Appendix 15B CCR Assessment

Project Timeframe	5														
Risk ID	Climate hazard	Data from climate predictions Trend or Likelihood of Climate Hazard Potential Climate Change	Impact Potential Climate Change Risk to Scheme	Construction/Operation Stage	Asset type	Examples in Grey Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazar	rd Impact		Uncer	tainty Level	Level of	Proposed additional resilience measure (only if Risk Rating = 'High' (4) or 'Very	Reference documenting relevant mitigation
			Increased temperatures leads to increased HVA			Expected temperature increase is within operational		Likelihood	Consequence	Risk rating	CC Projection	CC effect on asset	Uncertainty	high' (5))	
1	High temperatures	Rising temperatures impact bu performance	system power demand and increased energy consumption to cool buildings.	Operation	Buildings	range of systems designed to current standards for 20- year design life of HVAC system. Energy efficient systems to be selected.	A level of resileicene reached through maintenance of system and regular replacement	Unlikely	Minor	Very Low	Low	Low	Low		
2	High temperatures	Rising temperatures impact bu performance	Increased temperatures and extreme heat event lead to reduced thermal performance of buildings and reduce thermal comfort of occupants	operation	Buildings	Expected temperature increase is within operational range of systems designed to current standards for 20- year design life of HVAC system.	A level of resileicene reached through maintenance of system and regular replacement	Likely	Minor	Medium	Low	Medium	Low		
3	High temperatures	Rising temperatures impact materials performance	Increased temperatures lead to accelerated degradation of building facade materials	Operation	Buildings	Design of external building materials to current standards, monitored and maintained as per standard maintenance procedures.	A level of resileicene reached through maintenance of asset	Unlikely	Minor	Very Low	Low	Medium	Low		
4	High temperatures	Rising temperatures impact equipment performance	Extreme heat events lead to failure of sensitive equipment at high temperatures	Construction and Operation	Buildings	Sensitive equipment to be located in temperature- controlled areas of buildings. Building design to meet guidance in Health Technical Memoranda.	Resilience achieved through design decisions.	Unlikely	Moderate	Low	Low	Medium	Low		
5	High temperatures	Rising temperatures effecting r	ad surface Extreme heat events lead to damage to road surface through deformation of asphalt	Operation	Traffic and transport	Road construction to current standards, monitored as per standard maintenance procedures.	A level of resileicene reached through maintenance of asset	Unlikely	Minor	Very Low	Low	Medium	Low		
6	High temperatures	Rising temperatures impact bu	Opportunity: Increased temperatures lead to increased outdoor recreation opportunities for	Operation	Public realm										
7	High temperatures	Rising temperatures impact	Increased temperatures lead to accelerated degradation of materials in outdoor facilities and	Operation	Public realm	Faculties and pavement construction to current standards, monitored as per standard maintenance	A level of resileicene reached through maintenance of	Unlikely	Minor	Very Low	Low	Medium	Low		
8		Rising temperatures impact	Extreme heat events lead to overheating of	Operation	l Wilitias	Procedures. Expected temperature increase is within operational	Resiliance already accounted for	Linikely	Minor	VeryLow	Low	High	Modium		
0	rightemperatures	equipment performance Increased number of hot days	ay lead to Extended periods of hot days may lead to a risk			range of transmission lines.		Uninkery	IVIIIIOI	Very Low	LOW	nign	Medium		
9	High temperatures	shrinkage of soil and drying ou vegetation	of spontaneous grassland fires, causing building damage	Operation	Buildings			Very unlikely	Major	Low	Medium	Medium	Medium		
10	High temperatures	shrinkage of soil and drying ou vegetation	of spontaneous grassland fires, affecting safety public.	o Operation	Public realm			Very unlikely	Major	Low	Medium	Medium	Medium		
11	Low temperatures	Rising temperatures impact bu performance	ing Opportunity: Fewer frost days leads to decrease energy consumption to heat buildings	<sup>d</sup> Operation	Buildings										
12	Low temperatures	Rising temperatures impact bu performance	ing Opportunity: Fewer frost days leads to improved thermal comfort of building occupants	Operation	Buildings										
13	High precipitation	Increase in number of wet day building damage	may cause Extreme rainfall events lead to localised flooding causing damage to building structure, internal fit- out, and equipment and pumps	Construction and Operation	Buildings	Masterplan design is based on detailed flood risk assessment which incorporates projected climate change.	Resilience achieved through design decisions.	Unlikely	Moderate	Low	Low	Medium	Low		
14	High precipitation	Increased rainfall provides a w building	er supply to Opportunity: Extreme rainfall events lead to opportunity for rainwater harvesting	Operation	Buildings										
15	High precipitation	Increased rainfall may cause fl from river and groundwater so	bding risk ces Extreme rainfall events lead to localised flooding of roads and transport infrastructure, causing disruption to services and traffic	Operation	Traffic and transport	Masterplan design is based on detailed flood risk assessment which incorporates projected climate change.	Resilience achieved through design decisions.	As likely as not	Moderate	Medium	Low	Low	Low		
16	High precipitation	Increased rainfall may damage	oad suface Extreme rainfall events causing damage to road surface (increased stripping rate, likelihood of potholing from moisture entering cracks in	Operation	Traffic and transport	Road construction to current standards, monitored and maintained as per standard procedures. Resurfacing to occur within 10 - 20 years.	Resilience achieved through monitoring and maintenance of asset	Likely	Minor	Medium	Low	Medium	Low		
17	High precipitation	Increased rainfall may cause fl from river and groundwater so	bding risk Extreme rainfall events lead to localised flooding in public realm, causing disruption to users	Operation	Public realm	Masterplan design is based on detailed flood risk assessment which incorporates projected climate change.	Resilience achieved through design decisions.	Unlikely	Minor	Very Low	Low	Low	Low		
18	High precipitation	Increased rainfall can cause flo	ding Increased rainfall and flooding effects can damage internal building contents.	Operation	Buildings	Masterplan design is based on detailed flood risk assessment which incorporates projected climate change.	Resilience achieved through design decisions.	Unlikely	Moderate	Low	Medium	Medium	Medium		
19	High temperatures	Increased rainfall can cause se	level rising Extreme rainfall can cause coastal and inland flooding through rising sea levels. This leads to flooding effects and more coastal salt spray	Operation	Buildings			Unlikely	Minor	Very Low	Medium	High	High	https://www.labcwarranty.co.uk/blog/oh-we-do-like-to-build-beside-the-seaside/	
20	High precipitation	Increased rainfall may cause fl from river and groundwater so	oding risk Extreme rainfall events lead to localised flooding of infrastructure, causing disruption to services	Construction and Operation	Utilities	Masterplan design is based on detailed flood risk assessment which incorporates projected climate change.	Resilience achieved through design decisions.	Unlikely	Moderate	Low	Low	Medium	Low		
21	High precipitation	Increased rainfall may cause fl from river and groundwater so	oding risk Extreme rainfall events lead to sewer flooding an resulting effects	d Construction and Operation	Utilities	Masterplan design is based on detailed flood risk assessment which incorporates projected climate change.	Resilience achieved through design decisions.	Unlikely	Moderate	Low	Low	Medium	Low		
22	High precipitation	Increased rainfall effecting soil levels	noisure Increased average rainfall and extreme rainfall events lead to increased soil moisture levels,	Operation	Utilities	Design and construction of utilities to current standards, monitored as per standard maintenance procedures.	A level of resileicene reached through maintenance of asset	Unlikely	Moderate	Low	Low	High	Medium		
23	High precipitation	Increased rainfall may cause d sediment run-off	Extreme rainfall events leading to debris and sediment runoff, causing blockage to drainage systems. Blockage may result in flooding and	Construction and Operation	Utilities	Masterplan design is based on detailed flood risk assessment which incorporates projected climate change.	Resilience achieved through design decisions.	Unlikely	Moderate	Low	Low	Medium	Low		
24	Low precipitation	Decreased rainfall may increase shrinkage	resulting effects. Decreased average rainfall leads to drier soil conditions and soil shrinkage, causing damage to building foundation and possible ground	Operation	Buildings	Shinkage and dessication considered in foundation design however risk is low due to granular soils in local area	Resilience achieved through design decisions.	Unlikely	Moderate	Low	Low	High	Medium		
25	Low precipitation	Extended dry weather can lead desiccation of soil	o increased Dry spells lead to desiccation of soils, causing reduced slope stability and potential earthworks	Construction and Operation	Buildings	Shinkage and dessication considered in foundation design however risk is low due to granular soils in local area	Resilience achieved through design decisions.	Unlikely	Moderate	Low	Low	Medium	Low		
26	Low precipitation	Decreased rainfall can reduce to building	ater supply Decreased average rainfall and dry spells lead to disruption to water supply to building	Operation	Buildings	Buildings connected to mains water supply. Capacity checks have been undertaken with utilities to confirm capacity within network	Resilience already accounted for.	Very unlikely	Minor	Very Low	Low	High	Medium		
27	Low precipitation	Decreased rainfall can reduce to building	ater supply Decreased average rainfall leads to increased reliance on mains water for landscape irrigation	Operation	Public realm	Landscape Management Plan includes procedures for irrigation during establishment and ongoing maintenance.	A level of resileicene e reached through maintenance of asset	Likely	Minor	Medium	Low	High	Medium		
28	Low precipitation	Decreased rainfall can reduce	ater supply Decreased average rainfall leads to loss of vegetation during summer	Operation	Public realm	Landscape Management Plan includes procedures for irrigation during establishment and ongoing maintenance	A level of resileicene e reached through maintenance of asset	Likely	Moderate	Medium	Low	Medium	Low		
29	Low precipitation	Decreased rainfall may increase	soil Decreased average rainfall leads to drier soil conditions and soil shrinkage, causing damage to	Operation	Utilities	Shinkage and dessication considered in service infrastructure and foundation design however risk is low	Resilience achieved through design decisions.	Very unlikely	Moderate	Low	Low	Medium	Low		
30	Low precipitation	Increased number of dry days shrinkage of soil and drying ou	ay lead to Extended periods of dry days may lead to a risk of spontaneous grassland fires, causing building	Operation	Buildings	due to granular soils in local area.		Very unlikely	Major	Low	Medium	Medium	Medium		
31	Low precipitation	vegetation Increased number of dry days shrinkage of soil and drying ou	damage ay lead to Extended periods of dry days may lead to a risk of spontaneous grassland fires, affecting safety	o Operation	Public realm			Very unlikely	Major	Low	Medium	Medium	Medium		
32	Extreme winds	vegetation Increased stress due to extrem	public.         High winds lead to increased stress and damage to buildings, especially material fixtures, cladding	s Operation	Buildings	Current standards include sufficient allowance for changes in wind patterns	Resilience already accounted for in design standards	Very unlikely	Minor	Very Low	Medium	Medium	Medium		
33	Extreme winds	High winds can cause damage	High winds lead to damage to vegetation and	Operation	Public realm	Site is exposed and strong winds currently occur, layout of buildings considers mitigation of wind impacts through	Resilience achieved through design decisions.	Likely	Minor	Medium	Medium	Medium	Medium		
34	Extreme winds	Increased stress due to extrem	wind High winds lead to increased stress and damage	Operation	Utilities	Current standards include sufficient allowance for	Resilience already accounted for in design standards	Verv unlikelv	Moderate	Low	Medium	Medium	Medium		
			to above ground utility infrastructure			cnanges in wind patterns.	,	., minory							

Climate change risk assessment

35	Extreme winds	High winds can cause greater movement of dust in the air	High winds leads to movement of dust from construction, which can harm the health of construction workers and the public.	Construction
36	Lightning	Lightening effects can cause damage to vegetation	Increased lighting strikes lead to more frequent damage to trees	Operation
37	Lightning	Lightening effects can cause damage to utilities	Increased lighting strikes lead to more frequent damage to above ground utility infrastructure, including overhead electricity transmission lines	Operation
38	Lightning	Lightening effects can cause building damage	Increased lighting strikes lead to more damage, especially roofs, guttering and windows.	Operation
39	Humidity	Higher temperatures means air can carry more water vapour, causing more humidity.	Increased humidity through warmer air causes mould, condensation and decreased thermal performance of buildings.	Operation

t of	High winds leads to movement of dust from construction, which can harm the health of construction workers and the public.	Construction	Public realm			Very unlikely	Moderate	Low	High	Medium	High	
)	Increased lighting strikes lead to more frequent damage to trees	Operation	Public realm			Unlikely	Minor	Very Low	High	Medium	High	
)	Increased lighting strikes lead to more frequent damage to above ground utility infrastructure, including overhead electricity transmission lines	Operation	Utilities	Considered in standard design of above ground utilities.	Resilience achieved through design decisions.	Very unlikely	Moderate	Low	High	Medium	High	
	Increased lighting strikes lead to more damage, especially roofs, guttering and windows.	Operation	Buildings			Very unlikely	Moderate	Low	High	Medium	High	
y lity.	Increased humidity through warmer air causes mould, condensation and decreased thermal performance of buildings.	Operation	Buildings			As likely as not	Moderate	Medium	Medium	High	High	

Project Timeframe	3					change these									
Risk ID	Climate hazard	Data from climate predictions Trend or Likelihood of Climate Hazard	Potential Climate Change Impact	Potential Climate Change Risk to Scheme	Construction/Operation Stage	Asset type	Examples in Grey Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazard	Impact		Uncert	tainty Level	Level of Proposed additional resilience measure (only if Risk Rating = 'High' (4) or 'Very high	Reference documenting relevant mitigation
1	High temperatures		Increased number of hot days may increase	Increased heat stress for staff, particularly for	Construction and Operation	H&S	To be incorporated within proposed maintenance regimes These can be reviewed regularly to ensure H&S	. Resilience achieved through monitoring and maintenance o	f Unlikely	Consequence	Risk rating	CC Projection	CC effect on asset	Low (5)	
				Increased risk of thermal expansion joints being			requirements within Highways England are met	asset			,				
2	High temperatures		Increased number of hot days may cause thermal expansion.	pushed beyond their design capability, presenting a direct risk of damage to structures and assets (e.g. concrete joints).	Operation	Structures	твс		Very unlikely	Major	Low	Low	Medium	Low	The need to increase design temperature ranges for bridge expansion joints to be further explored
3	High temperatures		Increased number of hot days may lead to shrinkage of soil and drying out of vegetation.	Extended periods of hot, dry weather may lead to a risk of spontaneous grassland fires in vicinity of the route, affecting safety on the road.	Operation	Road Surface	Risk to be sufficiently mitigated through standard emergency procedures	Resilience achieved through standard measures already in place	Unlikely	Moderate	Low	Medium	High	High	
4	High temperatures		Increase in number of hot days may impact the road surface increasing the danger to road users.	d Asphalt surface may exhibit permanent deformation in long periods of hot, sunny conditions.	Operation	Road Surface	This risk will be managed through the selection of suitable road surface material as well as through the proposed maintenance regimes for road surface.	Resilience achieved through design and maintenance	Likely	Minor	Medium	Medium	High	High	Potential to use asphalt with different specifications relating to temperature may be explored
			Increase in number of het days may impact	High temperatures increase the risk of surfacing			This risk will be managed through the colocition of avitable								
5	High temperatures		the road surface increasing the danger to road users.	d temperatures also increase the risk of reduced skid resistance due to fatting and chipping embedment. This increase the risk of vehicle accidents.	Operation	Road Surface	road surface material as well as through the proposed maintenance regimes for road surface.	Resilience achieved through design and maintenance	Unlikely	Major	Medium	Medium	Medium	Medium	
6	High temperatures		Increased number of hot days may impact the bitumen binder hardening rate.	Inability to flex under traffic loads. Increased risk of road surface cracking and fretting with age.	Operation	Road Surface	This risk will be managed through the proposed maintenance regimes.	Resilience achieved through maintenance of the asset	As likely as not	Minor	Low	Medium	High	High	
7	High temperatures		Increased number of hot days may impact the bitumen binder hardening rate.	e Risk of being unable to lay road surface layers in how weather.	t Construction	Road Surface	Risk to be mitigated by following procedures detailed in the outline EMP	e Resilience achieved through management plan monitoring environmental impacts	Unlikely	Minor	Very Low	Low	Medium	Low	
8	High temperatures		Increased impact of diesel spills.	Decreased viscosity in head leads to greater spreading of diesel in a smaller timeframe. Higher temperatures and increased number of hot, dry days increase the likelihood of ignition of this diesel leading to road and forest fires.	s Operation	Road Surface	Risk to be sufficiently mitigated through proposed maintenance procedures	Resilience achieved through maintenance of the asset	Unlikely	Major	Medium	Medium	High	High	
9	High temperatures		Increased summer temperatures may impact on performance of electrical equipment.	Reduced efficiency and lifespan of LED luminaires.	Operation	Electrical Equipment	The impacts associated with increased ambient temperatu to be absorbed within current maintenance procedures. Design life 100,000hours (~25 years).	Resilience already accounted for.	As likely as not	Minor	Low	Low	Medium	Low	
10	Low temperatures		Impact of extreme cold weather on equipmen and infrastructure.	Change of risk of freeze-thaw occurring to road infrastructure and structures. (The mark against noise barriers is only applicable if not in the form of	Operation	Structures	To be mitigated by an appropriate choice of concrete mix.	Resilience achieved through design	As likely as not	Minor	Low	Medium	High	High	
				bunds- still not decided)			For construction: to be mitigated as described in the outline	e							
11	Low temperatures		Impact of extreme cold weather on staff health.	Possible negative health implications for staff.	Construction and Operation	H&S	For operation: To be incorporated within proposed maintenance regimes. These can be reviewed regularly to ensure H&S requirements within Highways England are me	Resilience achieved through maintenance et	Very unlikely	Minor	Very Low	Medium	Low	Low	
12	Low temperatures		Impact of extreme cold weather on equipmen and infrastructure.	It General risk of freezing of electrical equipment.	Operation	Electrical Equipment	Accounted for in the choice of appropriate electrical equipment	Resilience achieved through design	Very unlikely	Minor	Very Low	Medium	Medium	Medium	
13	Low temperatures		Potential decrease in ice on road surfaces from reduced cold days.	Opportunity: Reduced grit/salt used during winter, reducing deterioration of pavement.	Operation	Road Surface	Number of frost days is projected to decrease. However, cold spells are expected to be more severe and so it is recommended that preparedness levels remain unchanged	d							
14	Low temperatures		Increase in ice on road surfaces.	Increased risk of skidding for road users due to ice/snow on road - safety concerns + damage to road infrastructure.	Operation	Road Surface	It is recommended that preparedness levels remain unchanged.	Resilience achieved through current methods in place.	Very unlikely	Major	Low	Medium	Low	Low	
				Increase in slips trips and falls and construction			For construction: to be mitigated as described in the outline EMP.	ie							
15	Low temperatures		Increase in ice on road surfaces.	/maintenance worker injury.	Construction and Operation	H&S	maintenance regimes. These can be reviewed regularly to ensure H&S requirements within Highways England are me	Resilience achieved through maintenance	Very unlikely	Minor	Very Low	Medium	Low	Low	
16	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	Flooding of road surface.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% fo climate change (check performed for 40% increase) Climate change allowance in critical drainage areas increased to +40%	Resilience achieved through design	Very unlikely	Major	Low	Low	High	Medium	
17	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	Flooding of access roads and/or road infrastructure.	. Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% fo climate change (check performed for 40% increase) Climate change allowance in critical drainage areas increased to +40%	Resilience achieved through design	Very unlikely	Major	Low	Low	High	Medium	
				Increase risk of sewage overflow in floodwater			Attenuation ponds designed for 1/100 year event +20% fo	יר אר							
18	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	causing damage and impacting health of maintenance workers.	Operation	Drainage	Climate change allowance in critical drainage areas increased to +40%	Resilience achieved through design	Very unlikely	Moderate	Low	Medium	High	High	
19	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	Increased risk of scouring of culverts.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% fo climate change (check performed for 40% increase) Climate change allowance in critical drainage areas increased to +40%	Resilience achieved through design	Unlikely	Minor	Very Low	Medium	Medium	Medium	
20	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	Flooding causing damage to fibre optic cables running near to site.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% fo climate change (check performed for 40% increase) Climate change allowance in critical drainage areas increased to +40%	Resilience achieved through design	Very unlikely	Minimal	Very Low	Medium	High	High	
21	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	Increased pore water pressure in embankments/cuttings.	Construction and Operation	Earthworks	To be mitigated through drainage design Risk likely to be absorbed by conservative assumptions made during design	Resilience achieved through design	Very unlikely	Catastrophic	Medium	Low	Medium	Low	
22	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	Increased erosion at toe of embankment.	Operation	Earthworks	To be mitigated through drainage design Risk likely to be absorbed by conservative assumptions made during design	Resilience achieved through design	Unlikely	Catastrophic	Medium	Low	Medium	Low	
23	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	Water ingress to critical construction equipment.	Construction	Drainage	Drainage on site to be suitably managed, as specified with the outline EMP	in Resilience achieved through management plan monitoring environmental impacts	Very unlikely	Minor	Very Low	Low	Low	Low	
24	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	Water ingress to signalling, lighting and other operational electrical equipment.	Operation	Electrical Equipment	Water tight cables housed in plastic ducts. No water ingress to underground cables.	Resilience achieved through design	Very unlikely	Minor	Very Low	Low	Low	Low	
25	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources.	Change in ground water level affecting earth pressures and foundation settlement causing possible large ground movement	Operation	Drainage	To be mitigated through drainage design Risk likely to be absorbed by conservative assumptions made during design	Resilience achieved through design	Very unlikely	Catastrophic	Medium	Low	Medium	Low	
26	High precipitation		Increased risk of flooding from river/streams, surface and groundwater sources	Increased risk of debris deposit from water seeping up to the surface through the pavement e.g. calcium	Operation	Road Surface	Weather and weather effects on traffic considered within pavement design	Resilience achieved through design	Unlikely	Moderate	Low	Low	Low	Low	
27	High precipitation		Increased risk of flooding from river/streams,	Sulphate leading to reduced skid resistance. Construction site flooding during construction phase excavations flooded and site roads impassable.	e, Construction	Drainage	Drainage on site to be suitably managed, as specified with the outline EMP. H&S procedures to be further specified	nin Resilience achieved through management plan monitoring	Unlikelv	Moderate	Low	Low	Low	Low	
			Surrace and groundwater sources.	workers.			within the outline EMP								
28	High precipitation		surface and groundwater sources.	flooding of underpasses.	Operation	Drainage	To be mitigated through drainage design	Resilience achieved through design	Unlikely	Minor	Very Low	Low	Medium	Low	
29	High precipitation		Increased soil moisture levels.	Increased risk of earthworks failure and landslides. Exacerbated by variance between high and low precipitation events and soil moisture levels. (The mark against noise barriers assumes that they are in the form of bunds).	Construction and Operation	Earthworks	To be mitigated through geotechnical and drainage design Risk likely to be absorbed by conservative assumptions made during design	Resilience achieved through design	Unlikely	Catastrophic	Medium	Low	Medium	Low	

Climate change risk assessment



30 High precipitation	Increase likelihood of debris and sediment rur off.	n- Reduced capacity of attenuation ponds due to sediment build-up.	Operation	Drainage	Risk to be mitigated through the monitoring and maintenance procedures specified for the relevant attenuation ponds.	Resilience achieved through monitoring and maintenance of asset	As likely as not	Minor	Low	Medium	Medium	Medium	
31 High precipitation	Increase likelihood of debris and sediment rur off.	n- gulleys, blocking them. A blockage may result in flooding and resulting effects.	Operation	Drainage	Mitigated through drainage design and monitoring and maintenance procedures proposed for drainage systems	Resilience achieved through design and monitoring and maintenance of asset	Unlikely	Major	Medium	Medium	Medium	Medium	
32 High precipitation	Increase in number of wet days may impact the damage to road surface	Increase stripping rate of the road surfaces	Operation	Road Surface	This risk will be managed through the proposed maintenance regimes for road surface.	Resilience achieved through maintenance	Unlikely	Minor	Very Low	Medium	High	High	
33 High precipitation	Increase in number of wet days may impact the damage to road surface	Wetter surface may lead to reduced skid resistance	e Operation	Road Surface	This risk will be managed through the selection of suitable road surface material as well as through the proposed maintenance regimes for road surface.	Resilience achieved through design and monitoring and maintenance of asset	Unlikely	Major	Medium	Low	Low	Low	
34 High precipitation	Increase in number of wet days may impact the damage to road surface	Increased likelihood of potholing, rutting and cracking from moisture entering and remaining in road surfaces.	Operation	Road Surface	This risk will be managed through the proposed maintenance regimes for road surface.	Resilience achieved through maintenance	Likely	Minor	Medium	Low	Low	Low	
35 High precipitation	Increased flow of groundwater	Increased flow of groundwater causing accelerated weathering effects, weakening the embankment	d Operation	Earthworks	Risk likely to be absorbed by conservative assumptions made during design	Resilience achieved through design	Very unlikely	Major	Low	Medium	High	High	
36 Low precipitation	Increased risk of soil shrinkage around foundations of structures.	Potential risk of soil shrinkage impacting foundations, including signal gantries, lighting pylons, bridges, other structures. Possible ground movement (check differential settlement due to different types of foundations)	Operation	Earthworks	to be confirmed Risk likely to be absorbed by conservative assumptions made during design	Resilience achieved through design	Very unlikely	Major	Low	Medium	Medium	Medium	
37 Low precipitation	Dry weather for extended periods of time could lead to increased desiccation of soils.	Reduced slope stability and potential earthworks failure during or immediately after summer storm events falling on desiccated soils. (The mark agains noise barriers assumes that they are in the form of bunds).	st Construction and Operation	Earthworks	to be confirmed Risk likely to be absorbed by conservative assumptions made during design	Resilience achieved through design	Unlikely	Catastrophic	Medium	Medium	Medium	Medium	
38 Low precipitation	Dry weather for extended periods of time could lead to increased desiccation of soils.	Earthing and thermal/electrical conductivity issues for high voltage or dynamically loaded cables - in typical ground conditions (i.e. near surface geology and subsoil), ground resistance and electrical and thermal conductivity of earthing arrays and high voltage cables are controlled by a range of factors including the presence of moisture (% water saturation) and temperature. As ground moisture decreases, conductivity also decreases and ground 'resistance' therefore increases.	, Operation	Earthworks	High voltage cables largely overhead - suspended on pylon.	Resilience achieved through current methods in place.	Very unlikely	Minor	Very Low	Low	Medium	Low	
39 Low precipitation	Reduced inflow into attenuation ponds.	Anaerobic conditions may occur, risking die back of sediment collecting species, reducing attenuation pools functional capacity.	f Operation	Drainage	Risk to be mitigated through the monitoring and maintenance procedures specified for the relevant attenuation ponds.	Resilience achieved through monitoring and maintenance of asset	As likely as not	Minor	Low	Medium	High	High	
40 Extreme winds	Risk of windborne debris due to extreme winds.	Possible blockage of drainage systems due to obstructions and debris from domestic or third party objects.	y Operation	Drainage	Mitigated through drainage design and monitoring and maintenance procedures proposed for drainage systems	Resilience achieved through design and monitoring and maintenance of asset	Very unlikely	Minor	Very Low	Medium	Medium	Medium	
41 Extreme winds	Risk of windborne debris due to extreme winds.	Increased risk of wind-blown debris on the road, affecting road safety.	Operation	Road Surface	To be mitigated through appropriate design for barriers (incl. noise barriers), lighting columns and landscape	Resilience achieved through design	Unlikely	Major	Medium	High	Medium	High	
42 Extreme winds	Increase wind impacting construction activity.	Increase risk of wind interference with construction equipment and workers, particularly with temporary equipment.	Construction		to be mitigated as described in the outline EMP.	Resilience achieved through management plan monitoring environmental impacts	Unlikely	Major	Medium	High	High	High	
43 Extreme winds	Increased stress on proposed scheme infrastructure due to extreme winds.	Failure of or damage to assets as a result of changes in extreme winds.	Operation	Structures	Risk sufficiently mitigated within current design standards (structures, lighting columns, noise barriers)	Resilience achieved through current methods in place.	Unlikely	Major	Medium	High	Medium	High	
44 Extreme winds	Increased stress on electrical equipment due to extreme winds.	Failure of or damage to assets as a result of changes in extreme winds.	Operation	Electrical Equipment	Risk sufficiently mitigated within current design standards	Resilience achieved through current methods in place.	Unlikely	Moderate	Low	High	Medium	High	
45 Lightning	Increased risk of lightning strikes.	Indirect/ direct damage to roadside equipment lightning strikes damaging trees and vehicles.	Operation	Electrical Equipment	Surge protection only available for the LED luminaires locally, no plan for surge protection to the main electrical installation.	Resilience achieved through design	Unlikely	Moderate	Low	High	Medium	High	

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Project Timeframes	Data from climate productions				change these	Examples in Croy								
Risk ID Climate hazard	Trend or Likelihood of Climate Hazard	Potential Climate Change Impact	Potential Climate Change Risk to Scheme	Construction/Operation Stage	Asset type	Existing or embedded mitigation measure Res	sult of mitigation measure on resilience	Hazaro	Impact	Risk rating (	Uncerta CC Projection	CC effect on asset	Level of Proposed additional resilience measure (only if Risk Rating = 'High' (4) or 'Very high' (5))	Reference documenting relevant mitigation
1 High temperatures		Increased number of extremely hot days	Rail buckling and/or associated misalignment problems.	Operation	Rail Infrastructure	The design shall take into account climate change requirements for specific structure types including effects of increase in temperature. Further more heat watchmen will be deployed to look for risk signs and imposing restrictions. In addition, track is more likely to buckle when the ballast has been recently disturbed and so restrictions placed on track work in hot weather. Climate change allowances are also considered for steel material selection. Maintenence and monitoring measures will also be put in place with particular focus on preventing derailment due to a track fault.	e achieved through design and monitoring and nee of asset	Very unlikely	Catastrophic	Medium	Low	Medium	Low	
2 High temperatures		Increased number of extremely hot days	Increased heat stress for passengers and staff on trains	Operation	Human Factors	Trains will be air conditioned - but this is not being considered as part of the Hybrid Bill		Unlikely	Minimal	Very Low	Low	Medium	Low	
3 High temperatures		Increased number of extremely hot days	Increased heat stress for staff, particularly for outdoor maintenance workers.	Construction and Operation	Human Factors	Risk for staff working indoors is mitigated by Buildings being designed to BREEAM "Excellent Rating" which includes appropriate climate change measures. During construction principle contractors being aware of and taking appropriate measures during extreme weather events.	e achieved through management and monitoring	Unlikely	Minor	Very Low	Low	Medium	Low	
4 High temperatures		Increased number of extremely hot days	Increased heat stress for staff, particularly outdoor construction workers.	Operation	Human Factors	Risk of heat stress to staff during construction is mitigated by principle contractors being aware of and taking appropriate measures during extreme weather events. Plus	e achieved through management and monitoring	Unlikely	Minor	Very Low	Low	Medium	Low	
5 High temperatures		Increased number of extremely hot days	Overhead line equipment (OLE) including overhead lines (OHL) and traction distribution sites (ATFS, ATS) may fail to operate properly under extreme heat resulting in a reduction in electrical loading capability, fail to operature properly or be damaged.	Operation	Mechanical & Electrical Equipment	Risk of overheating of OLE and OHL is mitigated by design to be resilient to CC using existing design standards.	e achieved through current design methods in	Unlikely	Moderate	Low	Medium	Medium	Medium	
6 High temperatures		Increased number of extremely hot days	Increased risk of thermal expansion joints being pushed beyond their design capability, presenting a direct risk of damage to bridge structures and indirect of damage of other assets dependent on bridge.	Operation	Rail Infrastructure	The standard requires that climate change is incorporated in to bridge design, which consider a maximum shade air temperature of 40 degrees Celsius with an annual probability of being exceeded p of 0.0083, equivalent to 120 years design life.	e achieved through design and monitoring and nce of asset	Unlikely	Major	Medium	Low	Medium	Low	
7 High temperatures		Increased number of extremely hot days	Impact of extreme hot weather could lead to increase in auxiliary power demand (cooling) on trains resulting in increase demands on traction power system above design basis, leading to impac on train mechanical performance and journey times and overloading of electrical equipment, cabling and conductors.	ot Operation	Mechanical & Electrical Equipment	To be considered and addressed in future design stages		As likely as not	Minor	Low	Medium	Medium	Medium	
8 High temperatures		Increasured number of extremely hot days may lead to shrinkage of soil and drying out of vegetation, especially in conjunction with decreases in groundwater level.	Planting failures may occur due to drought.	Operation		Removal of planting has deterimental impact on stability of embankments. Mitigated against in embankment standard. Constraints are also placed on high-water demand plants. Plant selection also takes into account CC. Furthermore green bridges will have appropriate measures put in place to ensure water retention accounting for climate change.	e achieved through design and monitoring and noe of asset	Unlikely	Minimal	Very Low	Low	Medium	Low	
9 High temperatures		Increasured number of extremely hot days may lead to shrinkage of soil and drying out of vegetation, especially in conjunction with decreases in groundwater level.	Extended periods of hot days may lead to a risk of spontaneous grassland fires in vicinity of the route.	Operation	Rail Infrastructure	The risk of grassland fires in the Midlands/North West of England is very low. Therefore there are no explicit resilience measures put in place. However lineside vegetation species will be selected to be resilient to drought and appropriately managed and maintained.	e achieved through selection in design	Very unlikely	Minor	Very Low	Medium	High	High	
10 Low temperatures		Impact of extreme cold weather on line equipment and infrastructure.	Overhead line equipment (OLE) including overhead lines (OHL) or aerial busbars/connections of outdoo switchgear at traction power distribution sites (ATFS ATS etc) may fail may fail due to snow overloading. Also sensitive electronic equipment (protection, control etc) and mechanical 'operating mechanisms/moving parts/motors/solenoids' may fail to operate correctly due to low temperatures or freezing.	or S, Operation	Mechanical & Electrical Equipment	Low temperature risks to OLE/OHL mitigated by X, Y, Z Asset is desisgned to be resilient to CC using existing design standards.	e achieved through design	Unlikely	Moderate	Low	Low	Medium	Low	
11 Low temperatures		Impacts of extreme cold on train relability and operation.	Reliability of trains may reduce at low temperatures due to: Failure of train horns due to ice/snow accretion, Failure of sliding doors, couplers and pneumatic devices due to ice, snow and ice accretion reduces effectiveness of brakes, traction motor failures due to snow and/or water ingress, damage from snow and/or ice accretions being dislodged at speed. Freight trains more susceptible	Operation e.	Rail Infrastructure	Rolling stock not being considered as part of the Hybrid Bill		Unlikely	Minor	Very Low	Low	Medium	Low	
12 Low temperatures		Impact of extreme cold weather on staff and passenger health.	Possible negative health implications for passengers and staff, disruption to service operation	Operation	Human Factors	tbc		Unlikely	Minimal	Very Low	Low	Medium	Low	
13 Low temperatures		Impact of extreme cold weather on staff health.	Possible negative health implications for staff, disruption to construction	Construction	Human Factors	Risk of heat stress to staff during construction is mitigated by principle contractors being aware of and taking contractions during outcome worther events	e achieved through management and monitoring	Unlikely	Minimal	Very Low	Low	Medium	Low	
14 Low temperatures		Overall prevalance of cold conditions and snowfall, but cold weather events have the potential to be more extreme.	General risk of freezing of mechanical and electrical equipment	l Operation	Mechanical & Electrical Equipment	Risk of mechanical and electrical equipment is mitigated through the Infrastructure maintenance strategy which includes preventative measures.	e achieved through maintenance	Unlikely	Minimal	Very Low	Medium	Medium	Medium	
15 Low temperatures		Overall prevalance of cold conditions and snowfall, but cold weather events have the potential to be more extreme.	Increase risk of rail breaks due to extreme cold conditions.	Operation	Rail Infrastructure	The design shall take into account Climate change allowances for steel material selection. Maintenence and monitoring measures will also be put in place with particular focus on preventing derailment due to a track fault.	e achieved through design and monitoring and nee of asset	Very unlikely	Catastrophic	Medium	Medium	Medium	Medium	
16 Low temperatures		Overall prevalance of cold conditions and snowfall, but cold weather events have the potential to be more extreme.	Impact of extreme cold weather could lead to increase in auxiliary power demand (heating) on trains resulting in increase demands on traction power system above design basis, leading to impact on train mechanical performance and journey times and overloading of electrical equipment, cabling and conductors.	ot Operation	Mechanical & Electrical Equipment	To be considered and addressed in future design stages		As likely as not	Minor	Low	Medium	Medium	Medium	
17 High precipitation		Increased risk of flooding from river, surface and groundwater sources.	Flooding of track.	Operation	Rail Infrastructure	Rail line is designed to an appropriate extreme rainfall event (1 in 100 + climate change) with additional freeboard allowance (1m). This will protect the railway infrastructure from floodwater ensuring that the line will remain operational or can restart without delay. Drainage will also include additional allowance for climate change. During operation regular maintenence strategies will be put in place to ensure continual operation of infrastructure.	e achieved through design and maintenance	Unlikely	Major	Medium	Low	Low	Low	
18 High precipitation		Increased risk of flooding from river, surface and groundwater sources.	Flooding of tunnel portals	Operation	Rail Infrastructure			Unlikely	Major	Medium	Low	Medium	Low	
19 High precipitation		Increased risk of flooding from river, surface and groundwater sources.	Flooding of access roads and/or road infrastructure linked to HS2, such as access routes for HS2 staff and neighbouring landowners.	Operation	Rail Infrastructure	Access and maintenance routes are designed to 1 in 100 year + CC	e achieved through design	Unlikely	Moderate	Low	Low	Medium	Low	
20 High precipitation		Increased risk of flooding from river, surface and groundwater sources.	Water ingress to critical equipment, including traction power distribution sites (ATFS, ATS), leading to signalling or other electronic equipment failures, requiring switchoff or, possibly causing damage.	Operation	Mechanical & Electrical Equipment	Automatic Transformer (Feeder) Stations (AT(F)S) are essential in delivering traction power supply to the route. Where practical, ATFS/ATS will be located outside of EA flood zones. Where not practical, ATFS/ATSs will be located at flood level with sufficient freeboard. Tunnel Portals shall be protected by raising the entrance by 300mm above the 1 in 1000 year flood level from all sources without the need for intervention (passive provision).	e achieved through design	Unlikely	Major	Medium	Low	Medium	Low	
21 High precipitation		Increased risk of flooding from river, surface and groundwater sources.	Construction site flooding during construction phase excavations flooded and site roads impassable. Safety risk of slips, trips and falls to construction workers.	e, Construction	Human Factors	Flood risk during construction is mitigated by contractors paying due notice of extreme weather events and there impacts. Measures on site will also be put in place to prevent flooding.	e achieved through monitoring	Unlikely	Minor	Very Low	Medium	Medium	Medium	
22 High precipitation		Increased risk of flooding from river, surface and groundwater sources.	Increased risk of scouring of bridge piers and abutments during periods of peak river flow.	Operation	Rail Infrastructure	Scouring risk is reduced through use of reinforced concrete to strengthen structure of abutments and piers. A remaining operational risk will remain as a result of scouring of river beds during peak river flow.	e achieved through design	Unlikely	Major	Medium	Medium	Medium	Medium	

Climate change risk assessment



23 High precipitation	Increased soil moisture levels.	Increased risk of earthworks failure and landslides. Exacerbated by variance between high and low precipitation events and soil moisture levels.	Operation	Earthworks	Risk of earthworks failure mitigated by drainage design to be resilient to 1/1000 year event and be designed to a 1/100year + CC event. This is coupled with appropriate material and planting selction to ensure embankment stability as well as continued maintenence of embankments and drainage.	Resilience achieved through design and maintenance	Unlikely	Major	Medium	Low	Medium	Low	
24 Low precipitation	Increased risk of soil shrinkage around foundations of structures.	Movement of OHL equipment due to soil shrinkage.	Operation	Earthworks	Risk of earthworks shrinkage mitigated by appropriate material and planting selction to ensure embankment stability as well as continued maintenence of embankments and drainage.	Resilience achieved through design and maintenance	Very unlikely	Major	Low	Medium	Medium	Medium	
25 Low precipitation	Dry weather for extended periods of time could lead to increased dessication of soils.	Lowered slope stability and potential earthworks failure during or immediately after summer storm events falling on dessicated soils.	Operation	Earthworks	Risk of lowered slope stability is mitigated by limiting the gradient of slopes as well as appropriate material and planting selction to ensure embankment stability as well as continued maintenence of embankments and drainage. Planting will be to appropriate depths to prevent desication of soils.	Resilience achieved through design and maintenance	Unlikely	Major	Medium	Medium	Medium	Medium	
26 Low precipitation	Dry weather for extended periods of time could lead to increased dessication of soils.	Earthing and thermal/electrical conductivity issues for high voltage or dynamically loaded cables - in typical ground conditions (i.e. near surface geology and subsoil), ground resistance and electrical and thermal conductivity of earthing arrays and high voltage cables are controlled by a range of factors including the presence of moisture (% water saturation) and temperature. As ground moisture decreases, conductivity also decreases and ground 'resistance' therefore increases.	Operation	Earthworks	Thermal / electrical conductivity risks mitigated by protection of earthworks against any accelerated degredation. Appropriate maintenance of earthworks also enables the train service to operate under all environmental conditions thoughout their life cycle.	Resilience achieved through maintenance	Very unlikely	Moderate	Low	Medium	Medium	Medium	
27 Low precipitation	Dry weather for extended periods of time could lead to increased dessication of soils.	Impact on the effectiveness of earthing systems of traction power distribution sites (ATFS, ATS etc), leading to possibility of dangerous Earth Potential Rise and touch voltages. Similarly on effectiveness of OCS foundation earthing leading to possibility of dangerous trackside touch voltages.	Operation	Earthworks	Thermal / electrical conductivity risks mitigated by protection of earthworks against any accelerated degredation. Appropriate maintenance of earthworks also enables the train service to operate under all environmental conditions thoughout their life cycle.	Resilience achieved through maintenance	Very unlikely	Major	Low	Medium	High	High	
28 Extreme winds	Risk of windborne debris due to extreme winds.	Possible blockage of railway drainage systems due to obstructions and debris from domestic or third party objects, as well as potentially landing on track and causing damage to OHL.	Operation	Drainage	Appropriate monioring and inspections will be carried out with increased inspections and remote monitoring for high risk areas. Specific tree will be avoided within the HS2 line side boundary to minimise the risk associated with leaf fall and high winds. Debris can be carried by watercourses during floods. Flood Risk TN details that a min of 600mm above the 1/100 plus CC should apply to the lowest part of the bridge soffit levels to account for this.	Resilience achieved through design selection and monitoring and maintenance of asset	Unlikely	Minor	Very Low	Medium	Medium	Medium	
29 Extreme winds	Increased stress on trees due to extreme winds leads to risk of trees/branches falling and changes to leaf fall patterns. Exacerbated by other factors e.g. seasonal precipitation and temperature patterns.	Obstructions and debris on track and damage to OHL from fallen trees / branches.	Operation	Rail Infrastructure	Appropriate monioring and inspections will be carried out with increased inspections and remote monitoring for high risk areas. Specific tree will be avoided within the HS2 line side boundary to minimise the risk associated with leaf fall and high winds.	Resilience achieved through design selection and monitoring and maintenance of asset	Unlikely	Minor	Very Low	Medium	Medium	Medium	
30 Extreme winds	Increased stress on trees due to extreme winds leads to risk of trees/branches falling and changes to leaf fall patterns. Exacerbated by other factors e.g. seasonal precipitation and temperature patterns.	Increased disruption from autumn leaf fall or changed temporal patterns of leaf fall.	Operation	Rail Infrastructure	Appropriate monioring and inspections will be carried out with increased inspections and remote monitoring for high risk areas. Specific tree will be avoided within the HS2 line side boundary to minimise the risk associated with leaf fall and high winds.	Resilience achieved through design selection and monitoring and maintenance of asset	Very unlikely	Minor	Very Low	Medium	High	High	
31 Extreme winds	Increased stress on trees due to extreme winds leads to risk of trees/branches falling and changes to leaf fall patterns. Exacerbated by other factors e.g. seasonal precipitation and temperature patterns.	Wind interference with construction equipment and workers, particularly with temporary equipment.	Construction	Mechanical & Electrical Equipment	Changes to long-term seasonal averages are not considered to be as significant by 2020s and therefore specific resilience measures to address these changes are not required during the construction phase.	Resilience measures not required	Very unlikely	Minimal	Very Low	High	High	High	
32 Extreme winds	Increased stress on Proposed Scheme infrastructure due to extreme winds.	Failure of or damage to parts of structure or infrastructure as a result of changes in extreme winds. Noise barriers and fencing are likely to be most at risk.	Operation	Rail Infrastructure	in Phase 2a are deemed not to be sensitive to wind loading as there are no slender/suspension bridge type of structures.	Resilience measures not required	Very unlikely	Minor	Very Low	Medium	Medium	Medium	
33 Extreme winds	Increased stress on Proposed Scheme infrastructure due to extreme winds.	Failure of or damage to electrical and mechanical equipment including aerial busbars/connections of outdoor switchgear at traction power distribution sites (ATFS, ATS etc) may fail or be damaged	Operation	Mechanical & Electrical Equipment	Due to the high uncertainty in projection of wind events assets will be designed to existing standards, as climate change is unlikely to increase the peak high wind event.	Current resilience measures sufficient	Unlikely	Minor	Very Low	High	High	High	
34 Lightning	Increased risk of lightning strikes.	Indirect damage to buildings, structures, lineside equipment and equipment and cabling traction power distribution sites from lightning strikes damaging trees.	Operation	Rail Infrastructure	Risk of damage to assets is partially mitigated by If vegetation should be struck by lightning trees should not fall onto route of train. This is the primary risk for this hazard.		Very unlikely	Moderate	Low	High	Medium	High	
35 Lightning	Increased risk of lightning strikes.	Direct damage to buildings, structures, lineside equipment and equipment and cabling traction power distribution sites from lightning strikes.	Operation	Rail Infrastructure	To be addressed during further design stages.	Resilience achieved through design and maintenance	Unlikely	Moderate	Low	High	Medium	High	
36 Lightning	Increased risk of lightning strikes.	Safety risk to construction equipment and workers.	Construction	Human Factors	Risk of safety risk to construction workers due to lightning is mitigated by lead contractors taking appropriate measures to manage extreme weather events		Very unlikely	Major	Low	High	Medium	High	
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Project Timeframe	3					change these									
Risk ID	Climate hazard	Data from climate predictions Trend or Likelihood of Climate Hazard	Potential Climate Change Impact	Potential Climate Change Risk to Scheme	Construction/Operation Stage	Asset type	Examples in Grey Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazar Likelihood	rd Impact Consequence	Risk rating	Uncert CC Projection	ainty Level CC effect on asset	Level of Uncertainty	Proposed additional resilience measure (only if Risk Rating = 'High' (4) or 'Very high' (5)) Reference documenting relevant mitigation
1	High temperatures		Increased number of extremely hot days.	Increased heat stress for passengers and staff during operation of the airport; negative impacts on passenger experience	Operation	Airport Operation	technologies to reduce manual handling activities, onsite medical and occupational health facilities (see risk ID CCA	Resilience achieved through equipment selection and monitoring	Unlikely	Minor	Very Low	Low	Medium	Low	No additional resilience measures required.
2	High temperatures		Increased number of extremely hot days.	Sensitive electronic equipment and mechanical operating mechanisms may fail to operate correctly due to high temperatures.	Operation	Electronic Equipment	No current measures identified relating to resilience of electronic and mechanical systems to prolonged periods of high temperatures.		Very unlikely	Major	Low	Low	High	Medium	Recommend that STAL review and ensure robustness of electronic and mechanical systems to future temperature changes.
3	High temperatures		Increased number of extremely hot days.	Possible increase in number of days outside the normally acceptable range of conditions for cooling	Operation	Electronic Equipment	HVAC systems and controls, building management system, temporary spot cooling (fans) if needed, monitoring of temporatures in buildings (see risk ID CCA26)	Resilience achieved through equipment selection and monitoring	Very unlikely	Minor	Very Low	Low	Medium	Low	Recommend that STAL review temperature thresholds for cooling systems to ensure effective and efficient provision of cooling with increased passengers and higher temperatures in future.
4	High temperatures		Increased number of extremely hot days.	Flashpoint of aviation fuel exceeded on hot days, leading to delays in re-fuelling procedures.	Operation	Flights	Airside fuelling operations in line with Civil Aviation Publication (CAP) 748[i] (see risk ID CCA19).	Current resilience method sufficient	Unlikely	Moderate	Low	Low	Low	Low	No additional resilience measures required.
5	High temperatures		Increased number of extremely bot days	Possible increase in occurrence of days outside the acceptable range of temperatures affects aircraft and their utilisation schedule, due to air pressure		Flights	Measures relating to allowances in maximum take-off weight		Linikely	Moderate	Low	Low	Medium	Low	Recommend that STAL collaboratively review airline operators' allowances for
				changes affecting maximum take-off weight capacity.			by airline operators; recommend STAL review these.								within tolerance of extreme hot day occurrences.
6	Low temperatures		Extreme cold weather.	operating mechanisms may fail to operate correctly due to low temperatures or freezing	Operation	Electronic Equipment	regular inspections and rapid maintenance response (see risk ID CCA09).	Resilience achieved through monitoring	Unlikely	Catastrophic	Medium	Low	Medium	Low	No additional resilience measures required.
7	Low temperatures		Extreme cold weather.	Reliability of journeys may reduce at low temperatures due to cracking of pavement surfaces and snow/ice accretion on aircraft and runways/airfield pavements causing delays.	<sup>3</sup> Operation	Airport Infrastructure	Annual review of winter response, snow contingency plans, de-icing procedures; new snow clearing equipment purchased in 2015/16 (see risk ID CCA09).	Resilience achieved through monitoring and emergency planning	Unlikely	Moderate	Low	Low	Medium	Low	No additional resilience measures required.
8	Low temperatures		Extreme cold weather.	Possible negative health implications for passengers and staff, disruption to service operation.	Operation	Airport Operation	Disruption contingency plans, diversification of surface access toward public transport, HVAC systems and controls, onsite medical staff (see risk IDs CCA12 and CCA26).	Resilience achieved through monitoring and emergency planning	Unlikely	Minor	Very Low	Low	Low	Low	No additional resilience measures required.
9	Low temperatures		Extreme cold weather.	Possible increase in number of days outside the normally acceptable range of conditions for heating systems and increased risk of HVAC failure.	Operation	Electronic Equipment	Annual review of winter response and contingency plans, regular inspections and rapid maintenance response (see risk ID CCA09). HVAC systems and controls, building management system, monitoring of temperatures in buildings (see risk ID CCA26).	Resilience achieved through monitoring and emergency planning	Unlikely	Minor	Very Low	Low	Low	Low	No additional resilience measures required.
10	High precipitation		Increased frequency of flooding from river, surface and groundwater sources.	Flooding of infrastructure during operation: inundation of airfield, airport building basements and sub-structures, utility cables/tunnels	d Operation	Airport Infrastructure	A Flood Risk Assessment is currently being carried out in accordance with Climate Change Adaptation Progress Report2 (see risk ID CCA15). The results are reported in an Appendix to the ES		Very unlikely	Catastrophic	Medium	Low	Medium	Low	Continue to monitor extreme precipitation events on airport infrastructure including balancing pond system. Action plan to be put in place where capacity of balancing pond system is exceeded.
11	High precipitation		Increased frequency of flooding from river, surface and groundwater sources.	Flash flooding, erosion/scouring of embankment areas, ground destabilisation and possible weakening of foundations.	Construction and Operation	Earthworks	A Flood Risk Assessment is currently being carried out in accordance with Climate Change Adaptation Progress Report2 (see risk ID CCA15). The results are reported in an Appendix to the ES.		Very unlikely	Catastrophic	Medium	Low	Medium	Low	Continue to monitor extreme precipitation events on airport infrastructure including balancing pond system. Action plan to be put in place where capacity of balancing pond system is exceeded.
12	High precipitation		Increased frequency of flooding from river, surface and groundwater sources.	Flooding of infrastructure connecting to the airport during operation: inundation of access roads and railways. Effects of infrastructure interdependencies	Operation S.	Airport Infrastructure	Interdependencies not currently addressed in CCARP.		As likely as not	Minor	Low	Low	Medium	Low	Recommend risk assessment of interdependencies as suggested by CCC4.
13	High precipitation		Increased soil moisture levels.	Increased intensity of rainfall may increase risk of earthworks failure and landslides, saturation of sub- grade pavement layers and degradation.	Construction and Operation	Earthworks	Regular inspections, rapid maintenance response, regular surface relaying (see risk ID CCA25). Increased monitoring including weather warnings, emergency contingencies for areas affected by flooding and water ingress, ongoing monitoring and modelling dialogue with Environment Agency and Affinity Water (see risk ID CCA16).	Resilience achieved through monitoring and emergency planning	Unlikely	Catastrophic	Medium	Low	Medium	Low	No additional resilience measures required.
14	Low precipitation		Increased risk of soil shrinkage around foundation of structures.	Movement of shallow foundations.	Construction and Operation	Earthworks	Regular inspections, rapid maintenance response, regular surface relaying (see risk ID CCA25). Increased monitoring including weather warnings.	Resilience achieved through monitoring and emergency planning	Very unlikely	Catastrophic	Medium	Low	Medium	Low	No additional resilience measures required.
15	Low precipitation		Increased desiccation of soils.	Increased slope stability, but potential earthworks failure after summer storm events on desiccation- cracked soils.	Construction and Operation	Earthworks	Regular inspections, rapid maintenance response, regular surface relaying, surfaces defined by detailed design standards based on current best practice (see risk ID CCA25)	Resilience achieved through monitoring and emergency planning	Unlikely	Catastrophic	Medium	Low	Medium	Low	No additional resilience measures required.
16	Extreme winds		Risk of windborne debris due to strong winds.	Possible debris on runways and other airport infrastructure causing delays (foreign object debris).	. Operation	Airport Infrastructure	Regular inspection and contingency plans (see risk ID CCA14).		Unlikely	Moderate	Low	Low	Low	Low	No additional resilience measures required.
17	Extreme winds		Risk of windborne debris due to strong winds.	Vegetation fall due to strong winds leading to road and rail disruption	Operation	Airport Infrastructure	Regular inspection and contingency plans (see risk ID CCA14). Interdependencies not currently addressed in CCARP.	Resilience achieved through monitoring and emergency planning	Unlikely	Moderate	Low	Low	Medium	Low	Recommend risk assessment of interdependencies as suggested by CCC4.
18	Extreme winds		Increased stress on infrastructure and assets due to strong winds.	Failure or damage to parts of structure or infrastructure as a result of changes in strong winds and gustiness.	Operation	Airport Infrastructure	Reparation programme, electrical resilience strategy under development, design standards, regular inspections and maintenance as needed, operational guidance for airside staff in strong winds (see risk IDs CCA04 and CCA14).	Resilience achieved through monitoring and maintenance	Unlikely	Major	Medium	Low	Medium	Low	No additional resilience measures required.
19	Extreme winds		Increased stress on infrastructure and assets due to strong winds.	Change to prevailing wind direction and vortex effect may affect runway utilisation and schedules according to traffic flow sequencing and delay recovery to the flight schedule, including landing movement rates, interference with aircraft landing and take-offs.	Operation	Flights	Air Traffic Control procedures e.g. separation distances, contingency plans for disruption (see risk IDs CCA05 and CCA06).	Current resilience measures in place, with emegency planning	Very unlikely	Major	Low	Medium	High	High	No additional resilience measures required.
20	Extreme winds		Cross-wind speeds exceed limits for take-off and landing.	Aircrafts not permitted to land or take off, causing delays.	Operation	Flights	Air Traffic Control procedures e.g. separation distances, contingency plans for disruption (see risk IDs CCA05 and CCA06).	Current resilience measures in place, with emegency planning	Likely	Moderate	Medium	Low	Low	Low	Check cross-wind speed limits with airline operators and assess risks using historical and projections data.
21	Lightning		Increased risk of lightning strikes.	Indirect and direct damage to buildings, infrastructure, aircraft, equipment from lightning strikes.	Operation	Airport Infrastructure	Suspension of refuelling, dual feed electricity supply, monitoring and weather warnings, electrical resilience strategy under development, power outage contingencies (see risk ID CCA07).	Resilience achieved through monitoring and maintenance	Very unlikely	Major	Low	Medium	Medium	Medium	No additional resilience measures required.
22	Lightning		Increased risk of lightning strikes.	Suspension of activities on the ramp by ground handling agents, delaying the service and turnaround times for aircraft and stressing terminal/gatehouses.	d Operation	Flights	Suspension of refuelling, dual feed electricity supply, monitoring and weather warnings, electrical resilience strategy under development, power outage contingencies (see risk ID CCA07).	Resilience achieved through monitoring and maintenance	Unlikely	Major	Medium	Medium	Medium	Medium	Recommend close monitoring of lightning and thunderstorm events.
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nate change risk assessment

# Likelihood Rating

Level	Descriptor	Description
A	Very unlikely	Event only occurs in exceptional circumstances and would not be expected to occur in the lifetime of the development
В	Unlikely	Based on the current design, engineering and maintenance standards, the event is not excpected to occur more than once during the lifetime of the development
с	As likely as not	Event may occur at least once during the lifetime of the development
D	Likely	Event is expected to occur several times during the lifetime of the development
E	Very likely	Event is expected to occur many times during the lifetime of the development

# Consequence Rating

Level	Descriptor	Disruption	Public Perception
1	Minimal	Minpr service disruption within a single day <30 mins	Short-term adverse local stakeholder reaction
2	Minor	Minor service disruption for multiple days or delays up to 2h on a single day.	Adverse local media reports over sustained period; localised stakeholder concern.
3	Moderate	Service delays of up to 2h for multiple days or major delays (>2h) in a single day	Significant local and /or regional reports including social media. National media interest creating public concern
4	Major	Service closed for 1 day or major delays for multiple days	Negative national reporting and public disputes with key stakeholders, utility companies or other government agencies such as the Environment Agency.
5	Catastrophic	Service closed for multiple days	Extensive and prolonged negative reporting nationally and or public disputes with key stakeholders.

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	Α	Very Likely	Medium	Medium
poc	в	Likely	Low	Medium
eliho	С	As Likely as Not	Low	Low
Like	D	Unlikely	Very Low	Very Low
	Е	Very unlikely	Very Low	Very Low

# Level of Uncertainty

Uncertainity Level - Climate Change Predicition

Level	Descriptor	Consequence	
Α	Low	>66% probability of climate change hazard occuring	
В	Medium	33-66% probability of climate change hazard occuring	
С	High	<33% probability of climate change hazard occuring	

## Uncertainity Level - Effect of Climate Change on Asset

Level	Descriptor	Consequence	
1	Low	Climate Change event expected to impact scheme as described.	
2	Medium	Climate Change event may impact scheme as described.	
3	High	Climate Change event not expected to impact scheme as described.	

## Uncertainty Level - Effects of Climate Change

			1	2
Uncerainty			Low	Medium
Level -	Α	Low	Low	Low
Change	в	Medium	Low	Medium
Prediction	С	High	Medium	High

Financial	Safety	Damage
Insignificant financial loss.	Minor harm or near miss -no adverse human health effects or complaints.	No damage to assets
Additional operational costs. Minor financial loss.	Lost time injury or medical treatment, short term impact on persons affected	No permanent damage. Some minor restoration work required.
Moderate financial loss.	Long-term injury or illness, porlonged hospitalisation or inability to work	Widespread damage and loss of service. Damage recoverable by maintenance and minor repair. Partial loss of local infrastructure.
Major financial loss.	Single fatality/ multiple long-term injuries-emergency response	Extensive damage requiring extensive repair.
Significantly high financial loss.	Multiple fatalities - emergency response	Permanent damage and/or loss of service Retreat and translocation of development.

Consequence				
3		4		5
Moderate	Major		Catastrophic	

High	Very High	Very High
Medium	Very High	Very High
Medium	High	High
Low	Medium	Medium
Low	Low	Medium



Take highest

#### Project

Risk identification - resilience assessment				
	Mixed-use development Road			
	Rail			
	Airport			
Climate hazard + likelihood of changes	High temperatures	Increase in mean daily temperatures in the summer and winter, increase in the number of hot days (days when daily mean temperature is >25°C) and increased insolation		
	Low temperatures	Decrease in the number of frost days (days when daily minimum temperature <0°C)		
	High precipitation	Increase in mean daily rainfall in the winter, increase in the number of days with heavy rain		
	Low precipitation	Decrease in mean daily rainfall in the summer, increase in the annual number of dry spells		
	Extreme winds	Increase in extreme wind events		
	Lightning	Increase in the number of lighting days, particularly in Autumn		
	Humidity			
	Insolation			

Construction	Operation	Construction and Operation	
Asset type			
Buildings Structures	Traffic and transport Drainage	Public realm Road Surface	Utilities Electrical Equipment
Drainage	Earthworks	Rail Infrastructure	Human Factors
Airport Infrastructure	Electronic Equipment	Flights	Airport Operation

Earthworks

H&S Mechanical & Electrical Equipment Earthworks