamble: handling oil and refined products.
- Itchen berths; handling aggregates

Business Preparedness

Details of ABP's business preparedness prior to the Direction are detailed in the original Climate Change Adaptation Report (ABP, 2011), and not reproduced here.

In completing the original Adaptation Report and this update, we have used the same impact criteria as used in the group risk assessment, but have extended the likelihood rates to be longer-term and therefore more appropriate for looking at potential climate change impacts. The results of this exercise feed into the group risk reporting process.

It is worth remembering that ports by their very nature must be located in coastal areas and will therefore be at the front line of the effort to adapt to sea level rise. ABP has continued to review its business preparedness and completed a number of studies and activities since the publication of the Adaptation Report.

In particular, Flood Resilience Assessments have been completed for each of ABP's 21 ports. These port specific assessments addressed three fundamental questions to help develop a better understanding of flood risk across ABP Group, namely:

- What flood risk events can the port withstand now and in the future, and the likelihood of such events?
- What might be the consequences to critical assets across the port at such times? and
- What recommendations can be offered to make the port more flood resilient/resistant both now and in the future?

The flood resilience assessments identified what critical assets (if any) are considered at increased flood risk at each port and if they required improved flood protection to improve their resistance/resilience to extreme events. The study highlighted the importance of formal Flood Resilience Plans and recommendations for infrastructure improvement where necessary. In parallel ABP commissioned a number of other internal reports reviewing its critical infrastructure including reviews of its Electrical Infrastructure as well as development of Repair and Replace Programmes for critical assets.

These resilience assessments set a leading example for the rest of the port industry, particularly with respect to identifying 'site specific' flood risk issues both at present and in the future. The study has established a baseline position to help ABP manage a changing profile of flood risk, thus helping to ensure business continuity into the future, particularly from the increasing environmental threat presented by climate change.

The results of the assessments feed into ABP's Business Resilience and Continuity Plans and associated support software. These plan for the full range of emergency situations, including flood events. At an operational level, the outputs have fed into ABP's Compliance System and associated the Marine Safety Management Systems, dynamic risk assessments and safe systems of work.

Many asset improvements have already been implemented, including the order of new outer dock gates at Immingham. These gates are designed to a 1 in 1000 year event and cost circa £4.7m. We have also improved the static defences at Albert Dock in Hull along with significant resilience measures to the ports electrical substations, impounding pumps and other critical infrastructure across the Humber ports.

ABP works closely with the Environment Agency, local authorities and Flood Resilience Forums at both a planning level and through receipt of flood forecasts warnings. ABP is supporting the Environment Agency in its derivation of new extreme water levels for the Humber Estuary (now and with climate change) including the free provision of all relevant data. ABP is working with University College London on a number of flood resilience initiatives. These include a:

- Toolkit to improve resilience of critical ports and dependent national supply chain systems against extreme sea level rise (storm surge) events (Environmental Risks to Infrastructure Innovation Programme);
- Case Study: Immingham Port to Power Station Freight Route (Network Rail funded TRaCCA); and
- MARS; Methodology for Assessing Resilience of Seaports (funded by Department for Transport)

Identifying the Risks due to Climate Change

In conducting these risk assessments we have used both published materials including those published by the CCC and Marine Climate Change Impacts Partnership (MCCIP), local data, knowledge and expertise to look at the potential risks to our functions.

Information has been taken from the following publicly available sources:

- The Committee on Climate Change (CCC)[4];
- UK Climate Projections (UKCP09)[5];
- MCCIP Annual Report Card 2013 (including those produced and peer reviewed by ABPmer)[6];
- The Environment Agency Flooding Risk Maps;
- Local tide records; and
- Local knowledge and experience in relation to the areas of jurisdiction.

This has been supplemented by the information in the following internally commissioned reports:

- Flood Resilience Port Reports (ABPmer, 2014); and
- Future Evolution of Spurn Breach (ABPmer, 2014)

Climate Change Projections

The climate change assumptions adopted in this report are as per the original report. These are the medium emissions forecast, identified in UKCP09 (UK Climate Projections). The medium emissions

[4] www.theccc.org
[5] http://ukclimateprojections.metoffice.gov.uk/
[6] http://www.mccip.org.uk/

scenario has been maintained because as a statutory undertaker operating in a dynamic environment we are used to adapting to change. Many of our assets, e.g. vessels, buoys etc, have a short life span in climate change terms and are likely to be replaced within the periods we are reviewing and the impacts are therefore small. Our structures and buildings have been built to withstand the harsh marine environment as well as potential sea level rise and flooding and we therefore consider that the medium risk scenario is appropriate for this assessment.

We acknowledge the fact that current trends suggest that we are tracking at the level of the high emissions scenario and we have also reviewed some of these projections as part of this processes.

We have reviewed the climate change risks identified in the MCCIP 2013 Report Card[7] and the risks potentially impacting the function of a harbor authority are the same as those analysed in the original report, namely:

- Sea level rise and flooding
- Storm events and extreme weather
- Temperature, humidity, and precipitation
- Sedimentation
- Coastal erosion
- Water temperature
- Water quality
- Habitats and species

We will be undertaking a further review upon publication of next UKCP projections expected in 2018 (UKCP18).

Sea Level Rise and Flooding

Predictions for sea level rise for Southampton Water and the Humber have been considered. In Southampton Water an increase in water levels by 9.8cm, 21.9cm and 36.5cm for 2020, 2050 and 2080 respectively is predicted. In the Humber an increase by 10cm, 22.3cm and 37cm for 2020, 2050 and 2080 respectively is predicted. These are both areas with higher estimates as slightly larger sea level rise projections are obtained in southern parts of the UK where land is subsiding, and somewhat lower increases in relative sea level for the far north. For example, UKCP09 projects a relative sea level increase for Edinburgh of 24.4cm by 2080. MCCIP reports that sea level rise in the UK is consistent with the observed global mean of a 3mm increase per year (high confidence) and a medium confidence that there will be a greater rise in sea level in southern regions.

All of ABP's VTS operations are covered by Business Continuity Plans. They all have backup generators available in the event of a power outage. These would keep the operations running for a period of time (subject to fuel availability). Long-term power outages could pose more of a problem.

All of the ABP locations use common IT platforms and can be accessed remotely if any of our facilities become inaccessible. The servers are also backed up regularly which should minimise data losses in the event of system failures. There are many resilience actions being implemented across the Group and at port levels such as a national agreement with Generator Suppliers to provide mobile generators for all critical activities. These are all supported by our Business Continuity and Resilience Plans which are subject to ongoing review.

More details on flood risk management are provided below.

[7] http://www.mccip.org.uk/annual-report-card/2013/

Humber Harbour Authority

The Humber Estuary Services (HES) administration function is managed from the Port of Hull, and so benefits from the current standard of protection for the port (see below).

The VTS operations tower and pilotage operations are currently situated on the Spurn peninsular where the standard of protection dips as low as 1 in 5, and in very small sections is as low as 1 in 2 with an average 1 in 20 (Environment Agency, 2008). ABPmer and Environment Agency has undertaken studies on the risks and consequences of overtopping and breaching of the Spurn peninsular.

New VTS facilities are being built at Grimsby along with boarding/landing of pilots to Pilot launches. Plans are to relocate VTS to Grimsby by Autumn 2016 thereby offering more safe and secure site access and pilot transfer in the future. This is a typical example of our climate change adaptation measures in operation.

Hull

The sea defences around the seaward boundary of the port are incorporated as part of the defences for the urban area of Hull. ABP and the EA jointly invested money in the late 1990s in an improvement programme for most of the defences around the port, incorporating new lock gates and improved sea walls. The port is considered, in general, to be at 'unlikely' risk of flooding both at present and in the short term (i.e. over the next 20 years). Predictions suggest that the port cope levels will typically provide protection against a greater than 1 in 200 year extreme tidal event in the short term. This protection will decrease to 1 in 5 years over the next 100 years with climate change.

An assessment of the potential consequences of flooding to the critical assets at the port has identified that the existing power infrastructure (e.g. substations), pump houses and quayside heavy equipment are most at risk in the long term (i.e. in the next 50 to 100 years), with no immediate works required to make them more flood resistant/resilient. However, to provide improved flood protection we have fitted and commissioned reverse head props to the gates at Albert Dock minimising risk of failure during severe events.

Immingham

The Port of Immingham is considered at high risk to coastal flooding both at present and in the future. Predictions suggest that the port is presently only afforded protection against tidal flooding for a 1 in 20 year event, whilst the standard of protection reduces to a 1 in 2 year event over the next 50 years. A crucial factor for these relatively low standards of protection was the present nature of the outer lock gate, which offered little flood protection. These are in the process of replacement and the new gates will have a current standard of protection of circa 1 in 1,000 years at a cost of £4.7m. Liaison is continuing with the Environment Agency with respect to associated raising of the cope levels.

The December 2013 event, although very extreme (circa a 1 in 750 year event at Immingham), provided direct evidence of the significant damage to critical assets that can occur. A complete review of electrical infrastructure across the port identified that the existing power infrastructure (e.g. electrical substations) required both immediate and significant work to make individual assets more flood resilient to any future flood event. ABP has already invested over £0.5m in flood resilience works to electrical substations, impounding pumps, buildings and other infrastructure across the port and there is an ongoing Repair and Replace Programme.

Southampton

The Port of Southampton is considered to be at very low risk of flooding both at present and over the next 20 years. critical assets at the port are presently afforded protection against tidal flooding greater than a 1 in 1,000 year extreme event. This protection, however, is likely to decrease due to current climate change projections to a 1 in 200 year extreme event over the next 20 to 50 years for a variety of critical assets, e.g. electrical substations, water pumping facilities and cruise terminals.

The port fronts much of the city of Southampton and ABP has been working closely with Southampton City Council to better understand the predicted frequency and nature of both surface water and coastal flooding events. Extensive flood modelling has been undertaken to predict the impacts of future events on the city of Southampton and the results are being used by the port to plan for the future.

Storm Events and Extreme Weather

Closely linked to sea level rise and flooding are the predicted increase in storm events and extreme weather. Extreme weather events are defined as being unusually rare weather events such as high levels of snowfall or rain which may cause significant disruption to the undertaking of duties of the Harbour Master. This is most likely to result in accessibility problems for employees required to staff the VTS operations room or access to the pilot stations which are at relatively remote locations, hence the VTS move from Spurn to Grimsby.

It is generally concluded that extreme weather events will increase in frequency, but the low confidence in the climate change projections means that it is difficult to predict any changes. What we must assume is that extreme weather will become more frequent and an increase in the number of storm events corresponds to an increased risk in the safety of vessels at sea. Lloyd's definition of marine casualties relates to incidents where there has been loss of life or injury; where the vessel concerned is either holed or stranded; or damage is inflicted on the ships machinery, fixtures and fittings. The Maritime and Coastguard Agency (MCA), and in some instances the Marine Accident Investigation Branch (MAIB), requires ports to report each and every incident / accident where it is considered to be a 'reportable' incident. Incidents may include:

- Collision - contact between two or more vessels underway, drifting, under towage or otherwise not made fast to the ground;
- Striking - contact between one vessel underway or drifting and an object such as a buoy, another vessel at anchor, or another vessel secured to mooring buoys;
- Impact - contact between a vessel underway or drifting and an immovable object such as a dock, quay or jetty or another vessel secured to a dock, quay or jetty;
- Grounding - contact between a vessel and the bed of the berth, lock, channel or any other seabed area;
- Fire or explosion - a fire or explosion on or associated with a vessel;
- Sinking / Capsize - the loss of buoyancy of a vessel resulting in that vessel settling on the sea/channel/lock bed, or turning over; Ranging - the movement of a vessel relative to its berth due to disturbance of the water by wind, tide, current or a passing vessel, or inadequate moorings; and
- Equipment failure - the failure of shipboard equipment such as main engines, steering, bow thrusters, or the failure of other equipment such as tugs or tow lines that result directly in the occurrence of any of the above events.

While future predictions related to changes in storminess and extreme weather events are inconclusive we have taken this forward to our risk assessment as even small changes may impact our operations.

Temperature, Humidity and Precipitation

UNCP09 provides estimates of the changes in temperature, humidity and precipitation in 2020, 2050 and 2080. Of particular note is that winter precipitation in the Humber at 2080 is estimated to increase by 15% and 22% in the south east (Southampton), and summer temperatures rise by over 5^0C (central estimates medium emission scenario). A summary of the predictions in relation to the Humber ports and the Port of Southampton are provided below. Refer to UKCP09 for more details on the scenarios. Key estimates are:

- Winter mean temperatures for 2020, 2050 and 2080 are increases of 1.3, 2.2 and 3 degrees Celsius respectively for both the regions.
- Summer mean temperatures for 2020, 2050 and 2080 are increases of 1.3, 2.3 and 3.3 degrees Celsius for the Humber, and 1.6, 2.8 and 3.9 for the South East.

- Summer mean daily maximum temperatures for 2020, 2050 and 2080 are increases of 1.7, 3.1 and 4.3 degrees Celsius for the Humber, and 2.1, 3.7 and 5.3 for the South East.
- Summer mean daily minimum temperatures for 2020, 2050 and 2080 are increases of 1.4, 2.6 and 3.7 degrees Celsius for the Humber, and 1.7, 3.0 and 4.2 for the South East.
- Annual mean precipitation for 2020 and 2050 are for a 0 per cent change in both the regions. For 2080 there is still a 0% change in the Humber and a 1 per cent increase in the South East.
- Winter mean precipitation for 2020, 2050 and 2080 are increases of 4, 11, and 15 per cent for the Humber, and 6, 16, and 22 per cent for the South East.
- Summer mean precipitation for 2020 and 2050 are for decreases of 8, 19, and 23 per cent respectively for both regions.

In summary the implication of this data means that summers will become drier but the quantity and intensity of rainfall during the winter months will increase which could increase risk of surface water and combined fluvial/tidal flooding. Increased precipitation is addressed as part of the risks from sea level rise and extreme weather. The increase temperature is considered separately within the risk assessment.

Sedimentation

No specific information concerning predicted changes in sedimentation patterns or levels has been undertaken by any organisation to enable a review to take place. However, the latest numerical modelling of the Humber to derive extreme water levels (ABPmer and CH2M) is considering estuary changes in bathymetry in the derivation of future extreme events.

Our knowledge of the Humber Estuary and Southampton Water suggests that changes to flows from altered rainfall patterns could result in the seaward migration of the turbidity maximum during the winter and landward during the summer. This could affect sediment deposition patterns affecting navigation and dredging with resulting increases in costs of surveying and dredging. Conversely the changes could be beneficial and the changes in rainfall and resulting freshwater inputs could result in more sediment being lost from the system and a reduction in dredging and surveying (ABPmer, 2007).

The morphological response to sea-level rise is also very much determined by site-specific factors. These include the local geology, wave and tide conditions, longshore sediment transport, human impacts and the interactions between different coastal systems. More often than not, it is these site-specific factors that determine the coastal response, rather than a global change in sea level or a regional change in wave climate. For example, much of the fine material deposited within the Humber Estuary has been eroded from the Holderness cliffs and pulled into the Estuary by the tide. This forms the mudflats, salt marsh and beach areas that line both the north and south banks. In order to keep pace with the predicted rates of sea level rise, a considerable additional volume of sediment is likely be required in the future to be deposited in inter-tidal areas of the Humber (Scott Wilson, 2010).

The effects of such changes are likely to be minimal in the context of ongoing human development and due to the associated uncertainty the issue is not considered further in the risk assessment.

Coastal Erosion

Coastal erosion is a complex process that has a variety of causes, with rising sea level being only one of them. Most importantly, whereas climate change and relative sea-level rise are global and regional phenomena, respectively, coastal erosion is a local process.

The highly modified nature of ports means that the risk of coastal erosion is not a significant issue within the port boundaries. However, steepening or lowering of the subtidal profiles can expose the toe of the walls and change local wave conditions. While coastal erosion and squeeze are occurring in the areas that we operate it is not considered to impact on our statutory functions and is therefore not considered further in the risk assessment.

Water Temperature

UKCP09 states that the seas around the UK are projected to be 1.5–4 ºC warmer, depending on location by the end of the 21st century. The MCCIP 2010-11 report card used the 2009 projections to suggest increases in mean sea surface temperature of between 2.71-3.27º for around the Humber area by 2080 and 2.65-3.28 º for around the South East.

Warming of sea temperatures could also change the geographical distribution of species, which may increase the persistence of non-native species potentially from ballast water exchange. This is not thought to be a significant risk to port operational activities but could impact nature conservation objectives unless a firm international protocol is introduced to limit ballast water exchanges to the deep sea.

The predicted changes to water temperature are not considered to have a material impact on the functions of the harbour authority and therefore not considered further.

Water Quality

A deterioration in water quality could reduce levels of dissolved oxygen or increase suspended sediment concentrations which, either alone or in combination, may impact on fish migration, shellfish beds or fish nursery grounds. Water quality within the harbour area over the projected period is considered to be subject to indirect causes, predominately from storm water runoff which will increase the potential for pollution. An increase in the frequency of storm events and storm intensity may impact on pollution loading through increased volumes of sewage overflow discharges and riverine microbial fluxes, making compliance with the aims of the Shellfish Waters Directive and the Bathing Water Directive difficult. This could have implications for bathing water beaches within ABP Harbour Authority limits, such as Cleethorpes. Such pollution incidents are, however, not considered to impact on the arrival and departure of commercial vessels or the management of the harbour area.

Pollution of the marine environment is considered within the Oil Pollution Preparedness and Response Convention (OPRC) Plan implemented by the Harbour Masters' departments. Impacts on water quality are not considered further in this report or in the risk assessment process.

Habitat and Species

ABP's statutory powers include a duty to have regard to the conservation of flora and fauna. Potential changes to habitats and species under a changing climate include loss (extinction) of species, arrival of species not currently found in the area, change in populations and distribution of species, changes in extent and distribution of habitat, and changes to species composition and structure of habitats.

Habitat losses can occur through coastal squeeze. This is the process whereby the intertidal habitats cannot migrate naturally landward in line with sea level rise, resulting in a narrowing of the intertidal zone. In these situations schemes such as managed realignment (a deliberate breaching, or removal, of existing seawalls, embankments or dikes in order to allow the waters of adjacent coasts, estuaries or rivers to inundate the land behind) may be required.

ABP works with the statutory nature conservation advisors and voluntary organisations to manage the area in which it operates in the most effective way (such as Agreements we have signed with the RSPB and Environment Agency on the Humber). ABP will continue to engage in this way and will where practical, adapt our management for the benefit of nature conservation. ABP would also be pleased to see international agreement on ballast water exchange practices as a management control that can help to minimise the risk of alien species arriving in its harbour areas. Due to the international nature of shipping this would need to be taken forward on an international basis and with IMO taking the lead.

While ABP has functions relating to the protection of habitats and species the changes in this area as a result of climate change are beyond the remit of ABP and not considered further in this report.

Summary of Risks

This review has confirmed the risks to be taken forward for assessment are the same as those identified in the original report, namely:

- Increase in sea level rise and flooding events;
- Storm events; and
- Changes in air temperature.

Assessing Risks

ABP Risk Management

ABP has an existing internal risk management appraisal mechanism. In order to be consistent with that approach, a variation on the current corporate risk process has been developed which adopts timescales appropriate with climate change projections and predictions.

Risk assessment and management is a key process within ABP and we undertake a variety of assessments to inform decision making. We have already stated that we consider climate change risks as part of our normal group risk assessment. This risk assessment will be used to inform this report, and although the timescales will not be the same it will be used to suggest areas in which there should be greater consideration in the future.

The risks identified in this section have also been taken forward into the relevant Flood Resilience Plans, Business Continuity Plans and Marine Safety Management System. All these are subject ot periodic review.

Risk Assessment Process

Each of our harbour authority functions identified in section 4.3 have been assessed against the climate change risks considered appropriate in section seven of this report. These have been completed at a group level and it is recognised that there will be differences in the nature of individual risks and consequences at port level. As such the outcomes of the following risk assessment have been assessed further in support of port specific plans. These assessments are outside the scope of the Adaptation Report.

The impact to and likelihood has been assessed to ascertain whether the impact to ABP is considered to be high, medium or low using the criteria given below.

Impact is assessed and scored against the highest of the financial impact, reputation impact or service interruption.

Impact		Financial Impact (EBITDA[8])	Political / reputational impact	Service Interruption
1	Minor	< 1%	Others try to exert pressure / receives little coverage	< 24 hours interruption
2	Moderate	1% to 5%	Policy / Strategy undermined / adverse publicity with limited effect on public opinion	24 to 48 hours interruption

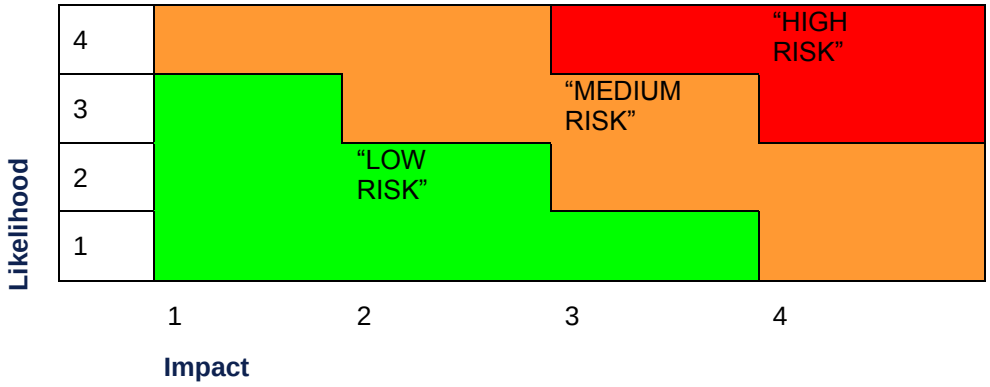
[8] Earnings before interest, tax, depreciation and amotorisation

3	Major	5% to 10%	Short-term loss of credibility / adverse publicity in local and national press affecting standing within local government and professional circles	48 to 96 hours interruption
4	Catastrophic	10%	Total loss credibility / adverse media coverage affecting public opinion	> 96 hours interruption

Likelihood is looking at the expected frequency of the event using extended time periods appropriate to the climate change risk assessment.

Likelihood	Expected Frequency
1	Little evidence to suggest it may occur in the next 40 years. No evidence of occurrence in past 40 years.
2	Risk may occur within the next 40 years and/or has occurred in the last 40 years.
3	Risk may occur within the next 10 years and/or has occurred in the last 10 years.
4	Risk is likely to occur in the next 5 years and/or has occurred in the last 5 years.

Risk Rating – Impact vs Likelihood



Assumptions and Uncertainties

These are set out in the original Climate Change Report and not reproduced here.

Barriers and Interdependencies

These are set out in the original Climate Change Report and not reproduced here.

Risk Assessment

Business Function	Climate Variable (e.g. increase in temperature)	Primary Impact of climate variable (e.g. health)	Threshold(s) above which business function will be affected	Potential impacts on organisation and stakeholders	Impact	Likelihood	Risk Rating	Proposed action to mitigate impact	Residual risks for the Harbour Authority	Residual risks outside Harbour Authority control (interdependency)
Engineering	Sea Level Rise / Flooding	Flooding / damage of harbour authority assets.	Nominal quay height or standard of protection of sea defences.	Damage to infrastructure including electricity supply (and backup generators), loss of operation. Potential knock-on effects to other critical infrastructure	3	4	High	Impact has occurred at Immingham and Hull; There has been significant investment to improve resilience of critical infrastructure (electricity sub-stations, IT etc.). Updated Business Continuity Plans, Flood Resilience Planning and Safety Management System.	Uncertainty in extreme water levels may leave residual risk of flooding out with port control. Construction programs for individual asset improvements ongoing.	Electricity, communication and rail infrastructure outside the port. On the Humber ports the failure of third party flood defence schemes could increase the risks.
	Temperature	Operating conditions for staff; reduction in engine operating efficiencies.	Dependent on specific task	Delays to immediate repairs.	1	2	Low	Health and safety assessments of workplace. Where appropriate consideration given to improving air conditioning and working at different times	None identified	Changes in Legislation related to working conditions / hours.
	Temperature	Degradation of assets not designed for the increases in temperature – e.g. tarmac etc.	Unknown as to what temperature increase would result in problems for our assets.	More repairs / remediation work required.	1	2	Low	Periodic review of assets. Replacement and upgrading of assets as required.	None identified.	None identified.

	Storminess	Delay in maintenance and emergency repairs. Increase in asset maintenance surveys. Increased frequency could imply greater repair costs. Increased insurance premiums.	Most engineering work would normally take place in calm conditions. Individual projects would be risk assessed. More extreme weather events would reduce the time windows for engineering works.	Delay in shipping movements	3	3	Med	Reschedule external works to alternative times. Review design parameters at asset reviews / refurbishment proposals to include resilience measures.	None identified.	None identified.
Dredging	Sea Level Rise	Change in maintenance dredging	Any change will impact on the dredging requirements, but there would need to be significant rise to impact on our operations.	Reduced need for dredging, increased requirement for surveying.	1	1	Low	Review by means of hydrographic surveys – unlikely to be more than the current surveying requirements.	None identified.	Vessels getting larger with deep draughts. Availability of dredgers to undertake works.
	Temperature	None identified as requiring consideration.								
	Storminess	Possible delays to dredger operation and change to patterns of sedimentation.	All subject to review depending on location.	Increased costs to the Harbour Authority and therefore customers.	1	2	Low	Monitor weather forecasts and seasonal trends. Amend scheduling if required.	None identified.	Dredger availability.
Hydrography	Sea Level Rise	Additional areas to survey.	There would need to be a significant increase for	Increased surveying requirements.	1	1	Low	Review survey data and tide / sea level information in the local area.	None identified.	None identified.

			the impacts to change our survey requirements.							
	Temperature	Operating conditions for staff	Surveying activities will benefit from the natural cooling associated with operating in a marine environment. The projected changes are unlikely to have an operational impact.	None identified.	1	1	Low	Under constant review as part of ABP's regional Energy Management System	None identified.	Changes in legislation related to working conditions.
	Storminess	Inability to operate survey vessel	Generally wind speeds above 16 knots (Force 5). No / limited surveying in fog for safety reasons.	Delay to survey information.	1	1	Low	Impact not thought to be material as survey will be rescheduled. Review and amend survey programme if required.	None identified.	None identified.
VTS	Sea Level Rise / Flooding	Interruption to services due to water ingress or erosion of port, radar facilities or power supply units.	Water level rising above the cope or sea defences.	Impact on ability to provide VTS. Access problems for staff into port, VTS buildings or other VTS facilities related to the HM functions.	1	2	Low	Both Humber and Southampton VTS being moved to more resilient locations Under constant review as part of Safety Management System and Business Contingency Plan – offsite access and emergency backups.	None identified.	Highways access; electrical supply.
	Tempe	Increase in	Would need to	Increased risk of	1	3	Low	Increases in the	None identified.	Development and race

	rature	leisure activity.	be significant increase in recreational numbers and facilities to impact on our operations.	collision with small craft.				number of moorings / races / events are all risk assessed.		programmes organised by marinas / developers / yacht clubs and sailing clubs.
	Tempe rature	Increase in temperature of working areas.	Dependent on working area, e.g. building or outside.	Increased cooling required resulting in increase of energy consumption.	1	2	Low	Under constant review as part of ABP's regional Resource Efficiency Groups.	None identified.	None identified.
	Stormi ness	Delays to arrivals and departures; transfer of pilots to vessels; vessel handling.	Force 5 initiates extra procedures.	Reduced service and ability to move vessels.	3	1	Low	Continue to monitor weather forecasting and consider increasing forward planning provisions.	None identified.	None identified.
	Stormi ness	Damage to VTS structures, infrastructure and access (Spurn).	Depends on structure and condition.	Increase insurance claims	3	1	Low	Both Humber and Southampton VTS being moved to more resilient locations	None identified.	None identified.
Pilotage	Sea Level Rise	Increased depth of water – improved safety.	Any increase in sea level will be beneficial for vessel underkeel clearance.	Less dredging	1	1	Low	Both Humber and Southampton VTS being moved to more resilient locations Monitor. Each vessel passage is subject to passage planning.	None identified.	Vessels getting larger with deep draughts.
	Tempe rature	Operating conditions for staff.	Considered to be within tolerance of predicted changes, coastal environment provides natural	Greater need for temperature controls and variation of clothing supplied.	3	1	Low	Health and Safety Assessments. Greater access to local temperature management. Change in clothing supplied.	None identified.	None identified.

			cooling.							
	Storminess	Operating conditions for staff. Delays to arrivals and departures.	Review of each boarding operation is considered in high winds / high swell.	Delay of vessels.	3	4	High	Humber pilot launch and landing station moved from Spurn to Grimsby. Monitoring of weather information.	None identified.	Reliability of weather forecasts.

Conclusions

The report details the functions of a harbour authority and looks at each of the functions in turn to ascertain whether they are likely to be impacted by changes in climate. This review concludes that the harbour authorities' functions related to engineering, dredging, hydrography, Vessel Traffic Services, pilotage and nature conservation could be affected by climate change. In completing this report ABP has reviewed previous work as well as using the most up to date climate projections related to the relevant reporting authorities. This work concluded that projected changes in sea level rise and flooding, air temperature and storminess were the most relevant to our operations.

The risk assessment has been reviewed and updated. Due to the extreme storms of 2013/14 and flooding of Immingham and Hull, we have raised our likelihood ratings with respect to flood risk and storminess.

The majority of the risks identified remain low risk but we have two high risks where associated mitigation has already been implemented, these are:

- Engineering / Sea Level Rise and Flooding - Impact has occurred at Immingham and Hull; Significant investment programmes are being implemented including £4.7m on new lock gates and £0.5m on resilience measures. We have reviewed and updated our Business Continuity Plans, Flood Resilience Planning and Safety Management System. This is also considered in our safety management system and as part of our Business Continuity Plans.
- Pilotage/storminess, in particular with respect to staff operating conditions. The pilot launch and landing station has moved from Spurn to Grimsby, the new site being subject to more sheltered metocean conditions. Review of each boarding operation is considered as part of ABP's Dynamic Risk Assessment and Compliance processes.

The following medium risk rating as a result of the assumed climate change variables are as follows:

- Engineering / Storminess – Increased risk or damage to assets and reduced windows for carrying out repair / maintenance of assets which could result in a delay to shipping movements. Engineering maintenance and repairs to be rescheduled and design parameters kept under review.

All other risks are considered to be low with a minimal impact to the provision of the Harbour Authorities' functions. In particular, VTS is no longer of medium risk from storminess and flooding as both Humber and Southampton VTS stations have moved to more flood and storm resilient locations. ABP has produced and adopted flood resilience plans and an extensive programme of flood resilience measures in the Humber. These risks are also subject to continuous review as part of Business Continuity and Compliance Systems.

While climate change may pose some risks to our operations we have also identified some opportunities. The main opportunity identified as a result of these changes is the potential increase in water depth in our navigational channels. There is also an opportunity related to increases in short sea shipping as a modal shift, in response to climate change pressures, as well as opportunities related to new cargoes and in aiding the development of offshore renewables.

The Climate Change Adaptation Reports are incorporated into ABP's Business Plans and Compliance Management System. In addition, key risks identified in this report will be used to inform the ABP group risk assessment process and should help to promote the

consideration of more long-term future risks facing our statutory functions as well as our wider operations.

There is uncertainty related to some of the climate change projections. ABP is confident that projections will improve over time and become more useful to those wishing to use them to inform decision making. ABP does not consider that there are any barriers to carrying out the adaptation monitoring works and reviews as proposed in this report.

To conclude we consider that harbour authorities, by the nature of their business and operating environment, will continue to adapt their operations to cope with change. The change might be reacting to changes in shipping design or demand, changes in technology or changes in the dynamic marine environment in which we conduct our operations. Climate change projections suggest that our ability to adapt will be tested, but we consider that we are well prepared for the challenge ahead.