Manchester Airports Group (MAG)

Climate Change Adaptation Report for East Midlands Airport and Manchester Airport

May 2011

MAG

Report submitted to the Department for Environment, Food and Rural Affairs (DEFRA) at:

Adapting to Climate Change
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On 31 May 2011 for evaluation.

1. Introduction

1.1 Purpose and scope

The Earth's climate is changing. Evidence shows that the world's climate, and that of the UK, is changing. There is a scientific consensus that this climate change is predominantly caused by human activities. Certain human activities produce gases that affect the earth's climate – greenhouse gases (GHGs) – and six have been identified for control in the international treaty, the Kyoto Protocol. Because of the persistence of GHG's in the atmosphere, typically lasting 30-40 years, further climate change is already inevitable – the extent of this will depend on how many GHGs we continue to release into the atmosphere. Changing plans and behaviour to respond to the impacts of climate change is known as 'adaptation'.

The Climate Change Act 2008 introduced a framework for building the UK's ability to adapt to climate change, including: (1) a UK wide climate change risk assessment every five years; (2) a national adaptation programme to address the most pressing climate change risks (to be reviewed every 5 years); and (3) the creation of an Adaptation Sub-Committee of the independent Committee on Climate Change in order to scrutinise progress on the Adapting to Climate Change Programme and advise on the risk assessment.

The Climate Change Act also gave the Secretary of State the Adaptation Reporting Power to direct reporting authorities (organisations with functions of a public nature and statutory undertakers) to produce reports on:

1. the current and future predicted impacts of climate change on their organisations; and
2. proposals for adapting to climate change.

When reporting, an authority must have regard to Statutory Guidance that has been produced by DEFRA[1]. The Direction to the reporting authority requires the Authority to consider its report when carrying out its functions.

In 2010, DEFRA directed 90 organisations to report. Of this total, 7 reporting authorities were airports. The 7 airports chosen are the strategic UK airports i.e. the busiest. MAG owns and operates four airports – Bournemouth, East Midlands, Humberside and Manchester Airports. As strategically important airports, East Midlands Airport and Manchester Airport are required to report, Bournemouth and Humberside Airports have not been identified by DEFRA as reporting authorities.

Manchester Airport had already made a voluntary commitment to report on adaptation in 2007. In Manchester Airport's Environment Plan 2007, part of the Airport's Master Plan to 2030, we had recognised the need to assess our operations and infrastructure for the future affects of climate change. Commitment C2 stated "Assess the effects of climate change on the Airport infrastructure and Airport operations". This report, prepared with due regard to DEFRA's statutory guidance, also meets this voluntary commitment.

This report contains the current and future predicted impacts of climate change, and proposals for adapting, for East Midlands and Manchester Airports. Bournemouth and Humberside will be completed and reported separately. The risk assessment process

[1] Adapting to Climate Change: helping key sectors to adapt to climate change. Statutory Guidance to Reporting Authorities 2009. Published by the Department for Environment, Food and Rural Affairs. 2009

described in this report is based on what MAG owns or operates. Those significant risks identified at the Airport that are outside our control are listed as interdependencies.

All airports within the Manchester Airports Group have far reaching environmental programmes, including programmes to reduce GHG emissions. This report focuses exclusively on adaptation and as such doesn't include any information about these mitigation plans and activities to reduce the emissions of greenhouse gases. Full information on these programmes is available in the Group's annual sustainability report.

1.2 East Midlands Airport (EMA)

Every year East Midlands Airport serves over 4.5 million passengers. The airport supports a wide range of charter flights and also is an important part of the European 'low cost' network with based airlines including Ryanair, BMIbaby and Jet2.com. The airport has over 90 passenger destinations ranging from Dalaman to the Dominican Republic and Morocco to Mexico. As the UK's primary pure freight airport, East Midlands handles over 300,000 tonnes of every year and is the largest base for Royal Mail, the second biggest European base for DHL and also home to other operators including TNT and UPS. Located centrally between Nottingham, Derby and Leicester, East Midlands Airport supports over 6,000 jobs and generates over £300 million annually for the region.

Airport land ownership extends to 445 hectares. The site is roughly rectangular in shape bounded by the M1 Motorway to the east, the A453 to the south, the Donington Park Motor Racing Circuit to the west and fields to the north. Approximately 50% of the developed area of the site is taken up by the 2,893m runway, a parallel taxiway and associated obstacle free grassland area, within which a number of essential navigational aids, including radar, are sited.

Passenger operations and supporting facilities such as security and catering are centrally located, clustered around a single passenger terminal building. Substantial air freight handling facilities are located to west and east of the Airport. Other significant land uses include an aircraft maintenance area, 3 fuel farms and a commercial zone at the eastern fringes of the site where offices, commercial premises and a number of hotels are located.

1.3 Manchester Airport (MAN)

Manchester Airport is the UK's busiest regional airport, handling 120,000 tonnes of freight and serving over 18 million passengers every year. With 65 airlines flying to over 200 destinations worldwide – including New York, Chicago, Philadelphia, Abu Dhabi, Dubai, Doha and Singapore – it is the only global gateway for the North of England. The airport is an economic hub in its own right, adding some £938m of economic value (gross value added) to the North West and employing over 19,000 people and is home to more than 300 companies.

MAG owns and operates Manchester Airport. The airport site occupies 900 hectares of land in the south of Manchester, of which 600 hectares is the operational area, the remainder being land owned for the management of landscape and habitat. There are two full length runways, three passenger terminals, a freight terminal and various other

buildings and infrastructure to support the operation such as maintenance facilities, aviation fuel farm, hotels, office buildings.

MAG manages the airfield operations and those within the terminals. Car parks and the on-site transport facility, containing train, bus and coach is also managed by MAG. MAG Developments manages a large property portfolio at the Airport. Some facilities and services at the Airport are not the responsibility of MAG. For example, some hotels and maintenance hangars are on long-term ground leases and MAG does not own or operate aircraft or aircraft ground handling operations.

2. Risk assessment methodology

2.1 Climate change projections

The UK Climate Impacts Programme (UKCIP) was established by DEFRA to inform an assessment of the future climate impacts of elevated greenhouse gases in the UK. The UKCIP have produced a range of scenarios based on temperature and precipitation. These projections are collectively known as UKCIP09 as they were published in 2009. The marine and coastal projections (sea level rise, storm surge, sea temperature) are also given but are not relevant to either of our airports in this report as both East Midlands and Manchester Airports are inland. There is also some more limited information on storms, wind-speed, fog, lightning and snow that was published by UKCIP in November 2010.

In determining what risks climate change presents to our business, and in order to assess their significance, we have used the UKCIP09 climate change projections. The projections have been prodcued for each region of the UK so we have used those made for the East Midlands region for EMA and those for the North West region for MAN.

For temperature and precipitation, the projections are made for 3 emissions scenarios, a range of probability levels and three 30-year time periods with reference to a 30-year baseline:

- 3 emission scenarios – high, medium and low;
- 5 probability levels – 10, 33, 50, 67 and 90%;
- 3 30-year time periods – 2020s (2010-2039), 2050s (2040-2069) and 2080s (2070 – 2099) with reference to 30-year averaging period 1961 – 1990.

There are some differences between the climate projections for the East Midlands and the North West regions but the general trends are similar. Table 2.1 shows some of this information for Manchester Airport, illustrating the range of projections available and the differences within them.

Table 2.1 – Illustration of climate change predictions data available from UKCIP09 for the North West region of the UK.

Year	Temperature (°C)			Precipitation (mm or %)	
	Winter average	Summer average	Summer daily maximum	Winter average	Summer average
Least extreme - low emissions, 10% probability					
2020s	+ 0.4	+ 0.8	+ 0.6	- 4	- 20
2050s	+ 0.8	+ 1.1	+ 1.0	- 1	- 34
2080s	+ 1.3	+ 1.3	+ 1.0	+ 5	- 35
Most extreme - high emissions, 90% probability					
2020s	+ 2.0	+ 2.5	+ 3.3	+ 13	+ 10
2050s	+ 3.3	+ 4.7	+ 6.5	+ 27	+ 2
2080s	+ 4.8	+ 7.3	+ 10.1	+ 50	- 2
Central estimate - medium emissions, 50% probability					
2020s	+ 1.2	+ 1.5	+ 1.9	+ 6%	- 8%
2050s	+ 1.9	+ 2.6	+ 3.3	+ 13%	- 18%
2080s	+ 2.6	+ 3.7	+ 4.8	+ 16%	- 22%

The UKCIP09 dataset also has information for other temperature and precipitation variables, such as warmest or wettest summer and winter days, relative humidity, cloud amount. These have not been used within our risk assessment process. We believe their inclusion would have introduced unnecessary complexity, and that no additional risks would have been identified and that our assessment of identified risks would not be significantly changed. In the future we will consider including these additional climate change variables.

The UKCIP09 excluded projections for some climate variables for a variety of reasons. A set of further reports (technical notes) were published by UKCIP in November 2010 to give some advice on storms, wind-speed, fog, lightning and snow. There is a high level of uncertainty with these projections and the data is not easy to extract, therefore a summary only is given in Table 2.2.

Table 2.2 – Climate change projections for storms, wind-speed, fog, lightning and snow from UKCIP.

Climate variable	Projection	Climate variable considered
Storms	No change	Not included
Wind-speed	Very small changes to seasonal average wind speed with projected reduction in summer of less than 0.2 ms^{-1}. No change in winter	Not included
Fog	>50% decrease in fog events in winter/spring 10-30% decrease in autumn Large decrease in summer	Yes; as an opportunity
Lightning	Winter similar. Summer increase from an average of 2 or 3 days lightning to 4 or 5 days	Yes; as a risk
Snow	Days of snowfall – >70% less autumn/spring, 40-70% less in winter Heavy snow events - >40% reduction in spring, >80% reduction in autumn/winter	Yes; as an opportunity

For the purposes of our risk assessments, we have assumed that storms and wind speed remain the same, so there are no risks associated with these climate variables. Fog is projected to decrease in frequency of events and snow will also decrease in frequency and severity so these become opportunities for us. Lightning does increase and has therefore been included in our risk assessments as a climate variable.

2.2 Identifying risks & opportunities

Although temperature and precipitation projections have been produced for 3 time periods, we decided to use the projections for 2020s and 2050s only. This takes us to 2069, 58 years from today. We didn't look beyond this because we do not plan for our assets to last this long - assets are given a life expectancy that is shorter. We also felt that there was too much uncertainty beyond the 2050s.

A workshop was carried out at each airport, using senior members of staff (Director or Head of Department level) from across each business to come up with a list of risks and opportunities presented by climate change. The risks and opportunities identified

were any part of the business operation that could be affected by a change in one or more of the climate change variables shown in Tables 2.1 and 2.2.

The degree of change in each climate variable was not considered at these initial workshops – the purpose of these workshops was to identify a list of risks and opportunities that could result from a change in the climate variable. The lists from EMA and MAN were compared and as far as possible, a common list of risks and opportunities was produced.

2.3 Assessing risks & opportunities

Having come up with a list of risks and opportunities, we then set about rating the significance of the risks. We considered which emissions scenario to use and at which probability level. There seemed merit in taking the middle emissions scenario, accepting that as the science changes and uncertainties are reduced, we will need to repeat the process. The middle approach is the central estimate, which has a 50% probability level.

A workshop to identify the significance of the previously identified risks was carried out at each Airport, using the information in Table 2.3

Table 2.3 – Climate change projection data used at the 'Assessing risks workshops'.

Year	Temperature (°C)			Precipitation (mm or %)	
	Winter average	Summer average	Summer daily maximum	Winter average	Summer average
East Midlands Airport					
2020s	+ 1.3	+ 1.4	+ 1.9	+ 5	- 6
2050s	+ 1.9	+ 2.3	+ 3.1	+ 11	- 12
Manchester Airport					
2020s	+ 1.2	+ 1.5	+ 1.9	+ 6%	- 8%
2050s	+ 1.9	+ 2.6	+ 3.3	+ 13%	- 18%

At Manchester, this information is the same as that presented in Table 2.1 for the central estimate. This information was prepared for the workshops at EMA and MAN to help workshop attendees judge the scale of risk. We felt that by keeping this information to just one figure for each climate variable, it would be easier for workshop participants to make a judgement. Opportunities were not rated for risk at the workshops.

The MAG risk team carried out the risk rating workshops, drawing upon senior management participants (Director level or Head of Department) ensuring that one or more individuals could cover each risk who was knowledgeable to lead a discussion before the risk rating took place. The risk team used an electronic voting system, which enabled all participants to vote independently and simultaneously, to capture the risk and then calculate immediately an average for scale of impact and likelihood. The exposure was then calculated by multiplying the average impact rating and average likelihood rating. The criteria used for assessing impact and likelihood is shown in Table 2.4 for assessing the impact of the risk and Table 2.5 for assessing the likelihood.

Table 2.4 – Risk rating criteria used to assess impact significance of climate change risks at East Midlands Airport and Manchester Airport.

Size of Risk - Impact		
Descriptor		**Impact Guide**
1	None	No impact
2	Insignificant	No impact on operations No regulatory consequences No reputational damage or adverse publicity Cost of adaptation up to £250,000 (EMA) Cost of adaptation up to £2.5m (MAN)
3	Minor	Minimal impact on operations No regulatory consequences No reputational damage or adverse publicity Cost of adaptation £250,000 to £400,000 (EMA) Cost of adaptation up to £2.5m to £5m (MAN)
4	Moderate	Some impact on operations No regulatory consequences No reputational damage or adverse publicity Cost of adaptation £400,000 to £500,000 (EMA) Cost of adaptation up to £5m to £10m (MAN)
5	Fairly significant	Limited impact on operations Limited regulatory consequences Limited reputational damage or internal adverse publicity Cost of adaptation £500,000 to £750,000 (EMA) Cost of adaptation up to £10m to £15m (MAN)
6	Highly significant	Significant impact on operations Significant regulatory consequences Significant reputational damage or local adverse publicity Cost of adaptation £750,000 to £1 million (EMA) Cost of adaptation up to £15m to £20m (MAN)
7	Substantial	Substantial impact on operations Substantial regulatory consequences Substantial/widespread reputational damage or national adverse publicity Cost of adaptation £1m to £5 million (EMA) Cost of adaptation up to £20m to £25m (MAN)
8	Major	Major impact on operations Major regulatory consequences Major/severe reputational damage or national adverse publicity Cost of adaptation £5m to £7.5 million (EMA) Cost of adaptation up to £25m to £30m (MAN)
9	Catastrophic	Catastrophic impact on operations Catastrophic regulatory consequences Impact at strategic level Catastrophic reputational damage or national adverse publicity Cost of adaptation over £7.5m (EMA) Cost of adaptation over £30m (MAN)

A scale of 0 to 10 was used for rating the impact and likelihood of each risk. The maximum exposure rating is therefore 100.

Table 2.5 – Risk rating criteria used to assess likelihood significance of climate change risks at East Midlands Airport and Manchester Airport.

Size of Risk - Likelihood		
	Descriptor	**Ability to Control or Adapt**
1	Incredible	Able to control or adapt
2	Improbable	
3	Remote	
4	Occasional	
5	Possible	Reasonably able to control or adapt
6	Probable	
7	Likely	
8	Highly likely	
9	Certainty	Not able to control or adapt

In November 2010 the UKCIP produced some information on additional climate change variables (Table 2.2). Following the risk rating workshops, some modest adjustment was made for a few risks ratings, with the relevant risk owners, to account for this information.

2.4 Uncertainties and assumptions

Throughout the risk assessment process, we were aware that there was significant uncertainty. This uncertainty hasn't prevented us from carrying out climate change adaptation risk assessments for our businesses. However, less uncertainty would not only make the risk registers more robust, but also give us the greater confidence to take forward actions where significant changes to the business are required, potentially involving significant capital expenditure. There are several key areas of uncertainty:

1. *Uncertainties around future emissions scenarios*
   The UKCIP09 data is based on three emissions scenarios. It is difficult to take a firm view on which emissions scenario is most likely because it depends on what government policies are implemented domestically and internationally, and how effective they are.

2. *Uncertainties around the accuracy of the climate change projections*
   The UKCIP09 data is for a range of probability levels. The range of probability levels is an indication of how uncertain the science is at the moment.

3. *Uncertainties with the UKCIP Technical notes for climate change projections*
   This set of data was published by UKCIP in November 2010, to add projections for storms, wind-speed, fog, lightning and snow. There is uncertainty with this information and it is difficult to access.

4. *Uncertainties around impact*
   In carrying out our risk assessments, there was sometimes uncertainty as to what extent the change in the climate variable would mean for the infrastructure or operation being impacted on. This is something we can look to improve on through further investigation.

5. *Uncertainties around likelihood*
   When carrying out the risk ratings, it was sometimes difficult for us to assess likelihood. Again, this is something we can look to improve on through further investigation.

6. *Uncertainties about our future Airports*
   In the risk assessments we made the assumption that all risks about future climate change would be based on our current infrastructure and operations. Clearly this will not be the case. For example, risks associated with aircraft have assumed that aircraft in the 2050s are the same as today when in fact their performance will be different. To have not done this would have required us to predict the future and it was felt to provide a reasonable worst case.

Because the risk ratings were produced from an average of a number of participants at a workshop, the variation in the scores given indicates to us that there is more agreement on some risks than others. This is helpful for us when looking at uncertainties around impact and likelihood.

3. Risks, Actions, Opportunities and Interdependencies

3.1 Risk register for East Midlands Airport

The completed risk register for East Midlands Airport is presented in Table 3.1. Table 3.1 lists all the risks identified and the calculated exposure, or risk rating, given for each risk in the two time periods 2020s and 2050s. A risk owner, a member of the Airport's management, is assigned responsibility for each risk. The risk register also includes the required actions. The scores given for impact and likelihood are also shown in Table 3.1.

In Table 3.1 risks are identified as:

- *High* – coloured red – Those risks with a calculated exposure of greater than 48;
- *Medium* – amber – Risks with an exposure of between 16 and 48;
- *Low* – green – Risks with an exposure of less than 16. It was decided by the workshop participants that some risks didn't require a quantitative assessment because they were felt to be clearly low. These risks are shown coloured green in Table 3.1 and have no ratings attached to them.

Required actions are apportioned to one of three categories:

- *Watching brief* – watching brief to be maintained in the short term on the latest information on climate projections and the situation at the Airport in regard to the risk;
- *Investigate* – Outlines what steps will be undertaken to more fully understand the risk, its impacts and likelihood and/or adaptation activities required; and
- *Action* – Defines actions that are known and needed in the short term to adapt to a climate change risk and/or for long term risks, actions that may be required now.

Table 3.1 – East Midlands Airport Climate Change Adaptation Risks Register, May 2011

Risk No	Airport	Business Unit	Risk Owner	Risk Narrative	Consequences	Climate variable	Exposure		Existing Controls	Required Actions	Short term - 2020s			Medium/ long term - 2050s		
							Short term 2020s	Medium/ long term 2050s			Impact	Likelihood	Exposure	Impact	Likelihood	Exposure
1	EMA	Planning & Development	Head of Development	**Thermal expansion of building infrastructure**, such as concrete and steel, leading to failures and reduced longevity	Structural failures and reduced longevity	Summer temperature	33	45	Maintenance programme. Additional spend may be required	Watching brief	6.2	5.4	33.5	6.8	6.6	44.9
2	EMA	Planning & Development	Head of Development	**Airfield surface and sub-surface structural damage** to runway and aprons from extreme heat	Runway surface buckling has already occurred during extreme high summer temperatures - risk rated for this	Summer temperature	53	60	Runway inspections carried out to ensure safe operations	Action: Consider future climate variables in proposed runway refurbishment project	7.8	6.8	53.0	8.1	7.4	59.9
3	EMA	Planning & Development	Head of Development	**Landside surface and sub-surface structural damage** to bitumous surfaces, such as car parks, landside roads	Tarmac loses integrity above 32°C. Structural failures and reduced longevity. Some impact during hot spells	Summer temperature	31	46	Maintenance programme. Additional spend may be required	Watching brief	4.9	6.3	30.9	6.3	7.3	46.0
4	EMA	Planning & Development	Head of Development	**Changes to clay soils** on which the airport is built during warmer, dryer summers and increased variance between summer and winter water levels	Increased ground movement leading to cracking /distorting of structures/buildings/underground drainage pipes and cable conduits	Summer temperature Summer rainfall Winter rainfall	18	25	Maintenance programme. Additional spend may be required	Watching brief	4.3	4.2	18.1	4.9	5.1	25.0
5	EMA	Operations	General Manager Fire, Airfield Operations and Emergency	**Changed growing conditions for airfield grassland**	Changes to airfield grassland maintenance. Changes to bird populations with increased, or changed pattern of, risk of aircraft bird strikes	Summer temperature Summer rainfall Winter temperature Winter rainfall	6	9	Airfield grassland maintenance	Watching brief	2.0	3.0	6.0	2.6	3.3	8.6
6	EMA	Planning & Development	Head of Development	**Balancing pond capacity**: changes in flow rates of surface water discharges with increased demand for balancing capacity	Have to hold water due to contaminants Breach of discharge regulations / consents	Winter rainfall	49	59	Surface water drainage system	Action: Look at requirement to increase surface water drainage system capacity	7.4	6.6	48.8	7.8	7.5	58.5
7	EMA	Planning & Development	Head of Development	**Drainage system capacity airfield**: changes in flow rates of surface water discharges with increased demand on key drainage including runway and	Surface water prevented from draining away leading to operational disruptions	Winter rainfall	26	36	Surface water drainage system	Watching brief	5.5	4.8	26.4	5.5	6.5	35.8
8	EMA	Planning & Development	Head of Development	**Drainage system capacity landside**: changes in flow rates of surface water discharges with increased demand on key drainage including car parks	Surface water prevented from draining away leading to operational disruptions	Winter rainfall	6	14	Surface water drainage system	Watching brief	1.9	3.0	5.7	3.4	4.2	14.3
9	EMA	Operations	Engineering Manager	**Debris accumulating in pipework** during longer dry spells then washed out	Pollution of local watercourses	Summer rainfall			Water quality monitoring programme	Watching brief						
10	EMA	Operations	General Manager Fire, Airfield Operations and Emergency	**Changes in distribution of bird populations** and/or migratory patterns	Increased, or changed pattern of, risk of aircraft bird strikes	Summer temperature Winter termperature Summer rainfall Winter rainfall	15	20	Airfield bird management activities	Watching brief	3.4	4.4	15.0	3.9	5.2	20.3
11	EMA	Operations	Engineering Manager	**Changes to which plants will grow** across the Airport estate	Changed landscape planting and maintenance regime	Summer temperature Winter termperature Summer rainfall Winter rainfall			Landscape management plan and activities	Watching brief						
12	EMA	Operations	Engineering Manager	**Drying/changing soils affecting tree stability**	Tree fall risk and potential to cause damage and/or injury	Summer temperature Summer rainfall Winter rainfall			Landscape management plan and activities	Watching brief						
13	EMA	Planning & Development	Head of Development	**Changes to water table** leading to subsidence and water ingress to underground services	Subsidence leading to instability of buildings/ structures. Damage to underground cables and chambers	Winter rainfall	36	49	None	Investigate: Look in more detail at this risk and requirement for monitoring any changes in its likelihood	6.8	5.3	36.0	7.1	6.9	49.0
14	EMA	Operations	Airfield Technical	**Flood damage to aircraft navigation systems/buildings and ILS**	Equipment shut down due water exposure. Unavailability of critical Navaid systems.	Winter rainfall	15	16	Equipment monitoring. Daily checks. Maintenance regime.	Watching brief	6.4	2.3	14.7	6.5	2.5	16.3
15	EMA	Operations	Airfield Technical	**Extremities of wet & dry affecting ground reflection of navigation aids**	Extreme raising and lowering of water table leading to incorrect ILS beam formation.Possible shut down of ILS equipment.	Summer rainfall Winter rainfall	16	17	Equipment monitoring. Daily checks. Maintenance regime.	Watching brief	5.4	3.0	16.2	5.8	3.0	17.4

Risk No	Airport	Business Unit	Risk Owner	Risk Narrative	Consequences	Climate variable	Exposure		Existing Controls	Required Actions	Short term - 2020s			Medium/ long term - 2050s		
							Short term 2020s	Medium/ long term 2050s			Impact	Likelihood	Exposure	Impact	Likelihood	Exposure
16	EMA	Operations	Senior Fire Officer	**Greater fire risk** due to hotter, dryer summers and increased incidence of lightning in summer	Grass and vegetation fires could cause poor visibility due to fire smoke and possible fire damage to outlying structures	Summer temperature Summer rainfall Lightning	13	19	Onsite fire brigade, fire hydrants, airfield and landscape management plans and activities	Watching brief	3.3	3.9	12.9	3.8	4.9	18.6
17	EMA	Operations	Operations Director	**Longer aircraft takeoff run** due to 'thin air' and reduced aircraft engine effciency	To continue to operate, aircraft increase power settings for takeoff which increases fuel use and noise. Aircraft also reduce payload. Some aircraft may not	Summer temperature	35	31	Cost of increasing runway length high. Payload restirctions on hotter days only.	Watching brief	6.4	5.4	34.6	5.7	5.4	30.8
18	EMA	Operations	Engineering Manager	**Increased build up of rubber on runway**	Increase is rubber removal	Summer temperature Summer rainfall	13	14	Runway inspections regime and rubber removal contractor retained	Watching brief	2.8	4.6	12.9	3.0	4.6	13.8
19	EMA	Operations	General Manager Fire, Airfield Operations and Emergency	**Interruptions to aircraft fuelling** during lightning events	Aircraft fuelling temporarily stopped leading to potential delays and inconvenience	Lightning			Fuelling procedures include consideration of lightning risk	Watching brief						
20	EMA	Operations	General Manager Fire, Airfield Operations and Emergency	**Potential increase in anti-icing** required during wetter winters as more standing water	Cost of anti-icing	Winter rainfall			Winter operations plan and activities	Watching brief						
21	EMA	Operations	General Manager Fire, Airfield Operations and Emergency	**Reduced visibility on airfield during heavy rain events**	Aircraft operations temporarily suspended. Increased risk of accidents	Winter rainfall			Airfield safety plan and activities	Watching brief						
22	EMA			**Overheating of aircraft cabins while on stand**	Warmer temperatures will require increased use of aircraft's APU or installation of PCA. Installation of PCA by us significant project and investement. APU use currenlty discouraged for noise and emissions reasons	Summer temperature			Liaison between ourselves and airlines thorugh groups such as AOC and FLOPSC	Watching brief						
23	EMA	Finance	Financial Controller	**Increased insurance costs**	Increased spend on insurance as risk of lightning events increases	Lightning			Current insurance policy	Watching brief						
24	EMA	Operations	Operations Director	**Increase in disease vectors** at the airport resulting from changes to their distribution	Increase in tropical and other diseases affecting staff and airport users	Summer temperature Winter termperature Summer rainfall Winter rainfall	8	13	Port Health services at the Airport. Occupational health service	Investigate: Research this risk in more detail to more fully understand the risk, existing controls and those that may be required	2.4	3.2	7.7	3.0	4.3	12.9
25	EMA	Operations	Health & Safety Manager	**Health & wellbeing of outside workers**	Increased protection for outside workers e.g. breaks, sun protection	Summer temperature Winter rainfall	10	17	Occupational health department	Watching brief	1.9	5.5	10.5	2.5	6.9	17.3
26	EMA	Operations	Operations Director	**Passenger comfort** within airport terminals	Increased running costs of airport cooling systems	Summer temperatures	49	58	Existing HVAC systems	Investigate: Thresholds for new plant and equipment against predicted temperature increases during the asset's lifetieme. Amend specifications if	7.2	6.8	49.0	7.4	7.8	57.7
27	EMA	Operations	Engineering Manager	**Staff comfort within buildings**	Impact on energy spend and suitability of existing buildings and design of new facilities, including additional HVAC required	Summer temperatures	21	30	Existing HVAC systems. Specifications for new plant/equipment	Investigate: Thresholds for new plant and equipment against predicted temperature increases during the asset's lifetieme. Amend specifications if	4.5	4.6	20.7	5.3	5.6	29.7
28	EMA	Sustainability	Environment Manager	**More residents' windows open, particularly at night**, leading to greater propensity to complain	Change of nature to SIGS Scheme from sound insulation to air conditioning Potential for affecting 20,000 homes	Summer temperatures	18	32	Current SIGS based on delivering secondary glazing	Investigate: Research this risk in more detail to more fully understand the risk, existing controls and those that may be required	7.0	2.6	18.2	7.0	4.6	32.2
29	EMA	Sustainability	Environment Manager	**Increase in local air quality pollutants**, such as ozone	Health impacts more likely	Summer temperatures			Airport air quality monitoring for range of pollutants in place. Airport emissions reduction plan	Watching brief						
30	EMA	Planning & Development	Head of Development	**UV degradation of materials and equipment**	Degradation of balancing pond liners. Rubber belts on snow equipment. Increased maintenance and replacement costs	Summer temperatures	27	33	Maintenance programme. Additional spend may be required	Watching brief	4.7	5.8	27.3	5.3	6.2	32.9

3.2 Risk register for Manchester Airport

The completed risk register for Manchester Airport is presented in Table 3.2. Table 3.2 lists all the risks identified and the calculated exposure, or risk rating, given for each risk in the two time periods 2020s and 2050s. A risk owner, a member of the Airport's management, is assigned responsibility for each risk. The risk register also includes the required actions. The scores given for impact and likelihood, which were used to calculate the risk rating, are also shown in Table 3.2.

Required actions are apportioned to one of three categories. These are the same categories used in the risk register for EMA.

Table 3.2 – Manchester Airport Climate Change Adaptation Risks Register, May 2011

Risk No	Airport	Business Unit	Risk Owner (Head of)	Risk Narrative	Consequences	Climate variable	Exposure		Existing Controls	Required Actions	Short term - 2020s			Medium/ long term - 2050s		
							Short term 2020s	Medium/ long term 2050s			Impact	Likelihood	Exposure	Impact	Likelihood	Exposure
1	MAN	MA External Engineering	Head of External Engineering	**Thermal expansion of building infrastructure**, such as concrete and steel, leading to failures and reduced longevity	Structural failures and reduced longevity	Summer temperature	8	10	Maintenance programme. Structures can cope with projected climate variable	Watching brief	3.3	2.3	7.6	3.6	2.9	10.4
2	MAN	MA External Engineering	Head of External Engineering	**Airfield surface and sub-surface structural damage** to runway and aprons from extreme heat	Runway surface buckling has already occurred during extreme high summer temperatures - risk rated for this	Summer temperature	6	6	Runway inspections carried out to ensure safe operations. Structures can cope with projected climate variable	Watching brief	2.4	2.4	5.8	2.8	2.3	6.4
3	MAN	MA External Engineering	Head of External Engineering	**Landside surface and sub-surface structural damage** to bitumous surfaces, such as car parks, landside roads	Tarmac loses integrity above 32°C. Structural failures and reduced longevity. Some impact during hot spells	Summer temperature	10	12	Maintenance programme. Additional spend may be required	Watching brief	3.0	3.3	9.9	2.9	4.0	11.6
4	MAN	MA External Engineering	Head of External Engineering	**Changes to clay soils** on which the Airport is built during warmer, dryer summers and increased variance between summer and winter water levels	Increased ground movement leading to cracking /distorting of structures/buildings/underground drainage pipes and cable conduits	Summer temperature Summer rainfall Winter rainfall	13	16	Maintenance programme. Additional spend may be required	Watching brief	3.4	3.7	12.6	3.7	4.3	15.9
5	MAN	MA External Engineering	Head of External Engineering	**Changed growing conditions for airfield grassland**	Changes to airfield grassland maintenance. Changes to bird populations with increased, or changed pattern of, risk of aircraft bird strikes	Summer temperature Summer rainfall Winter temperature Winter rainfall	4	7	Airfield grassland maintenance	Watching brief	1.7	2.2	3.7	1.8	3.7	6.7
6	MAN	MA External Engineering	Head of External Engineering	**Balancing pond capacity**: changes in flow rates of surface water discharges with increased demand for balancing capacity	Have to hold water due to contaminants so possibility of breach of discharge regulations / consents	Winter rainfall	30	47	Surface water drainage system but already can reach capacity	Action: Prepare a business case to increase capacity of surface water drainage system balancing ponds	4.3	6.9	29.7	6.1	7.7	47.0
7	MAN	MA External Engineering	Head of External Engineering	**Drainage system capacity airfield**: changes in flow rates of surface water discharges with increased demand on key drainage including runway and	Surface water prevented from draining away leading to operational disruptions	Winter rainfall	30	58	Surface water drainage system	Action: Prepare a business case to increase capacity of those parts of the surface water drainage system that are approaching capacity	4.7	6.3	29.6	7.1	8.1	57.5
8	MAN	MA External Engineering	Head of External Engineering	**Drainage system capacity landside**: changes in flow rates of surface water discharges with increased demand on key drainage including car parks	Surface water prevented from draining away leading to operational disruptions	Winter rainfall	11	14	Surface water drainage system	Watching brief	2.7	4.0	10.8	2.9	4.9	14.2
9	MAN	MA External Engineering	Head of External Engineering	**Debris accumulating in pipework** during longer dry spells then washed out	Pollution of local watercourses	Summer rainfall	3	4	Water quality monitoring programme	Watching brief	1.2	2.1	2.5	1.7	2.3	3.9
10	MAN	MA External Engineering	Head of External Engineering	**Changes in distribution of bird populations** and/or migratory patterns	Increased, or changed pattern of, risk of aircraft bird strikes	Summer temperature Winter temperature Summer rainfall Winter rainfall	4	7	Airfield bird management activities	Watching brief	1.7	2.2	3.7	1.8	3.7	6.7
11	MAN	MA External Engineering	Head of External Engineering	**Changes to which plants will grow** across the Airport estate	Changed landscape planting and maintenance regime	Summer temperature Winter temperature Summer rainfall Winter rainfall			Landscape management plan and activities	Watching brief						
12	MAN	MA External Engineering	Head of External Engineering	**Drying/changing soils affecting tree stability**	Tree fall risk and potential to cause damage and/or injury	Summer temperature Summer rainfall Winter rainfall			Landscape management plan and activities	Watching brief						
13	MAN	MA External Engineering	Head of External Engineering	**Changes to water table** leading to subsidence and water ingress to underground services	Subsidence leading to instability of buildings/ structures. Damage to underground cables and chambers	Winter rainfall	5	7	None	Investigate: Look in more detail at this risk and requirement for monitoring any changes in its likelihood	2.0	2.7	5.4	2.1	3.1	6.5
14	MAN	MA External Engineering	Head of External Engineering	**Flood damage to aircraft navigation systems/buildings and ILS**	Equipment shut down due water exposure. Unavailability of critical Navaid systems.	Winter rainfall	4	4	Equipment monitoring. Daily checks. Maintenance regime.	Watching brief	3.3	1.2	4.0	3.2	1.2	3.8
15	MAN	MA Operations	Head of Airfield Strategy & Compliance	**Extremities of wet & dry affecting ground reflection of navigation aids**	Extreme raising and lowering of water table leading to incorrect ILS beam formation.Possible shut down of ILS equipment.	Summer rainfall Winter rainfall	4	5	Equipment monitoring. Daily checks. Maintenance regime.	Watching brief	1.4	2.6	3.6	1.7	3.1	5.3

Risk No	Airport	Business Unit	Risk Owner (Head of)	Risk Narrative	Consequences	Climate variable	Exposure		Existing Controls	Required Actions	Short term - 2020s			Medium/ long term - 2050s		
							Short term 2020s	Medium/ long term 2050s			Impact	Likelihood	Exposure	Impact	Likelihood	Exposure
16	MAN	MA Operations	Head of Airfield Operations	**Greater fire risk** due to hotter, dryer summers and increased incidence of lightning in summer	Grass and vegetation fires could cause poor visibility due to fire smoke and possible fire damage to outlying structures	Summer temperature Summer rainfall Lightning	12	14	Onsite fire brigade, fire hydrants, airfield and landscape management plans and activities	Watching brief	3.0	3.9	11.7	3.1	4.6	14.3
17	MAN	MA Operations	Head of Airfield Operations	**Longer aircraft takeoff run** due to 'thin air' and reduced aircraft engine effciency	To continue to operate, aircraft increase power settings for takeoff which increases fuel use and noise. Aircraft also reduce payload. Some aircraft may not	Summer temperature	5	10	Cost of increasing runway length high. Payload restirctions on hotter days only.	Watching brief	2.0	2.6	5.2	2.9	3.3	9.6
18	MAN	MA Operations	Head of Airfield Operations	**Increased build up of rubber on runway**	Increase is rubber removal	Summer temperature Summer rainfall	8	10	Runway inspections regime and rubber removal contractor retained	Watching brief	2.3	3.4	7.8	2.4	4.1	9.8
19	MAN	MA Operations	Head of Airfield Operations	**Interruptions to aircraft fuelling** during lightning events	Aircraft fuelling temporarily stopped leading to potential delays and inconvenience	Lightning			Fuelling procedures include consideration of lightning risk	Watching brief						
20	MAN	MA Operations	Head of Airfield Operations	**Potential increase in anti-icing** required during wetter winters as more standing water	Cost of anti-icing	Winter rainfall			Winter operations plan and activities	Watching brief						
21	MAN	MA Operations	Head of Airfield Operations	**Reduced visibility on airfield during heavy rain events**	Aircraft operations temporarily suspended. Increased risk of accidents	Winter rainfall			Airfield safety plan and activities	Watching brief						
22	MAN	MA Operations	Head of Airfield Operations	**Overheating of aircraft cabins while on stand**	Warmer temperatures will require increased use of aircraft's APU or installation of PCA. Installation of PCA by us significant project and investement. APU use currenlty discouraged for noise and emissions reasons	Summer temperature			Liaison between ourselves and airlines thorugh groups such as AOC and FLOPSC	Watching brief						
23	MAN	Group Risk Assurance	Risk Manager	**Increased insurance costs**	Increased spend on insurance as risk of lightning events increases	Lightning			Current insurance policy	Watching brief						
24	MAN	MA Operations	Head of Environment	**Increase in disease vectors** at the airport resulting from changes to their distribution	Increase in tropical and other diseases affecting staff and airport users	Summer temperature Winter termperature Summer rainfall Winter rainfall	7	21	Port Health services at the Airport. Occupational health service	Investigate: Research this risk in more detail to more fully understand the risk, existing controls and those that may be required	2.1	3.1	6.5	3.3	6.3	20.8
25	MAN	MAG Health & Safety	Head of Health & Safety	**Health & wellbeing of outside workers**	Increased protection for outside workers e.g. breaks, sun protection	Summer temperature Winter rainfall	6	8	Occupational health department	Watching brief	2.2	2.7	5.9	2.3	3.5	8.1
26	MAN	MA Internal Engineering	Head of Terminals Facilities	**Passenger comfort** within airport terminals	Increased running costs of airport cooling systems	Summer temperatures	14	17	Existing HVAC systems	Investigate: Thresholds for new plant and equipment against predicted temperature increases during the asset's lifetieme. Amend specifications if	3.3	4.3	14.2	3.1	5.4	16.7
27	MAN	MA Internal Engineering	Head of Terminals Facilities	**Staff comfort within buildings**	Impact on energy spend and suitability of existing buildings and design of new facilities, including additional HVAC required	Summer temperatures	21	30	Existing HVAC systems. Specifications for new plant/equipment	Investigate: Thresholds for new plant and equipment against predicted temperature increases during the asset's lifetieme. Amend specifications if	4.5	4.6	20.7	5.3	5.6	29.7
28	MAN	MA Human Resources	Community Relations Manager	**More residents' windows open, particularly at night**, leading to greater propensity to complain	Change of nature to SIGS Scheme from sound insulation to air conditioning Potential for affecting 20,000 homes	Summer temperatures	9	19	Current SIGS based on delivering secondary glazing	Investigate: Research this risk in more detail to more fully understand the risk, existing controls and those that may be required	4.7	2.0	9.4	5.0	3.8	19.0
29	MAN	MA Operations	Head of Environment	**Increase in local air quality pollutants**, such as ozone	Health impacts more likely	Summer temperatures			Airport air quality monitoring for range of pollutants in place. Airport emissions reduction plan	Watching brief						

3.3 Commentary

Table 3.1 shows the Climate Change Adaptation Risk Register for East Midlands Airport and Table 3.2 shows the risk register for Manchester Airport. The same methodology was used to produce the two risk registers, utilising the existing MAG Risk team and corporate risk assessment process. The two risk registers have the same 29 risks, with an additional risk at EMA.

Of the 30 risks at EMA, there are 2 defined adaptation actions identified in the risk register. These require actions to be taken in the near term. One action relates to the need to increase the capacity of the surface water drainage system and the other was an action for considering current and future climate for the proposed runway refurbishment project. In addition to these, 5 'Investigate' actions are required. These are ones that require work to be undertaken to more fully understand the risk, its impacts and likelihood and/or adaptation activities required. These risks are:

- Changes to water table
- Increase in disease vectors
- Passenger comfort in airport terminals
- Staff comfort within terminal buildings
- More residents' windows open, particularly at night

The remaining risks were identified as requiring a watching brief.

EMA had an additional risk to MAN, related to the UV degradation of the balancing pond liners. MAN has no balancing pond liners exposed to daylight so this risk is not present.

Of the 29 risks at MAN, there are 2 defined adaptation actions in the risk register. The 2 actions both relate to the surface water drainage system. In addition to these, the same 5 risks were identified as requiring 'Investigate' actions. The remaining risks were identified as requiring a watching brief.

Those risks identified as presenting greatest risk (shown red in Tables 3.1 and 3.2) are discussed more fully in Table 3.3, to provide a fuller commentary and an explanation of the findings of the risk assessment group.

Table 3.3 – List of highest scoring climate change risks at EMA and MAN with a supporting explanatory commentary.

Risk no.	Airport	Risk narrative	Discussion
2	EMA	Airfield surface and sub-surface structural damage to runway and aprons from extreme heat	The Airport's runway is, of course, critical to all aircraft operations and it is potential damage to the runway surface that was the principal concern resulting in a relatively high risk rating. The runway surface is subject to frequent and regular planned inspections and as such the expert assessment group was confident that the safety of aircraft operations would not be compromised. However experience has shown that when exceptionally high summer temperatures (>30 degrees Celsius) were experienced in 2005 surface deformations of the runway were observed and urgent remedial works were required to maintain aircraft operations. Whilst engineering studies of the runway surface have not been conclusive, the deformations are believed to have been caused by expansion within the sub-surface. As part of the planned maintenance of the airfield, within the next 3 years the runway will be subject to an overlay. This maintenance project will provide an opportunity to ensure that forecast changes in climate, in particular extremes in summer temperature, are built into the engineering brief and that in the future, the risk of surface deformation and the potential disruption to aircraft operations is reduced to an acceptable minimum.
3	EMA	Landside surface and sub-surface structural damage to bitumous surfaces, such as car parks, landside roads	The Airport has an extensive road network providing access to and around the site and 7 surface car parks. Roads and most car parks have a bitumous type surface. The expert assessment group was concerned that some bitumous surfaces can begin to melt at temperatures of greater than 32 degrees Celsius and that the climate scenarios informing the risk assessment suggested that these conditions were more likely to occur in the future. There were also some anecdotal reports of damage to road and car park surfaces during the exceptionally hot summer of 1976. The Group considered that this risk was most likely to manifest itself in terms of reduced asset life and changes to surface specifications, which are likely to incur additional capital expenditure.

Risk no.	Airport	Risk narrative	Discussion
6	EMA	Balancing pond capacity: changes in flow rates of surface water discharges with increased demand for balancing capacity	The Airport has a complex surface water drainage system which is computer controlled from a central facilities function. The drainage system includes 6 large balancing ponds, the largest of which has a capacity of 60,000 cubic metres. The balancing ponds have 2 purposes to segregate and control the flow of water contaminated with de-icing fluids and to prevent local flooding during periods of heavy rain. The current system was designed to withstand a 1 in 150 year storm event. The expert assessment group considered that the current system is near capacity and that the combined pressures of future airport development of paved surfaces and the increased likelihood of increased winter rainfall is likely to bring forward the need to invest in increased surface water balancing capacity. A detailed drainage model has already been developed and this requirement will be considered in detail as part of the Airport's development plan, which is likely to be reviewed during 2012/13. The potential mitigation offered by employing permeable surfaces in new developments wherever possible was discussed and this will be taken forward to provide partial mitigation.
13	EMA	Changes to water table leading to subsidence and water ingress to underground services	The future climate scenarios suggest greater variation in temperature and rainfall between summer and winter seasons. The expert assessment group considered that the resulting ground movements and the rise and fall of the water table might lead to increased property damage and damage to underground services. The Airport has a myriad of underground services ranging from oil supply lines, to fibre optic communications. Damage to underground services could be costly to repair and disruptive to the operation of the Airport.
27	EMA	Passenger comfort within airport terminals	The Airport aims to provide a high level of customer service to all passengers. The passenger terminal is heated and cooled to a comfortable ambient temperature. Passengers board / disembark from aircraft either on foot or by coach. Currently all walking stands are open to the elements and no transfer coaches are air-conditioned. Whilst there is significant uncertainty, the expert assessment group considered that in the future the demands placed on terminal heating and cooling systems would likely be increased. However as the current terminal development plans include a new, biomass fired, heating and cooling system it was felt that with regard to the passenger terminal this risk would only result in some increased revenue spend. The Group also expressed some concern that there would be a need to specify relatively expensive air conditioning systems on transfer coaches. The Group's greatest concern was with regard to the suitability of the existing airside infrastructure. Currently passengers are required to walk from 6 stands to the arrivals building and, during busy periods, queues can form outside of the protection of the building. The Group noted that a protected walkway is already included within the Airport's future development programme but it was considered that the future climate change scenarios might increase the specification of this walkway or bring forward the required implementation date. The Group also considered that there may be pressure to introduce further substantial terminal infrastructure enhancements, such as the supply of pre-conditioned air to aircraft.

Risk no.	Airport	Risk narrative	Discussion
28	EMA	More residents' windows open, particularly at night, leading to greater propensity to complain	The Airport offers sound insulation grants to those local dwellings most impacted by aircraft noise, a total of approximately 1,400 dwellings. The Airport's investment in sound insulation grants is typically in the region of £250k to £600k annually. Sound insulation is much less effective when windows are open and community feedback indicates that some residents feel the need to open windows during hot summer nights. The forecast increases in average summer temperatures suggest that the number of residents who feel compelled to ventilate their rooms at night is likely to increase and as a result the Airport may need to consider extending the scheme to add air conditioning to bedrooms to ensure that adequate noise mitigation can be achieved at all times. The capital expenditure required to support such an amendment could be in excess of £1,000k.
6	MAN	Balancing pond capacity: changes in flow rates of surface water discharges with increased demand for balancing capacity	Manchester Airport has a large and complex drainage system to capture surface water from the large areas of hardstanding – aprons, taxiways and runways. In order to attenuate the flow of this water to local watercourses, to prevent pollution and the sudden and very large volumes of water that are present during heavy rainfall, 6 large balancing ponds exist. These balancing ponds store the water from the airfield and allow it to be released into local watercourses at a controlled rate. The balancing ponds are already at the limit of their capacity during heavy rainfall events. Any increase in areas of hardstanding or the amounts of rainfall will require additional balancing pond capacity to be built. The expert assessment group were aware of the current system's limits and considered that an increase in rainfall in the future was a significant climate change risk to our business. The defined action is to prepare the business case to increase the capacity of the surface water balancing ponds to take account of future planned developments and climate change adaptation. There are uncertainties at the moment that will need to be considered.
7	MAN	Drainage system capacity airfield: changes in flow rates of surface water discharges with increased demand on key drainage including car parks	Similar to risk number 6 at MAN, there are important parts of the existing surface water drainage system, separate to the balancing ponds, that are close to capacity. When new areas of hardstanding are added, the accompanying new drainage system may be fitted with oversized pipes to allow for the storage of water and attenuation. Again, the defined action is to prepare the business case to increase the capacity of the surface water balancing ponds to take account of future planned developments and climate change adaptation. There are uncertainties at the moment that will need to be considered.

The UKCIP advice on average wind speeds in the future due to climate change indicate that wind speed will not change significantly, and that the small change will be for a slightly lower average wind speed (Table 2.2). There is no information that we could find on wind gusts, which is the wind variable more important for airport and aircraft operations. The prevailing wind direction is also critical to airport operations, and a substantial change to this would be an important risk. For these reasons, no risks have been included in the risk registers for risks caused by wind. Table 3.4 lists those risks we identified that would relate to any change in wind.

Table 3.4 – Risks associated with changes in wind speed, gust and direction (not assessed).

No.	Risk narrative	Consequences	Climate variable
1	**High, exposed structures at risk from wind**, e.g. high mast lighting, aircraft steps	Damage to buildings/structures. Airfield equipment blown around causing damage and possible injury	Wind speed (gust)
2	**Increase in missed approaches / diversions / cancellations due to high wind speeds**	Operational disruptions	Wind speed (gust)
3	**Increase in wind speeds and frequency will increase risk of FOD**		Wind speed
4	**Change in prevailing wind direction leading to increase in cross-winds** and diversions	Aircraft unable to operate at current levels Permanent change could require re-alignment of runway direction	Wind direction

Should further wind projection information become available then we will need to consider the wind variable against these risks, and include them in our risk registers.

There were several other risks that we identified in the initial workshops across the business that we haven't included in the risk register. These all relate to the impact that climate change may have on our business more generally, such as more 'staycations' leading to fewer outbound flights and an increase in incoming passengers to holiday in the UK from abroad. It is impossible at this stage to say what the predicted climate variables will mean for these potential risks and opportunities. It will depend on what happens in the UK and elsewhere in the world. These risks also do not impact directly on how we manage our core business of running an airport to serve passengers, airlines and tenants. For these reasons we haven't included them in the risk register but it is something we will clearly need to keep a watching brief on.

The key barrier to adaptation activities at EMA and MAN is uncertainty and cost. By way of illustration, enhancing the capacity of the drainage infrastructure is likely to cost millions of pounds. Enhancing the surface water drainage system has been identified as a climate change adaptation action at both EMA and MAN. Uncertainty over the accuracy of the UKCIP projections increases the difficultly in making a robust business case to support these types of substantial capital investment. To take a precautionary approach and build in more capacity than the projections suggest can mitigate the risk but would incur substantial additional costs.

3.4 Opportunities

As well as identifying risks to our business from climate change, we also identified a number of opportunities. These haven't been quantitatively assessed but those we identified are listed below in Table 3.5.

Table 3.5 – Opportunities identified from climate change at EMA and MAN.

Opp. no.	Opportunity narrative	Consequences	Climate variable
1	**Reduced requirement for winter operations**, such as anti-icing	Reduced costs and less disruption to operations	Winter temperature Snow
2	**Less heating of buildings in winter**	Reduced costs	Winter temperature
3	**Longer outdoor work season**	Milder winters enables more outdoor work to be completed	Winter temperature
4	**Rainwater harvesting in winter**	More winter rainfall could be collected, especially for use in dryer summers	Winter rainfall
5	**Less fog**	Fog events require Low Visibility Procedures which reduce the number of aircraft landings and take offs per hour	Fog

These opportunities will be included in future reviews of the risk registers, to ensure that they remain subject to regular consideration and scrutiny.

3.5 Interdependencies

Our risk assessment process highlighted a number of important interdependencies, which have the potential to significantly impact our business operations. These risks, which are outside our control, were not rated. They include utility supply, telecommunications and surface access.

In carrying out our risk assessments, we have made the assumption that all of these interdependencies have fully adapted to climate change and will continue to function as now. Table 3.6 lists those the key risks identified, along with the interdependency(s).

Table 3.6 – Interdependencies for climate change adaptation at EMA and MAN.

Int. no.	Risk narrative	Consequences	Climate	Interdependency
1	Greater call on local authority fire fighting resources so less support available to airports	Requirement for enhanced fire and rescue support at airports	Summer temperatures Summer rainfall	Local fire services
2	Water availability and water pressure	Water restrictions in dryer summers. Water pressure reduced due to demand elsewhere	Summer temperatures	Utility supplier (water)
3	Loss of external supply of electricity and gas	Inability to run hot water/heating boilers if no gas. Inability to power airport	Summer temperatures Winter rainfall Extreme weather	Utility suppliers (electricity and gas)
4	Loss of external supply of liquid fuels	Loss of gas oil or vehicle fuels could halt airport operations	Summer temperatures Winter rainfall Extreme weather	Fuel suppliers
5	Changes to aircraft performance/ operations	Safety must be maintained and operations could be affected	Summer temperatures Winter rainfall Extreme weather	NATS (MAN only) CAA
6	Service partners unable to operate as normal	Potentially serious disruption to key airport operations	Extreme weather	Airlines Ground handlers Caterers Service partners
7	Loss of external telecommunications services	Inability to communicate externally and failure of key airport systems	Summer temperatures Winter rainfall Extreme weather	Telecommunications providers
8	Surface access disruption	Staff and passengers could be prevented from getting to the airport	Summer temperatures Winter rainfall Extreme weather	Highways Agency Local authorities Rail and bus operators
9	Fuel stored becomes more volatile at higher temperatures	Fuel could ignite so new controls needed. Avgas is particularly susceptible	Summer temperature	Fuel companies on-site

In the coming years, as more information becomes available, it will become increasingly important that we work with identified partners to ensure that they have in place robust adaptation policies and that our assumptions are correct. Additional risks highlighted by this process will be added to our risk registers in the future to ensure that the risk is assessed and appropriate mitigation applied where we are able to do so. In managing these interdependencies we note the key role of local and central government to oversee the integrated approach that is implied by this process.

4. Monitoring and Review

In carrying out the workshops at each Airport to produce the risk registers presented in this report, awareness has been raised amongst key management staff of the impact that future climate change will have on our airports and how we need to progressively consider and adapt to this. The climate change risk registers are a first step. They have been produced using our standard corporate risk methodology, with our risk team. The corporate risk register, that contains all the risks to our business, now has an entry for climate change adaptation. This means that the risk registers will now be reviewed annually at the most senior level within the organisation.

The risk registers at EMA and MAN, and the associated opportunities and interdependencies will form part of this review. We will work to more fully understand the thresholds, and indicators that can be used, to monitor risks. The review will be facilitated by the Environment departments at each Airport, under the direction of the Group Director of Sustainability. The detail of this review will be decided upon each year based on various factors such as changes in the assumptions and the uncertainties previously discussed. Examples are the availability of new climate change projections and also outcomes from our own required investigations and actions within the climate change adaptation risk register. The actions and investigative actions at East Midlands Airport and at Manchester Airport will be worked on over the forthcoming year and then formally reviewed. The review will take place in April/May to align with the DEFRA established timetable for this first climate change adaptation risk work and also to link in with our normal business planning cycle. The outcome of the annual review, and revised risk registers, will be communicated to all stakeholders.

Although not required by regulation, this process will now be extended to include Bournemouth and Humberside Airports and the resulting risk registers will be reported separately.

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Glossary

AOC	Airline Operators Committee
APU	Auxiliary power unit
ATC	Air traffic control
CAA	Civil Aviation Authority
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EMA	East Midlands Airport
FLOPSC	Flight Operations and Safety Committee
GHG	Greenhouse gas
ILS	Instrument landing system
MAG	Manchester Airports Group
MAN	Manchester Airport
NATS	National Air Traffic Services
PCA	Pre-conditioned air
UKCIP	United Kingdom Climate Impacts Programme