

Appendix 15B

CCR Assessment

Climate change risk assessment

Project

Timeframes

Data from climate predictions

Examples in Grey

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	Result of mitigation measure on resilience	Hazard Impact		Uncertainty Level		Level of Uncertainty	Proposed additional resilience measure (only if Risk Rating = 'High' (4) or 'Very High' (5))	Reference documenting relevant mitigation
									Likelihood	Consequence	Risk rating	CC Projection			
1	High temperatures		Rising temperatures impact building performance	Increased temperatures leads to increased HVAC system power demand and increased energy consumption to cool buildings.	Operation	Buildings	Expected temperature increase is within operational range of systems designed to current standards for 20-year design life of HVAC system. Energy efficient systems to be selected.	A level of resilience reached through maintenance of system and regular replacement	Unlikely	Minor	Very Low	Low	Low		
2	High temperatures		Rising temperatures impact building performance	Increased temperatures and extreme heat events 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 resilience 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 resilience 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 road 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 resilience reached through maintenance of asset	Unlikely	Minor	Very Low	Low	Medium	Low	
6	High temperatures		Rising temperatures impact building usage	Opportunity: Increased temperatures lead to increased outdoor recreation opportunities for development occupants	Operation	Public realm									
7	High temperatures		Rising temperatures impact materials performance	Increased temperatures lead to accelerated degradation of materials in outdoor facilities and pavements	Operation	Public realm	Facilities and pavement construction to current standards, monitored as per standard maintenance procedures.	A level of resilience reached through maintenance of asset	Unlikely	Minor	Very Low	Low	Medium	Low	
8	High temperatures		Rising temperatures impact equipment performance	Extreme heat events lead to overheating of overhead electricity transmission lines	Operation	Utilities	Expected temperature increase is within operational range of transmission lines.	Resilience already accounted for.	Unlikely	Minor	Very Low	Low	High	Medium	
9	High temperatures		Increased number of hot days may lead to shrinkage of soil and drying out of vegetation	Extended periods of hot days may lead to a risk of spontaneous grassland fires, causing building damage	Operation	Buildings			Very unlikely	Major	Low	Medium	Medium	Medium	
10	High temperatures		Increased number of hot days may lead to shrinkage of soil and drying out of vegetation	Extended periods of hot days may lead to a risk of spontaneous grassland fires, affecting safety to public.	Operation	Public realm			Very unlikely	Major	Low	Medium	Medium	Medium	
11	Low temperatures		Rising temperatures impact building performance	Opportunity: Fewer frost days leads to decreased energy consumption to heat buildings	Operation	Buildings									
12	Low temperatures		Rising temperatures impact building performance	Opportunity: Fewer frost days leads to improved thermal comfort of building occupants	Operation	Buildings									
13	High precipitation		Increase in number of wet days may cause building damage	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 water supply to building	Opportunity: Extreme rainfall events lead to opportunity for rainwater harvesting	Operation	Buildings									
15	High precipitation		Increased rainfall may cause flooding risk from river and groundwater sources	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 road surface	Extreme rainfall events causing damage to road surface (increased stripping rate, likelihood of potholing from moisture entering cracks in surface)	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 flooding risk from river and groundwater sources	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 flooding	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 sea level rising	Extreme rainfall can cause coastal and inland flooding through rising sea levels. This leads to flooding effects and more coastal salt spray causing corrosion.	Operation	Buildings			Unlikely	Minor	Very Low	Medium	High	High	https://www.labourwarranty.co.uk/blog/oh-we-do-like-to-build-beside-the-seaside/
20	High precipitation		Increased rainfall may cause flooding risk from river and groundwater sources	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 flooding risk from river and groundwater sources	Extreme rainfall events lead to sewer flooding and resulting effects	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 moisture levels	Increased average rainfall and extreme rainfall events lead to increased soil moisture levels, causing landslip and damage to utilities	Operation	Utilities	Design and construction of utilities to current standards, monitored as per standard maintenance procedures.	A level of resilience reached through maintenance of asset	Unlikely	Moderate	Low	Low	High	Medium	
23	High precipitation		Increased rainfall may cause debris and sediment run-off	Extreme rainfall events leading to debris and sediment runoff, causing blockage to drainage systems. Blockage may result in flooding and resulting effects.	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 soil shrinkage	Decreased average rainfall leads to drier soil conditions and soil shrinkage, causing damage to building foundation and possible ground movement.	Operation	Buildings	Shrinkage and desiccation 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 to increased desiccation of soil	Dry spells lead to desiccation of soils, causing reduced slope stability and potential earthworks failure following subsequent rainfall events	Construction and Operation	Buildings	Shrinkage and desiccation 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 water supply to building	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 water supply to building	Decreased average rainfall leads to increased reliance on mains water for landscape irrigation during summer	Operation	Public realm	Landscape Management Plan includes procedures for irrigation during establishment and ongoing maintenance.	A level of resilience reached through maintenance of asset	Likely	Minor	Medium	Low	High	Medium	
28	Low precipitation		Decreased rainfall can reduce water supply to building	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 resilience reached through maintenance of asset	Likely	Moderate	Medium	Low	Medium	Low	
29	Low precipitation		Decreased rainfall may increase soil shrinkage	Decreased average rainfall leads to drier soil conditions and soil shrinkage, causing damage to underground service infrastructure	Operation	Utilities	Shrinkage and desiccation considered in service infrastructure and foundation design however risk is low due to granular soils in local area.	Resilience achieved through design decisions.	Very unlikely	Moderate	Low	Low	Medium	Low	
30	Low precipitation		Increased number of dry days may lead to shrinkage of soil and drying out of vegetation	Extended periods of dry days may lead to a risk of spontaneous grassland fires, causing building damage	Operation	Buildings			Very unlikely	Major	Low	Medium	Medium	Medium	
31	Low precipitation		Increased number of dry days may lead to shrinkage of soil and drying out of vegetation	Extended periods of dry days may lead to a risk of spontaneous grassland fires, affecting safety to public.	Operation	Public realm			Very unlikely	Major	Low	Medium	Medium	Medium	
32	Extreme winds		Increased stress due to extreme wind	High winds lead to increased stress and damage to buildings, especially material fixtures, claddings and fasteners	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 to vegetation	High winds lead to damage to vegetation and trees	Operation	Public realm	Site is exposed and strong winds currently occur, layout of buildings considers mitigation of wind impacts through creation of microclimates.	Resilience achieved through design decisions.	Likely	Minor	Medium	Medium	Medium	Medium	
34	Extreme winds		Increased stress due to extreme wind	High winds lead to increased stress and damage to above ground utility infrastructure	Operation	Utilities	Current standards include sufficient allowance for changes in wind patterns.	Resilience already accounted for in design standards	Very unlikely	Moderate	Low	Medium	Medium	Medium	

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	Public realm			Very unlikely	Moderate	Low	High	Medium	High		
36	Lightning		Lightening effects can cause damage to vegetation	Increased lightning strikes lead to more frequent damage to trees	Operation	Public realm			Unlikely	Minor	Very Low	High	Medium	High		
37	Lightning		Lightening effects can cause damage to utilities	Increased lightning 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		
38	Lightning		Lightening effects can cause building damage	Increased lightning strikes lead to more damage, especially roofs, gutters and windows.	Operation	Buildings			Very unlikely	Moderate	Low	High	Medium	High		
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	Buildings			As likely as not	Moderate	Medium	Medium	High	High		

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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	Result of mitigation measure on resilience	Hazard Impact			Uncertainty Level		Level of Uncertainty	Proposed additional resilience measure (only if Risk Rating = 'High' (4) or 'Very High' (5))	Reference documenting relevant mitigation
									Likelihood	Consequence	Risk rating	CC Projection	CC effect on asset			
1	High temperatures		Increased number of hot days may increase impact to staff	Increased heat stress for staff, particularly for outdoor construction and maintenance workers.	Construction and Operation	H&S	To be incorporated within proposed maintenance regimes. These can be reviewed regularly to ensure H&S requirements within Highways England are met	Resilience achieved through monitoring and maintenance of asset	Unlikely	Minor	Very Low	Low	Medium	Low		
2	High temperatures		Increased number of hot days may cause thermal expansion.	Increased risk of thermal expansion joints being pushed beyond their design capability, presenting a direct risk of damage to structures and assets (e.g. concrete joints).	Operation	Structures	TBC		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.	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
5	High temperatures		Increase in number of hot days may impact the road surface increasing the danger to road users.	High temperatures increase the risk of surfacing rutting leading to water ponding in the ruts. Higher 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	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	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.	Risk of being unable to lay road surface layers in hot weather.	Construction	Road Surface	Risk to be mitigated by following procedures detailed in the outline EMP.	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.	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 temperature to be absorbed within current maintenance procedures. Design life: 100,000 hours (~25 years).	Resilience already accounted for.	As likely as not	Minor	Low	Low	Medium	Low		
10	Low temperatures		Impact of extreme cold weather on equipment 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 bunds- still not decided)	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		
11	Low temperatures		Impact of extreme cold weather on staff health.	Possible negative health implications for staff.	Construction and Operation	H&S	For construction: to be mitigated as described in the outline EMP. For operation: To be incorporated within proposed maintenance regimes. These can be reviewed regularly to ensure H&S requirements within Highways England are met	Resilience achieved through maintenance	Very unlikely	Minor	Very Low	Medium	Low	Low		
12	Low temperatures		Impact of extreme cold weather on equipment and infrastructure.	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 as it is recommended that preparedness levels remain unchanged									
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		
15	Low temperatures		Increase in ice on road surfaces.	Increase in slips trips and falls and construction maintenance worker injury.	Construction and Operation	H&S	For construction: to be mitigated as described in the outline EMP. For operation: To be incorporated within proposed maintenance regimes. These can be reviewed regularly to ensure H&S requirements within Highways England are met	Resilience achieved through maintenance	Very unlikely	Minor	Very Low	Medium	Low	Low		
16	High precipitation		Increased risk of flooding from rivers/streams, surface and groundwater sources.	Flooding of road surface.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% for 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 rivers/streams, surface and groundwater sources.	Flooding of access roads and/or road infrastructure.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% for 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		
18	High precipitation		Increased risk of flooding from rivers/streams, surface and groundwater sources.	Increased risk of sewage overflow in floodwater causing damage and impacting health of maintenance workers.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% for climate change (check performed for 40% increase) 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 rivers/streams, surface and groundwater sources.	Increased risk of scouring of culverts.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% for 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 rivers/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% for 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 rivers/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 rivers/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 rivers/streams, surface and groundwater sources.	Water ingress to critical construction equipment.	Construction	Drainage	Drainage on site to be suitably managed, as specified within the outline EMP.	Resilience achieved through management plan monitoring environmental impacts	Very unlikely	Minor	Very Low	Low	Low	Low		
24	High precipitation		Increased risk of flooding from rivers/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 rivers/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 rivers/streams, surface and groundwater sources.	Increased risk of debris deposit from water seeping up to the surface through the pavement e.g. calcium sulphate leading to reduced skid resistance.	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 rivers/streams, 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.	Construction	Drainage	Drainage on site to be suitably managed, as specified within the outline EMP. H&S procedures to be further specified within the outline EMP	Resilience achieved through management plan monitoring environmental impacts	Unlikely	Moderate	Low	Low	Low	Low		
28	High precipitation		Increased risk of flooding from rivers/streams, surface and groundwater sources.	Increased ground water level in winter may lead to 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		

30	High precipitation	Increase likelihood of debris and sediment run off.	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 run off.	Increased risk of debris washing into drainage 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	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	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 against noise barriers assumes that they are in the form of bunds).	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 pylons	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 ponds functional capacity.	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.	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	

Climate change risk assessment

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									Likelihood	Consequence	Risk rating	CC Projection	CC effect on asset			
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. Maintenance and monitoring measures will also be put in place with particular focus on preventing derailment due to a track fault.	Resilience achieved through design and monitoring and maintenance 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 BREEM 'Excellent Rating' which includes appropriate climate change measures. During construction principle contractors being aware of and taking appropriate measures during extreme weather events.	Resilience 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 H&S standards.	Resilience 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 operate 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.	Resilience achieved through current design methods in place.	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 0.003, equivalent to 120 years design life.	Resilience achieved through design and monitoring and maintenance 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 impact on train mechanical performance and journey times and overloading of electrical equipment, cabling and conductors.	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		Increased 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 detrimental 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.	Resilience achieved through design and monitoring and maintenance of asset	Unlikely	Minimal	Very Low	Low	Medium	Low		
9	High temperatures		Increased 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 tree-side vegetation species will be selected to be resilient to drought and appropriately managed and maintained.	Resilience 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/connectors of outdoor 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.	Operation	Mechanical & Electrical Equipment	Low temperature risks to OLE/OHL, mitigated by X, Y, Z... Asset is designed to be resilient to CC using existing design standards.	Resilience achieved through design	Unlikely	Moderate	Low	Low	Medium	Low		
11	Low temperatures		Impacts of extreme cold on train reliability 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	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	etc		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 appropriate measures during extreme weather events.	Resilience achieved through management and monitoring	Unlikely	Minimal	Very Low	Low	Medium	Low		
14	Low temperatures		Overall prevalence 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	Operation	Mechanical & Electrical Equipment	Risk of mechanical and electrical equipment is mitigated through the Infrastructure maintenance strategy which includes preventative measures.	Resilience achieved through maintenance	Unlikely	Minimal	Very Low	Medium	Medium	Medium		
15	Low temperatures		Overall prevalence 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. Maintenance and monitoring measures will also be put in place with particular focus on preventing derailment due to a track fault.	Resilience achieved through design and monitoring and maintenance of asset	Very unlikely	Catastrophic	Medium	Medium	Medium	Medium		
16	Low temperatures		Overall prevalence 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.	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 maintenance strategies will be put in place to ensure continual operation of infrastructure.	Resilience 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	Resilience 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 switch-off or, possibly causing damage.	Operation	Mechanical & Electrical Equipment	Automatic Transformer (Feeder) Stations (ATFS) 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/ATS 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).	Resilience 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.	Construction	Human Factors	Flood risk during construction is mitigated by contractors paying due notice of extreme weather events and their impacts. Measures on site will also be put in place to prevent flooding.	Resilience 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.	Resilience achieved through design	Unlikely	Major	Medium	Medium	Medium	Medium		

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
B	Unlikely	Based on the current design, engineering and maintenance standards, the event is not expected to occur more than once during the lifetime of the development
C	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	Minor 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.

Risk Rating

1

Minimal

2

Minor

Likelihood	A	Very Likely	Medium	Medium
	B	Likely	Low	Medium
	C	As Likely as Not	Low	Low
	D	Unlikely	Very Low	Very Low
	E	Very unlikely	Very Low	Very Low

Level of Uncertainty

Uncertainty Level - Climate Change Prediction

Level	Descriptor	Consequence
A	Low	>66% probability of climate change hazard occurring
B	Medium	33-66% probability of climate change hazard occurring
C	High	<33% probability of climate change hazard occurring

Uncertainty Level - Effect of Climate Change on Asset

Level	Descriptor	Consequence
1	Low	Climate Change event expected to impact scheme as described. <input type="checkbox"/>
2	Medium	Climate Change event may impact scheme as described. <input type="checkbox"/>
3	High	Climate Change event not expected to impact scheme as described. <input type="checkbox"/>

Uncertainty Level - Effects of Climate Change

		1	2
Uncertainty Level - Climate Change Prediction		Low	Medium
	A	Low	Low
	B	Low	Medium
	C	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, prolonged 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



on Asset

3

High

Medium
High
High



Take highest



Project

Risk identification - resilience assessment

Mixed-use development
 Road
 Rail
 Airport

Climate hazard + likelihood of changes	<i>High temperatures</i>	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
	<i>Low temperatures</i>	Decrease in the number of frost days (days when daily minimum temperature <0°C)
	<i>High precipitation</i>	Increase in mean daily rainfall in the winter, increase in the number of days with heavy rain
	<i>Low precipitation</i>	Decrease in mean daily rainfall in the summer, increase in the annual number of dry spells
	<i>Extreme winds</i>	Increase in extreme wind events
	<i>Lightning</i>	Increase in the number of lightning days, particularly in Autumn
	<i>Humidity</i>	
	<i>Insolation</i>	



Construction

Operation

Construction and Operation



Asset type

Buildings

Traffic and transport

Public realm

Utilities

Structures

Drainage

Road Surface

Electrical Equipment

Drainage

Earthworks

Rail Infrastructure

Human Factors

Airport Infrastructure

Electronic Equipment

Flights

Airport Operation



H&S
Mechanical &
Electrical Equipment
Earthworks

Earthworks



