

Welsh Government

**A40 Llanddewi Velfrey to Penblewin
Improvements**

Appendices to Chapter 18 Climate Change

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This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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Appendix 18.1 Greenhouse gas (GHG) emissions assessment

This section outlines the emissions factors used in the GHG emissions assessment. The reference sources for these factors are:

- 'Inventory of Carbon and Energy (ICE) Version 2.0' developed in 2008 and updated in 2011 by the University of Bath: Sustainable Energy Research Team;
- 'Greenhouse gas reporting: conversion factors 2017', published in August 2017 by the UK Department of Business, Energy and Industrial Strategy (BEIS);
- 'Environmental Product Declarations (EPDs)' – specifically for methacrylate resin products¹, and
- 'Energy and Emissions Projections', published in 2015 by the former Department of Energy and Climate Change (DECC)².

Table 1 Emissions factors used in carbon assessment

Item type	Emission s factor	Unit	Reference
Materials			
Aluminium: general	9.16000	kgCO ₂ -e/kg	ICE
Bitumen	0.49000	kgCO ₂ -e/kg	ICE
Blockwork: 10MPa	0.07800	kgCO ₂ -e/kg	ICE
Bricks	0.24000	kgCO ₂ -e/kg	ICE
Concrete: 12/15 MPa GEN 2 30% Fly Ash	0.09300	kgCO ₂ -e/kg	ICE
Concrete: 6/8 MPa GEN 0 30% Fly Ash	0.06100	kgCO ₂ -e/kg	ICE
Concrete: 8/10 MPa GEN 1 30% Fly Ash	0.08200	kgCO ₂ -e/kg	ICE
Concrete: C20/25 typical	0.10700	kgCO ₂ -e/kg	ICE
Concrete: C25/30 typical	0.11300	kgCO ₂ -e/kg	ICE
Concrete: C32/40 typical	0.13200	kgCO ₂ -e/kg	ICE
Concrete: C40/50 typical	0.15100	kgCO ₂ -e/kg	ICE
Iron	2.03000	kgCO ₂ -e/kg	ICE
Methacrylate resin products (waterproofing)	1.92000	kgCO ₂ -e/kg	EPD - refer above
Mortar (1:1:6 Cement:Lime:Sand mix)	0.14000	kgCO ₂ -e/kg	ICE

¹ Bauder, EPD for MMA resin products, <https://www.bauder.co.uk/assets/e/n/environmental-product-declaration-mma-resin-products-liquitec.pdf> [Accessed November 2017]

² DECC, Energy and Emissions Projections, 2015, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/501265/Web_Figures_2015.xls [Accessed November 2017].

Item type	Emission factor	Unit	Reference
Mortar (1:3 Cement:Sand)	0.22100	kgCO ₂ -e/kg	ICE
Plastic: General	3.33100	kgCO ₂ -e/kg	ICE
Polyethylene: General	2.54000	kgCO ₂ -e/kg	ICE
Polyethylene: Low Density (LDPE)	2.08000	kgCO ₂ -e/kg	ICE
Polypropylene: Oriented Film	3.43000	kgCO ₂ -e/kg	ICE
Precast Concrete	0.16800	kgCO ₂ -e/kg	ICE
PVC Pipe	3.23000	kgCO ₂ -e/kg	ICE
Quarried aggregate	0.00520	kgCO ₂ -e/kg	ICE
Road & Pavement Asphalt	0.07100	kgCO ₂ -e/kg	ICE
Steel: galvanised sheet	1.54000	kgCO ₂ -e/kg	ICE
Steel: general (59% recycled)	1.46000	kgCO ₂ -e/kg	ICE
Steel: section	1.53000	kgCO ₂ -e/kg	ICE
Steel: sheet	1.38000	kgCO ₂ -e/kg	ICE
Steel: stainless	6.15000	kgCO ₂ -e/kg	ICE
Steel: wire	3.02000	kgCO ₂ -e/kg	ICE
Stone: general	0.07900	kgCO ₂ -e/kg	ICE
Thermoplastic (assume similar to ABS)	3.76000	kgCO ₂ -e/kg	ICE
Timber: general	0.72000	kgCO ₂ -e/kg	ICE
Vitrified clay pipe DN 100 & DN 150	0.46000	kgCO ₂ -e/kg	ICE
Fuels			
Gas oil	2.95351	kgCO ₂ -e/L	BEIS
Diesel (100% mineral diesel)	2.67193	kgCO ₂ -e/L	BEIS
Petrol (100% mineral petrol)	2.30075	kgCO ₂ -e/L	BEIS
Electricity			
Electricity generated (UK)	0.243 (in 2020) to 0.018 (from 2050)	kgCO ₂ - e/kWh	DECC
Transport			
Rigid Truck: Average	0.00020	kgCO ₂ - e/kg.km	BEIS
Shipping: Container ship	0.00002	kgCO ₂ - e/kg.km	BEIS
Average Car (fuel unknown)	0.18242	kgCO ₂ -e/km	BEIS

Appendix 18.2 Climate change resilience (CCR) Assessment

The resilience of the development in relation to climate change has been assessed through consideration of the likelihood and consequences of each potential risk.

For each risk, the likelihood and consequence were determined in accordance with Table 2 and

Table 3 respectively. The risk rating for each combination of likelihood and consequence is defined in Table 4.

Table 2 Likelihood scale

Level	Descriptor	Description
A	Very likely	Event is expected to occur many times during the lifetime of the development (50-year design life)
B	Likely	Event is expected to occur several times during the lifetime of the development
C	As likely as not	Event is expected to occur at least once during the lifetime of the development
D	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
E	Very unlikely	Event only occurs in exceptional circumstances and would not be expected to occur in the lifetime of the development

Table 3 Consequence scale

Level	Descriptor	Consequence	Environmental	Social	Financial
1	Insignificant	No change	No adverse effect on natural environment	No adverse human health effects or complaints.	Insignificant financial loss.
2	Minor	Localised service disruption. No permanent damage. Some minor restoration work required. Lifespan reduced by 10-20%.	Minimal effects on the natural environment.	Short-term disruption to occupants (staff, residents or businesses). Slight adverse human health effects or general amenity issues. Negative reports in local media.	Additional operational costs. Minor financial loss.
3	Moderate	Widespread damage and loss of service. Damage recoverable by maintenance and minor repair. Partial loss of local infrastructure. Lifespan reduced by 20-50%.	Some damage to the environment, including local ecosystems. Some remedial action may be required.	Frequent disruptions to occupants. Adverse human health effects. Negative reports in regional media.	Moderate financial loss.
4	Major	Extensive damage requiring extensive repair. Lifespan reduced by >50%.	Significant effect on the environmental and local ecosystems. Remedial action likely to be required.	Permanent physical injuries and fatalities may occur from an individual event. Negative reports in national media. Public debate about performance.	Major financial loss.
5	Catastrophic	Permanent damage and/or loss of service. Retreat and translocation of development.	Very significant loss to the environment. May include localised loss of species, habitats or ecosystems. Extensive remedial action essential to prevent further degradation. Restoration likely to be requirement.	Severe adverse human health effects – leading to multiple events of total disability or fatalities. Emergency response. Negative reports in international media.	Significantly high financial loss.

Table 4 Risk matrix

	Consequence	1	2	3	4	5
Likelihood		Insignificant	Minor	Moderate	Major	Catastrophic
A	Very likely	Low	Low	High	Extreme	Extreme
B	Likely	Low	Low	Medium	Extreme	Extreme
C	As likely as not	Low	Low	Medium	Extreme	Extreme
D	Unlikely	Very low	Very low	Medium	High	High
E	Very unlikely	Very low	Very low	Low	High	High

Table 5 CCR assessment results

Risk ID	Climate hazard	Description of impact	Existing or embedded mitigation measure	Timeframe: 2020s			Timeframe: 2070s		
				Likelihood	Consequence	Risk rating	Likelihood	Consequence	Risk rating
1	High temperatures	Extreme heat events lead to damage to road surface, deformation of asphalt	Road construction to current standards, monitored as per standard maintenance procedures.	Very unlikely	Minor	Very low	Likely	Minor	Low
2	Low temperatures	Extreme low temperatures lead to damage to road surface, deformation of asphalt- through freeze-thaw	Road construction to current standards, monitored as per standard maintenance procedures.	Unlikely	Minor	Very low	Likely	Minor	Low
3	High precipitation	Extreme rainfall events lead to localised flooding of roads and transport infrastructure, causing disruption to services and traffic	Masterplan design is based on detailed flood risk assessment which incorporates projected climate change.	Very unlikely	Moderate	Low	As likely as not	Moderate	Medium
4	High precipitation	Extreme rainfall events causing damage to road surface (increased	Road construction to current standards, monitored and	Likely	Minor	Low	Likely	Minor	Low

		stripping rate, likelihood of potholing from moisture entering cracks in surface)	maintained as per standard procedures. Resurfacing to occur within 10 - 20 years.						
5	High precipitation	Increase in frequency of heavy rainfall may cause disruption to drainage systems which could lead to their failure and flooding.	Critical assets have been designed with an embedded climate change allowance to account for changes in rainfall.	Unlikely	Minor	Very low	Unlikely	Minor	Very low
6	Low precipitation	Drier conditions and drier soils may lead to damage to drainage systems	Critical assets have been designed with an embedded climate change allowance to account for changes in rainfall.	Unlikely	Minor	Very low	Unlikely	Minor	Very low
7	High precipitation	This visual screening of the new road using shrubs and trees may be impacted by warmer wetter weather, increasing pests and diseases.	The planting design will take account of this, and the management and monitoring of newly planted trees will help to identify any trees that are infected.	Likely	Minor	Low	Likely	Minor	Low

8	Storms and gales	Potential for blown debris during operation and construction causing disruption.	CEMP will be carried out during construction period to mitigate impacts and road management will be undertaken during operation.	As likely as not	Minor	Low	As likely as not	Minor	Low
9	All	Cascading failures due to interdependent infrastructure networks (e.g. power failure causing disruption to streetlighting)		As likely as not	Minor	Low	Likely	Minor	Low

Appendix 18.3 In-combination climate change impact (ICCI) assessment

The in-combination climate impact assessment was undertaken by assessing each identified risk in line with the scales defined for the CCR assessment.

Each environmental topic was then assigned a rating based on the following significance criteria:

- a) many potential in-combination climate change impacts with high consequences;
- b) some potential in-combination climate change impacts with high consequences;
- c) some potential in-combination climate change impacts with low consequences; and
- d) no potential in-combination climate change impacts.

Table 6 ICCI assessment results

Environmental topic	Resources / receptors impacted by proposed scheme	Effects of proposed scheme on receptors / resources	Existing mitigation measures	Climate hazard	Potential in-combination climate change impacts on resources / receptors	Likelihood	Justification	Consequence	Justification	Risk rating
Health	Residents of Llanddewi Velfrey	Neighbourhood quality, life, mental health and wellbeing of residents will be improved by reduced traffic through the centre of the village i.e. less air quality, visual and noise impacts.	Development provides beneficial impact	High temperatures and lower precipitation	Hotter weather may cause both residents opening windows more and increased concentrations of air pollutants such as ozone and NO _x - this increased impact may be averted by the scheme.	Likely	Hotter weather will likely cause changes to air pollutants in the future	Minor	There is likely to be less vehicles producing these air pollutants on this road in the future.	Low
Transport	Road users	Driver Delay	Junction improvement schemes as presented in the Transport Assessment	High precipitation	Extreme rainfall events lead to localised flooding of roads and transport infrastructure, causing disruption to services and traffic	As likely as not	Extensive flood mitigation has been incorporated into design	Moderate		Medium
Noise	Residential properties	During operation-noise of road.	Development provides beneficial impact	high temperatures and humidity	Increased numbers of residents with windows open.	Likely	It is likely that temperatures will increase leading to increasing numbers of residents opening windows.	Insignificant	It is likely that properties further away from the current route, but within 600m of the proposed route may experience an insignificant increase in noise, but there would be significant permanent direct beneficial effect for most of the residents of Llanddewi Velfrey	Low
Air quality	a. Residential b. Ecological	Increased traffic flows could result in increased NO ₂	Measures to reduce polluting vehicle use and encourage alternative travel modes	High temperatures	Hot and sunny conditions lead to higher concentrations of ozone and NO ₂	Likely	While summers are expected to be hotter, the expected temperature increase is unlikely to be sufficient to	Insignificant	Changes to dispersion of pollutants has not been modelled, effects on local air quality from the operation of this road has be	Low

Environmental topic	Resources / receptors impacted by proposed scheme	Effects of proposed scheme on receptors / resources	Existing mitigation measures	Climate hazard	Potential in-combination climate change impacts on resources / receptors	Likelihood	Justification	Consequence	Justification	Risk rating
							cause significant increases in ozone concentrations		determined as no significant effects to air quality.	
Air quality	a. Residential b. Ecological	Increased traffic flows could result in increased NO ₃		Extreme winds	Windier conditions lead to increased dispersion of pollutants	Unlikely	No conclusive projections relating to wind patterns available, however, it is unlikely that there will be major changes to the spread of pollutants	Insignificant	Changes to dispersion of pollutants has not been modelled, effects on local air quality from the operation of this road has been determined as no significant effects to air quality.	Very low
Ecology	Legally protected species (including dormice and bats)	The potential project may impact these legally protected species.	Survey and mitigation measures will be conducted for these species	High precipitation, extreme winds	Increased frequency and intensity of storm events lead to destruction of trees and habitats.	As likely as not	Increased levels of damage due to storms are expected to occur	Minor	Potential impacts to habitat are not expected to be significant for species including amphibians, bats, reptiles, and breeding birds. There is moderate chance of impacting dormice, otter and badgers meaning mitigation will be in place.	Low
Ecology	Invasive species		There will be a plan to deal with any invasive plants and pest during construction and operation.	High temperatures	Increased temperature change the suitability of habitat conditions, potential for increase in spread of non-native species, pests and diseases if native species/plants can't survive.	Likely	Projected temperature increases and precipitation changes are expected to be within the tolerance of local habitats	Minor	Potential impacts to habitat are not expected impact the viable locations of vulnerable species	Low
Community	Residents of Llanddewi Velfrey	Isolation of residential properties from other properties and	Development provides beneficial impact	High precipitation	Potential increase in fluvial flooding caused by runoff may	Likely	Likely increase in precipitation.	Minor	There will be a plan in place to mitigate flooding that will consider climate	Low

Environmental topic	Resources / receptors impacted by proposed scheme	Effects of proposed scheme on receptors / resources	Existing mitigation measures	Climate hazard	Potential in-combination climate change impacts on resources / receptors	Likelihood	Justification	Consequence	Justification	Risk rating
		infrastructure-caused by current road through village			exacerbate isolation of village.				change. During operation the proposed scheme is not expect to cause any increase in flood risk.	
Archaeology and Cultural Heritage	Listed buildings	Potential disruption of historic landscape setting	Planting will be implemented to screen the impact the potential project	High temperatures and increased rainfall	This may lead to an increase in growing season that will lead to an increased rate of growth of vegetation. The landscape may therefore be positively or negatively effected.	Likely	It is likely that temperatures and rainfall will increase.	Minor	The increased growth rate may impact the setting/view of listed buildings. Management plan will be need to maintain vegetation.	Low
Ground conditions	No impacts identified for operational phase following mitigation									
LVIA	No in-combination climate impacts identified									