ARCADIS Design & Consultancy for natural and built assets

ARCADIS GUIDANCE TO THE CIVIL AVIATION AUTHORITY ON HEATHROW EXPANSION PROGRAMME

HIGH-LEVEL ASSESSMENT OF THE ARORA SCHEME PROPOSAL

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ARCADIS Design & Consultancy for natural and built assets

CONTACTS

JONATHAN EDWARDS
Account Lead for the Civil Aviation Authority

M: +44 (0) 7881 354 720
E: Jonathan.Edwards@arcadis.com

Arcadis
34 York Way
London
N1 9AB

JASON BUCKLAND
Head of Aviation Business Consulting

M: + 44 (0) 7818 525 930
E: Jason.Buckland@arcadis.com

Arcadis
Bernard Wetherill House
8 Mint Walk
Croydon CR0 1EA

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Authors	Kevin Nelis Simon Rawlinson Nicky Jones Simon McCarroll Steve Ginns Jonathan Edwards
Checker	Jason Buckland
Approver	Tim Walder
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Glossary

Abbreviation	Description
AGL	Airfield Ground Lighting
APM	Automatic People Mover
ART	Airside Road Tunnel
ASIAD	Aviation Security in Airport Development
ATC	Air Traffic Control
ATMs	Air Traffic Movements
BAU	Business as Usual
BHS	Baggage Handling System
CA	Concept Architect
CAA	Civil Aviation Authority
CAV	Connected and Autonomous Vehicles
CBI	Complex Build Integrators
CIP	Corridor Improvement Programme
CONOPS	Concept of Operations
CS-ADR-DSN	Certification Specifications and Guidance Material for Aerodromes Design
CTA	Central Terminal Area
DCO	Development Consent Order
DfT	Department for Transport
EASA	European Aviation Safety Agency
EIA	Environmental Impact Assessment
HWC	Heathrow Western Campus
ICAO	International Civil Aviation Organisation
IDL	International Departure Lounge
MARS	Multiple Aircraft Ramp System
MPPA	Million Passenger Per Annum
MSCP	Multi Story Car Park
NPS	National Policy Statement
NRM	New Rules of Measurement
NRM1	New Rules of Measurement 1 - Order of Cost Estimating and Cost Planning for Capital Building Works
OB	Optimism Bias
OCE	Order Cost Estimate
OLS	Obstacle Limitation Surfaces
PCA	Preconditioned Air
RAG	Red, Amber, Green
RIBA	Royal Institute of British Architects
RICS	Royal Institute of Chartered Surveyors

Abbreviation	Description
T2	Heathrow Terminal 2
T3	Heathrow Terminal 3
T5	Heathrow Terminal 5
T6	Heathrow Terminal 6
TfL	Transport for London
TTS	Track Transit System
VCC	Vertical Circulation Core

Notes:
Differing terminology has been associated to the proposal by the Arora Group regarding expansion at Heathrow Airport. For the benefit of the reader and for consistency within our report, when referring to the proposals for expansion at Heathrow Airport by the Arora Group we commonly use the terminology the 'Arora Scheme Proposal' and the Arora proposal for the 'Heathrow Western Campus' (HWC).

We are aware of multiple stakeholders / consultants that have and will be appointed by the Arora Group in support of its proposal. During our assessment, we have engaged with consultants including namely Bechtel, Corgan, and Doig+Smith. For ease of reference within our report, we refer to the Arora Group, stakeholders and consultants from all organisations as the 'Arora team' or 'Arora'.

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1 Executive Summary

Arcadis has been appointed by the Civil Aviation Authority (CAA) to provide technical advice in support of their work on capacity expansion at Heathrow Airport.

The Arora Group (Arora) is seeking rights to undertake the expansion of Heathrow Airport.

Arcadis was commissioned by the CAA and the Airline Community to complete "*a high-level, information gathering, and evidence led review of the Arora Scheme Proposal on behalf of the CAA and Airline Community*".

The CAA and Airline Community wished to gain a greater understanding of the Arora Scheme Proposal. The purpose of the Arcadis review was to examine the proposals developed by Arora and to understand and assess whether it can demonstrate an ability to deliver the objectives of airport expansion at Heathrow Airport. These objectives included the Arora Scheme Proposals ability to deliver 740,000 Air Traffic Movements (ATMs) and 130 million passengers per annum (mppa) terminal capacity at the Heathrow Western Campus (HWC).

The Arcadis report covers four aspects of the Arora Scheme Proposal agreed to be assessed in this high-level engagement:

- Scope and design
- Cost and affordability
- Operability
- Timing and delivery

Our assessment is based on workshops held between the Arcadis and Arora teams, and a review of material provided by Arora and relevant queries of this material by Arcadis.

During our engagement, Arora has sought to prepare and present an innovative proposal which combines the existing Terminal 5 (T5) with a new Terminal 6 (T6) developed to the full extent of land available for use to the West of Heathrow Airport. The Arora Scheme Proposal features a Central Processing Unit for check-in and departures that will be shared by T5 and T6. T6 itself is designed to provide target capacity via three full contact piers linked by a 'Departure/Arrivals Bridge Connector'. The Arora Scheme Proposal broadly adopts the layout of the new 3rd Runway as per the Airport Commission to deliver 740,000 ATMs.

Further commentary on the design of the Arora Scheme Proposal is detailed in Section 4 of this report.

1.1 Overall assessment

Compliance with the National Policy Statement (NPS): Our assessment is that whilst Arora is taking the necessary steps to demonstrate that proposals for its HWC are compliant with the NPS, at this stage of development, it is not possible to confirm that its current proposals represent a scheme that will be in full compliance.

Compliance with runway dimension requirements: Our assessment of the Arora Scheme Proposal confirms that Arora intend to rely on the new 3rd Runway being provided by a third-party. Our understanding is that these third-party proposals currently meet the stated performance requirements of the NPS and Arora will rely upon their successful delivery.

Provision of 740,000 ATMs and 130 mppa by 2036: Our assessment confirms that the Arora Scheme Proposal intends for its HWC development to provide capacity for 740,000 ATMs and 130 mppa. However, the current level of maturity of design development by Arora means that we are not currently able to validate whether this capacity can be delivered through its proposals. Our report identifies aspects of design and modelling work that are necessary to demonstrate that the capacity is deliverable. Arora has confirmed its intention to develop the proposals to provide the necessary detail. It should be noted that in the report, we highlight the current Development Consent Order (DCO) programme as a risk to the timely delivery of capacity.

Capability for incremental phasing of the development: Arora has demonstrated its intention to deliver the HWC as a phased development. The programme and construction sequence are currently available but

only at a high-level of detail and the extent of inter-dependencies between the development and other facilities, such as T5, has not yet been detailed. As a result, and based on current information, Arcadis is not able to validate that phased delivery of the scheme can be achieved.

Cost and affordability of the proposals: This report examines the Arora Order Cost Estimate (OCE) which details a total cost of the Arora Scheme Proposal equalling £14.4bn (excluding VAT). We have assessed the sources of the cost information used and the scope of work included within this estimate, whilst also considering the allowances for risk adopted by Arora. Our assessment highlights scope, benchmarks and the allowance for risk that we believe should be included in the Arora OCE at this stage of development. As the design of the Arora Scheme Proposal is not sufficiently mature to demonstrate that the project is deliverable, we are also unable to determine whether Arora can meet its specified budget, despite insistences by the Arora team that its proposal will total no more than £14.4bn. Given the current stage of development of the Arora Scheme Proposal, we cannot state whether Arora can meet the objective of no increase in Heathrow Airport's Airport Charges arising from expansion (in real prices) or achieve its aspiration for a "*real reduction*" in airport charges.

Meeting the interests of consumers: This report examines the Arora Scheme Proposal from the perspective of scope and design, operability, cost and affordability, and timing and delivery. In each section of our report we find that currently not enough development has taken place to enable Arcadis to validate that target outcomes for consumers can be met. Accordingly, whilst Arora rightly seek to develop its proposals to meet the interests of the consumer, at present it is not possible to demonstrate that its plans, once developed to an appropriate level of detail, will be deliverable and achieve the desired consumer outcomes.

Status of the proposals: Whilst Arcadis has welcomed the time committed and the information provided by Arora to enable our high-level assessment, our findings highlight that more information and a greater level of detail and maturity is needed in its proposal. This will enable a better understanding of the Arora Scheme Proposal by the CAA, Airline Community and other stakeholders. Arora appear committed to developing its information and progressing its proposals. In doing so, we would envisage further developments in its structure, process and the recording and exchanging of information with stakeholders going forward. We expect the evidence supporting the Arora Scheme Proposal and the information Arora is capturing and utilising to advance its plans for scope and design, cost and affordability, operability and timing and delivery to develop alongside the maturity of the programme. This may enable many of the issues raised in this report to be addressed directly. It may allow Arora to effectively share its proposals with relevant stakeholders, planned forums and future selected / wider consultations. It may provide confidence in their ability to meet the demands of the programme and to meet statutory requirements.

Arora has shared its short-term programme for the delivery of the consent phase of the development. This confirms that they have commissioned and appointed a team of consultants with appropriate expertise in the fields of aviation design and delivery and DCO submission.

Arcadis has been notified by Arora that new appointments to its team will be tasked with undertaking outstanding activities highlighted in this report, such as the detailed analysis of all terminal requirements, a surface access strategy and the continued development of its cost estimate. However, as this work has not been completed at the time of report it is not subject to review by Arcadis.

1.2 Observed level of maturity

In considering the maturity level of the scheme, Arcadis has used the Royal Institute of British Architects (RIBA) project stages as a benchmark for stages of development.

At the time of this report, and based on the information provided by Arora, Arcadis believe that the level of maturity of the overall Arora Scheme Proposal is at or equivalent to RIBA Stage 0/1: 'Strategic Definition' and 'Preparation and Brief'.

Figure 1: RIBA project stages

We have considered the maturity level of the Arora Scheme Proposal for each of the four aspects of our assessment and provide relevant commentary within our report in relation to the observed level of maturity using the RIBA project stages.

1.3 Scope and design

1.3.1 Scope of assessment

3rd Runway: The proposal to deliver 740,000 ATMs is based on the location and positioning of the new 3rd Runway proposed by Heathrow Airport Limited. The Arora Scheme Proposal includes a 3,500m long runway and separation for independent operation. Arora has indicated that they will adopt development work undertaken by Heathrow Airport Limited to demonstrate how the 3rd Runway will contribute to 740,000 ATMs. Arcadis has not seen assessments that independently demonstrate that this runway proposal can deliver the planned capacity in conjunction with the Arora terminal development.

Airfield: The Arora HWC proposal concentrates development to the West of T5. This approach does not restrict plans for the future redevelopment of the Eastern end of the airfield. Linking T5 and T6 creates the opportunity for an airline alliance to be collocated into a single hub location, with potential benefits for airlines and passengers.

Arora propose a three-taxiway solution to connect to the new 3rd Runway. The Arcadis view is that the provision of a third taxiway will increase the resilience of the airfield. However, further analysis is required to support this assessment.

Arora has not yet completed a whole-of-campus operational assessment for the impact of these changes to Heathrow Airport, and its ability to deliver 740,000 ATMs. As a result, Arcadis cannot validate that the proposed airfield layout will deliver required capacity at this time.

Terminals: The proposed T6 is calculated by Arora to provide capacity of [redacted] mppa in a two-phase development. The proposal is innovative in that all piers are connected to check-in and security by a Departure/Arrivals Bridge Connector.

The methodology used to calculate terminal capacity is a simplified approach. Based on current design development, Arcadis cannot assure that planned capacity can be provided to meet the operational demands of a 130 mppa airport. Further modelling work, which needs to be undertaken by Arora, will help to demonstrate compliance.

Check-in for the combined T5/T6 hub is provided in a Central Processing Unit. This could free-up space in T5. The subsequent opportunities for T5 reconfiguration have not been assessed to date.

Arora anticipate that the reconfigured T5/T6 hub will be occupied by an airline alliance, which could potentially create opportunities for the enhanced operation of Heathrow Airport.

Landside: Landside facilities for T5 and T6 will be provided in new structures, located below a new Central Processing Unit developed for check-in and security. Proposed car park capacity is planned to be equivalent to the T5 multi story car park (MSCP), and drop-off access will be enhanced with access from both the North and South. The location of the MSCP has yet to be determined as initial proposals by Arora are non-compliant with Aviation Security in Airport Development (ASIAD) security requirements.

Arcadis has not seen design calculations to demonstrate that the access capacity required to meet 130 mppa can be provided by 2036. Furthermore, detailed design work is required to demonstrate that proposed parking, drop-off and bus/coach facilities can be accommodated within the site constraints.

Wider surface access: The Arora Scheme Proposal utilises existing London Underground, Heathrow Express and proposed Crossrail connections. For surface access, Arora has developed a scheme involving

extensive changes to transport links. No traffic modelling has been undertaken so far to demonstrate compliance with the NPS.

1.3.2 Other considerations

Maturity of the proposal: Our assessment of design maturity is that the scheme is at the RIBA Stage 0/1. This reflects the need for simulation and capacity studies to be completed as well as design criteria, such as facility area schedules. Arcadis has not requested full details of the work required to demonstrate that the current proposal complies fully with the NPS. However, there is limited evidence that wider considerations associated with sustainability, air quality and noise, for example, have been considered at an equivalent level of maturity at this stage.

This consideration is material with respect to the scale of work and the time required to progress the design to enable and complete a DCO submission.

1.3.3 Risks and opportunities

Airfield and runway simulation: In the absence of more detailed airfield simulation and capacity simulation work, based on a representative model of airport activity, it is not possible to demonstrate that investments in runways, airfield and terminals will deliver the planned capacity of 740,000 ATMs and an operational 130 mppa in combination with other airport terminals. The proposal also relies on the operation of T5 and T6 as a combined entity, and we have not seen details of the modelling of this operation to confirm that it will deliver the required capacity.

Landside security: Vehicular access to the combined T5/T6 hub is located below a proposed Central Processing Unit. This solution will need to demonstrate ASIAD compliance to meet NPS requirements and, so far as we are aware, the access concept has not been tested against ASIAD security criteria.

Airfield configuration: The Eastern campus will be left free and unencumbered for future rationalisation.

Terminal configuration: The combined T5/T6 hub may enable the collocation of an airline alliance which should deliver operational efficiencies. For example, Arora cite reduced walking distances and maximum connection times as benefits of the combined terminals.

Contact stand configuration: Arora highlight that its proposal features three full contact piers rather than remote piers as used elsewhere on the airfield. Arora state that the benefits of this configuration are improved passenger experience, and longer dwell times which may maximise opportunities for non-aviation revenues.

1.4 Operability

1.4.1 Scope of assessment

This assessment considers the airfield, terminal and landside elements of the proposal based on an appraisal of data, standards and assumptions adopted by the Arora team.

We have not considered issues associated with the safe operation of the facilities, operating costs or potential for non-airfield revenues.

All parties recognise that the 3rd Runway and associated terminal infrastructure will be operated on a whole-airfield basis.

Design proposals are at an early stage of development and rely on a significant range of assumptions made in advance of modelling and simulation work. Documents that are necessary to demonstrate the operation of the airport are currently not available, such as:

- Concept of Operations (CONOPS) review
- Terminal and airfield operations simulation
- Traffic modelling to demonstrate the effectiveness of surface access proposals

The CONOPS document, for example, will relate traffic forecasts and capacity assessments to area allowances for facilities.

Arora state these reports will be developed as part of their development process. However, at this stage, it is not possible to validate the operation of the HWC to deliver 130 mppa and 740,000 ATMs, and in particular to confirm whether taxiway provision can support the operation of the expanded HWC. Similarly, there is not enough detailed simulation data available to discuss the resilience of whole airport operations under the Arora proposals.

We are also not able to comment on the ability of the Arora Scheme Proposal to support the long-term flexibility of airport operation and in particular the adoption of a parallel design for the rest of Heathrow airport.

1.4.2 Risks and opportunities

In addition to uncertainties associated with the early stage design and lack of modelling input, we have identified a small number of specific risks that require further work to assure mitigation:

- Interface between parallel Code F taxiway and T6C pushback operations
- Capacity of taxiway access to North Runway

Arora has highlighted future opportunities for changes to the operation of the terminal and landside, supported for example by remote check-in and the adoption of Connected and Autonomous Vehicles (CAV). We observe that innovations like these may be necessary for Arora's scheme to accommodate further, future expansion or reconfiguration. However, we also note that the development and adoption of these enabling innovations are outside of the control of Arora and will apply to all proposals for capacity enhancement.

1.5 Cost and affordability

1.5.1 Scope of assessment

This assessment is based on a review of an Order Cost Estimate (OCE) prepared by Arora.

The total of the estimate is £14.4bn at Q1 2014 prices. This assessment excludes allowances for Optimism Bias (OB), an additional risk allowance that is applied to large, complex programmes in the public sector. The Arora assessment also excludes other items such as rail connections. Section 6.2.3 details further excluded scope items in more detail.

The maturity of the estimate reflects the level of development of the wider design proposals. For example, we have not seen evidence that either the construction sequence and programme or risks associated with the development have been considered in the production of the Arora estimate.

[redacted] of the value of the estimate is based on quantities and rates assessed by Arora. The remaining [redacted] is a combination of allowances, either made by the Arora team or sourced from the Airports Commission Report (2014).

The early stage of design maturity and lack of market-tested data means that Arcadis cannot confirm whether the scheme can be delivered within the stated cost of £14.4bn. The approach taken to estimate known scope is appropriate, but the extent of undefined scope combined with a high-risk profile and an extensive list of exclusions means that at this stage, mean it is not possible to validate the Arora OCE.

Section 6.2.5 provides a commentary of the information provided to support the current Arora estimate, alongside a comparison with benchmarks used by Arcadis. The analysis highlights where rates used by the Arora team are in line with the ranges expected by Arcadis and where there is a divergence.

Based on the estimates provided and the level of design maturity, it is not possible to confirm that 130 mppa can be provided without an increase to airport charges. However, as cost levels for many components are similar to those used in alternative proposals, it is reasonable to infer that the Arora Scheme Proposal is as likely to deliver this outcome as others at this stage.

1.5.2 Risks and opportunities

Maturity of the estimate: The Royal Institution of Chartered Surveyors (RICS) provide criteria in their New Rules of Measurement (NRM). Based on information provided to Arcadis, we have not seen evidence that the design material is sufficiently mature for an Outline Cost Estimate to be prepared. The key information, including a schedule of accommodation and an initial risk register, have not been incorporated within the

estimate. As a result, we expect higher risk allowances to be included in the estimate to account for a high proportion of undefined scope.

Level of risk allowance: The risk allowance applied to the Arora estimate is [redacted] with no allowance for OB. Our analysis suggests that this level of risk provision is more appropriate for a project at the end of RIBA Stage 2 rather than RIBA Stage 0/1. On this basis, we believe that the risk allowance should be larger to reflect higher levels of uncertainty. The Airports Commission's estimate for example, includes 20% for risk and 20% for OB. Arora has informed us that, as a private sector developer, they do not consider it common practice to include OB in its estimates. They are reviewing its decision as a result of the Arcadis review.

1.6 Timing and delivery

1.6.1 Scope of assessment

This assessment considers the approach, consent and critical path of the Arora Scheme Proposal.

High level construction programmes dealing with phase one terminal construction and surface access construction have been developed; these cover a period of eight years. This programme covers construction of terminals T6A and T6B delivering [redacted] mppa. The programmes assume a commencement date of [redacted] for illustrative purposes. According to the programme, the development will deliver [redacted] mppa by [redacted].

The time scale for the delivery of phase 2, increasing capacity to [redacted] mppa is not stated.

Further programme information has been provided detailing planned durations for the submission and consideration of the Development Control Order (DCO). Arora proposes to submit the DCO for the HWC in [redacted]. Arora is not proposing a separate DCO submission for the new 3rd Runway. This is a tight programme. Arora has explained that they are building a team to deliver the DCO and will be adopting a resource-efficient, commercial approach to its production. However, our experience of simple DCO processes on public-sector projects worth under £500m, is that the development process can take 1.5 to 2.5 years.

The strategy for consent approval is also dependent on an integration with the DCO submission programme being led by Heathrow Airport Limited.

Based on our assessment, although it is evident that Arora is making significant investments into the DCO process, Arcadis is unable to provide assurance that Arora will be able to achieve consent within its stated timescale. We deem Arora's ability to deliver the DCO to meet overall delivery dates to be an open risk.

Further work is required to define timescales for the DCO process and to increase certainty of overall delivery timescales.

Other significant issues associated with the delivery of Phase 1 include:

- Interfaces with existing assets associated with T5, for example, forecourt building and surface transport links
- Sequencing of works associated with the replacement of existing assets including energy centres, baggage facilities and the airside road tunnel portal. These works are not included in the programme and as a result their potential impact on the critical path has not been considered
- The phased demolition of the T5 MSCP in line with the construction of the Central Processing Unit
- Substantial surface access works including two new junctions on the M25 which have a critical path relationship with the development of T6 and the maintenance of access to T5

1.6.2 Risks and opportunities

The Arora development programme is complex and at an early stage of development. The programme information presented is consistent with the earliest stages of a large-scale investment. Accordingly, there are many detailed risks that need to be identified and mitigated. The early development of a risk management and mitigation strategy presents the best opportunity to address these issues.

The principal open risk, at this stage, is the short duration available for DCO development. Although Arora has a programme for this process, until more work is undertaken to determine the detailed activities and resources needed to complete the DCO submission and inspection process, the delivery dates for additional capacity cannot be assured.

We are not aware of the development of plans to ensure the continued operation of Heathrow Airport at required capacity during construction. This is an open risk effecting the timing and delivery of T6 and the operation of Heathrow Airport. We anticipate the continued progression of the Arora Scheme Proposal will address these issues.

Similarly, the completion date for T6C and the delivery of potential capacity for 130 mppa has not yet been incorporated into the construction sequence and as a result, the date for delivery of 130 mppa cannot be stated at this stage. This programme is currently under development by Arora.

2 Introduction

Arcadis has been appointed by the CAA to provide technical advice in support of their work on capacity expansion at Heathrow Airport.

The Arora Group (Arora) is seeking rights to undertake the expansion of Heathrow Airport. Arora's stated overall objective is to add value by introducing competition at Heathrow Airport.

Arora has stated that in the absence of Heathrow Airport Limited committing to a joint approach, they will be submitting its own DCO application. As such, Arora is seeking to demonstrate a commitment to its proposal for expansion at Heathrow Airport and ongoing development and progress with its plans. Arora maintain they are fully committed to partnership and engagement with airlines, and all stakeholders, in developing its plans and progressing to DCO application.

Following initial engagement and discussion with stakeholders, Arcadis were requested to conduct a high-level review of the Arora Scheme Proposal on behalf of the CAA and representatives of the Airline Community at Heathrow Airport.

Our assessment is based on workshops held between the Arcadis and Arora teams, a review of material provided by Arora with regards to its proposed expansion of the HWC, and responses provided by the Arora team to questions raised by Arcadis during our engagement.

Throughout our review, Arora has provided access to key stakeholders and Arcadis has appreciated the constructive dialogue with relevant members of the Arora team. Arora has been prepared to share information and evidence to support its proposal and to enable our assessment.

It should be noted that Arora has welcomed our engagement and believe it has presented an opportunity to demonstrate its ideas and commitment to the expansion at Heathrow Airport.

Arora has also been keen to express that they see this high-level assessment by Arcadis as the start of more formal and structured engagement with stakeholders. They welcome the opportunity for ongoing exchanges with stakeholders (namely the Airline Community, the CAA, and Arcadis as their advisors) regarding its proposal for expansion at Heathrow Airport.

3 Objectives of the report

Arcadis were asked to conduct "*a high-level, information gathering, and evidence led review of the Arora Scheme Proposal on behalf of the CAA and Airline Community*".

The CAA and airlines wished to understand more of the detail behind the current Arora Scheme Proposal and to develop a more informed understanding of the key aspects of the Arora proposals for the Heathrow Western Campus and its future plans.

It was agreed that Arcadis would focus this high-level assessment on four aspects of the Arora proposal:

- Scope and design
- Cost and affordability
- Operability
- Timing and delivery

Our report is structured with detail and commentary on each of the above.

Our assessment is based on a review of material provided by Arora as well as responses to questions raised by Arcadis during and following a series of review workshops.

Arcadis has sought to identify any potential opportunities, risks or current/future items of interest regarding the Arora Scheme Proposal that are relevant to the CAA and Airline Community.

Our assessment and the findings in this report do not seek to definitively determine whether the Arora Scheme Proposal can or cannot deliver the outcomes set out in the NPS, meet the requirements for a successful DCO application, or deliver upon the desired objectives of expansion at Heathrow Airport.

However, we do provide in our assessment several observations with respect to the present maturity of the Arora Scheme Proposal against these matters.

4 Scope and design

4.1 Definition of theme

This section of the report reviews the scope and design aspects of the Arora Scheme Proposal for expansion at Heathrow Airport. Our review comprises of a high-level assessment of the available information and the analysis provided to us by Arora at the time of writing this report.

Arcadis has assessed the assumptions contained within the Arora scheme design, considered the compatibility of the Arora scheme design with the existing layout of Heathrow Airport, and sought to review the adherence to statutory requirements and known constraints.

In this high-level assessment for scope and design, we have considered the following elements of the Arora Scheme Proposal:

- 3rd Runway
- Airfield
- Terminals
- Landside
- Wider surface access considerations
- Capacity

Arcadis has sought to provide comment on the observed level of maturity of the Arora Scheme Proposal for scope and design.

4.2 Initial assessment of scope and design proposal

4.2.1 General comment

Arora has adopted the airport planning principles including those provided by:

- ICAO (International Civil Aviation Organisation)
- European Aviation Safety Agency (EASA) Certification Specifications and Guidance Material for Aerodromes Design (CS-ADR-DSN)
- UK Department for Transport (DfT)
- Civil Aviation Authority (CAA)

We agree that the Arora Scheme Proposal provides the minimum required runway length and meets the requirements set out in NPS regarding the 3rd Runway.

Arcadis believe that more detail is required for airfield, terminal and landside capacity to validate the proposal meets the NPS requirements. Arcadis acknowledge that the Arora team has completed initial reviews and design visions for its proposal. Arcadis has not assessed this information in our engagement but are aware that Arora has completed further work since its initial response to the NPS consultation in 2017.

4.2.2 3rd Runway

Arora has explained that they completed some runway option analysis for its initial NPS response. To date, no further analysis has been undertaken by Arora to determine whether there are any opportunities to optimise the 3rd Runway location as Arora propose its existing design for the runway meets NPS requirements.

It is reasonable for Arora to accept the proposed location and positioning of the 3rd Runway as a base assumption. The developments and information for design have incorporated this location and positioning which has been applied consistently across its proposal.

Arora has indicated that they will adopt the development work undertaken by Heathrow Airport Limited for the 3rd Runway, to set out how the runway will contribute to meeting the 740,000 ATMs.

In addition, we have seen no evidence or analysis completed to date that indicates Arora can independently demonstrate that its scheme proposal for the 3rd Runway can deliver the 740,000 ATMs. However, we understand airfield capacity simulation work has been commissioned by Arora.

Until additional work has been completed, the primary risk associated with the 3rd Runway is the timing of delivery and the ability to meet and support the objective of 740,000 ATMs per annum.

4.2.3 Airfield

The Arora Scheme Proposal focusses on the expansion of the Western Campus of Heathrow Airport.

Arora state that the construction of T6 and the expansion of the Western Campus will allow airlines currently operating at Terminal 3 (T3) to vacate. This will allow Heathrow Airport Limited to redevelop the Central Terminal Area (CTA).

It is Arcadis' view that the Arora Scheme Proposal and focus on the Western Campus and T6 would not restrict Heathrow Airport Limited's existing plans for the redevelopment of Terminals 2 and 3.

Arora anticipate that the new Western Campus and T6 will be occupied by an airline alliance rather than a single airline group. Arcadis would consider this decision to have likely implications on airfield operations that have not yet been modelled by Arora.

Arora has not proposed changes to the layout of the existing Northern runway but do propose developing the necessary taxiway infrastructure to access the new 3rd Runway. Arora state that its proposal will not generate adverse impacts on Obstacle Limitation Surfaces (OLS) or operations. Arcadis has not seen detailed analysis outside the OLS report that considers the whole-of-campus operation of the airfield. At this stage, we cannot assess the potential implications of airfield operation and demonstrated compliance with the NPS.

By focussing on the Western Campus, Arora has presented the opportunity and potential benefit for the Eastern Campus of Heathrow Airport to be expanded or reconfigured independently. We also note that Arora has indicated a further benefit that its scheme proposal leaves the Eastern Campus free for future rationalisation of terminal and airfield provision.

The latest Arora designs have evolved to change from a two-taxiway design to a three-taxiway design to connect to the new 3rd Runway. Arora has not provided detailed analysis or evidence that any capacity study has been undertaken to confirm this level of infrastructure is sufficient for the proposed operations as per the design change. However, it is our opinion, that its design change is likely to offer greater resilience than a proposed two-taxiway layout. Further analysis would need to be completed to support this assessment and it should be linked to the operation of the wider airfield. Arora may be able to identify further opportunities with its three-taxiway design following a study on simulation for capacity and demand/gap analysis.

Arcadis has been made aware that Arora has appointed further consultants to its team to undertake airfield simulation, to establish all operational parameters, and to stress test capacity scenarios for both aircraft movements and parking in its proposed HWC. However, Arcadis has not been provided with any airfield simulation or capacity analysis at the time of our report and as such we cannot comment upon the validity of this work or the planned future activity. Until this information is available, Arora is limited in its ability to accurately quantify the impact of its proposals for the operations across Heathrow Airport. This risk is currently unquantified.

Finally, we understand that Arora plan to conduct a full assessment of operational impacts across the entire airfield, in collaboration with Air Traffic Control (ATC) and Heathrow Airport Limited, upon completion of the latest airspace proposals.

4.2.4 Terminals

The Arora Scheme Proposal includes a new T6 at Heathrow Airport. It is proposed, based on a mixture of contact and no-contact stand configuration, that T6 will provide [redacted] mppa.

Arcadis note that Arora intend to complete capacity studies, that may allow remote stands to provide an excess capacity beyond the NPS requirements.

Arcadis believe that the proposed layout of T6 is innovative in that all piers are connected to check-in and security by a Departure/Arrivals Bridge Connector. The proposal also includes having the main retail offering along the Departure/Arrivals Bridge Connector. As all departing and transiting passengers will utilise this area, it will provide an opportunity for the generation of non-aeronautical revenues from retail in T6. The

Arora Scheme Proposal has also indicated that its design will seek to provide additional lounge space which offers benefits to passengers.

Arora currently propose to develop T6 in a site that is entirely bounded by taxiways and which is constrained at the Western perimeter by a road and waterway corridor. Arcadis considers that the implication of this design and these constraints could limit future opportunities to provide additional stand capacity. This may be required should current passenger throughput assumptions be revised as a result of more detailed modelling of future use.

In addition to the physical constraints, Arcadis would note that the Arora proposal will require aircraft pushback onto the dual perimeter taxiways. This perimeter taxiway is vital to the capacity and aircraft movement around the airfield, including to the new 3rd Runway. To date, Arcadis has not seen any analysis setting out the operational implications that this pushback will have on the overall effectiveness of the airfield and capacity.

The Arora Scheme Proposal includes [redacted] remote Code C stands adjacent to T6C and [redacted] Code C stands south of the 3rd Runway. Arora provided a commentary on its T6 capacity modelling in a memorandum to Arcadis. Arcadis note that these stands are not included within the current calculations for [redacted] mppa, which are based on a total of [redacted] contact stands.

The memorandum provided by Arora also outlines individual gate capacity used to calculate the number of gates required in its design. As a stand-alone exercise for a smaller terminal Arcadis would consider this appropriate for a high-level understanding of capacity. However, we do not believe this approach is sufficient for a significant development such as that proposed by Arora for the expansion of Heathrow Airport. We would have expected greater analysis to have been completed, even at this stage in the Arora programme, to enable appropriate design assumptions and development. Moreover, terminal demand-gap capacity planning is yet to be undertaken. As such it is difficult for Arcadis to review whether proposed terminal sizing will deliver an operational 130 mppa in combination with other terminals across Heathrow Airport.

The Arora Scheme Proposal indicates that it will be developing [redacted] wide piers in the new T6. Arcadis is satisfied that the [redacted] width of the piers is appropriate based on current design standards and sizing of piers at Heathrow Airport in operation today.

As part of the Arora Scheme Proposal, T5 check-in facilities will be removed from T5 and incorporated into a Central Processing Unit for the HWC comprising T5 and T6. The Arora Scheme Proposal will enable the expansion of the existing T5 security and retail functions into the space vacated in T5. Arcadis has not been provided any detailed capacity demand/gap analysis to demonstrate that this solution provides sufficient processing capacity during the construction phases of the programme and for future operations at Heathrow Airport.

However, as Arora propose to take check-in out of T5 and include it within the new T6 facility this should enable additional area within T5 for alternative utilisation, such as providing additional retail capacity. Following further simulation for capacity and demand/gap analysis, Arora may be able to identify further opportunities that could be realised in its terminals design.

As noted, the Arora Scheme Proposal also assumes that the current pattern of terminal occupancy across Heathrow Airport will change and an airline alliance, rather than a single airline group, will occupy the reconfigured T5/T6 hub. This concept and the impacts of this assumption are yet to be assessed by Arora.

However, the assumption that the expanded T5/T6 hub could permit the co-location of an airline alliance could be seen as a competitive opportunity for airlines. It should enable shared check-in and associated facilities, along with common baggage handling, that could deliver operational efficiencies in the T5/T6 hub. Arora has stated that it is looking to take lessons and preferences from the design and operation of the current Terminal 2 (T2) at Heathrow Airport. This is on the basis that T2 is a multi-airline and alliance terminal and Arora hope that this insight will support the development of its design.

Arcadis would also note that the Arora proposal is to locate T6 on an existing transport node (Underground, Express, Crossrail). This surface access provision and use of public transport is a simplified design solution. We have also noted that Arora propose to provide airport check-in at the basement level in its design. This could further integrate mass transit plans and provide alignment to objectives in the NPS. Whilst it offers an

opportunity, this simplified concept is one that requires substantial further investigation and design solutions in order to be feasible.

Although not included as part of our initial assessment, Arcadis would note that further studies and analysis by Arora could investigate whether its scheme design could deliver:

- Sustainability benefits, for example, requiring less investment in transport infrastructure at Heathrow Airport
- Additional commercial benefits of contact stands
- Efficiencies, for example, as a result of the lack of need for Automatic People Mover (APM) to access T6 piers
- Benefits as a multi-modal hub and the means to offer changing transport modes
- Further improvements to operations in T5, for example, by moving security into the check-in hall and expanding the International Departure Lounge (IDL)
- Reduced walking distances and minimum connection times for passengers

4.2.5 Landside

Arora has designed the majority of landside facilities to be underneath the Central Processing Unit. This includes the housing of drop-off forecourts, public transport facilities and car parking.

At the time of this report, Arora is unable to provide information to demonstrate how this proposal is ASIAD compliant. Arora note that the potential security risks associated with housing these landside facilities within the terminal building are significant.

For example, vehicle access into the new T6 is proposed to be through the lower levels of the new T6 facility. As such, this access route creates a potential safety and terrorist security risk for Heathrow Airport. The Arora design would mean the Central Processing Unit will be located above these publicly accessible roads and areas.

Arora is unable to provide evidence that they have considered ASIAD compliance at this stage in its design, for example, how a fire or an explosive blast would be contained within this area that is directly under the new T6 and near the existing T5.

We appreciate that Arora has stated all security best practice and ASIAD requirements, including bomb blast, will be considered within its design. Arora is aware that demonstrating ASIAD compliance will be a requirement of the NPS, for example, the impact of the 30m rule for bomb blast as the minimum distance required by the Department of Transport (DfT). Arora has sought to recently appoint a specialist security consultant(s) to its team to seek to address this issue in its proposal.

However, Arora has not provided detailed risk analysis to support this proposed element of design within its scheme and we believe that this is an important consideration of the design.

Notwithstanding the security issues, the proposed car park layout in the Arora design assumes capacity is equal to that of the existing T5 MSCP. Arora has not provided the analysis or assumptions made to calculate the landside requirements.

Our understanding is that further to our engagement and as a result of ASIAD requirements, this proposal regarding MSCP is now subject to substantial redesign. Arora has indicated that are now seeking to relocate the MSCP away from its current proposed location beneath the Central Processing Unit.

In addition, the car parking provision will change significantly as a result of the demolition of the present T5 short-term carpark as proposed by the Arora design. Arora state that its proposal will provide an equivalent level of on-site parking provision at Heathrow Airport. As noted in our assessment of 'Cost and affordability' the Arora Scheme Proposal does not include a provision for additional car parking. Arora has stated that its proposed scheme is retaining most of the existing car parking on the Northern perimeter road and as such no additional car parking provisions are required

However, we have not seen space calculations to confirm that this can be achieved. Furthermore, we have not seen any evidence that Arora has considered any changes to a modal split in surface access

requirements for parking and landside facilities. Arora has been able to provide high-level concept phasing drawings but to validate the assumptions in its design, further work would be required.

Without more detailed work, the ability to calculate requirements, such as the departures and arrival kerb lengths and the number of car parking spaces required, is limited. Arcadis would expect further capacity analysis to be undertaken to demonstrate that the proposed landside areas are sufficient to meet the demands of 130 mppa.

Arora has stated that new appointments to its team will be providing a surface access strategy and plan for its HWC proposal. This will include developing initiatives in multi-modal access and car parking requirements and locations. At the time of this report, this work has not been completed and this information is unavailable.

Arcadis would reflect that the proposed two road access routes into the combined T5/T6 hub by Arora do offer the opportunity for improved resilience in access to the complex. Following further analysis, additional opportunities to the Arora design may be identified.

4.2.6 Wider surface access considerations

We note that at the time of this report, no traffic modelling has been completed for Arora's surface access scheme including for the local roads and M25 access.

Furthermore, no modelling to demonstrate compliance with NPS transport mode share targets for passengers or employees has been made available to Arcadis.

In addition to road-based infrastructure, we have not seen any assumptions regarding the connections to existing rail infrastructure by Arora, apart from a high-level aspiration to connect to this facility.

Arora has indicated, during our engagement, that a full surface access study, including traffic modelling and analysis of relevant mode share initiatives to meet the NPS requirements, will be completed with the ongoing development of its proposal.

4.2.7 Capacity

The Arora Scheme Proposal has developed a plan for expanding the HWC to deliver [redacted] mppa.

In reviewing the capacity assumptions provided by Arora, Arcadis has assessed two elements:

- The maturity of the assumptions on which [redacted] mppa has been calculated
- The assumptions that have been used to calculate terminal facilities required

We also include any risks of capacity excess or shortfall.

To enable our assessment, Arora provided a memorandum on how it has identified (gate) capacity at a high level.

[redacted]

Figure 2: Gate capacity calculated from annual passenger numbers

Arcadis believe this memorandum is a simplified approach that allows high level concepts to be developed. However, given the significance and scope of this project, further detail would be expected now and in the future.

In order to confirm overall terminal capacity, Arora will need to develop a future mock forecast schedule with anticipated airlines and their mix of aircraft. The mix of aircraft would also include airline types and current fleet mix, along with aircraft on order. The development of the mock schedule allows a more detailed analysis of gate demand, rather than the reliance on a single aircraft type (Airbus A321).

This schedule determines all other airfield, terminal space and facility and landside requirements. It should consider peak demand and other drivers, such as desired levels of service.

Arcadis' experience is that forecast schedules of this type are typically produced along with the earliest conceptual design of airport and airfield facilities, to support planning considerations and development objectives.

4.3 Observed level of maturity

At the time of this report and based on the information provided by Arora, Arcadis believe that the level of maturity of the Arora Scheme Proposal for 'Scope and design' is at:

- RIBA Stage 0/1: 'Strategic Definition' and 'Preparation and Brief'.

For design and scope, Arora appear to have considered all the major design elements to be expected for a project of this type and associated with an airport expansion.

However, the level of detail and the maturity is still in the initial stages. Detailed technical work, such as simulation and capacity studies and demand/gap analysis, are yet to be completed.

This additional work will likely provide both opportunities and risks for the Arora design and potential amendments to the Arora Scheme Proposal.

We would also expect to see evidence of work associated with developing the scheme and the design to include, but not limited to:

- Sustainability
- Air quality
- Noise
- Carbon
- Impact on local communities
- Habitat and wild birds
- Equality
- Health

Additional work, such as this, will be required to develop the design and meet the requirements of a DCO proposal. Arora has indicated that its current plan is to submit a DCO in [redacted].

At this stage, Arcadis has only been instructed and can only provide a high-level view of the design and scope of the Arora Scheme Proposal.

On balance, our assessment cannot determine whether the Arora proposal demonstrates compliance with the NPS in its entirety, given the current level of maturity in design.

Arora has confirmed that the additional works and studies associated and required to demonstrate compliance with the NPS will be undertaken as part of the Environmental Impact Assessment (EIA) for the DCO. However, only very early studies have been completed at this stage in the process. Arcadis note, and Arora agree, that further work is required for a DCO submission and in the wider context of proposing a responsible airport development.

Arora has confirmed our assessment and have indicated its DCO submission will be developed to the equivalent of RIBA Stage 2 'Concept Design' as an aggregate across its proposal.

5 Operability

5.1 Definition of theme

This section of the report provides information on the operability of the Arora Scheme Proposal and the layout for the new 3rd Runway at Heathrow Airport.

Arcadis has considered the airfield, terminals and landside elements of the Arora Scheme Proposal and appraised the feasibility of the operability of these elements. We have assessed the data, calculations, assumptions and standards that have been used by Arora to inform its design. Our assessment has sought to determine the suitability of the design at this stage in its programme and to determine how robust the design is with regards to the assumptions and other inputs used in developing this scheme.

All parties appreciate that the 3rd Runway will be designed, contracted and operated on whole airport operation. To date, Arora has not been able to demonstrate the maturity of its assessment of whole airport operation.

5.2 Initial assessment of operability proposal

5.2.1 General comments

The Arora Scheme Proposal has used a significant number of assumptions in developing the scope and design of its scheme. Based on the detail and completeness of the information provided to Arcadis at the time of this report, we conclude that these assumptions are at a high level. We understand these assumptions and the scope and design will be developed further. However, these assumptions should inform the layout of the airfield, terminal and landside facilities and will impact the operability of the airport system. It is the detailed modelling and simulation work on the airfield, terminals and landside that are required to determine whether the operability of the Arora Scheme Proposal is viable.

In our assessment of 'Operability', Arcadis would note the following:

- A detailed simulation study for both the terminal and airfield has not been provided. This means it is difficult to qualify how the proposed development will operate
- A formal demand and gap capacity study for the terminal has not been provided. This means it is difficult to qualify how the proposed terminal sizing and operations will be provided
- Arora has not yet conducted any traffic modelling regarding the surface access scheme proposed for the M25 layout. In addition, we are not aware of any traffic modelling work associated with proposed local road changes detailed in the Arora Scheme Proposal

If capacity assessments have been undertaken, we are unaware as to the type of modelling used (i.e. static or dynamic) and what assumptions have been implied. We have not been provided with information relating to the analysis and the assumptions used to determine the facility requirements inside the terminal, although it has been requested. Our understanding is that, since our engagement, Arora has commissioned consultants to provide these essential studies.

5.2.2 Airfield

Due to the lack of an airfield simulation study from Arora, Arcadis is currently unable to confirm whether the taxiway configuration will support the proposed enlarged HWC. Arcadis is unable to determine and assess the broader impact across the wider airfield.

It is noted that Terminal 6C stands will involve pushback on to the parallel Code F taxiway. This may have a significant impact on the operation of the airfield. However, as no simulation or modelling of this has been provided, the operational impact cannot be assessed.

Additionally, we have seen no information to determine that the three-taxiways proposed by Arora between T6 and the new 3rd Runway are sufficient for operations. However, Arcadis does acknowledge that Arora increased from two-taxiways as part of its early design optioneering. Arcadis also understand initial analysis has been undertaken and a more detailed simulation has been commissioned by Arora to understand the impact of aircraft crossing the current Northern Runway undershoot when taxiing to the new 3rd

Runway. Arora has stated to Arcadis during our engagement that its proposals will not generate adverse impacts on OLS or operations, subject to design development.

5.2.3 Terminal

Arora has a key assumption that T5 and T6 will be operated as an integrated facility. This assumption relies on three key enablers:

- That the combined T5/T6 hub has enough capacity to meet the 130 mppa target
- That the current owner of T5 will agree to combined operation
- That the baggage strategy is resolved

Arcadis has assessed these three key enablers at a high-level.

5.2.3.1 Terminal capacity

Arcadis has not been provided with detailed capacity planning studies of either the T6 proposal or the combined T5/T6 hub by Arora.

Given the extent of potential changes to the current T5 operation and the high-level nature of the capacity calculations for T6 provided by Arora, it is unclear whether the proposed design by Arora will support 130 mppa.

If not, Arora will need to determine whether there is additional space to incorporate the required stands to meet this objective. Arcadis understand that further work to consider this design issue and the impact on operability is underway.

Arcadis note that an opportunity exists in the Arora Scheme Proposal to expand T6B and T6C in a phased manner. This may manage capacity and operations across the airfield more appropriately than if they were delivered simultaneously.

5.2.3.2 Combined operation

The Arora Scheme Proposal includes the integration of all passenger check-in facilities for the HWC in a Central Processing Unit by combining T5 and T6 operations.

Arora has not been able to indicate how the use of T5 will change as a result of this integration. Arora has indicated this matter will be subject to further discussion with airlines and operations and based upon likely forecast and fleet mixes.

Arcadis has not seen any detailed capacity planning work to model the operation of the combined terminal. Arcadis understands that work in this area is underway by the Arora team, but not yet completed to accompany its existing proposals regarding operability.

5.2.3.3 Baggage

The Baggage Handling System (BHS) is proposed on Basement Level 1 within the T6 in the Arora Scheme Proposal.

Arcadis has not been provided with analysis to determine that the space requirements for the BHS can be met. As analysis for the accommodation for the BHS is not provided, its feasibility and the impact on operability is unknown at the time of this report.

At the time of this report, Arora is also unable to provide details of how baggage will be processed in the Central Processing Unit.

Arora has confirmed that baggage processing is under development and additional consultants will be appointed to its team.

Arcadis observe that the current baggage system at Heathrow Airport is highly integrated. This will present further complexities to the design of the solution proposed by Arora. Arcadis are currently unclear as to how baggage will be effectively processed in T5 should the existing check-in functions be removed from this terminal as proposed by Arora.

Arcadis anticipate that the solutions for these three key enablers, and other matters, will be developed as the Arora Scheme Proposal design matures. This will in turn inform the operability of the Arora Scheme Proposal.

However, Arcadis would note that as design matures, and operability is further developed this may require changes to the current Arora Scheme Proposal. This could impact the Arora cost and scheduled delivery of the programme.

5.2.4 Landside

Arcadis has not seen any landside traffic modelling output or analysis to inform the proposed landside road layout. Arcadis cannot therefore determine if the proposed road layout will be sufficient for the flow of anticipated traffic using Heathrow Airport.

Arcadis would note that any proposed design and the associated operability will not only impact the flow of traffic to and from Heathrow Airport but also the existing flow of traffic around the airport and using the M25 motorway.

Arcadis would also observe that the lack of assumptions presented by Arora regarding car parking spaces and kerb lengths presents an open risk, as they may not be sufficient for the demand and the flow of traffic.

Due to the lack of studies currently, we also unable to assess the impact of overall car parking requirements and their operation across the proposed HWC, with a specific note on the loss of car parking product due to the new 3rd Runway development.

Arora would highlight that a significant level of existing car park capacity located on the airport perimeter is retained under its current proposals and is not required to be displaced by the 3rd Runway development proposed.

5.3 Observed level of maturity

At the time of this report and based on the information provided by Arora, Arcadis believe that the level of maturity of the Arora scheme proposal for 'Operability' is at:

- RIBA Stage 0/1: 'Strategic Definition' and 'Preparation and Brief'

Although the overall scope and design set out in the Arora Scheme Proposal includes the high-level design elements required for this type of airport expansion, it should be noted that the level of maturity for individual elements is low. Arcadis has not been provided with details of studies and analysis that are needed to inform the design and therefore impact on the future operability of the airport.

We would anticipate, in due course, to see a high-level concept design that is backed up by an appropriate CONOPS plan and formal capacity assessments of landside, terminal and airside areas that utilise agreed assumptions. This would be further supported by robust traffic forecasts.

6 Cost and affordability

6.1 Definition of theme

This section of the report reviews the cost and affordability aspects of the Arora Scheme Proposal for expansion at Heathrow Airport. Our review comprises of a high-level assessment of the available information and the analysis provided to us by Arora at the time of writing this report.

Arcadis has predominately reviewed the Arora Order of Cost Estimate (OCE) which supports its proposal.

Best practice is that an OCE should be provided in line with RICS NRM1 guidelines. Following these guidelines helps to ensure that the uncertainty associated with the early stage development of a complex project is clearly communicated.

Arcadis has concentrated the review for this engagement on Arora's OCE, and provide insight into the approach taken, the certainty of the cost estimate, and the observed level of maturity. We have sought to understand how Arora's proposal will be affordable in terms of airport charges and how the evidence Arora has provided supports the claim that its solution is affordable.

For cost and affordability, we have also sought to evaluate, at a high-level, the robustness of evidence provided by Arora in relation to its proposal.

For the overall review, we assessed Arora's approach to the following key elements of the OCE as summarised below:

- **General Approach:** The approach adopted by Arora in building up the OCE
- **Scope capture:** Relevant elements considered in the OCE
- **Quantification:** Assessing the amount measured, the basis of the measurements and the extent of work where quantification has not yet been undertaken
- **Pricing:** Where this is based on benchmark data
- **Benchmarking:** Analysing the depth and relevance of the sample base analysed
- **Project specifics:** Costs associated with working on this programme specifically, for example, constrained working, airside working, phased delivery and logistics
- **Application of on-costs:** Considered for design
- **Risk:** Percentages applied and/or analysis of the risk management process

Arcadis has sought to provide comment on the level of maturity of the Arora proposal for cost and affordability.

6.2 Initial assessment of cost proposal

6.2.1 General Comment

Arora has completed its OCE based on the current scheme design proposal. The estimated cost is £14,400,000,000 (excluding VAT) (£14.4bn).

Arora has noted that the base date of this cost estimate is Q1 2014. Rationally, this base date aligns with the report: Jacobs Cost and Commercial Viability: Cost and Revenue Identification Update Heathrow Airport North West Runway prepared by Jacobs, dated 30 June 2015.

In our assessment, Arcadis has queried the level of confidence and certainty that Arora has with regards to this total cost.

Arora has stated that £14.4bn is the total cost for the delivery of the Arora Scheme Proposal for expansion at Heathrow Airport. It is the total sum and includes all elements necessary to deliver the expansion and meet the objectives of 740,000 ATMs and 130 mppa. The sum encompasses all planning, development and delivery of its proposal for expansion at Heathrow Airport. However, it should be noted, as with all major projects and proposed developments, these costs are at a base date (Q1 2014) and will be subject to inflation.

Arora has also stated that "*The Arora Group agrees with the objective of no increase in Heathrow Airport's Airport Charges arising from expansion (in real prices)*".

Arora state an aspiration for a "*real reduction*" in airport charges as a target. At this time, Arcadis has not requested any evidence to substantiate this aspiration. Arora would be expected to provide information and further clarification around this statement as the proposal develops.

Arcadis consider best practice for a cost estimate to be built upon three pillars; the base cost, associated risks, and programme and delivery impact. These factors must be considered in parallel to accurately estimate the cost of a project, rather than independently. This is called an integrated estimating process.

For stakeholders and external perception of the project, an integrated estimating process is important. The implications of risk and programme are critical to the way in which the scheme will be delivered, the total cost estimated and the accuracy of that estimate at the end of the project. The planned duration and method of delivering the programme of works will influence the OCE. Arcadis notes that the 'Basis of Estimate' statement in the Arora OCE does not demonstrate that the delivery of the programme has been considered in detail. However, the Arora OCE does include an undefined allowance for logistic requirements.

With a programme of this nature, there are numerous scenarios for procurement through to delivery. To provide additional assurance to the OCE, evidence that these aspects of the programme have been considered will need to be provided. For example, Arcadis would expect Arora to develop its procurement strategy as its proposal evolves and for its cost estimate to be updated and aligned accordingly. We would not necessarily expect it at this stage of the programme. As a result, procurement should be considered at this stage to be an open risk.

Prior to the production of a detailed Programme and Project Execution Plan there is a greater level of risk on the OCE which needs to be reflected in the level of risk applied. Arcadis has a significant variance between the Arora and Arcadis assessments in the application of risk. Arora has allowed for [redacted] within its total cost estimate. The Arcadis assessment, given scope and design is considered at RIBA Stage 0/1 is to allow, at a minimum, 30%. This increases the total cost estimate for the Arora Scheme Proposal by approximately [redacted].

Arcadis requested a 'Basis of Estimate' document from Arora. Production of the 'Basis of Estimate' statement is recommended by the RICS in line with the NRM. It defines the information used, assumptions applied, inclusions and exclusions within a cost estimate. It would support the cost estimate at each point through the programme / project stages. Formal documentation of a 'Basis of Estimate' would be expected of a programme of this size and nature. Whilst this was discussed with Arora, the formal capturing of this information and level of detail provided is not in a manner we would have expected to see.

Cost estimates at the early stage of all programmes are subject to high levels of uncertainty. Research demonstrates additionally high levels of uncertainty are associated with the delivery of all complex mega-projects, for which we would associate the expansion at Heathrow Airport.

Arora has provided its OCE to Arcadis for the purposes of this assessment. The OCE is summarised in the Table 1.

Table 1: Arora OCE Summary

The costs in Table 1 are at Q1 2014 to align with the base date of the Airports Commission's review of Heathrow Airport Limited's submission.

6.2.2 Approach by Arora

Arora has completed its cost estimate of £14.4bn by completing its own OCE assessment on the design components within its scheme proposal. Arora's design focuses on the terminals, satellites, airfield and local roads.

Where currently its design is not sufficiently mature to enable an OCE assessment, Arora has either included a lump sum allowance or incorporated the cost for the relevant facility item from the Airport Commission's assessment, as provided in 2015. These costs and the process for determining the sums was undertaken by Jacobs on behalf of the Airport Commission.

Alternatively, for a small percentage of items, Arora has either taken the Airport Commissions quantities or rates and applied its own quantities or rates to complete the estimate. This can be seen in the Table 2 which details the percentage of the OCE fully assessed by Arora.

Table 2: Percentage of OCE assessed by Arora

Arcadis would note an immediate observation that at present there is a significant reliance ([redacted]) on either the Airport Commissions' assessment or lump sum allowances in the total cost of the Arora scheme proposal.

Only just [redacted] ([redacted]) of the current cost estimate of the Arora scheme proposal is based on quantities and cost rates known and applied by its own team. This contributes to a high level of uncertainty associated with the OCE. Whilst these allowances may be appropriate for this stage of the programme, the total Arora cost can be expected to fluctuate as components and corresponding quantities and rates are reviewed and determined by its team. There is scope for variation in each of the components in both directions (higher or lower) as the design is developed and the cost is more accurately estimated, this in turn will determine the accuracy of its total estimate.

To further assess the cost of the Arora scheme proposal, Arcadis has undertaken a high-level review of multiple design components and considered how its cost has been determined. For the purposes of this assessment, we have approached our assessment as a review of the Arora OCE rather than a fully detailed independent estimate.

Of the [redacted] ([redacted] net of on-cost and risk) of the quantities and rates that have been assessed by Arora, it is our view that this cost should be [redacted] net, [redacted] higher than produced by Arora. This is an [redacted] of approximately [redacted]. This has been based on Arcadis measurements and the application of Arcadis benchmarks.

As an example of the uncertainty and the robustness of the benchmarking data used to support rates applied by Arora, we highlight the following; Arora has predominately relied upon a single previous project estimate prepared in 2006 for [redacted]. Arora has uplifted these rates to Q1 2014 price levels. We would note that it does not appear that these rates have been market tested and are, therefore, based on market conditions from 13 years ago. In addition, no specific consideration of the risk and bespoke programme aspects of the [redacted] development has been incorporated into the assessment. To our knowledge, Arora were not involved in the delivery of [redacted] and, therefore, the costs utilised for this estimate do not necessarily reflect the actual costs of the delivery of the [redacted] programme.

Where Arora has included lump sum allowances and cost (quantities and rates) as determined by the Airport Commission, the Arcadis review determined an estimate within 1% of the figure allocated by Arora and appear reasonable.

However, whilst the allowance at this stage is reasonable, we would note that the cost certainty of these items is low because of the low level of maturity of the design. This should be reflected in the application of risk in the cost estimate. Furthermore, Arora do not have visibility of the detail behind the Airport Commission's assessments. They do not have the visibility of what has been included and, therefore, the estimates and their certainty.

Arcadis would note that the Airport Commission's assessment is partly based on Heathrow Airport Limited's submission to the Airport Commission in May 2014, and partly its own assessment. In several instances, the Airport Commission reduced Heathrow Airport Limited's allowances.

Arcadis appreciate that these numbers can be assumed to be reliable to a degree. However, over reliance on these figures, without adequate insight and knowledge of how these costs were determined is not best practice. It is appropriate for a high-level assessment but does not provide high levels of confidence in the accuracy of the total cost of the scheme proposal. It should also be noted that the Airport Commission adopted 20% risk and 20% OB on its total estimate.

In addition, we have identified, at a facility level, the basis of assessment completed by Arora, this is in Figure 3.

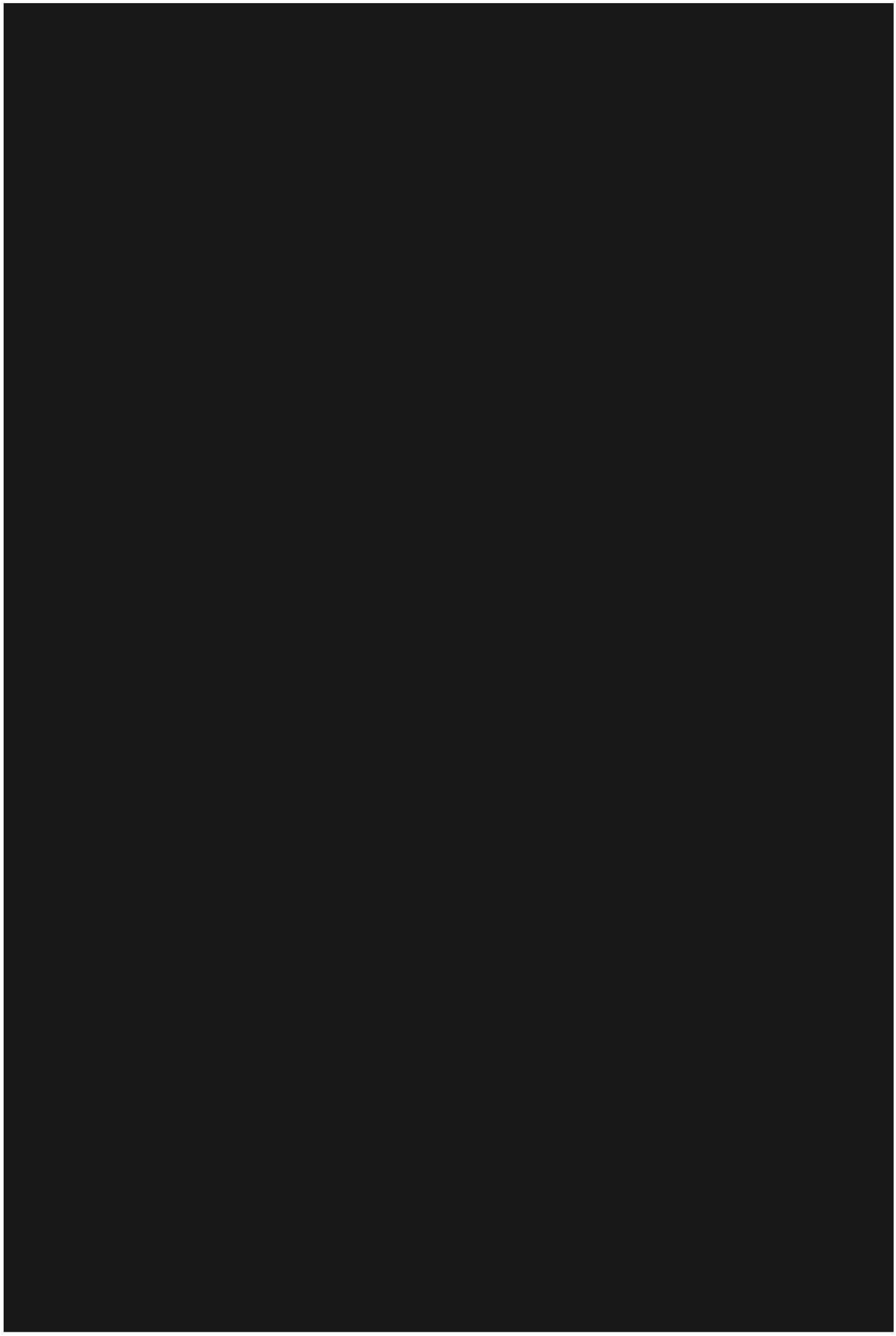

Figure 3: Approach to Assessment of Facilities

6.2.3 Scope Capture

Arora has aligned its OCE with the Jacobs Cost and Commercial Viability report provided for the Airport Commission. As such, Arora has excluded allowances for any works associated with the following items:

- Rail connections
- Potential relocation of airlines
- Works to existing Northern runway

Arora note that where new taxiways are required, as a result of the Arora scheme proposal, they are aligned to its proposed taxiway network and taxiway rates.

In combination with our assessment of the general approach adopted by Arora, Arcadis has also identified potential scope gaps within the current Arora OCE. This includes:

- Temporary relocation of car park 5 and access to T5
- T6B and T6C basement
- Third taxiway connecting North campus to existing campus

In assessing the Arora OCE, at present there are no provisions provided for additional car parking associated with its scheme proposal. Arora has stated that its proposed scheme is retaining most of the existing car parking on the Northern Perimeter Road and as such no additional car parking provisions are required.

Arora has further stated that inter campus connectivity does not form part of the Arora scheme proposal and is therefore, not included within its OCE.

Arora has subsequently confirmed that these items are not included in its estimate as they did not form part of the Arora scheme at the time the estimate was prepared. It should be noted therefore, that the £14.4bn does not include the items detailed above.

The Arora scheme proposal also only includes an undefined provisional allowance of £500m for works to T5. No additional works are stated as proposed by Arora and therefore no cost allowance is included for works within the existing campus.

We have also identified the following items that are reflected in the Arora drawings but do not appear to be reflected in the OCE:

- Passenger tunnel between T6B and T6C
- Future proofing for a Track Transit System (TTS) (the requirements for this will be developed as part of the DCO submission)
- Mezzanine floor (currently shown in drawings is optional and the requirement for this will be developed as part of the DCO submission)

Arora has subsequently confirmed that these items are in its scope and will be included in its next estimate.

Arora has confirmed that they made a deliberate decision, at the time of its current OCE, to exclude allowances for OB. Arora has confirmed they will again review the need for OB allowances going forward in future cost estimates. Arcadis would like to understand more fully how OB will be incorporated into the OCE and managed going forward. Arcadis has not reviewed this item with Arora, however, we have not seen any evidence that risk management has been comprehensively reflected in the development of its current OCE. If OB were to be included, it would increase the cost of the overall scheme. Further information on risk and OB is included in Section 6.2.8.

6.2.4 Quantification

Arora has provided substantiation to its quantification for the following elements:

- Local roads
- Site clearance
- Taxiways
- Soft landscaping

- Security fence

Arcadis has undertaken a verification exercise on the above and these elements have come within an acceptable tolerance of the Arora quantities.

However, there is some discrepancy between drawings with versions showing two-taxiways going towards the new 3rd Runway and newer versions showing three-taxiways. Therefore, the taxiway measurement is approximately 5% (50,000m^2) undermeasured at a value of approximately [redacted].

Arora has confirmed that the current OCE and our assessment is based on a two-taxiway layout. The design has progressed to now include three-taxiways and Arora propose for the cost estimate to be updated to reflect the amendment to the design.

Arcadis has extrapolated a sample of terminal and satellite quantities from the Arora presentations. We have undertaken an extremely high-level review and verified that the quantities are within the OCE quantities.

The runway measurement is taken from the Airport Commission's assessment. We understand this is based on 3,500m long, 60m runway, plus shoulders at 7.5m, and in line with European Aviation Safety Authority (EASA) standards.

6.2.5 Pricing / Benchmarking

In compiling an OCE of this nature Arcadis would expect to see the key facilities benchmarked against comparable schemes. The use of benchmarked rates helps to inform an efficient and realistic position, it increases certainty and can optimise value.

Cost benchmarks, by definition, are the analysis of historical data adjusted for known variances to provide an indication, at high-level, of the likely cost of a similar project if replicated at a given time and location.

In line with industry best practice, it is our view that Arora has not undertaken a full benchmarking review of the key facilities. Instead it has undertaken differing approaches for the key facilities.

Therefore, Arcadis has reviewed and assessed those facilities with benchmarks individually and provided a RAG (Red, Amber, Green) status.

The definition and our summary of RAG status for facilities is provided in the Table 3 and Table 4 respectively.

RAG Rating	Definition
	Within the Arcadis benchmark data range for facilities of a comparative nature and level of specification.
	Not within the Arcadis benchmark data range for facilities of a comparative nature and level of specification however due to the level of price there is no significant impact to the CAPEX Plan.
	Not within the Arcadis benchmark data range for facilities of a comparative nature and level of specification.

Table 3: RAG rating definition

Facility	RAG Review of Benchmarking Level
Terminal	
Piers and Satellites	
Runway	
Taxiway	
Stands	

Tunnels	[redacted]
Departure/Arrivals Bridge Connector	[redacted]
VCC, Airbridge, PCA, Nodes and Fixed Links	[redacted]

Table 4: Arcadis RAG rating of facilities

6.2.5.1 Terminals

An estimate undertaken by the Arora team in 2006 for [redacted] was used as the basis for pricing, the rates analysed and normalised to exclude project specifics, items not applicable to a £/m^2 metric (such as baggage and airbridges) omitted and the costs uplifted to Q1 2014. This is a recognised approach for the normalisation of data.

Arcadis would however, expect to see the basis of the costs as outturn and hence market tested. Arcadis would also expect to see a data set from a range of comparable projects and sources.

Arora has applied two rates [redacted] for superstructure and [redacted] for substructure giving an overall rate of [redacted]. This is slightly lower than the top end of Arcadis' terminal benchmarking which ranges from [redacted] - [redacted] inclusive of allowance for preliminaries and contractor overheads and profit.

6.2.5.2 Piers and Satellites

The pier / satellite rate utilised is [redacted] which Arora advised is based upon industry benchmark rates. Arora has provided basic details of [redacted] costs but do not state whether these costs are an estimate or outturn and hence market tested rates.

Based on Arcadis' benchmark data for piers and satellites this sits below the lower end of the range, [redacted] - [redacted], inclusive of preliminaries, contractor's overheads and profit.

6.2.5.3 Runway

Arora has undertaken a bottom up estimate for the runway applying industry rates. In Arcadis' view, the overall rate of [redacted], inclusive of Airfield Ground Lighting (AGL) and drainage, is generous and allows for an extent of risk on the runway.

6.2.5.4 Taxiway

Arora has detailed a rate of [redacted] that has been applied for Taxiways. £330/m^2 is towards the upper end of Arcadis' benchmarks of [redacted] - [redacted].

6.2.5.5 Stands

Arora has based the rate utilised for stands on the estimate they prepared for [redacted] in 2006. This is therefore not outturn / market tested costs. However, the [redacted] is within the Arcadis' benchmark range of [redacted] - [redacted].

6.2.5.6 Tunnels

Arora has provided back up for the passenger walkway tunnels and the baggage tunnels. Again, they have utilised the previous [redacted] estimate. Whilst the fitout rates are in line with what Arcadis would expect, the cost of the civils element of the tunnels appears to be low in relation to outturn data available to Arcadis. The costs for these works would increase the tunnels civils rates by [redacted].

6.2.5.7 Departure/Arrivals Bridge Connector

Arora has confirmed that these are included within the overall terminal / satellite area and as such the associated terminal / satellite rate has been applied. Arcadis believe that a basic rate should be built up. This high-level walkway will mainly be passenger facing and is likely to be a feature of the overall design. It is therefore reasonable to assume a potentially high-quality cladding with walkways and high-quality finishes.

Due to the large spans, structure costs also likely to be greater than for a pier construction. Our understanding is that there are few precedents for this design solution. Arcadis believe that the cost of this may be in excess of the current allowance but without any design information it is difficult to say what the cost of this element could be.

6.2.5.8 Carparks

Arora has allowed [redacted] per space. Heathrow Airport carparks have historically been at the top end of the benchmark range at approximately [redacted] per space. The uplift allows for the creation of the carpark within the terminal itself.

However, Arcadis expect significant design implications with this proposed solution and one area where Arora will need to investigate solutions further is the ASIAD compliance impact. The additional scope of which could have a significant impact on cost.

Arora has also confirmed that the rate needs to allow for the re-provision of the bus / shuttle area currently located under MSCP 5 at ground floor. This requirement needs to be addressed separately to the carpark rate to ensure the required scope is fully captured.

6.2.5.9 Vertical Circulation Core (VCC) Airbridge, Preconditioned Air (PCA), Nodes and Fixed Links

Arora has used a [redacted] estimate to price this facility.

An allowance of [redacted] per stand has been included and makes no differentiation for Multiple Aircraft Ramp System (MARS) stands. Arcadis believe this rate is sufficient for the Code C stands.

However, dependent on the configuration of the fixed link, node, vertical circulation core and passenger boarding bridge Arcadis believe that the allowance should be between £3m - £4m for MARS stands.

6.2.5.10 Landside Infrastructure

For the M25 realignment Arora has included an allowance of [redacted]. Arora stated that they further validated this figure with its consultant's, and they are comfortable with the allowance allocated.

However, Arcadis note there is no evidence to substantiate the scope and sequence of work and the basis of the allowance.

With regards to the rates for the local roads, no benchmarking or back up to substantiate the rates has been provided.

The Arora Scheme Proposal includes road tunnels which go under the airfield. These will need to be ASIAD compliant and currently there is no recognition of this within its OCE.

6.2.5.11 T5 Reconfiguration

An allowance of [redacted] has been included for the reconfiguration of T5. The scope of this is yet to be defined but the proposals are to link T5 and T6 at the uppermost level and centralise some of the processing facilities, check in and security.

An allowance of [redacted] is also included for the re-provision of the buildings to the South-West of T5. Within this location are baggage facilities, control post and airside road tunnel portal, forecourt and bus / shuttle area and Arora plan to maintain the existing front door to T5. Arora need to substantiate this allowance in order to verify the level of this allowance. Arcadis, at this stage and based on our current level of review, believe that the level of re-provisions required could be in excess of the current sum indicated by Arora.

6.2.5.12 Land Purchase

Arora is not requiring the same extent of property purchase as contained within the Airport Commission's scheme due to the reduced area of the red line boundary.

Arora has retained the Airport Commissions allowances for residential and land purchase and increased the allowance for commercial property by [redacted] ([redacted]).

6.2.5.13 Navigational Equipment / Lighting

Arora has used the allowance of the Airport Commission for navigational and lighting equipment. This allowance has been reduced to take into account the inclusion of the AGL in the runway and taxiways allowance allocated within its estimate.

6.2.6 Project Specifics

As stated by Arora, the site during Phase 1 will be landside. Therefore, there is no requirement for airside working, night working and extensive phasing.

However, Arora has identified that logistics could be a challenge and have identified an allowance within its OCE for this. Arcadis agree that this approach is reasonable given the nature and complexity of the site location and the constraints of the surrounding areas.

Previously Heathrow Airport Limited utilised a remote logistics centre at Colnbrook during the delivery of T5 and T2 which incorporates a railhead. This existing centre is within the redline boundary as proposed by Arora. Therefore, it will need to be re-provided for the delivery of the expansion of Heathrow Airport as proposed by Arora.

When Phase 2 is delivered the site will be airside constrained on all four sides by terminals and operational taxiways. There is a significant amount of unknown scope associated with this phase which requires consideration and has the potential to impact cost, which to date has not been accounted for in the Arora proposal.

6.2.7 Application of On-Costs

Arora has allowed [redacted] for Project and Design Team fees on all works except land acquisition.

For land acquisition Arora has allowed [redacted]. The [redacted] is based upon Arora's internal property team's advice. This allowance will include any necessary Heathrow Airport Limited charges.

6.2.8 Risk

As with any process of estimating and information management, the accuracy of the outputs will only be as good as the brief, the detail available and the professional application of appropriate techniques. If there is little base information, the quality and maturity of the outputs will reflect this. The conceptual stages of a project are particularly sensitive to this challenge.

Dependent on the facility, as detailed in our observations on the level of maturity Arora is still overall at RIBA Stages 0/1. For example, there is no design for the diversion of the waterways and therefore the P50/80 risk conversion to a percentage should remain high as shown in the process map in Figure 4.

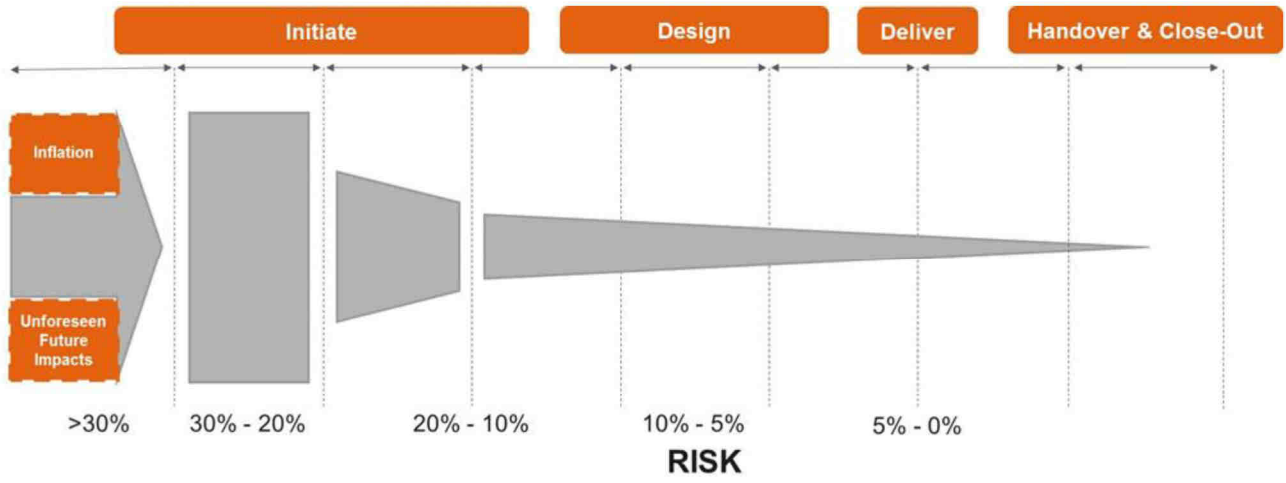

Figure 4: Project Risk Process Map

Currently, Arcadis are not aware of any Arora risk management structure in place and Arora has applied risk at [redacted].

Given the current level of maturity of the Arora Scheme Proposal, together with the inclusion of [redacted] ([redacted]) of costs coming from the Airport Commission, Arcadis believe that the level should be more in line with the Process Map in Figure 4 and, as a minimum risk, should be at 30%.

As noted, this increases the total cost estimate for the Arora proposal, at this stage, by approximately [redacted].

We also note that the Airport Commission adopted 20% risk and 20% OB on its total estimate. Arora has decided to not include OB in its OCE at this stage and were it to be included it would again increase the cost estimate.

6.3 Observed level of maturity

At the time of this report and based on the information provided by Arora, Arcadis believe that the level of maturity of the Arora scheme proposal for 'Cost and affordability' is at:

- RIBA Stage 0/1: 'Strategic Definition' and 'Preparation and Brief'

In accordance with RICS guidelines an OCE is produced at RIBA Stage 0/1 and adherence to this code is a means of demonstrating the application of appropriate professional skill and care by Arora.

The RICS guidelines aligns the estimate with NRM. The NRM defines the information on which the OCE should be based and how on-costs and risk should be approached.

NRM recommendations suggest that the presentation of the OCE should include the following:

- Project description
- Cost statement
- Project information
- Area schedule
- Statement of assumptions
- Base date
- Inclusions and exclusions

Whilst the majority of information on which the OCE should be based is available in the 'Basis of Estimate' statement, there are gaps in the documentation provided by Arora, namely:

- Schedule of accommodation
- Indicative specifications, including services and structural
- Indicative environmental strategy
- Initial risk register

As such the Arora OCE is not fully compliant with the RICS guidelines.

The current outputs are a cost statement and there is no associated statement of assumptions, inclusions and exclusions.

A further integral part of the estimating process is undertaking a maturity assessment. The maturity of the information is key to understanding the detail and method by which way the estimate is developed. As it matures a superior scope definition of a project emerges and the risks of the project also become more evident and clearly defined. Greater risk certainty permits the risk allowance to be reduced. Mitigation actions can be undertaken to reduce impact of risks inherent in a project, or they are engineered out by design.

To assess the reliability of the information and consider next steps, it is regarded as best practice to view the maturity of the information in the first instance. Although acknowledged as a subjective matter, a scoring system which rates the four elements of an estimate (Scope, Cost, Risk, and Programme) 1 to 5 against

descriptive criteria is recommended to provide a common basis for a maturity assessment. This does not appear to have been completed by Arora at this time.

Due to the high-level nature of the Arora proposal, the associated OCE, and the informal documentation available from Arora, Arcadis cannot at this stage validate its confidence in its cost estimates and assumptions regarding affordability.

As this is an initial assessment, Arcadis cannot determine whether the Arora Scheme Proposal can or cannot be delivered as per the estimated £14.4bn cost.

We also cannot say whether Arora can or cannot achieve the objective of no increase in Heathrow Airport's Airport Charges arising from expansion (in real prices) or achieve its aspiration for a "*real reduction*".

The depth of our review of the Arora Scheme Proposal, at this stage, would not allow for us to make a fair determination on either matter.

Should a determination be sought on both cost certainty and the correlating aspect of affordability, the level of detail, maturity of information and available data from Arora would not, at this time, allow us to complete a comprehensive review. The design is not sufficiently mature to demonstrate that the project is deliverable within the specified budget and there are no assessments to show that the operations of the completed facility will be at cost levels compatible with current Airports Charges.

7 Timing and delivery

7.1 Definition of theme

This section of the report considers the timing and delivery of the Arora Scheme Proposal. Our review comprises of a high-level assessment of the available information and the analysis provided to us by Arora at the time of writing this report.

Arora acknowledge that the planned timing and delivery of its scheme proposal and associated detail and information is still at initial stages, a conceptual level and requires significant development. As such, our assessment is at a very high-level as enabled by the quantity and quality of information available.

Nevertheless, in this initial assessment for timing and delivery, we have considered the following elements of the Arora Scheme Proposal:

- Approach
- Consent
- Critical path

Due to the location and the need to maintain a key national asset (Heathrow Airport), the sequence and timings of any proposed scheme will impact a significant number of stakeholders. Our initial assessment has considered the information required to clarify the impact on these stakeholders. We have also sought to assess the viability of the Arora Scheme Proposal and identify risks associated with its timing and delivery.

Arcadis has sought to provide comment on the observed level of maturity of the Arora Scheme Proposal for timing and delivery.

7.2 Initial assessment of timing and delivery proposal

7.2.1 General comment

There is a significant interdependency between timing and delivery and the other themes of our review, namely scope and design, cost and affordability, and operability. This is the case for any major programme and highly relevant for the expansion of Heathrow Airport. The adequacy of timing and delivery considerations are important to provide confidence that a scheme can be delivered in accordance with the proposed programme and cost estimate.

We note that in reviewing the design information presented by Arora, that the focus has been on the development of a preferred scheme and how this can deliver the proposed capacity. Arora has been able to provide floor plans and imagery demonstrating its assumptions and plans in its scheme proposal. They have been able to provide a draft development timescale which sets out the proposed sectional completion dates. This helps to convey the principles which underpin the proposed delivery sequence and is consistent with the early stages of a large development programme.

However, on a large programme we would expect timing and delivery to be adequately developed in conjunction with the development of other aspects of a proposal including the road system, public transport and airfield operations. Arora has stated that this work will be developed from Q1 2019 onwards.

In our assessment, Arcadis has made several observations from the conceptual information available; we believe there are risks which could affect the viability, sequencing, and timings of the delivery. We anticipate that Arora will complete further analysis and to provide more evidence in the future to demonstrate that these risks have been identified and mitigated.

Arora has articulated its strong commitment to developing a design and programme to enable the DCO submission for its expansion of Heathrow Airport. This DCO is focused on the HWC and will rely on separate DCOs prepared by third parties for the new 3rd Runway and other development outside of the scope of HWC. There is an understanding that to do so Arora acknowledge that the proposed DCO will require significant investment and considerable time and effort from an experienced and competent team. Arora is taking steps to appoint an experienced technical team to deliver the DCO.

We appreciate Arora is at the early stages of this process but believe they have undertaken initial work in each of the areas discussed within this report on which its proposal and team can build upon in the following months.

Nevertheless, the timescale available for the DCO submission is short, with submission targeted for [redacted]. Arora currently has a scheme developed to RIBA Stage 0/1 which conveys indicative spatial solutions to capacity and function. The agreed solution will need to be finalised and developed to the equivalent of RIBA Stage 2 for the DCO. Furthermore, we would have expected greater detail on its delivery methodology and programme at this stage of its proposal.

A test of Arora's commitment to developing its scheme proposal and its preparation for the project will soon be evidenced as Arora will need to quickly build, expand, and formalise a greater organisation dedicated to the expansion of Heathrow. Arora has, during our engagement, evidenced actions being taken on its programme to deliver its DCO including the expansion of its existing team through appointed consultants and the provision of necessary office space.

Through discussions with Arora, they have been clear that they are approaching the DCO with a commercial mindset. Accordingly, the plans for the DCO are to provide the base information required together with informal and formal opportunities for engagement. They will look to utilise experience from within its organisation and will also look to continue to appoint consultants and a network of UK and internationally recognised organisations with experience in aviation, infrastructure and large capital expenditure programmes to support and deliver its DCO submission and plans for expansion.

In doing so, we would encourage Arora to seek to understand and consider best practice delivery methodologies, lessons learned, and innovation from other major programmes in the infrastructure sector.

Irrespective of the immediate demands of the DCO process, we also anticipate Arora will continue to develop the capability, structure and governance of its expansion team to enable successful development of its proposal and programme. This will enable Arora to proactively and reactively address the multiple areas of development as well as the opportunities and risks that will unfold as its programme progresses. It will also enable Arora to accommodate increased stakeholder engagement, input and scrutiny.

Arcadis note a potential key advantage of the Arora Scheme Proposal is the intention for a large majority of the project to be built in an off-site or landside environment. Arcadis understand Arora aim to undertake necessary detailed constructability reviews through the design process and as part of DCO works. This activity will provide robustness to its proposed scheme and delivery programme. It is also needed to provide credibility to the Arora Scheme Proposal that expansion can be delivered while maintaining adequate operations at Heathrow Airport.

Arcadis would note, that at present, given the level of development of timing and delivery within the Arora Scheme Proposal and the known requirements for a DCO submission targeted for [redacted], there is as an open risk to the delivery of capacity within the stated Arora timescale.

A further risk we would note is that with little information currently available on the impacts on Business as Usual (BAU) at Heathrow Airport during proposed construction and delivery phases, Arora need to plan and complete considerable and constructive engagement, with key stakeholders, to enable successful DCO submission and potential delivery.

7.2.2 Approach

Arora has produced a series of outline (Level 2) programmes and construction sequence explanation documentation, that sets out its high-level methodology. The extracts cover sections on Construction Staging and on the proposed Surface Access Scheme.

Arora also presented a Level 2 programme to indicate the timescale for delivery of the DCO. This is supported by a detailed Level 3 programme, providing more detail on the high-level activities.

The overall Arora construction programme duration is eight years and is split into four stages. These are:

- Stage 0 – enabling works
- Stage 1 – construction of T6A South and road system amendments

- Stage 2 – construction of T6A North and new road systems
- Stage 3 – T6B and airfield works

The planned start of the Stage 0 is currently indicated to be [redacted] with work to deliver Stage 1 completed by the end of [redacted]. The airfield and T6B works (Stage 3) are then planned to be completed by [redacted].

The start date for Stage 0 is planned for 10 months after the submission of the DCO. This is an ambitious timescale which assumes that stages in the DCO process will be completed faster than the maximum timescales allowed in the 2008 Planning Act.

The Arora programme does not indicate the completion date for T6C. Arora has confirmed that T6C is necessary to meet the [redacted] mppa capacity of its HWC and achieve the 130 mppa target for overall capacity of Heathrow Airport. Arora state they will include T6C within all delivery studies and planning going forward.

Arora has produced a high-level report that accompanies the construction programme to explain the initial proposal for sequencing. This document provides an indication of the associated timescales. Arcadis appreciate these documents help to identify some of the work sequences and interfaces but believe that more detail is required currently to fully assess risks associated with the construction sequence.

Arcadis note that with a lack of clarity, risk is increased. This includes the risk of increased costs associated with the required sequence of the programme and BAU support. This also further increases the risk to delivery timescales.

7.2.3 Consent

Originally, Arora verbally presented its proposed strategy to gain consent approval (DCO) of its scheme proposal.

Arora has a developed DCO programme that is targeting a submission to PINS for [redacted] and a target consent approval of [redacted], which is the planned start date for Stage 0.

Arora has presented a Level 2 programme to indicate the timescale for delivery its DCO for the HWC. This is supported by a detailed Level 3 programme, providing more detail on the high-level activities.

The [redacted] programme sets out the activities and timescales necessary to achieve a DCO document submission date of currently [redacted].

Arora acknowledge that this timescale is aggressive and that it been planned with a high degree of optimism derived from Arora's private-sector experience of the management of the planning process.

Arcadis observes, that based on our experience and as an approximate benchmark, typical public-sector consent processes and the development of the submission for a non-contentious DCO assessments for small projects (e.g. sub £500 million) typically take 18 months.

The Arora programme requires a proactive and positive engagement with key stakeholders and consent granting bodies within the defined informal and formal consultation windows. It does not allow for any delays in this engagement. Therefore, the programme appears to rely upon the performance, good will and positive engagement by others, which increases the risk associated with achieving these goals. An example of this positive approach is the provision of a short two-month window between the conclusion of the Statutory Consultation and the submission of the DCO.

Arora is currently mobilising an experienced team to create and deliver the information for the DCO process. The programme gives the team relatively little time to work up the design to achieve the planned design freeze at equivalent RIBA Stage 2 by [redacted].

Arora has indicated that to date, they have not been able to reach an agreement on a common DCO submission in conjunction with Heathrow Airport Limited. There exist dependencies between the Community Consultation and Statutory Consultation periods for both submissions. This represents a risk to both parties seeking DCOs for the development of Heathrow Airport.

Arora has indicated that initial discussions have been held with key parties associated with the DCO process. Arcadis would require greater levels of information and evidence of engagement to assess the likelihood of success via this consent route.

Arcadis observe that under current proposals, Arora will be developing its DCO submission for the HWC in competition with Heathrow Airport Limited and within the same timescale. Arcadis would note this will increase resourcing risks associated with the development of the proposal, the speed of responses from stakeholders, capacity of inspectors to better minimum durations of review, and the speed of response by the Secretary of State.

We would note that Arora's assumptions, associated with the durations of its scheme proposal and the needs required for consent approval, have little precedent. There is limited evidence that the overall programme delivery dates have been tested against a comparative DCO development and assessment process. We further note that the assumptions have not been validated with the various key stakeholders and statutory authorities, including the Planning Inspectorate and airlines, beyond initial conversations.

On the basis of our assessment, although it is evident that Arora is making significant investments into the DCO process, Arcadis is unable to provide assurance that Arora will be able to deliver the consent within its stated timescale. We deem Arora's ability to deliver the DCO to meet overall delivery dates to be an open risk.

7.2.4 Critical Path

The Arora Scheme Proposal and narrative indicates that the critical path of the construction programme runs through the T6A South, followed by the T6A North development.

The high-level critical path activity determines the opening of the new T6. Arcadis would note that there are several significant and substantial works that could cause delays to the stated goals in the Arora Scheme Proposal for example, road diversions and enabling works.

The information provided by Arora to support its critical path and programme are useful to demonstrate, at a high-level, the overall development timescales and sequencing. However, our review is limited until a detailed assessment of construction methodology is undertaken by Arora.

In the meantime, we provide commentary on aspects of the construction programme delivery sequence and information provided by Arora that may impact the critical path.

7.2.4.1 T6A Delivery

The current Arora programme and narrative provides no detailed assessment of the methodology and sequence of works that would be required to adapt the T5A forecourt building to allow for the demolition and removal of the existing car park forecourt structure.

The planned works to create the required space for the T6A South development will involve the complete demolition and removal of up to [redacted] of the existing multi-storey structure.

As well as being above and around the existing public transport interfaces, these include access to the Heathrow Express station box, the underground station, coach station and public drop off zones, as well as emergency egress, all of which are essential to the operation of the building.

There are many challenges with developing this space while maintaining the 'front door' of the T5A facility. There is a significant amount of work required to validate this methodology and construction sequence. Arora concur that this is a significant undertaking and are keen to collaborate with Heathrow Airport Limited on this issue. Arcadis understand that to date there has been no collaboration between Heathrow Airport Limited and Arora which, therefore, poses a particular risk to the Arora Scheme Proposal.

7.2.4.2 Site Constraints

To develop the Southern T6A area, the programme indicates the complete removal of the existing T5 energy centre after the delivery of a new replacement facility. The programme also indicates a second energy centre will be constructed as part of the Stage 2 works.

Currently Arora is unable to provide specific information and definitively indicate as to where these energy centres will be constructed. This could be a significant impediment to the DCO timescale as it may need to be included within any Environmental Assessment.

Arora has indicated that "*further work will be undertaken during the design development phase of the DCO production to identify replacement locations and required capacity*."

The existing Southern area of Heathrow Airport also includes a key baggage facility, control post and the tunnel portal for the Airside Road Tunnel (ART). The construction and delivery of these replacement assets are not indicated on the Arora programme or listed in the narrative. These are core airfield assets and its replacement may cause delays to the release of the proposed development space. Arcadis believe the ART portal poses a particular challenge as it is within the airfield critical area and forms the key to cross campus connectivity to and from the existing T5 facility.

The western extent of the HWC contains three rivers which require diversion. Two are currently in culverts that can be diverted to facilitate construction as proposed by Arora. The third, the River Colne, feeds into key water courses to the South of the development and will require a careful management, in agreement with the Environmental Agency, by Arora and poses additional risks to its proposal.

Arora is aware of the critical nature of these several assets and have begun to attempt to mitigate its impact on programme during expansion. Further information and detailed studies are not available at the time of this report.

7.2.4.3 Landside Road System

To develop the area to the West of the existing T5 forecourt the Arora Scheme Proposal includes a reconfiguration of the road system around the M25 main artery.

The Arora proposal is to reconfigure the existing T5 spur road to allow for the reconfiguration of the T5 forecourt. This is followed by the Southern road system, including adaptions to the existing M25 junction 14. Therefore, the Arora proposal indicates changes to both current M25 junctions that feed Heathrow Airport from the West and changes on top of the existing road routes.

Arcadis believes these proposals will be significantly challenging to deliver. We would advise that Arora undertake further modelling and analysis to indicate the validity of these proposals. Information from this further analysis will demonstrate the Arora Scheme Proposals ability to deliver the construction timescales and its ability to maintain full access for existing and planned traffic flow from the West of Heathrow Airport. It should also be noted that these proposals are in addition to the proposed re-alignment of the M25 motorway.

The Arora Scheme Proposal also indicates that the new Northern approach road system will be constructed within tunnels, beneath the airfield and piers T6B and T6C. To gain access to these road tunnels from the South, the access road would need to be constructed in a tunnel beneath the existing M25, around junction 14A. Due to the proposed sequence this would be delivered as part of Stage 2 works. Arcadis would note this would preclude any operational airfield connection to the North, including the new 3rd Runway, until the new road tunnels and airfield works have been completed.

Arora has stated that they do not anticipate that there will be any impairment to airfield connections during or following construction and are developing proposals in line with this objective.

7.2.4.4 Maintaining Current Operations

The Arora Scheme Proposal does not indicate the closure of the existing T5A function. However, the delivery sequence requires the complete reconfiguration of the existing T5A forecourt to allow for construction activities from a point South of the Northern car park ramps.

These proposed changes can be expected to have a significant impact on the day to day operations of the terminal. The key passenger interface is maintained by keeping the Northern sector of the T5 car park. Arora, at the time of this report, are unable to provide any detailed studies demonstrating how this requirement will be achieved during its proposed construction process.

We also observe that other considerations, including the coach station and other functions supported by the car park, do not appear to have been assessed by Arora to date.

For Arcadis to comment on the feasibility to maintain airport operations in the Arora Scheme Proposal, we would require a more detailed assessment of the impacts of the works sequence and timings on the existing airport functions. We would comment that Arora would also be able to utilise this information to inform the key stakeholders and provide a more robust engagement strategy.

Arcadis would recommend that Arora consider the development of a delivery methodology that is built around maintaining the current airport operation during the transition process. Arcadis has not yet seen evidence that demonstrates how existing functions will be maintained, as well as future capacity safeguarding, central to its proposed development.

Arcadis again note that the lack of detail provided by Arora on its methodology and construction delivery has the potential to impact its cost estimate. The cost estimate relies upon an assessment of duration and risk as well as quantum. Further analysis may pose opportunities and/or risks that can shorten or delay the programme respectively. These challenges are to be expected with complex phasing or sub-optimal work sequences and those required to ensure BAU is maintained throughout construction phases. There is the opportunity or risk for shorter or longer delivery timescales and associated amendments to cost estimates.

7.2.4.5 Potential Environmental Impacts

The Arora Scheme Proposal requires a significant degree of road reconfiguration. Consequently, this may have a greater effect on some of the key environmental impact assessment criteria associated with its proposal.

Arora, in developing its proposal, may be required to complete additional baseline studies to fully assess its proposed traffic routes and changes.

Arcadis would highlight that due to the extent of the development, particularly around the airfield to the West of T6C, the impacts on the flood plain of the River Colne will require studies and agreement with the relevant authorities. In addition, the proposed diversion of the River Colne will also need to be considered in the EIA.

Furthermore, the new energy centres require careful consideration and understanding of the associated impact on the environment. Arcadis appreciate that, once the scheme parameters are set, these works can progress in conjunction with the DCO process by Arora.

7.3 Observed level of maturity

At the time of this report and based on the information provided by Arora, Arcadis believe that the level of maturity of the Arora Scheme Proposal for 'Timing and delivery' is at:

- RIBA Stage 0/1: 'Strategic Definition' and 'Preparation and Brief'

Arcadis believe that Arora will seek to develop a detailed DCO and construction management plan to fully articulate how and when its scheme will be delivered. Arora intend for this to be developed to the equivalent of RIBA Stage 2 for the DCO submission.

Arcadis appreciate that initial work has been completed for timing and delivery based on the architectural layouts and operational space.

We have not received any information on the Arora plans to ensure the continued operation of Heathrow Airport at required capacity. We note that the key to the proposed expansion of Heathrow Airport will be in the timing and delivery and continued management of the existing functions around the construction zone.

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