



A Second Runway for Gatwick Appendix

A25

Operational Risk

YOUR LONDON AIRPORT
Gatwick

Gatwick Airport Limited

**Airports Commission Framework
- Phase 2**

Operational Risk

228066-57

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This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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Executive Summary

The objective of the appraisal of operational risk¹ is to capture the inherent risk to airport operations of the following disruptive events (threats) as part of Gatwick Airport Limited's (Gatwick) proposal for a second runway:

- Flooding
- Power outages
- Reduced fuel supplies
- Terrorism attacks
- Extreme weather events
- Adaptability to climate change.

However in addition to the baseline requirements of the appraisal, the Gatwick Master Plan can deliver significant opportunities to increase the overall resilience of the airport and its operations. The benefits of a resilient Gatwick would have implications both regionally as well as locally.

Capability of Gatwick Master Plan

The development of Gatwick to a two runway, three terminal airport provides the opportunity to create one of the world's leading airport facilities which could enhance the resilience of the London airport system as a whole. The management and operational enhancements needed to achieve this can be developed in the context of the construction of a major new terminal in the midfield, a substantially redeveloped transport interchange and cyclical renovations to the North and South terminals. These new and redeveloped facilities can be developed to provide flexible, secure spaces and accommodate new and emerging technologies. This, in combination with the necessary management and operational procedures, would ensure resilient and safe operations of the airport appropriate for a major nationally important transport system.

While this report focuses on how high levels of resilience may be achieved at Gatwick, it is important to note that a future London airport system comprising a two runway Heathrow, a two runway Gatwick along with Stansted, Luton and City airports can have a higher level of inherent resilience than if future increased capacity is focused in a three runway Heathrow; failures at a single dominant airport would have a greater shock to the system as a whole.

When considering the capability of the Gatwick Master Plan to prevent, absorb, adapt to and recover from the risks associated with threats it is necessary to understand the extent to which the current systems are vulnerable, any vulnerabilities that the Master Plan may introduce and the extent to which its components could then mitigate them.

In summary, the Master Plan has a number of key advantages in resilience terms compared to the existing facility. The introduction of a second runway, a third terminal and a midfield apron area all introduce additional or new duplication of facilities which improve the system's ability to absorb shocks. The growth of the

¹ Airports Commission Appraisal Framework Consultation dated April 2014.

airport will of course increase complexity, but the Master Plan's overall simplicity with rapid and efficient connectivity between terminals can help when developing appropriate management and operational procedures to mitigate this. The construction of major new terminal facilities with flexible space could also assist. In addition, the component parts of the Gatwick Master Plan create no new vulnerabilities other than a general increased complexity which can be mitigated by updating the airport's management systems.

Risk Evaluation

When considering the headline risks, as identified by the Airports Commission in their Evaluation Criteria, associated with the nominated hazard events, the Gatwick Master Plan is assessed as delivering the following levels of risk:

- **Flooding** – The Master Plan can deliver significant flood mitigation measures such that the level of risk would be negligible. The key benefits can be derived by the rerouting of the River Mole, enhancements to upstream catchment systems and designing the surface water drainage associated with the new development to accommodate 100 year + 20% events. In addition the design of the waterways can be used to further enhance the perimeter security measures.
- **Power outages** – The redesign of the power grid supplying Gatwick provide for an additional High Voltage (HV) feed which can allow for improved geographical resilience as well as improved switching capability. These enhancements should result in a minimal level of risk. In addition, taking the provision of standby power generation in-house in lieu of using call-off contracts could further reduce the residual risk to the level of negligible.
- **Reduced fuel supplies** – The capability of the current fuel supply network to deliver 250% of Gatwick's current demand provides a high level of resilience until 2040. The resultant level of risk from fuel supply is negligible until 2040; between 2040 and 2050 this negligible risk can be maintained with the planned increases to both storage and pipeline capacity.
- **Terrorism attacks** – The risks associated with acts of terrorism are complex to assess given the very low likelihood of occurrence. Mitigation is not solely the responsibility of the airport operator, which is dependent upon the support received from the police. The Master Plan does, however, provide the opportunity to further enhance resilience levels and drive down the residual risks even further by enabling:
 - A significant proportion of the perimeter to be redesigned to incorporate global best practice in physical design and technical support to operational measures thereby improving resistance to penetrative attacks.
 - The inclusion of Secured by Design (SbD) and Crime Prevention Through Environmental Design (CPTED) principles across the built environment.
 - The inclusion of specific measures to counter agreed Design Basis Threats in the protection of members of the public along with local and national infrastructure (some of which will form part of the Critical National Infrastructure (CNI)).
 - The enhanced surface routes could enable faster response times to incident in remote locations around the airport.

That said the inherent risks are considered no greater than might occur at any equivalent international airport.

- Extreme weather events – Gatwick has recently experienced significant disruption as a result of extreme weather events. Lessons learned have already been implemented and continue to be refined. The Master Plan takes into account the effects of extreme weather, including the recent disruption, in its model. The Master Plan incorporates enhancements to the airport's infrastructure to mitigate the impacts of extreme weather events. Similarly, the management systems to cope with a more complex physical and technical environment would need to be developed to address the operational ones. The current risk is assessed as being minimal for single events and medium for multiple ones. Changes to the way Gatwick manages such events with the appropriate operational procedures would enable risks to be further reduced to negligible and minimal respectively. There have always been extreme weather events, however, although they are increasing in likelihood as a consequence of climate change they are still not common in the context of 365 day a year operations and in some instances will affect all airports equally.
- Adaptability to climate change – The master plan and subsequent detailed design can mitigate the physical vulnerabilities associated with climate change whilst the management system changes should mitigate the organisational ones. Overall, the risks associated with climate change to airport operations are considered minimal.

Capability of Current Structures

As can be seen from many of the specialist assessments carried out on the current systems, Gatwick is already in the process of developing its infrastructure to create a more resilient architecture to better meet its current needs. This approach provides confidence that the transition to a resilient environment will continue to be carried forward into the development of the Master Plan.

Gatwick, as a 'learning organisation', is already taking steps to further improve its overall operational resilience; therefore, the recent disruptions caused by multiple events during a period of extreme weather have already been addressed.

When looking across the airport, there are multiple examples of good practice that can be used to benchmark the redevelopment of any procedures and plans. In addition, reference to external benchmarks such as the petro-chemical industry can be used to provide examples of structural good practice and effective risk management regimes in complex environments where the maintenance of operations is an essential business output.

Overall Assessment and Wider Benefits

Gatwick can be a world leading airport in resilience terms, the Master Plan shows how the design can be developed to deliver the passenger numbers, freight tonnage and aircraft movements needed to cope with projected demand. In addition, the detailed designs can incorporate class leading resilient features whilst management structures supported by new technologies and purpose built facilities can evolve to keep pace with the increasingly complex technical physical and risk environments.

By 2050, it can be assumed that better collaboration between the public and private sectors could mean that Gatwick may be more involved in times of crisis. This would include Gatwick working closely with local government, emergency planning departments, the blue light services and regional government supported by the use of technology. A major facility such as Gatwick has the potential to provide a significant social function in addition to its more conventional, economic, role. A resilient Gatwick could provide a regional command, control and co-ordination facility for the whole south east of England (outside of London itself). This could in turn improve the communication and coordination of incidents that occur on-site at Gatwick airport.

1 Introduction

1.1 Background

Arup has been commissioned to support Gatwick respond to the Airports Commission's appraisal module 15:

- To enhance individual airport and airports systems resilience.

We have conducted a high level risk assessment of Gatwick's current Operational Risk profile and its projected profile as set out in the Gatwick Master Plan under the proposed development scheme:

- Wide Spaced Runway Mixed Mode Option.

Arup has reviewed the available risk registers and major operational, response and contingency plans; in addition, we have examined the high level command, control and communication functionality.

The outcome of this exercise has been to provide Gatwick with a high level assessment and report which addresses the statement and intent contained within the Airports Commission Appraisal Framework - Operational Risk as defined within Section 15.1:

- "...for airport infrastructure to prove resilient, both in isolation and as part of a wider airport and airspace system" and
- "...the ability of proposals to adapt both to lower level of disruption arising in the course of day-to-day operations and to major disruptive events."

The output from the process identifies the key risks, possible mitigation and opportunities which could be incorporated into the second runway proposals to evidence Gatwick's overall systemic resilience to day-to-day and major disruptive events.

1.2 Information Gathering

In addition to the direct investigation by Arup of Business Continuity, Security and Power Provision at Gatwick, the team has also liaised directly with the following:

- Flooding, water provision, waste water and sewage - CH2M Hill
- Aviation fuel provision - Astor Consulting
- Master planning – Arup
- Surface access – Arup
- Energy – Arup

1.3 References

The following references apply:

- Master Plan – Operational Efficiency, April 2014, by Arup
- The Surface Access Assessment by Arup

- Water and Flood Assessment Report by CH2M Hill
- Gatwick Airport, Fuel Farm Facilities, Runway (September 2013) - by Astor Consulting
- National Risk Register
- The Meteorological Office publicly available data.

2 Change in Context

2.1 Proposed Changes at Gatwick

The core elements of the proposed changes for Gatwick under the Master Plan are as follows:

- A new 3,400 m runway south of the existing one.
- A new (third) terminal.
- An increase in staff from 21,025 to around 40,000.
- A significant increase in passenger capacity from 45 mppa.
- Increased cargo throughput from 100k tonnes to over 1,000k tonnes.

Each of these headline changes will clearly require a broad spectrum of supporting changes (detailed in other reports) to be made in order to maintain a smooth transition from 2014 to 2050. Those changes include (but are not limited to):

- Re-routing roads including the A23.
- Increased road, rail, coach and parking capacity.
- Re-routing the River Mole and making improvements to the both the drainage and water management in the local area as well as within the curtilage of the airport.
- New energy centre.
- New fire station.
- New Air Traffic Control (ATC) tower.
- Temporary measures to accommodate runway and terminal construction phases.
- Increased stand space, catering, fuel, and other aircraft operating essentials.

Although the transformation will take place over many years there will be significant milestones along that journey that could require a number of step changes in the ways that the airport operates.

2.2 Changes in the Broader Environment

2.2.1 Emergency Services

Between 2014 and 2050 there are likely to be significant changes within the broader social and structural environment that the airport operates within; for example, we have already seen the regionalisation of the Ambulance Service and we can expect to see the same happen with both the Police and Fire Services. Across Britain individual 'county' police forces are pooling resources to create regionally based specialist teams; for example:

- Surrey and Sussex already share firearms specialists, major crime and forensic services.

- Lincolnshire, Nottinghamshire, Northamptonshire and Leicestershire will be sharing firearms, dog, search and roads policing services.
- Thames Valley Police are sharing IT, firearms, dogs and roads policing with Hampshire.

The next logical extension may be the merging of 'county' constabularies (proposed as recently as 2006) into regional ones such as the Thames Valley, West Mercia and Devon & Cornwall constabularies in order to achieve even greater economies of scale and manpower efficiencies. Therefore, it is credible to assume that even now a major incident at Gatwick will see a response from Surrey in lieu of Sussex and that well before 2050 it is quite plausible that Surrey, Sussex and possibly Kent could be a single constabulary.

In a similar fashion it is credible to assume that the county based Fire Services will also regionalise over time.

With increased regionalisation of the Emergency Services, it is also credible to assume that other functions such as County Emergency Planning will also involve considerably more regional co-operation and co-ordination in the years ahead.

2.2.2 Social Change

Over the next 35 years there will also be social changes that will affect Gatwick, the way it does business and the manner in which it responds to contingencies. It is not within the remit of this study to foresee the full range of social changes that may be experienced; however, it can be expected that:

- Within the perimeter:
 - Passengers may probably have increasing expectation of as smooth a transit and as pleasant an experience as possible increasing the pressure on staff and systems to minimise delays, reduce stress levels and be right first time, every time.
 - Pressures on airline margins will continue to grow, increasing the need for increased efficiency, quicker turnarounds and faster recovery from unplanned events.
 - Every element of the aviation industry will be under pressure to do more with less thereby increasing the need to manage risk and understand risk appetites.
 - Security requirements will continue to get more stringent thereby increasing the pressures on security staff, the reliance on technology and the frustration of the travelling public (if not properly managed).
 - There will be increasing technical and interdependency related complexities in the equipment and systems needed to operate the airport efficiently.
- Beyond the airport perimeter:
 - Population density in the south east of England will continue to increase placing more people under immediate influence of the Airport and its operations.

- There is a view that as the population increases there will be an increasing need to provide government at a regional level to achieve both economies of scale and local accountability.
- In an increasingly litigious environment more people may be more likely to resort to the courts if they don't get their own way in many contexts slowing down approvals processes and increasing costs.
- Air travel will continue to be a 'target of choice' for extremist groups and fixated individuals of whatever motivation resulting in the continued need for stringent aviation security measures and the potential to add delay and increase stress.
- Continued pressure on Government budgets could impact on future pipeline transport schemes that are awaiting funding approvals; which are beyond Gatwick's control or influence. Whilst this is a potential risk, the likelihood of it resulting in a shortfall in transport capacity relevant to Gatwick is small due to the high proportion of committed (i.e. already funded) or, priority schemes that are justified on the basis on non-airport benefits. Local road network improvements affecting journey times would be fully funded by Gatwick and therefore are not subject to the same potential funding risks that could affect passengers and first responders at other transport hubs.

2.3 Potential Consequences of Changes

At the fundamental level, the consequences of the potential organisational changes that may occur within the agencies providing immediate support to Gatwick may include:

- Gold Command no longer being at Lewes – a new location will need to be nominated for the strategic decision makers to meet.
- Additional first responders and some specialist resources may no longer be from West Sussex or even the immediately adjacent parts of Surrey – a consistency of response to incidents at the Airport will need to be maintained.
- Increased dependence on local knowledge provided by Gatwick based personnel – Gatwick staff and contractors may need to be more self-reliant and provide more of the immediate responses to certain incidents.
- Increased expectation that immediate actions will be timely, accurate and effective – staff and contractors will need to be even better prepared to meet new and increased expectations.
- Increased complexity brings with it increased dependence and increased vulnerability to multiple disruptive events – the recovery systems, procedures and personnel will need to be prepared so that such events do not lead to catastrophic failures.

By 2050, it can be assumed that better collaboration between the public and private sectors could mean Gatwick may be more involved in times of crisis, even if they are not directly affected. This would include Gatwick working closely with local government, emergency planning departments, the blue light services and regional government supported by the use of technology. A major facility such as Gatwick has the potential to provide a significant social function in addition to its more conventional, economic, role. A resilient Gatwick could provide a regional

command, control and co-ordination facility for the whole south east of England (outside of London itself).

2.3.1 Organisational Consequences

Like many institutions that have developed organically, Gatwick's organisational structure and operational responses have evolved over time. However, the addition of a second runway and third terminal will represent a significant step change in functional complexity. Therefore, organisational change will need to lead the way so that the systems are tested and refined in the current, known, environment and are in place as soon as the new building works are complete.

3 Assessment of Disruptive Events

This section examines each of the nominated disruption events in detail and assesses the extent to which the airport is currently vulnerable to them and how the Master Plan seeks to address those vulnerabilities.

3.1 Flooding

Information supplied CH2M Hill.

3.1.1 Current Situation

Extensive flood modelling has taken place in conjunction with the Environmental Agency and Crawley District Council under the general heading of the Upper Mole Flood Alleviation Scheme (UMFAS). Gatwick has contributed to the Tilgate Lake scheme (completed) and the Worth Farm Scheme (partially completed). The Clay Lake scheme is still in the planning stage.

In addition, Gatwick has commenced work on the Gatwick Stream Flood Attenuation Scheme and the progress so far is considered to have alleviated some of the flooding on 24 December 2013.

Following the events of December 2013, there are 2 sources of flooding risk to be considered, rivers (fluvial) and rainfall (pluvial). Current schemes associated with the threat from river based flooding provide protection against a 100 year + 20% event; however, extreme rainfall will still present short term problems.

Gatwick's investigation into the flood of December 2013 was undertaken by David McMillan and included a number of key recommendations that have all been accepted by Gatwick. However, current mitigation strategies for rainfall derived flooding do not involve new surface water drainage schemes and are based upon assessing the maximum water levels and ensuring that critical infrastructure is positioned above that datum.

The McMillan Report recommended bringing forward a scheme for a flood alleviation reservoir at Ifield. This scheme has failed to meet the Environment Agency cost benefit analysis threshold and had been placed on hold but Gatwick is now considering funding the scheme. It has been assessed (by CH2M Hill) that the scheme's main beneficiaries will be the population of Ifield although it will also be of some minor benefit to Gatwick.

3.1.2 Master Plan Enhancements

A number of flood prevention schemes are planned or have already been executed. CH2MHill have completed several studies for the Master Plan to establish the additional holding pond requirements and, since the flood in December 2013, are revising their modelling to adjust some of the model parameters in the light of the observed behaviour.

The designs supporting the Master Plan have been developed to accommodate current 100 year event levels plus a 20% factor for climate change. The mitigation for flood alleviation includes the introduction of a deep river valley for Crawlers Brook and the River Mole which would be moved from the current culvert which

runs underneath the existing runway into this new valley. New attenuation ponds to replace any lost flood plain from the development with improved flow control measures will not only see Gatwick protected but may also provide increased mitigation against flooding for those communities downstream of the airport. Although the surface water drainage is being designed to accommodate major storms, pluvial flooding will always be a potential problem.

3.1.3 Related Risk Areas

3.1.3.1 Water Supply

Current Situation: Mains water is supplied by Sutton and East Surrey Water which has enough planned capacity to supply Business as Usual (BAU) demands until 2040 (their development horizon is 25 years). The supply is currently only vulnerable because of there being a single supply route.

Planned Enhancements: The vulnerability of the single supply route is being addressed by Sutton and East Surrey Water which has plans to increase resilience by providing a second route by 2040. In addition, as part of Gatwick's "Decade of Change" initiative, the airport has already reduced its demand for potable water by approximately 25% (equivalent to around 650m³ per day) between 2010/11 and 2012/13. This saving has been achieved by a combination of active leak management and increased use of water efficient appliances. Furthermore, there are proposals to further reduce BAU demand as part of the redevelopment of Gatwick by making increased use of rainwater and grey water for non-potable functions.

3.1.4 Waste Water & Sewage

Current drainage measures take waste water and sewage to water treatment works at Horley (South Terminal) and Crawley (North Terminal). Current predictions indicate that there will be a problem at Horley until the new terminal is built; however, as that new terminal is intended to use Crawley the problem should only be temporary and not justify any investment at Horley. It has therefore been proposed to mitigate the risks presented at Horley by balancing the flows to Crawley until the new terminal is in use and demand reduces.

Currently all wastewater is treated in the same manner via the public drainage systems; however, the long term plans to recycle as much rainwater and grey water as possible could reduce the overall BAU demand on the Horley and Crawley treatment works. That said there will still need to be increased investment at the Crawley plant and the additional space needed has been allocated by Gatwick in the Master Plan.

3.1.5 Summary

In summary, therefore, the vulnerabilities associated with flooding, water supply and drainage have been adequately mitigated by the designs proposed by CH2M Hill.

3.2 Power Outages

3.2.1 Current Situation

3.2.1.1 High Voltage (HV) Electrical Supply

The airport is served by two sets of triplicate 33kV supplies known as AF (from Smallfield) and BF (from Three Bridges). In normal operation these supply the North and South Terminals respectively. In the event of a failure of either feed there is capacity to power the entire airport from the remaining one; however, it is expected that there will be an outage period whilst loads are switched over. These supplies are transformed down to 11kV and distributed to over 70 substations around the airport where the voltage is further transformed down to 415V.

The 11kV network is owned and operated by UK Power Networks Services (independent of Gatwick) who have a 90-year lease. Both the main 11kV bus bars are normally split into 3 sections but can be connected if necessary on the failure of the incoming 33kV feeders. There is very limited interconnectivity between the AF and BF supplies and no 11kV ring main.

3.2.1.2 Low Voltage (LV) Electrical Supply

Terminal and airfield loads which are considered essential are dual fed with automatic changeover switching and back up diesel generation. The typical dual feed is via twin transformers each running at 50% capacity with automatic change over. Uninterrupted power supplies (UPS) are understood to be provided to vital functions such as the Baggage Handling Control and the Gatwick Control Centre.

There are shortfalls in the provision of system documentation for the LV network which represents a vulnerability as it impacts on the management of the network with the potential to delay effective restoration of supply.

Standby power generation is provided by 415V diesel generators at a number of sub stations and call-off contracts with external suppliers.

3.2.2 Related Areas

3.2.2.1 Other Critical Power

The aircraft landings, take offs and taxiing are controlled by NATS. The ATC tower is electrically dual fed with UPS and diesel generator back up. It should be noted that although there is an auxiliary control tower it does not possess the same level of functionality as the primary one therefore the resilience of the main tower is maintained as a high priority. The new ATC tower should be provided with a similarly robust level of supply to provide the same high level of resilience.

3.2.2.2 Gas

The boiler houses provide the principal demand for gas and are supplied by Scotia Gas Networks (SGN); there is, however, a limited amount of gas used for commercial catering. The boilers are currently single fuel (gas) but studies are

underway to modify a number to be dual fuel to enable a minimal heating to be maintained in the event the gas supply is interrupted. There are main energy centres in the North and South Terminals each supplied by a single pipe from the network.

3.2.3 Planned Enhancements

Gatwick is planning that the new HV network for the Master Plan will have more resilience built in and would remain under Gatwick ownership and control. The current supply agreement places constraints on the supply capacity available for the Master Plan via the existing AF and BF feeds. The intention is to add another 33kV primary substation to increase the available supply capacity and therefore the resilience of the supply. When new primary substation is operated with AF and BF they will be able to support the entire airport even if one of the 33kV supplies fails. In order to further enhance resilience and reduce the vulnerability of the delayed power switch over, it is proposed that the system architecture could be reconfigured to support a greater level of auto-switchover and enhanced load sharing capability across the mesh HV network. A further enhancement would be made to overall resilience levels with the provision of additional on-site standby power provision as part of the new Energy Centre to eliminate the reliance on third party call-off contracts to supply back-up power.

Gatwick has stated its intention that as new infrastructure is brought on line it can bring all system documentation of both new and existing networks up to the same level. That level should provide sufficient detail to ensure the prompt switching of loads to maintain services and to restore power to critical areas in an emergency.

3.2.4 Summary

In summary, therefore, although designed with redundant capacity to mitigate disruption to the supply, the power network is typical of many that have developed organically to meet growing demand. In the design of the HV, LV and standby generation for the new runway and terminal it will be possible to eliminate many of these residual risks and create an even more robust network. In addition, by reducing dependence on call-off contracts and bringing such capacity 'in-house' it will be possible to further minimise any vulnerability created by dependency upon an external agent.

3.3 Fuel Supply

Information provided by Astor Consulting.

3.3.1 Current Situation Through to 2040

The fuel farm is owned and operated by Gatwick Airport Storage and Hydrant Company (GASHCO) who are responsible for storage and delivery to the aircraft via the underground pipe network. Current usage is reported to be 6 million litres of aviation fuel per day with a fuel supply pipeline capacity of 15-16 million litres per day. This level of supply gives clear headroom within the current flight profile and ample capacity until 2040.

3.3.2 2040 Onwards

By 2040 planned usage will require the provision of an additional 8 million litres of on-site fuel storage. There will still be sufficient fuel supply pipeline capacity to maintain that storage and there is space available and allocated for the new storage tank.

By 2050 the planned usage will have increased to a point where the inbound fuel supply pipeline will need to be upgraded to supply two new 10 million litre on-site storage tanks. These enhancements have been identified in the Master Plan.

3.3.3 Summary

In summary, therefore, there is ample fuel supply capacity to meet the forecast needs of operations under the Master Plan until 2040 and plans in place to maintain the supply levels needed beyond that date. In vulnerability terms, it is only engineering design and maintenance that need to be constantly monitored to maintain operation effectiveness and Gatwick's current practices adequately address these.

3.4 Terrorism Attacks

Terrorism is more than simply hijacking an airliner or placing an improvised explosive device (IED) on an outbound flight. There are increasing concerns amongst security agencies over the possibility of Marauding Terrorist Firearms Attacks (MTFA); such have been seen in Nairobi and Mumbai, being carried out in the west. In addition, terrorist groups can cause disruption by attacking any of the critical systems (such as power and fuel) that the airport is dependent upon.

Over the past 35 years we have seen increasing sophistication employed by terrorist groups and the sort of lateral thinking previously thought the domain of hostile government agencies. For example, the IRA plotted to cripple London by attacking key electricity sub-stations well away from the critical facilities that they supplied. It is reasonable to presume, therefore, that over the next 35 years groups will develop that may consider Gatwick and the economic effects of disrupting air travel/freight to be legitimate targets for their attention.

The ability of Gatwick to recover from a terrorist attack clearly depends upon the nature of the attack. A large Vehicle Borne Improvised Explosive Device (VBIED) of the sort seen at Bishops Gate, St Mary Axe and Manchester city centre could be devastating to any existing airport; however, the new terminal and other critical facilities can be designed to withstand a range of design basis threats (DBT).

For the most part, the key vulnerabilities associated with strategic terrorist threats are common to any airport and include:

- Any publicly accessible area is vulnerable to a MTFA.
- Anywhere accessible to a motor vehicle is vulnerable to a VBIED.
- Baggage systems can be used to introduce an IED.
- External supply nodes for power, fuels and communications systems.
- A long perimeter that is difficult to defend.

- Clearly identifiable critical assets such as the ATC primary tower and fuel farm.

The airport related vulnerabilities are currently managed through the Airport Security Plan (ASP) which is a mandated process involving internal and external stakeholders and the primary agency for anti-terrorist operations – the police (Sussex Police). The ASP includes physical and procedural mitigation measures that are externally audited and meet national and international standards. In addition to the basic requirements, recent investment includes a new £45m state-of-the-art South Terminal security area incorporating the latest screening technology.

The Master Plan does, however, provide the opportunity further enhance resilience levels and drive down the residual risks even further by enabling:

- A significant proportion of the perimeter to be redesigned to incorporate global best practice in physical design and technical support to operational measures thereby improving resistance to penetrative attacks.
- The inclusion of Secured by Design and Crime Prevention Through Environmental Design principles across the built environment.
- The inclusion of specific measures to counter agreed Design Basis Threats in the protection of members of the public along with local and national infrastructure (some of which will form part of the Critical National Infrastructure (CNI)).
- The enhanced surface routes will enable faster response times to incident in remote locations around the airport.

The external vulnerabilities are considered to be part of the Critical National Infrastructure (CNI) and, as such, subject to protective measures in their own right.

In addition to the specific mitigation measures designed into the operation of the airport, having multiple terminals with geographical separation means that a single terrorist act cannot have a catastrophic impact on its operations. Such an act might include an MTFA strike in one terminal or an IED being detonated in the search area or the baggage handling system. Whilst each has the potential to have a locally severe impact; it will, nonetheless, be localised and not have a catastrophic impact on the whole of the airport's operations.

3.4.1 Summary

This is a sensitive area and cannot be discussed in detail here; however, the legislative and regulatory framework within which airports have to operate in respect of security provides a high level of assurance that the risks associated with acts of terrorism are being adequately mitigated now. In addition, the Master Plan does not introduce any additional vulnerability and that the detailed design of the new terminal and any critical assets can be made resilient against a broad range of agreed DBT.

3.5 Extreme Weather Events

3.5.1 Current Situation

The main extreme weather events are precipitation (rain and snow) and wind although extremes of heat and cold may become increasing concerns as we see greater levels of climate change. During the storms of late December 2013, for example, wind speeds were in the range of 27-34 knots for a period of 9 hours with gusts in the 47-57 knot range whilst 66mm of rain fell in an 18 hour period on top of already sodden ground.

3.5.1.1 Snow

Gatwick has a well-developed snow clearance contingency plan. At present there is a system of warnings for snow conditions that range from State 1 to State 7. All the stakeholders use these states to amend and adjust their operations accordingly. It is understood that similar warning systems are being introduced for wind and rain.

To mitigate historical concerns over snow clearance, Gatwick has recently invested £10m in new snow clearing equipment for airside and landside areas. Based upon its performance over the winter of 2012/2013 when no operational hours were lost, it can be determined that the airport is now very well prepared for periods of heavy snowfall. The provision for a proportionate increase in snow clearing resources to accommodate Second Runway Development (R2) has been included in the cost plan.

3.5.1.2 Rain

The surface drainage system has been designed to accommodate 1 in 10 yearly events; therefore, when heavier rainfall is experienced flooding becomes a possibility. Following the recent floods where 66mm of rain fell in 18 hours on already saturated ground, a study has been undertaken to identify vulnerable assets so that mitigation measures can be taken to maintain resilience levels.

3.5.1.3 Wind

All airports have issues with high winds and their nature (expansive and lacking shelter) makes them particularly vulnerable. Wind can have many impacts on the operation of an airport from:

- Preventing flying because it exceeds aircraft operating limits;
- Preventing the opening of aircraft doors;
- Increasing Foreign Object Debris (FOD) hazards by mobilising large pieces of equipment and other insecure items;
- Causing injuries by blowing people over or by blowing things into people;
- Disrupting rail operations and
- Disrupting road travel.

Clearly, some of these events are beyond the control of the best designed and operated airport and will affect all equally. However, Gatwick is introducing a scheme to provide a graduated response to high winds similar to that used to mitigate snowfall. This approach should ensure that there are common approaches taken amongst the stakeholders and a hierarchy of precautions to minimise the potential impact on the safe operation of the airport.

3.5.1.4 Volcanic Ash

Volcanic ash² and is made up of pulverised rock, assorted minerals and volcanic glass³ with a particle size of less than 2mm it can also include particles larger than 2mm when it is more correctly referred to as tephra. Volcanic ash represents a danger to aviation because of its effects on aircraft engines. The ash can cause mechanical problems when ingested into engines because of the temperatures involved in both the ash and the engine components. In addition, the mechanical damage the ash can cause engines to ‘flame-out’ and, in effect, to stall; this effect is most dramatically evidenced in the loss of all 4 engines on a BA Boeing 747 over Indonesia in 1982 after flying through the ash cloud emanating from an eruption of Mt Galunggung. This was not an isolated event and a similar incident also affected a KLM B747 over Alaska involving an ash cloud from Mt Redoubt.

It is the ash clouds from the Icelandic volcanoes Mt Eyjafjallajökull in 2010 and Mt Grimsvotn in 2011 that have had the greatest effect on European air travel in recent years. The 2010 eruption is reported to have led to the cancellation of up to 107,000 flights over an 8-day period. During periods of disruption the airports have to cope with the uncertainties amongst the travelling public, many of whom may be stranded mid-journey, and the operational impacts on airlines caused by scenarios such as aircraft being out of place when the opportunity to resume flights occurs. The management of the airport has to be flexible enough to react to a constantly changing situation. The manner in which Gatwick managed the passenger disruption and the speed with which it was able to return to full operations following the volcanic disruptions shows that there are effective contingency plans that can be scaled up for a two runway operation.

Volcanic Ash is problem for aircraft in flight and is not something that can be mitigated by airport design; similarly, as ash clouds cover large areas it is improbable that an airspace closure affecting one airport would not also affect all others in the vicinity. Therefore, as the area of greatest volcanic activity close to UK airspace is Iceland and with the prevailing winds being westerly, an ash cloud affecting Gatwick would almost certainly also affect all other airports in at least southern England if not those in the rest of the UK.

3.5.2 Master Plan and Other Enhancements

The cost plan allows for an expansion of the snow clearance fleet to meet the needs of the Master Plan.

² Rose, WI; Durant AJ “Fine ash Content of Explosive Eruptions2”, Journal of Volcanology & Geothermal Research (2009).

³ Heike, G; Wohletz, KH “Volcanic Ash”, University of California Press (1985).

The design of the waste water and flood mitigation measures for the Master Plan are intended to accommodate an increased capacity to meet the demands of a 100 year + 20% event.

During the detailed design process for the Master Plan the creation of sheltered environments will be studied to allow for the safe embarkation and disembarkation of passengers and the movement of baggage in high wind situations. Gatwick intends to work with the airlines to create innovative solutions to meet their design parameters.

3.5.3 Summary

In summary, therefore, Gatwick has both reacted positively to previous extreme weather events and pre-emptively in respect of potential ones. Recent expenditure on snow clearing equipment, studies on flood levels and resilience measures combined with the Master Plan's mitigation of flood risks all demonstrate intent to improve overall resilience against extreme weather events.

3.6 Adaptability to Climate Change

Climate change will create multiple effects including:

- Increased extremes of weather
- Increased frequency of extreme weather events
- Increased pressure on water supply
- Increased power demands for heating and cooling
- Increased pressure to use fossil fuels more efficiently.

Gatwick's adaptability to climate change is embodied throughout the redevelopment plans and can be evidenced in many ways. The effects of extreme weather are discussed in Section 3.5 above whilst the plans to re-route the River Mole, increase rainwater harvesting and grey water recycling covered in Section 3.1 demonstrate forward planning to mitigate the effects of climate change.

In risk terms, the threat of climate change cannot be affected; however, when it comes to how vulnerable the airport will be Gatwick are able to take steps to eliminate clear vulnerabilities and reduce the potential impacts. At a basic level, Gatwick will be no more vulnerable to climate change than any other airport, dependent as they are on a transport system that relies on fossil fuels, however, Gatwick is taking positive steps to minimise the airport's vulnerability to climate change in both its short and long term plans.

Once in place, the Master Plan can provide as high levels of mitigation against the effects of climate change as can reasonably be foreseen given the lack of empirical data available.

4 Additional Strategic Benefits

In addition to the specific risk mitigation benefits discussed above, the Master Plan also incorporates a number of additional features which could add to the overall operational resilience of Gatwick.

- The three terminal configuration means that a single event that prevents the use of a terminal will still leave Gatwick with the remaining two through which to maintain operations.
- The Automated People Mover (APM) will facilitate the movement of passengers between all three terminals to support flexible operations.
- The improved surface access can expedite the arrival of First Responders to wherever they need to be at the airport. Should their first route not be available, additional routes have been designed for all roads around the airport.
- The improved railway station and increased rail service capacity can facilitate the mass evacuation of the airport in the event of an extreme crisis.
- The expansion of the airport means that a significant portion of the perimeter can be redesigned to incorporate the latest integrated physical and technical security solutions.
- The diversion of the River Mole could be incorporated into the airport perimeter security solution.

The Master Plan does, as previously stated, provide the opportunity to further enhance resilience levels and drive down the residual risks even further by designing out the opportunity for crime and terrorism and designing in significant mitigation measures:

- A significant proportion of the perimeter to be redesigned to incorporate global best practice in physical design and technical support to operational measures thereby improving resistance to penetrative attacks.
- The inclusion of Secured by Design (SBD) and Crime Prevention Through Environmental Design (CPTED) principles across the built environment.
- The inclusion of specific measures to counter agreed Design Basis Threats in the protection of members of the public along with local and national infrastructure (some of which will form part of the Critical National Infrastructure (CNI)).

In addition operational resilience and blue-light response capabilities will benefit from the enhanced surface routes which could enable faster response times to disruptive or criminal incident in remote locations around the airport.

5 Key Approaches to Mitigation

The mitigation of identified vulnerabilities will be delivered in three distinct ways:

- Master planning
- Design development
- Organisational change.

5.1 Master Planning

The Master Plan addresses the larger strategic level vulnerabilities with mitigation measures that include:

- Flood alleviation centred on the rerouting of the River Mole, which provides additional environmental benefits as well as eliminating the risks associated with the fluvial flooding.
- Improved wastewater management, which can minimise the risks associated with pluvial flooding whilst also providing environmental benefits through making the maximum use of rainwater harvesting and grey water reuse.
- Improvements to the local road network to reduce congestion and introducing multiple contingency options which will also minimise risks associated with response times for any supporting Blue Light Services or call-off contractors that need to respond to the site.

At a regional level, the Master Plan provides London and the south-east with the capacity of an additional runway. From a resilience perspective, an increase in the capacity of the London airport system from 6 to 7 runways by building a second runway at Gatwick, reduces the impact of a single catastrophic event compared with a three runway Heathrow. A single event would impact only 28.6% of the available runways compared with 43% and these impacts would also be spread more widely in terms of airspace and surface access.

5.2 Design Development

As the design of the Master Plan is developed in detail it will be possible to ensure that any existing vulnerabilities are eliminated or at the very least minimised (depending upon the cost benefit analysis and appetites for risk). The detailed design can address detail vulnerabilities such as:

- Localised drainage issues.
- Power distribution and network documentation issues.
- Detailed protection of critical assets against DBT.

At the same time, the detailed design can take the best elements of current mitigation strategies such, as the Gatwick Control Centre (GCC), and incorporate them into the new facilities making them even better.

5.3 Organisational Change

With the changes envisaged for Gatwick there will be a marked increase in the complexity and interdependencies of the systems involved; therefore, the change also represents an opportunity to upgrade the supporting organisations to meet the new challenges that the Master Plan will bring. Gatwick has demonstrated a capacity to adapt and develop to meet changing situations and the step change in complexity from the current single runway operation to a full 2 runway model can result in a comparable set of organisational changes.

The current systems within Gatwick have developed organically to meet changing scenarios and fully meet the needs of its current operations; however, with such a major change on the horizon it is considered that the next round of changes should be developed and introduced as a separate project in its own right. The project delivery could include a formal change management process to ensure that everything is tested and proved before being adopted in 'live' operations. The change process should run in parallel to the construction programme so that the 'old' airport is working to the new methods before needing to transition to the inherently more complex 'new' layout.

When looking at potential benchmarks in other industries, there are synergies between the complex of integrated systems that constitutes an airport with complex engineering environments such as the petro-chemical industry and similar major hazard facilities. In these benchmark industries there is an awareness of complex interdependencies and that being vulnerable to multiple events increases risk to beyond acceptable levels. Therefore, in order to mitigate risks to within tolerable levels the benchmarks have tended to adopt highly structured risk management processes with detailed mitigation measures provided via a well-structured hierarchy of plans, procedures, supporting documentation and contingency plans.

6 Conclusions

6.1 Objective

To improve individual airport and airport system resilience:

“.....for airport infrastructure to prove resilient, both in isolation and as part of a wider airport and airspace system” and “.....the ability of proposals to adapt to both lower level of disruption arising in the course of day-to-day operations and to major disruptive events.”

6.2 Disruptive Events (15.4)

The Master Plan has a number of key advantages in resilience terms compared to the existing facility. The introduction of a second runway, a third terminal and a midfield apron area all introduce additional or new duplication of facilities, which improve the system’s ability to absorb shocks. The growth of the airport will of course increase complexity, but the Master Plan’s overall simplicity with rapid and efficient connectivity between terminals will help when developing appropriate management and operational procedures to mitigate this. The construction of major new terminal facilities with flexible space will also assist. In addition, the component parts of the Gatwick Master Plan create no new vulnerabilities other than a general increased complexity, which can be mitigated by updating the airport’s management systems. When considering the headline risks, identified by the Commission in their Evaluation Criteria, associated with the nominated hazard events, the Gatwick Master Plan is assessed as delivering the following:

- Flooding – negligible risk following the rerouting of the River Mole, enhancements to upstream catchment systems and designing the surface water drainage associated with the new development to accommodate 100 year + 20% events.
- Power outages – minimal risk based upon current mitigation strategies using call off contracts and has the potential to be further reduced to a negligible level if taken ‘in-house’.
- Reduced fuel supplies – negligible risk until 2040 due to general overcapacity in the system. Between 2040 and 2050 this level can be maintained with increases to both storage and pipeline capacity.
- Terrorism attacks – the risks associated with acts of terrorism are complex to assess given the very low likelihood of occurrence. In addition, mitigation is not solely the responsibility of the airport operator, which is dependent upon the support received from the civil police. That said the inherent risks are considered no greater than might occur at any equivalent international airport. The Master Plan does, however, provide the opportunity further enhance resilience levels and drive down the residual risks even further.
- Extreme weather events – the risks associated with extreme weather events are as much about how these are managed as their physical impact on the airport and its infrastructure. There have always been extreme weather events, however, although they are increasing in likelihood as a consequence of

climate change they are still not common in the context of 365 day a year operations.

- The Master Plan is more resilient to the physical aspects of extreme weather events, such as flooding, high winds, and snow. As the airport develops, its management and operational systems can be upgraded to reflect the technical environment of a two runway airport. The current risk is at worst ‘minimal’ for single events and ‘medium’ for multiple ones. With the appropriate operational procedures in place we consider that the extreme weather risks can be reduced further to ‘negligible’ and ‘minimal’ respectively.
- Adaptability to climate change – the risks associated with climate change to the operation of Gatwick are covered in the individual sections such as flooding and extreme weather. Similarly the mitigation measures for addressing the risks are also covered in the individual sections. The Master Plan and subsequent detailed design can mitigate the physical vulnerabilities and the management system changes can mitigate the organisational ones. Overall, the risks to airport operations from climate change are considered minimal.

6.3 Capability of Current System to Meet the Needs of the Master Plan (15.5)

The specialist assessments carried out on the current systems show that Gatwick is already in the process of developing its infrastructure to create a more resilient architecture to better meet the current needs. This approach provides confidence that the transition to a resilient environment can continue to be carried forward into the development of the Master Plan.

Gatwick, as a ‘learning organisation’, is already taking steps to further improve its overall operational resilience; therefore, the recent disruptions caused by multiple events during a period of extreme weather have already been addressed.

When looking across the airport, there are multiple examples of good practice, robust design and effective operational control that can be used to benchmark the redevelopment of any other procedures and plans. In addition, reference to external benchmarks such as the petro-chemical industry can be used to provide examples of structural good practice and effective risk management regimes in complex environments where the maintenance of operations is an essential business output.

6.4 Additional Mitigation Strategies (15.7)

In addition to the mitigation strategies set out in the Master Plan, the Surface Access Plan and the water management plans, Gatwick has other opportunities to minimise the airport’s exposure to risk. The additional mitigation strategies involve:

- A change management process to update the management and organisational structures in preparation for runway 2 being brought into operation;
- Bringing critical call-off contract (such as emergency power generation) in-house and reducing dependency on external suppliers.

6.5 Categorisation of Identified Impacts (15.8)

The appraisal framework calls for an assessment of the strategic impacts on local communities arising out of the scheme and its proposed mitigations. Therefore, at the strategic level the impacts of the Master Plan on local communities will be positive and will primarily be:

- Increased local direct and indirect employment.
- Reduced risks associated with fluvial flooding.
- More resilient waste water treatment facilities.
- Improved traffic management.

6.6 Opportunities

By 2050 Gatwick can be a world leading airport in resilience terms, the Master Plan shows how the design can be developed to deliver the passenger numbers, freight tonnage and aircraft movements needed to cope with projected demand. In addition, the detailed designs can incorporate class leading resilient features whilst management structures supported by new technologies and purpose built facilities can evolve to keep pace with the increasingly complex technical physical and risk environments.

As has already been seen with the floods in Somerset, better collaboration between the private sector and local government, emergency planning departments, the blue light services and regional government will mean that businesses such as Gatwick can be expected to perform a social function. This social role could include providing assistance in times of crisis. A major facility such as Gatwick airport has the potential to provide a significant social function in addition to its more conventional, economic, role. A resilient Gatwick could provide a regional command, control and co-ordination facility for the whole south east of England (outside of London itself). This could in turn improve the communication and coordination of incidents that occur on-site at Gatwick airport.

In terms of risk profile, Gatwick will be transitioning to a new type of resilient environment that addresses vulnerabilities and reduces the top level operational risks to within parameters that should be tolerable to the Risk Owner (assumed to be the CEO of Gatwick).

Appendix A

Qualitative Risk Assessment

A1 Introduction

This appendix contains a high level qualitative risk assessment for Gatwick with the Master Plan fully implemented, based on the disruptive events highlighted in the Airports Commission assessment framework. The disruptive events (threats) are assessed against the vulnerabilities identified in our assessment of the future plans. We consider the mitigation currently in place or proposed in the plans to arrive at the Residual Risk faced by Gatwick. The result of the analysis is shown in a risk register which provides a visual demonstration of the extent to which risks could be managed by the proposed mitigation methods.

A2 Methodology

At its basic level, risk is a function of threat and impact; however, when we look at mitigation measures these seldom have a direct effect on threat and, in reality, usually affect the vulnerability of an asset. Therefore, when considering risk we propose to use the following factors:

- Threat.
- Vulnerability.
- Impact.

In the model used in this report, the threat is modified by the asset's vulnerability; therefore, although threat by itself is a constant value, the overall metric is be factored up or down depending upon the extent to which the asset is vulnerable to it. The methodology therefore is:

- (Threat + Vulnerability) + Impact = Risk.

When considering the effects of mitigation measures on residual risk they will either reduce the asset's vulnerability and/or the impact. This approach means that it is far easier to demonstrate the effects of mitigation upon risks.

The impact rating spectrum is necessarily generic when looking forward over a 35 year period; however, the basic premise remains that extreme threat plus critical impact will equate to a red (extreme) risk.

A2.1 Visualisation

The scoring matrices used in this assessment are as follows:

Likelihood		Vulnerability	
Constant	Red	Extremely vulnerable	Red
Frequent	Orange	Highly vulnerable	Orange
Regular	Yellow	Median level of vulnerability	Yellow

Likelihood		Vulnerability	
Unlikely		Slightly vulnerable	
Rare		Barely vulnerable	

Table 1 - Likelihood & Vulnerability Ratings

To determine the overall threat rating, the two Likert scales are compared in the following look up matrix. It should be noted that this matrix is not mathematically determined and is based upon a subjective assessment; therefore although there are 25 squares the categories of threat do not appear 5 times each:

Threat					
	Rare	Rare	Low	Low	Moderate
	Rare	Low	Moderate	Moderate	High
	Low	Moderate	Moderate	High	High
	Low	Moderate	High	High	Extreme
	Moderate	High	High	Extreme	Extreme

Table 2 - Threat Matrix

Impact		
Critical		Prolonged interruption to operations
High		Interruption to operations
Medium		Some impact on operations
Minimal		Minimal impact on operations
Negligible		Negligible impact on operations

Table 3 - Impacts

Risk is then assessed by matching the threat level from Table 2 with the potential impact as shown in Table 3 as shown in Table 4 below:

Risk		Threat				
		Rare	Low	Moderate	High	Extreme
Impact	Negligible					
	Minimal					
	Medium					
	High					
	Critical					

Table 4 - Risk Matrix

A3 Threats

The following high level threats are considered:

- Flooding
- Power outages;
- Fuel supply;
- Terrorism;
- Extreme weather events;
- Adaptability to climate change.

A3.1 Flooding

A3.1.1 Threats

There are two basic sources of flooding threat, fluvial (the River Mole/Gatwick Stream) and pluvial (rainfall/snow melt). The flooding from the rivers is directly related to upstream rainfall and subsequent flow management. The threat from pluvial flooding is directly related to rainfall/snow melt and the inability of the surface water drainage system to clear the water as quickly as it accumulates.

The overall likelihood of a major flooding event remains 'rare'.

A3.1.2 Vulnerabilities

The chief vulnerabilities associated with flooding are:

- The upstream flood management on the River Mole/Gatwick Stream.

- The containment of the River Mole under the airfield; although the culvert has the capacity for 1:1000 year event (possibly 1:600 year allowing for climate change) it remains, however, inherently vulnerable to collapse and blockage.
- The amount of impervious surface materials that limit natural drainage and increase surface water runoff.
- The capacity of the surface water drainage system.
- Protection of critical assets against water ingress, e.g. substations.

A3.2 Power Outages

A3.2.1 Threats

The loss of either the HV supply or the LV supply remains the main threat. The dual feeds into the HV system provide a level of inherent resilience; however, the increase in demand will require a third source to be provided by the time the Master Plan is fully operational.

Overall the loss of the HV power supply is unlikely.

The likelihood of losing parts of the LV system is regular; losing the whole system is rare.

A3.2.2 Vulnerabilities

The basic vulnerabilities associated with the power systems are:

- Accessibility of the national HV supply before it crosses the airport boundary.
- The provision of comprehensive records for the LV system limiting internal switching to mitigate outages when failures occur.
- Reliance on call off contracts for standby generation which places a dependence on external suppliers and the road network to ensure delivery.

A3.3 Fuel Supply

A3.3.1 Threats

The threats to the fuel system relate primarily to the delivery of the fuel onto Gatwick and its distribution around the airfield. The external threats relate to deliberate disruption by malicious third parties and technical failures of the network. The external threats are outside the control of Gatwick and are, therefore, risks that will have to be transferred. GASHCO are responsible for the safeguarding of the on-site supply network and its continued maintenance and expansion to meet the needs of Gatwick.

A3.3.2 Vulnerabilities

Prior to 2040, the principal vulnerabilities are:

- The distribution pipe network.

- The physical bulk of the storage tanks.
- The dependence on a third party supplier GASHCO for the delivery of maintenance and enhancements.

A3.4 Terrorism

A3.4.1 Threats

Terrorism is more than simply hijacking an airliner or placing an Improvised Explosive Device (IED) on an outbound flight. There are increasing concerns amongst security agencies over the possibility of Multi Terrorist Firearms Attacks (MTFA) such have been seen in Nairobi and Mumbai. In addition, terrorist groups can cause disruption by attacking any of the critical systems (such as power and fuel) that the airport is dependent upon.

Over the past 35 years we have seen increasing sophistication employed by terrorist groups and the sort of lateral thinking previously thought the domain of state actors. For example, the IRA plotted to cripple London by attacking key electricity sub-stations well away from the critical facilities that they supplied. It is reasonable to presume, therefore, that over the next 35 years groups will probably develop that may consider Gatwick and the economic effects of disrupting air travel/freight to be legitimate targets for their attention.

A3.4.2 Vulnerabilities

The key vulnerabilities associated with strategic terrorist threats are common to all airports and include:

- Publicly accessible areas vulnerable to an IED or MTFA.
- Internal supply nodes for power, fuels and communications systems.
- A long perimeter that is difficult to defend.
- Clearly identifiable critical assets such as the ATC primary tower, navigation aids and fuel farm.

In addition to the above, there are the vulnerabilities associated with the threats to aircraft from hijacking and IED infiltration.

A3.5 Extreme Weather Events

A3.5.1 Threats

Gatwick has a well-developed snow clearance contingency plan. At present there is a system of warnings for snow conditions that range from State 1 to State 7. All the stakeholders use these states to amend and adjust their operations accordingly. It is understood that a similar warning systems are being introduced for wind and rain.

The surface drainage system has been designed to accommodate 1 in 10 yearly events; therefore, when heavier rainfall is experienced flooding becomes a possibility. Following the recent floods where 66mm of rain fell in 18 hours on

already saturated ground, a study has been undertaken to identify vulnerable assets so that mitigation measures can be taken to maintain resilience levels.

All airports have issues with high winds and their nature (expansive and lacking shelter) makes them particularly vulnerable.

However, Gatwick is introducing a scheme to provide a graduated response to high winds similar to that used to mitigate snowfall. This scheme should ensure that there are common approaches taken amongst the stakeholders and a hierarchy of precautions to minimise the potential impact on the safe operation of the airport.

A3.5.2 Vulnerabilities

The key vulnerabilities associated with extreme weather events currently centre around:

- Prompt clearance of snow.
- Safe disposal of rain water.
- Exposure of critical assets to raised water levels.
- Effects of high winds that exceed safe operating limits on equipment.

A3.6 Adaptability to Climate Change

A3.6.1 Threats

As stated in the main body of the report the main direct threats from climate change will probably include:

- Specifically related to the airport:
 - Increased extremes of weather.
 - Increased frequency of extreme weather events.
- Related as much to the broader community as the airport:
 - Increased pressure on water supply.
 - Increased power demands for heating and cooling.
 - Increased pressure to use fossil fuels more efficiently.
 - Increased social pressure to travel less.

A3.6.2 Vulnerabilities

Gatwick's vulnerability to climate change is no different to any other airport the existence of which is dependent on fossil fuels. Gatwick is, however, taking positive steps to minimise those vulnerabilities to climate change that are within its control in both its short and long terms plans.

The individual vulnerabilities are addressed in the specialist areas (such as flood control and extreme weather events) directly affected by them. Therefore, it is inappropriate to repeat them in isolation as the mitigation measures are also directly addressed in the relevant sections. Suffice it to say that once in place, the

Master Plan can provide as high levels of mitigation against the effects of climate change as can reasonably be foreseen given the lack of empirical data available.

A4 Assessment Risk Register

In the risk register below under the mitigation column, the measures identified as ‘CM’ (Current Mitigation) relate to those that are currently in place. The measures identified as ‘FP’ (Future Plans) relate to those which would be put in place as part of the Master Plan or developed alongside it.

Threat	Likelihood	Vulnerability	Mitigation	Residual Assessment - the Master Plan				Comments
				Vulnerability Rating	Threat Rating	Impact	Risk Rating	
Flooding or collapse of river culvert		Upstream management of the River Mole & Gatwick Stream.	CM⁴ : Improved balancing ponds and other short term measures. FP⁵ : Diversion of River Mole into a new valley with enhanced environmental and drainage benefits plus planned upstream management schemes.		Rare			Subject to external (EA) control and priorities.
		Containment of River Mole under the airfield.	FP : Diversion of River Mole into a new valley with enhanced environmental and drainage benefits		Rare			Impact also reduced to ‘negligible’ by moving the river.

⁴ CM = Current mitigation.

⁵ FP = Future plans.

Threat	Likelihood	Vulnerability	Mitigation	Residual Assessment - the Master Plan				Comments
				Vulnerability Rating	Threat Rating	Impact	Risk Rating	
		Impervious surfaces limiting natural drainage and increase surface water runoff.	CM: Current use of capture ponds FP: Improved surface drainage plans in the Master Plan.		Rare			
		Capacity of surface water drainage system.	FP: Master Plan sees surface water drainage enhanced.		Rare			
		Protection of critical assets from water ingress.	CM: Plans to move critical assets to levels above current high water marks. FP: Gatwick should ensure any new infrastructure built on site meets the same standards.		Rare			
HV Power Outages		Identifiability and accessibility of the HV supply before it crosses the airport boundary.	FP: Provision of a 3 rd incomer to reduce the vulnerability of the other 2.		Rare			Protection of the national power supply network is a CNI issue and the external risks are, therefore, transferred.

Threat	Likelihood	Vulnerability	Mitigation	Residual Assessment - the Master Plan				Comments
				Vulnerability Rating	Threat Rating	Impact	Risk Rating	
		8 hour transition time when cross patching HV feeds.	FP: Addition of a 3 rd incomer with the capability to patch into either of the other nets can eliminate 8 hour delay.		Rare			
		Reliance on call off contracts for standby generation.	FP: Increased resilience in the design plus in-house control.		Rare			Also a significant reduction in potential impact to at least 'Minimal'.
LV Power failures		Internal network failure – single points of failure within the network.	FP: Updated and uprated network with increased inherent resilience plus greater control of standby generation capability.		Rare			
		Provision of LV system drawings for all areas of the airport.	FP: Updated and uprated network with fully maintained system documentation.		Rare			
		Reliance on call off contracts for standby generation.	FP: Increased resilience in the design plus in-house control.		Rare			

Threat	Likelihood	Vulnerability	Mitigation	Residual Assessment - the Master Plan				Comments
				Vulnerability Rating	Threat Rating	Impact	Risk Rating	
Fuel Supply		Not vulnerable until 2040 when current capacity is reached.	FP: Long term requirements identified and space allocated on the master plan.		Rare			
		Fuel pipe network and storage tanks.	See Terrorism	NA	NA	NA	NA	As targets for terrorists risks from this threat are covered in the Terrorism entries.
		The dependence GASHCO for the delivery of maintenance and enhancements	CM & FP: Management of GASHCO relationship.		Rare			
Terrorism		Aviation security based vulnerabilities.	CM & FP: ASP audited security measures to protect deliver mandatory standards of security. On site police presence. Continued use of latest security technology.		Rare			

Threat	Likelihood	Vulnerability	Mitigation	Residual Assessment - the Master Plan				Comments
				Vulnerability Rating	Threat Rating	Impact	Risk Rating	
		Accessibility to MTF A and IED attacks targeting the airport itself.	CM & FP: Multiple terminals and multiplexed systems		Rare			An element of Risk transfer to Sussex Police included.
		Clearly identifiable critical assets such as ATC, fuel farm, internal supply nodes and lengthy perimeter.	CM: ASP audited security measures to protect the critical assets. On site police presence.		Rare			Assets identifiable but not easily accessible.
Extreme weather events		Build-up of snow	CM: Improved snow plan with 7 levels and unified measures. £10m investment in snow clearance fleet. FP: Funding allocated in the cost plan to expand fleet to meet needs of R2.		Low			
		Current drainage patterns.	CM & FP: Revised drainage including diversion of the River Mole and other management plans		Rare			

Threat	Likelihood	Vulnerability	Mitigation	Residual Assessment - the Master Plan				Comments
				Vulnerability Rating	Threat Rating	Impact	Risk Rating	
		Exposure of plant and equipment to flooding	CM: Relocation of critical plant to above peak flood levels. FP: Design of future networks to facilitate advanced switching and support controllability.		Rare			
		Exposure to prolonged high winds.	FP: Proposals to visit methods of providing shelter in the detailed design of the new terminal and its stands.		Moderate			All airports are equally affected by high winds due to aircraft operating limits and safety constraints. .
Volcanic Ash		Ash is a problem to aircraft in flight at the altitudes where the ash is held in suspension. Does not affect ability of the operability of the airport.	CM: Plans to manage disruption to passengers and airlines caused by airspace restrictions. FP: Increased capacity in the plans to accommodate larger numbers and more movements.		Rare			The ash would have no effect on the airport's ability to operate but airspace restrictions may be imposed by others and passengers who cannot fly will have to be managed.

Threat	Likelihood	Vulnerability	Mitigation	Residual Assessment - the Master Plan				Comments
				Vulnerability Rating	Threat Rating	Impact	Risk Rating	
Adaptability to climate change	NA	NA	NA	NA	NA	NA	NA	See individual risk entries above.

Table 5 - Risk Visualisation

A5 Additional Mitigation Strategies (15.7)

In addition to the mitigation strategies set out in the Master Plan, the Surface Access Plan and the water management plans, Gatwick has other opportunities to minimise the airport's exposure to risk. The additional mitigation strategies involve:

- A change management process to update the management and organisational structures in preparation for a 2 runway, 3 terminal operation.
- Bringing critical call-off contract (such as emergency power generation) in-house and reducing dependency on external suppliers.

Appendix B

Wider Effects

B1 Airports Commission Requirement

In accordance with the Assessment Framework, this section examines, in brief, the effects that the mitigation measures can be expected to have at the local, regional and national level.

B2 Local Effects

B2.1 Flooding

The improved drainage and flood mitigation measures at Gatwick will probably have a beneficial impact on the communities downstream of the airport on the River Mole. By managing the flow of water into the river and its flow immediately before the airport there can be increased control of the flows downstream which should reduce the likelihood of the River Mole flooding as it passes through communities.

B2.2 Fuel Supply

The fuel supply is ample and should result in no discernible difference to the local communities before 2040. Between 2040 and 2050 the pipeline and storage improvements will see limited local increases in traffic during construction phases. With the extant safety regulations there is no reason to conclude that there would be any increased risk to the local communities in the event of there being an incident involving aviation fuel.

B2.3 Terrorism

Nothing associated with the expansion of Gatwick to the full Master Plan configuration is likely to affect the risk to the local community from acts of terrorism. As a recognised international airport Gatwick is a potential target for terrorist groups and fixated individuals. Should any of these groups choose to attack Gatwick there is chance of collateral damage within the local community, that chance will remain largely unchanged as the airport grows.

B2.4 Extreme Weather

The effects of extreme weather on the local communities around Gatwick are likely to be minimised following the development of the Master Plan. We have already seen how the water management can reduce the risk of flooding but the ability to maintain operations in all but the most extreme of conditions should reduce the number of occasions where backlogs at the airport could impact on the local roads and transport systems.

B3 Regional Effects

B3.1 Flooding

The River Mole ultimately enters the River Thames, as the River Ember, opposite Hampton Court Palace which is upstream of the flood control measures at Teddington which protect central London. Any improvement in the management of the Mole will probably also serve to protect all of the communities beyond the immediate vicinity of Gatwick Airport until it becomes part of the schemes to manage the River Thames.

B3.2 Fuel Supply

There is no discernible regional impact in respect of fuel supply. Clearly any disruption affecting the flow of fuel via the pipeline would see a significant increase in road tanker journeys but that would still be a small proportion of the total road journey movements.

B3.3 Terrorism

An act of terrorism that severely compromised Gatwick's ability to operate would have a regional impact as the displaced aircraft and passengers were diverted to the other airports in the London area. In a 2+2 configuration the loss of either airport could place a strain on the regional ability to maintain the number of flights, passenger numbers and quantity of freight; however, in a 3+1 configuration a catastrophic event at Heathrow would probably have a far greater impact.

B3.4 Extreme Weather

In a regional context, a severe weather event affecting Gatwick would probably affect the other airports in the London area to a similar degree.

B3.5 Other

By 2050, it can be assumed that better collaboration between the private sector and local government, emergency planning departments, the blue light services and regional government, achieved in part by technology but driven by political pressure, could mean that businesses such as Gatwick may be expected to perform a social function and to assist in times of crisis even if they are not directly affected. Therefore, a major facility such as Gatwick airport has the potential to provide a significant social function in addition to its more conventional, economic, role. A resilient Gatwick could provide a regional command, control and co-ordination facility for the whole south east of England (outside of London itself).

B4 National Effects

B4.1 Flooding

No effect at the national level.

B4.2 Fuel Supply

No effect at the national level.

B4.3 Terrorism

As stated in the Regional assessment, single catastrophic events that could impact the country would be partially mitigated by having two airports with a 2 runway capacity rather than a 3+1 configuration.

B4.4 Extreme Weather

No quantifiable effect at the national level.