LONDON-WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

Preliminary consideration of potential climate change impacts (CT-009-000)

Climate

November 2013

VOL 5

ES 3.5.0.3.3

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Department for Transport

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Appendix CT-009-000

Environmental topic:	Cross topic	CT
Appendix name:	Preliminary consideration of potential climate change impacts	009
Community forum area:	All CFAs	000

Contents

List of tables

1 Introduction

1.1 Overview

1.1.1 This appendix summarises the outcomes of the preliminary consideration of potential climate change impacts undertaken by each environmental topic to determine the requirement for, or possibility and feasibility of, undertaking a further, more detailed assessment. This approach was based on professional judgement and the methodology described in Section 6(A) of the SMR Addendum (Volume 5: Appendix CT-001-000/2).

1.1.2 On the basis of preliminary consideration, all topics, with the exception of water resources and flood risk, have concluded that it is not possible to robustly incorporate climate change trends into the future baseline, nor undertake detailed assessment of the combined effects of climate change on the Proposed Scheme at the local level.

1.1.3 Table 1 to Table 13 in this document contain the outcomes of the preliminary considerations that were used to inform the identification of impacts of the Proposed Scheme. They also contain, where possible or feasible, measures to enhance climate change resilience.

1.1.4 The resilience measures that have been identified are not exhaustive. This is because for some topics, mitigation and avoidance measures identified prior to this preliminary consideration already support enhanced climate change resilience. For example, guidelines for soil handling followed by agriculture, forestry and soil resources topic and guidance contained in the National Planning Policy Framework (NPPF) followed by the water resources and flood risk topic. Therefore, these measures have not been reiterated here.

1.1.5 For other topics, certain resilience measures identified support enhanced climate change resilience for other topics. For example, the green infrastructure approach identified by the landscape and visual assessment topic has the potential to enhance the resilience of ecological receptors and resources.

1.1.6 Further information is contained in Section 7, 8 and 9 of Volume 1 of this Environmental Statement.

2 Outcomes of preliminary consideration of potential climate change impacts

2.1 Agriculture, forestry and soils

2.1.1 Climate change impacts have been considered primarily in terms of potential direct and indirect effects on the soil resource which, amongst other key functions, underpins the production of food and timber. Whilst most impacts of the Proposed Scheme on agriculture, forestry and soil resources will occur during the construction phase, climate change effects on the soil resource are likely to extend beyond this phase. However, there is insufficiently detailed evidence at the local level to be able to incorporate these future possible effects in the assessment and determine how, in combination, they may affect the impacts of the Proposed Scheme on agriculture, forestry and soil resources.

2.1.2 Table 1 contains the outcomes of the preliminary consideration that was used to inform the identification of impacts of the Proposed Scheme and climate change on agriculture, forestry and soil resources and, where possible, the development of measures to enhance climate change resilience.

Table 1: Agriculture, forestry and soils – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	**Potential climate change impacts on resources/receptors**	**Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme.**
Soils temporarily and permanently displaced by the construction of the scheme and potential compaction and damage to soil structure during stripping, storage and the reinstatement of soil profiles	For natural and undisturbed soils drier conditions could affect the quality and capability of agricultural soils, with currently droughty soils being downgraded but wet soils potentially upgraded. These effects could be exacerbated by compaction and damage to soil structures during soil handling. Wetter conditions could increase the area of lower quality and marginal land on reinstatement, where the soils have heavier textures.	This is generally addressed by good practice in soil handling guidelines. The creation of suitable well-drained landforms in reinstated areas is an option; together with the installation of field drains, as necessary.
Loss of agricultural soils	More extreme weather events (eg localised high intensity rainfall), particularly on moderately steep to steep gradients, and where the soils have heavier textures with deep cracking. Dry topsoils exposed to more frequent high winds by ploughing and cultivation. Increased loss of soils as a result of flooding.	The creation of suitable well-drained landforms with appropriate gradients in reinstated areas; together with the installation of field drains, as necessary
Loss of forestry	Loss of trees as a result of drought, and consequent exposure of soils to surface water erosion.	Plant with suitable species.
	Longer growing season could benefit tree growth.	Plant with suitable species.
	Increased risk of tree loss due to greater	Reinstating land for woodland

	frequency of storms/high winds, and consequent exposure of soils to surface water erosion.	with suitable soils which facilitate deep rooting. Plant deeper rooting species resistant to storms and wind conditions.
Loss of/damage to agricultural buildings	Some building designs and materials may no longer be suitable.	No specific climate change resilience measures are required.
Disruption to irrigation and water supply systems	Could lead to greater need for irrigation because of projected increase in drought conditions. Risk to harvest if irrigation systems are disrupted. However, constraints on the extraction of water from rivers and groundwater. Damage to water supply systems where the soils have heavier textures with deep cracking.	Design appropriate water supply systems.
Disruption to reinstated drainage systems	Damage to water supply systems where the soils have heavier textures with deep cracking	Design appropriate replacement drainage systems.
	Increased need to drain lower lying areas of land within receiving sites during wetter winters and during periods of intense heavy rainfall. Failure of drainage system could lead to the flooding of agricultural land.	Design appropriate replacement drainage systems
Spread of weeds and damaging plants	The potential spread of weeds along linear transport infrastructure could be exacerbated by climate change.	The presence of noxious weeds will be controlled by an appropriate management regime.
Run-off	Increased run-off and infiltration rates in winter due to wetter conditions. Also in summer with intense rainfall events and rapid penetration of soils through deep cracks in heavy soils.	Consider capacity of drainage system to be installed on reinstated land.
	Could see reduced run-off and infiltration rates during drought conditions.	No additional measures identified

2.2 Air quality

2.2.1 There is no definitive evidence about how climate change may affect the future baseline for air quality at the local level. Therefore it has not been possible to evaluate the Proposed Scheme's impact on future air quality with climate change. Having considered this, it has been assumed that there are no additional effects arising from the in combination effects of climate change, air quality and the Proposed Scheme.

2.2.2 Table 2 contains the outcomes of the preliminary consideration that was used to inform the identification of impacts of the Proposed Scheme and climate change on air quality and, where possible, the development of measures to enhance climate change resilience.

Table 2: Air quality – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	**Potential climate change impacts on resources/receptors**	**Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme.**
Dust generation due to the demolition of buildings and the construction of new	Hotter and drier conditions may exacerbate dust generation.	The nominated undertaker will ensure appropriate measures within the draft CoCP are implemented and, as

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme.
structures and earthworks.		appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.
	Wetter conditions in winter may suppress dust movement.	No specific climate change resilience measures are required.
Dust from vehicles on highways as a result of vehicles departing from construction areas.	Hotter and drier conditions may exacerbate dust generation.	The nominated undertaker will ensure appropriate measures within the draft CoCP are implemented and, as appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.
	Wetter conditions in winter may suppress dust movement.	No specific climate change resilience measures are required.
Increased air pollution from increased traffic associated with vehicles.	Hotter conditions may exacerbate concentrations of certain air pollutants e.g. ground level ozone[1].	There is no definitive evidence about how climate change may affect the future baseline for air quality at the local level; therefore it has not been possible to evaluate the Proposed Scheme's impact on future air quality with climate change. No specific climate change resilience measures have therefore been identified.
Dust generation due to loading/unloading of waste and materials at construction sites.	Hotter and drier conditions may exacerbate dust generation.	The nominated undertake will ensure appropriate measures within the draft CoCP are implemented and, as appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.
	Wetter conditions in winter may suppress dust movement.	No specific climate change resilience measures are required.

2.3 Community

2.3.1 There is insufficiently detailed evidence at the local level about how potential climate change impacts will affect communities along the Proposed Scheme during construction and operation. Having considered this, it is not possible to incorporate these future possible impacts and changes into the assessment and determine how, in combination, this may affect the impacts of the Proposed Scheme on community resources.

2.3.2 Table 3 contains the outcomes of the preliminary consideration that was used to inform the identification of impacts of the Proposed Scheme and climate change on communities and, where possible, the development of measures to enhance climate change resilience.

[1] Defra (2012), Climate Change Risk Assessment: Health, Defra, London.

Table 3: Community – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme.
Residential property (including gardens) and community infrastructure lost to land required for the construction of the Proposed Scheme.	No impact.	There is insufficiently detailed evidence at the local level about how potential climate change impacts will affect communities along the Proposed Scheme during construction and operation. Having considered this, it is not possible to incorporate these future possible impacts and changes into the assessment and determine how, in combination, this may affect the impacts of the Proposed Scheme on community resources. Therefore there are no specific climate change resilience measures in place.
Potential amenity impacts on residential properties and community infrastructure.	Temperature increase may affect thermal comfort (e.g. opening windows to regulate temperature within buildings may result in greater exposure to air quality, and sound, noise and vibration effects associated with the Proposed Scheme)[2].	
Properties and infrastructure experiencing temporary loss of land required for the construction of the Proposed Scheme.	Hotter, drier conditions could exacerbate loss of grassland e.g. gardens and sports pitches[3].	
Isolation of residential properties and community properties from other properties and infrastructure.	Potential for extreme weather events which may exacerbate isolation, for example through extreme flood events[4].	

2.4 Cultural heritage

2.4.1 Table 4 contains the outcomes of the preliminary consideration of climate change and the Proposed Scheme on cultural heritage.

Table 4: Cultural heritage – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme.
Climate change effects include a series of complex interrelations between environmental, social and economic factors including asset type, fragility, soil type, drainage, current and future land use and management regimes which are difficult to predict with certainty. Having considered this, it is not feasible to incorporate these future potential impacts and changes into the assessment and determine how, in combination, they may affect the impacts of the Proposed Scheme on cultural heritage resources.		

2.5 Ecology

2.5.1 Table 5 contains the outcomes of the preliminary consideration of climate change and the Proposed Scheme on ecology.

[2] Frontier Economics (2013), Economics of Climate Resilience: Health and Well-Being, Defra, London.
[3] *Ibid.*
[4] *Ibid.*

Table 5: Ecology – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources /receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme.
Potential climate change impacts include a series of complex and dynamic biological interrelations between animals and plants and the ecological features in which they live which makes them difficult to predict with certainty. Having considered this, it is not feasible to incorporate these future potential impacts and changes into the assessment and determine how, in combination, they may affect the impacts of the Proposed Scheme at the local level. Further information on the potential impacts of climate change for ecological resources, based on a route-wide assessment, is contained in Volume 3.		

2.6 Electromagnetic interference

2.6.1 Table 6 contains the outcomes of the preliminary consideration of climate change and the Proposed Scheme on electromagnetic interference.

Table 6: Electromagnetic interference – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
The levels of generated electromagnetic fields (EMF) and electromagnetic interference (EMI) are dependent on traction power, which has been calculated for a worst case scenario based on the maximum trains running per hour. Any change in climate is unlikely to affect the output from the traction power and cause any significant increase in EMF or EMI.		

2.7 Land quality

2.7.1 Whilst climate change has the potential to bring about changes in the groundwater regime (for example groundwater depths and gradients) and in landfill gassing regimes, there is insufficiently detailed evidence to predict with certainty the impact that climate change will have on the assessment and remediation of contaminated land. Therefore, it is not considered feasible to incorporate climate change factors meaningfully into the current assessment. However, the detailed assessment of contamination and the detailed design of remediation will need to consider potential changes in the groundwater or landfill gassing regimes, and other potential effects, to ensure that remediation designs are resilient.

2.7.2 Table 7 contains the outcomes of the preliminary consideration that was used to inform the identification of impacts of the Proposed Scheme and climate change on land quality and, where feasible, the development of measures to enhance climate change resilience.

Table 7: Land quality – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
The route passes through a number of landfills where gas and leachate control systems may be required[5].	Increased occurrence of heat waves can cause heightened levels of methane production.	Whilst climate change has the potential to bring about changes in the groundwater regime (for example groundwater depths and gradients) and in landfill gassing regimes, there is insufficiently detailed evidence to predict with certainty the impact that climate change will have on the assessment and remediation of contaminated land. Therefore, it is not considered feasible to incorporate climate change factors meaningfully into the current assessment. However, the detailed assessment of contamination and the detailed design of remediation will need to consider potential changes in the groundwater or landfill gassing regimes, and other potential effects, to ensure that remediation designs are resilient.
	Heavy metal contamination inhibited by higher temperatures and drier climates[6].	
Storage of contaminated soil on sites.	Increased high wind speed events could increase concentration of wind-blown dusts[7].	
Engineered cover and stabilised/solidified soil systems for pollutant containment systems vulnerable to severe wet/dry and freeze-thaw cycles[8].	Variation in range of extreme weather events is predicted to increase due to climate change.	
Remobilisation of contaminants affecting groundwater.	Flooding could increase risk of mobilisation of contaminants.	
Accidental discharge or coolant leaks from auto-transfer stations. Potential for minor leakage of hydraulic or lubricating oils from the trains.	Flooding, drought and storms increase risk of damage to infrastructure thus increased risk of leaks.	

2.8 Landscape and visual assessment

2.8.1 Potential climate change impacts include a series of complex interrelations between environmental, social and economic factors including plant species and provenance, soil type, drainage, and current and future land use and management regimes which are difficult to predict robustly. Having considered this, it is not feasible to incorporate these future potential impacts and changes into the assessment and determine how, in combination, they may affect the impacts of the Proposed Scheme on landscape resources.

2.8.2 Table 8 contains the outcomes of the preliminary consideration that was used to inform the identification of impacts of the Proposed Scheme and climate change on landscape and visual amenity and, where feasible, the development of measures to enhance climate change resilience.

Table 8: Landscape and visual assessment – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
Changes to landscape character during construction and operation – removal of landscape features such as woodland	Could exacerbate impact on landscape character as drought conditions and increase in pests and diseases could lead	Although it has not been possible to determine climate change impacts at the local level, the selection of native

[5] Al-Tabbaa, A, Smith, S E, Duru, U E, Iyengar, S R, De Munck, C, Moffat, A J, Hutchings, T R, Dixon, T, Doak, J, Garvin, S L, Ridal, J, Raco, M and Henderson, S (2007), Climate Change, Pollutant Linkage and Brownfield Regeneration, CL:AIRE, London.
[6] *Ibid*
[7] *Ibid.*
[8] *Ibid.*

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
and hedges, severance of agricultural land and the activity associated with construction of structures and large scale earthworks.	to loss of vegetation and defoliation.	plant and tree species for mitigation and replacement planting will be suitable for future climate conditions. A green infrastructure approach has been included in the Proposed Scheme for some areas to address the landscape and visual assessment effects associated with the Proposed Scheme. This approach will contribute towards a multi-functional landscape that will contribute to reduced vulnerability and increased resilience to climate change.
	Longer growing season could increase rate of growth of vegetation.	
	Could exacerbate impact on landscape if trees are lost through high winds.	
	Could change the type and structure of vegetation within the view as agricultural land becomes marginal, drought tolerant trees become more prevalent, or wetlands disappear.	
Changes to views during construction and operation through the removal of vegetation leading to the visibility of construction plant and structures.	Could exacerbate impacts on views as drought conditions and increases in pests and diseases could lead to a loss of mitigation vegetation and defoliation.	
	Longer growing season could increase rate of growth of vegetation.	Although it has not been possible to determine climate change impacts at the local level, the selection of native plant and tree species for temporary or permanent mitigation will include species that are deemed suitable for future climate conditions. This has been included in the Proposed Scheme. Construction related impacts would be addressed through the measures in the CoCP. In urban areas the screening of construction activities will incorporate site boundary hoarding boards to reduce visual impacts relating to construction activities. These have been incorporated into the Proposed Scheme.
	Could exacerbate impact on views if trees are lost through high winds.	
	Could change the type and structure of vegetation within the view as agricultural land becomes marginal, drought tolerant trees become more prevalent, or wetlands disappear.	

2.9 Socio-economics

2.9.1 There is insufficiently detailed evidence about how potential climate change impacts will affect socio-economic resources along the Proposed Scheme during construction and operation. Having considered this, it has not been possible to incorporate these future potential impacts and changes into the assessment at the local level and determine how, in combination, they may affect the impacts of the Proposed Scheme on socio-economic resources.

2.9.2 Table 9 contains the outcomes of the preliminary consideration that was used to inform the identification of impacts of the Proposed Scheme and climate change on socio-economic resources and, where feasible, the development of measures to enhance climate change resilience.

Table 9: Socio-economics – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
Businesses (non-community) and community organisations lost to land required for the construction of the Proposed Scheme.	No impact.	There is insufficiently detailed evidence about how potential climate change impacts will affect socio-economic resources along the Proposed Scheme during construction and operation. Having considered this, it has not been possible to incorporate these future potential impacts and changes into the assessment at the local level and determine how, in combination, they may affect the impacts of the Proposed Scheme on socio-economic resources. Therefore no specific climate change resilience measures have been identified.
Amenity value of infrastructure (used for employment purposes) is potentially changed resulting in an impact on businesses and organisations' operations.	Temperature increase may affect thermal comfort within buildings (e.g. opening windows to regulate temperature within buildings may result in greater exposure to air quality and sound, noise and vibration effects associated with the Proposed Scheme)[9].	
Severance of infrastructure (used for employment purposes) from receptors resulting in an impact on businesses and organisations' operations.	Potential for extreme weather events which may delay or prevent access to infrastructure, for example through extreme flood events[10].	
Direct employment opportunities associated with construction and operational phase.	No impact.	
Indirect employment opportunities associated with construction and operational phase.	No impact.	

2.10 Sound, noise and vibration

2.10.1 Potential climate change impacts are unlikely to affect baseline sound levels or forecast sound levels from the Proposed Scheme. However, overall increases in ambient temperature may increase the need for, or regularity of, opening windows for ventilation and cooling of residential property. The assessment of the Proposed Scheme's effects has taken account of open windows.

2.10.2 Table 10 contains the outcomes of the preliminary consideration that was used to inform the identification of impacts of the Proposed Scheme and climate change on sound, noise and vibration and, where feasible, the development of measures to enhance climate change resilience.

Table 10: Sound, noise and vibration – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
Potential noise or vibration impacts on receptors due to the construction of the scheme	Could exacerbate impacts where evening and night-time working planned. Hotter nights, aggravated by the urban heat island effect, may mean that people will prefer to sleep with their windows open.	No additional climate change resilience measures are required. Potential climate change impacts are unlikely to affect baseline sound levels or forecast sound levels from the construction or operation of the Proposed Scheme. However,
Potential airborne noise impacts on	Increased temperature and change in	

[9] Frontier Economics (2013), Economics of Climate Resilience, Health and Well-Being, Defra, London.
[10] *Ibid*.

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
receptors, due to the operation of the Proposed Scheme	humidity may alter propagation characteristics of sound through the air, at distance.	overall increases in ambient temperature may increase the need for, or regularity of, opening windows for ventilation and cooling of residential property. The assessment of the Proposed Scheme's effects has taken account of open windows and has incorporated mitigation accordingly.
	Hotter nights, aggravated by the urban heat island effect, may mean that people will prefer to sleep with their windows open.[11]	
Potential minor ground-borne noise and vibration impacts affecting receptors very close to the route, due to the operation of the Proposed Scheme	No impact.	No resilience measures required.

2.11 Traffic and transport

2.11.1 Current projections indicate that climate change is likely to have an influence on the future baseline against which the Proposed Scheme has been assessed. For example, an increase in the frequency of extreme weather events, such as more intense rainfall events and very hot weather may affect traffic and transport resources, the community and travelling public. However, there is insufficiently detailed evidence about how climate change will affect future traffic patterns and transport users during construction and operation. Therefore it has not been possible to determine how climate change may affect the Proposed Scheme's impacts on traffic and transport resources.

2.11.2 Table 11 contains the outcomes of the preliminary consideration that was used to inform the identification of impacts of the Proposed Scheme and climate change on traffic and transport and, where feasible, the development of measures to enhance climate change resilience.

Table 11: Traffic and transport – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
Changes in traffic levels and patterns during construction due to construction activities, temporary diversions and road closures.	Hotter conditions could encourage increased pedestrian and cycling activity and use of the public realm[12]. Potential increased health and safety issue due to increased presence of construction vehicles.	The nominated undertaker will ensure appropriate measures within the draft CoCP are implemented and, as appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.
Activities associated with the construction of the Proposed Scheme.	Increased temperatures and/or increased rainfall or cold weather events cause delays to the anticipated construction programme for the Proposed Scheme.	The nominated undertaker will ensure appropriate measures within the draft CoCP are implemented and, as appropriate, additional measures to ensure the resilience of the proposed mitigation of impacts during extreme weather events.

[11] Greater London Authority (2011), Managing Risks and Increasing Resilience.
[12] Bennett, J (2011) Preparing for Climate Change: Adapting Local Transport. UK Climate Impacts Programme: Oxford.

2.12 Waste and material resources

2.12.1 Current projections indicate that there may be potential climate change impacts on waste and material resources. However, these are not considered to have any significant direct impact and hence are not considered further within the assessment.

2.12.2 Table 12 contains the outcomes of the preliminary consideration that was used to inform the identification of impacts of the Proposed Scheme and climate change on traffic and transport and, where feasible, the development of measures to enhance climate change resilience.

Table 12: Waste and material resources – potential climate change impacts and measures to enhance climate change resilience

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
Odour from putrescible wastes during construction and operation.	Hotter conditions may accelerate decomposition and odour production.	Consider locating site waste storage areas away from receptors. Store putrescible waste in lidded containers and ensure frequent collection off-site to permitted waste facilities.
	Drier conditions may slow decomposition and odour production.	No additional measures required.
Increased amounts of beverage packaging wastes during construction and operation.	Hotter drier conditions could increase consumption of beverages by construction workers and passengers.	Consider building adaptation responses and resilience into waste management systems. Consider providing sufficient waste storage for dry recyclables such as plastic and aluminium or steel cans to facilitate segregation from the residual waste stream.

2.13 Water resources and flood risk

2.13.1 For the assessment of flood risk, consideration of climate change has been incorporated within the future baseline based on projections specified in the NPPF and its technical guidance. Further details are given in Volume 1: Section 7 and 8.12. The outcome of this assessment is detailed within Volume 2: CFA reports, Section 13 and Volume 5: Appendix WR-001-000.

Table 13: Water resources and flood risk – potential climate change impacts and potential additional mitigation measures

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
Excavation of cuttings, sheet piling and dewatering during construction could reduce groundwater flows.	Drought conditions could exacerbate low flows[13].	Climate change allowances and requirements have been included in existing mitigation measures.
	Wetter conditions could reduce low flows[14].	As above.

[13] Gill, E (2008), Making Space for Water - Urban Flood Risk and Integrated Drainage (HA2): IUD Pilot Summary Report, Defra, London.
[14] *Ibid.*

Resources/receptors potentially impacted by the Proposed Scheme	Potential climate change impacts on resources/receptors	Measures in place to enhance the climate change resilience of resources/receptors significantly affected by the Proposed Scheme
Increase in flood risk due to bridges.	Increased flood risk in summer and winter due to projected intensity of rainfall events and river flows.	Allowances for increased river flows due to climate change have been incorporated in design of bridges.
Increased surface water run-off.	Increased run-off due to projected intensity of rainfall events [15].	Climate change allowances and requirements have been included in the design of attenuation and sustainable drainage systems (SuDS).
Discharges to watercourses during operation.	Increased discharge volume due to projected intensity of rainfall events.	As above. Appropriate storage to be provided and flow restrictions applied.
Surface water flow paths are interrupted.	May be lower flows in watercourses during periods of low rainfall; risk of existing ponds reducing in level or drying out.	Ensure that flow paths are not obstructed by including conveyance in structures e.g. culverts in embankments.
	May be an in increase surface water run-off due to periods of intense rainfall; risk of infiltration basins flooding.	Climate change allowances and requirements have been included in design of attenuation and SuDS.
	Potential reduction in groundwater levels due to lower summer rainfall.	Offset by increase in winter rainfall profiles.
Abstraction of water for construction, if required, may affect other water local abstraction supplies to local businesses.	Increased evaporation due to high summer temperatures and lower rainfall levels could lead to low river flows and reduced groundwater recharge and levels[16].	Minimise water use and encourage reuse. Consider coordinating water abstraction required for construction with needs of local community.

[15] Frontier Economics (2013) Economics of Climate Resilience: Natural Flood Management, Defra, London.
[16] *Ibid.*