MAYOR OF LONDON

Transport for London

`

<u>Inner Thames Estuary Feasibility Study</u>

Response to Airports Commission Call for Evidence

The Mayor of London's Submission:

Supporting technical documents

23 May 2014

Title: **A Flood Resilient Airport Hub for London**

Author: **Atkins**

Purpose of paper: **To outline how an Inner Thames Estuary airport can be designed to be resistant to sea level rises and flooding, drawing on examples from around the world.**

Key messages:

- There are examples from around the world which set the precedent for airport development in areas of high flood risk and even where airports are built below sea level.
- An Inner Thames Estuary airport will benefit from the wide range of approaches successfully adopted elsewhere, and can take advantage of lessons learnt.
- The uncertainty of sea level rise and climate change give way to a phased approach for the design and construction of defences.

Mayor's Aviation Works Programme - New Hub Airport

Technical Note – A flood resilient airport hub for London

Transport for London

May 2014

Plan Design Enable

Notice

This document and its contents have been prepared and are intended solely for Transport for London's information and use in relation to the Mayors Aviation Works Programme – New Hub Airport study.

Atkins Ltd assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 8 pages including the cover.

Document history

Job number: 5114507			**Document ref:**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
A	2nd Draft	JL	TR	NB / PT	MP	16/05/2014
1	Final submission	JL	TR	NB / PT	MP	21/05/2014

Client signoff

Client	Transport for London
Project	Mayor's Aviation Works Programme - New Hub Airport
Document title	Technical Note: A flood resilient airport hub for London
Job no.	5114507

Table of contents

Summary

- Examples from around the world set the precedent for major aviation development in areas of high flood risk and in some cases airports are even built below sea level.
- A new inner Thames Estuary airport will benefit from a wide range of approaches that have been successfully adopted elsewhere, and can take advantage of lessons learnt.
- An inner Thames Estuary airport can be readily designed to be resistant to sea level rises and flooding from all sources and can be designed to a level consistent with neighbouring significant infrastructure.
- The uncertainty of sea level rise and climate change give way to a phased approach for the design and construction of defences.
- Any new airport infrastructure in the south east of England will require specific flood risk analysis and mitigation, due to the large areas of hardstanding and requirements for development below ground; this applies to any of the options being considered by the Airport Commission.

1. Introduction

Determining the location of major infrastructure always comes with its own set of unique challenges. Sustainable design which enhances and brings benefits to the neighbouring areas is one factor in ensuring that these challenges can be overcome.

Whilst the location of an airport hub on the Isle of Grain, which is classed as part of the inner Thames Estuary comes with its own set of unique challenges, its location does not mean that flood risk cannot be negated. The challenges of flood risk are not just isolated to estuary and coastal areas such as the Isle of Grain. Developments of any size are subject to an assessment of flood risk from all sources of flooding.

2. Existing airport examples

Airport construction all over the world has to overcome many challenges; some even chose to reclaim land to enable construction. Some are built below sea level. Hong Kong International Airport, located on the island of Chek Lap Kok. This is an example of building an airport up from sea level to reduce flood risk. Hong Kong International Airport was built on a large artificial island, formed by levelling Chek Lap Kok and Lam Chau islands (3.02 km² and 0.08 km² respectively), and reclaimed 9.38 km² of the adjacent seabed. Elsewhere the Netherlands, a country renowned for many areas being below sea level also has its airport, Schiphol, four metres below sea level and is the lowest lying airport in the world. Not only is Schiphol below sea level, but it is also built upon low lying tracts of land enclosed by embankments, known as polders. Schiphol is an example of airport development below sea level. A more recent and relevant precedent for an airport constructed below sea level is at Incheon, Seoul, South Korea; here the airport has been developed on the sea bed on land reclaimed from the sea and protected by dykes.

The construction of Incheon Airport is one of the biggest civil engineering projects in South Korean history, not least because it is built upon 47.43 km² of reclaimed land. Built between the islands of Yeongjong and Yongyu, the site has a bund around it of nine metres in height. This bund forms the boundary of the airport. The area inside the boundary was dredged and transformed into a five metre thick layer of silt clay to ensure that it could withstand the major construction required for the airport. As the airport is built upon reclaimed land, the airport also has a ‘dewatering system’, which automatically activates upon the detection of a rise in water levels. The airport site itself is also protected from surface water flooding via 75km long system of storm drainage channels surrounding the airfield and is designed to handle up to 103mm of rain per hour. Incheon airport is comparable in size to the site of the proposed airport hub on the Isle of Grain.

3. Possible design solutions

3.1. Tidal protection

The Isle of Grain site is at risk of coastal flooding, but by building defences up to protect against coastal flooding the risk is mitigated, leaving only residual risks behind. The design of the flood defences must consider an appropriate standard of protection and the impact of the residual risk (the impact of events more severe than the designed standard or protection). Recent severe flooding of LaGuardia airport in New York demonstrated the impact of flooding when events occur that exceed the capacity of the flood defence measures; however the airport re-opened within a couple of days. The uncertainty in sea levels and climate change need to be accounted for and this can be done in a phased manner, by leaving space behind the defences to enable them to be built up at a later date, as demonstrated in Figure 3-1 below.

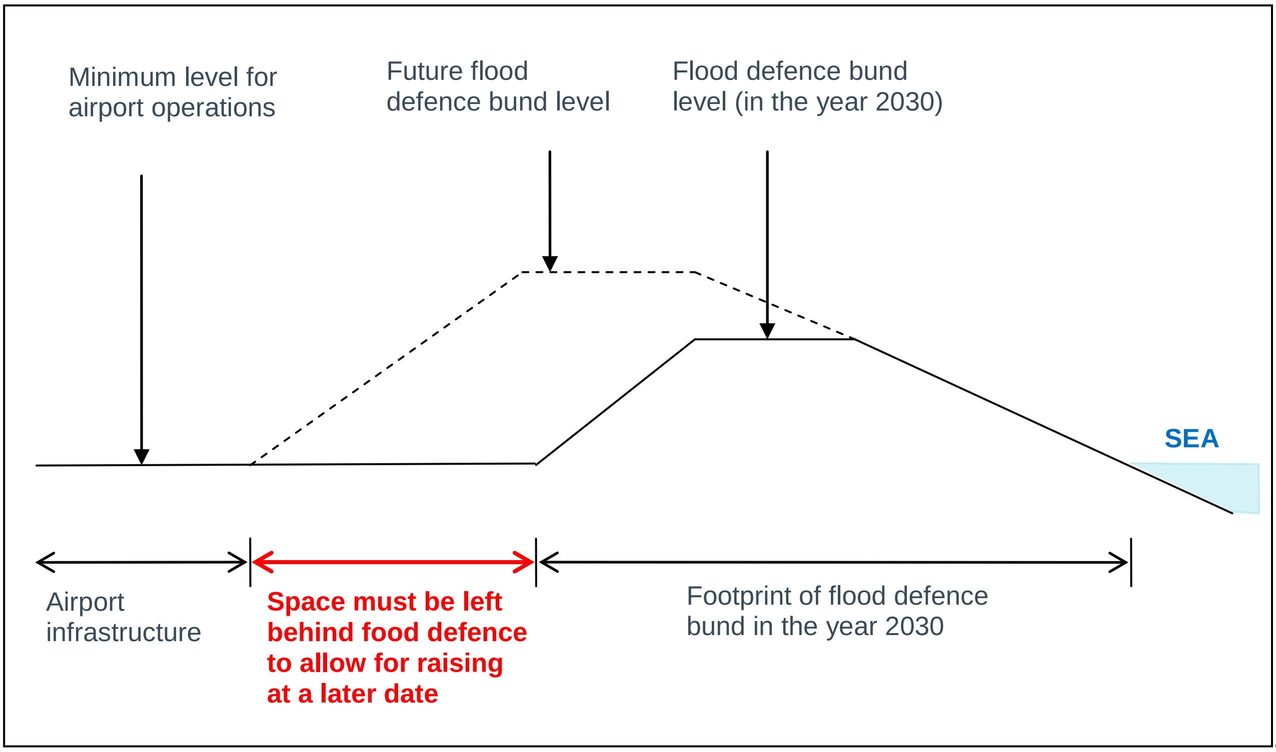

Figure 3–1 Safeguarding for future reinforcement of flood defence bund

The Inner Estuary Airport would be classified as critical national infrastructure and therefore on this basis, providing a 1 in 1000 annual chance Standard of Protection (SoP) should be considered at this stage of the assessment. As the scheme develops there may be justification for changing the proposed SoP once there is a better understanding of the consequence of floods on the operation of the airport.

The 1 in 1,000 annual chance SoP in 2060 (assuming the medium term climate change scenario) indicative level has been calculated as 8.8m AOD (above ordnance datum) and includes a nominal freeboard of 300mm. Sea level rise could then be monitored over time and if sufficient space is left behind the bund the defences could then be raised up to an indicative level of 11.2 m AOD (1 in 1,000 annual chance level in the year 2100 assuming the highest climate change scenario).

As with any development, the site has to remain safe for staff and visitors. There is the requirement for this development to have works below ground, in the form of vehicle running tunnels, baggage handling etc. In order to ensure the utmost safety the development could utilise the same standards as that of dam safety. Utilising Dam Category A for design (the highest category where risk to life is a factor), there are other considerations that need accounting for in the design, such as wind events and wave actions. A design to Dam requirements alongside secondary defences and a phased approach to building defences would ensure that the site remains safe in the event of flooding.

The Isle of Grain site itself is protected by Flood Defences maintained by the Environment Agency as part of the Thames managing defences until 2100. The Inner Estuary airport at the Isle of Grain should seek to align and enhance the proposed flood risk management policies along the Thames.

3.2. Surface water protection

Managing surface water flood risk is another major factor in the design of an airport on the inner Thames Estuary. The proposed drainage system must have sufficient capacity to hold the runoff during periods of high tide due to the potential risks of tide locking. Following recent flooding caused by Hurricane Sandy, LaGuardia airport in New York is improving its flood barriers and drainage and moving electrical and mechanical equipment to higher ground to minimise the risk of future flooding. However, as with the example of Incheon airport, this surface water flood risk can be designed to have minimal impacts. At the Isle of Grain a storage capacity of between 1.11 million m^3 and 2.53million m^3 has been calculated (depending on climate change scenario) as required for year 2060. A phased approach in the design of the surface water system which accounts for the uncertainty in climate change and utilising lessons learnt from airports that have experienced surface water flooding can also be adopted.

4. Conclusion

An Inner Estuary airport can be designed to be resistant to sea level rises and flooding from all sources; however flood risk is never completely designed out with any development, of any size at any location. There will always be residual flood risks remaining and these risks must be considered. Planning policy is based around ensuring that development is located within the areas at the lowest risk of flooding. The final airport design will have to make provisions to ensure that staff and visitors to the airport are safe with respect to flood risk. Providing secondary defences to protect from ingress should primary defences fail. This approach is adopted by many developments which include critical infrastructure. The provision of safe evacuation routes and access routes for emergency services should also be considered as a measure of secondary defences. Another measure is to raise site critical equipment above the appropriate standard of protection; this level of protection is also considered necessary for major critical energy infrastructure sites.

Airports Team
Atkins
Woodcote Grove
Ashley Road
Epsom
KT18 5BW

info@atkinsglobal.com