Shropshire Council

Carbon Management Plan

Shrewsbury North West Relief Road

70056211 – Shrewsbury NWRR CMP
November 2024

Confidential

Shropshire Council

Carbon Management Plan

Shrewsbury North West Relief Road

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Quality control

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Checked by		TG	TG	TG
Authorised by		SP	SP	SP
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Executive summary

WSP UK Ltd. have been commissioned by Shropshire Council to prepare a Carbon Management Plan to support the design of the Shrewsbury North West Relief Road (NWRR). The NWRR's Outline Business Case (OBC) was approved by DfT in March 2019, and the Full Business Case (FBC) to which this CMP is appended is expected to be submitted in October 2024. This CMP has been prepared in line with best practice carbon management principles and DfT guidance.

Project Outcomes

Project outcomes include:

- Enhanced local and longer distance connectivity
- Reduced congestion and quicker, more reliable journey times
- Improved local and strategic network capacity, efficiency and resilience
- Supporting the delivery of the Shrewsbury Big Town Plan
- Enhancing the benefits of other transport scheme investment (e.g. the OLR and Shrewsbury ITP)
- Protecting and enhancing Shrewsbury's built and natural environment
- Improved health, wellbeing and quality of life for local communities
- Improved road safety
- Facilitating the delivery of planned housing and economic growth in Shrewsbury and Shropshire

Whole Life Carbon Assessment

The estimated project whole life carbon (WLC) impact is shown in Table 1.

Table 1 – Updated project carbon impact estimates

Project Carbon Impact Estimates	Carbon Impact (tCO_2e)
User carbon [B8/D]	+53,236
Capital carbon [A1-A5]	+33,317
Operational carbon [B1, B3-B4, B6]	+7,904
Total whole life carbon over 62 years (2-year construction period plus 60-year appraisal period post-opening)	**+94,457**

Potential Carbon Benefits and Loads Beyond the System Boundary

A carbon impact of -12 tCO_2e (a reduction) due to a modal shift associated with the footway/cycleway along the length of the NWRR is included under 'User carbon' in Table 1.

In addition to this modal shift, delivery of the NWRR will result in a reduction in traffic and congestion in Shrewsbury's town centre, enabling road space reallocation and the delivery of additional public and/or active transport infrastructure. This is likely to result in a further modal shift to more sustainable modes of transport; carbon reductions associated with this modal shift have not been captured in the whole life carbon quantification.

Shropshire Council is considering measures to address residual impacts of the combined NWRR and OLR schemes. Details will be provided as part of the planning process addressing both schemes.

Carbon Reduction Target

A target has been set to reduce the infrastructure carbon impact of the project by 30% compared with the carbon baseline of 55,332 tCO_2e (see Section 3.2.5 for detail). A reduction of 26% has been achieved thus far.

1 Introduction

1.1 Project and business case stage

1.1.1. WSP UK Ltd. have been commissioned by Shropshire Council (SC) to prepare a Carbon Management Plan (CMP) to support the development of the Shrewsbury North West Relief Road (NWRR) scheme (hereafter referred to as the 'Proposed Scheme').

1.1.2. This CMP outlines the carbon management approach for the Proposed Scheme. It has been prepared to demonstrate alignment with Department for Transport (DfT) decarbonisation policies and commitments, and with PAS 2080:2023 Carbon Management in Buildings and Infrastructure.

1.1.3. The CMP is a live document, updated by the relevant parties at each project stage. This CMP succeeds the previous Carbon Management Report of April 2021 and is currently updated for the Full Business Case (FBC) stage of scheme development. After FBC, it is intended that this CMP will be adopted during project implementation. Carbon will be reported and tracked across project delivery to provide visibility of the effectiveness of embedded carbon management practices.

1.2 Project description and objectives

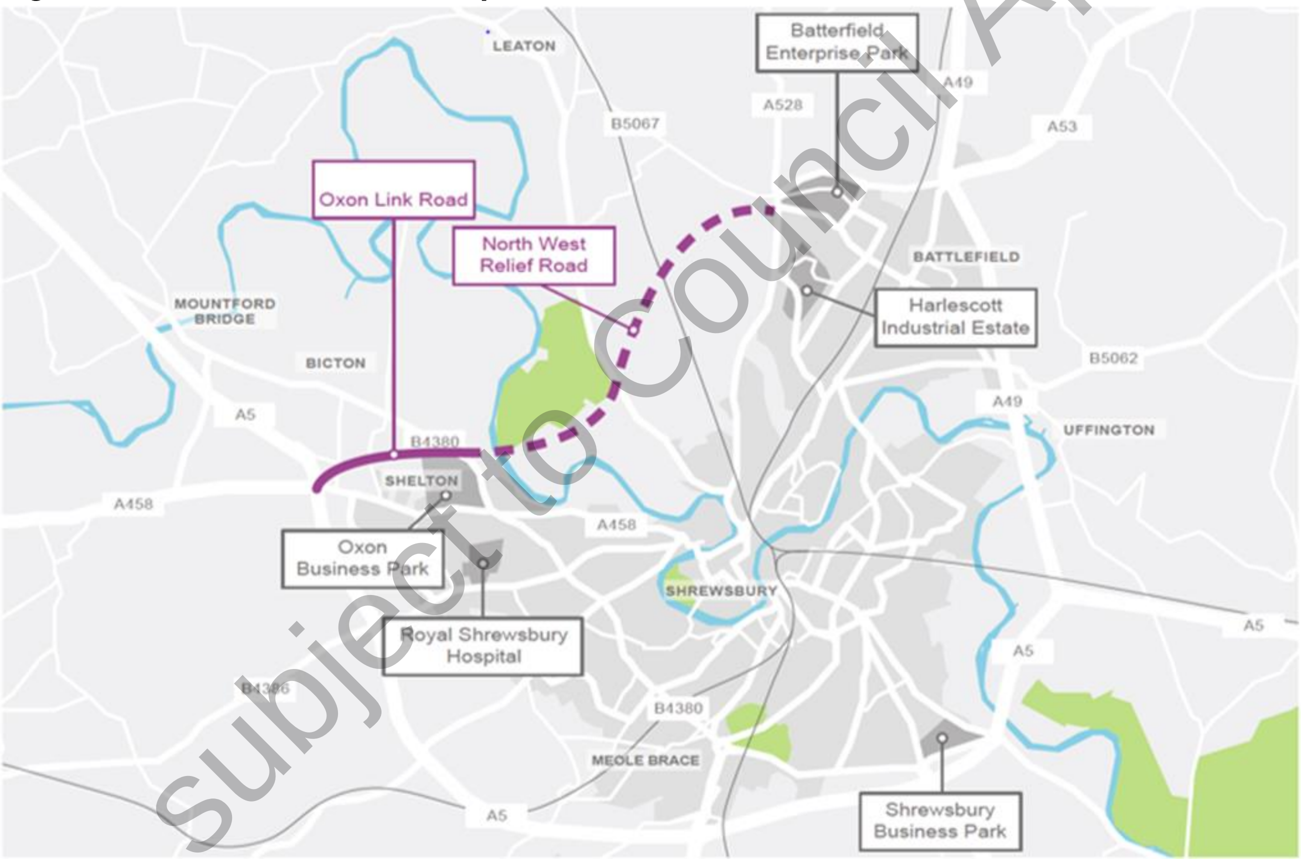
1.2.1. The NWRR scheme is in the north-west of Shrewsbury, as shown in Figure 1-1. Core elements of the Proposed Scheme's scope are listed below:

- A 7.3m wide single carriageway all-purpose 4.85km long road with 1.0m margins and a permitted speed limit of 60 mph, located in the north-west of Shrewsbury connecting the eastern end of the proposed Oxon Link Road (OLR) with the western end of the existing A5124 Battlefield Link Road that provides access to the Battlefield Enterprise Park
- The NWRR will include a shared 3m wide footway / cycleway along the length of its southern side, addressing the severance of a number of local roads, footpaths and PRoW
- Construction of a 36.4m long equestrian culvert to divert the existing bridleway just to the east of the B4380 Holyhead Road Roundabout under the NWRR, maintaining connectivity for pedestrians, equestrians, mammal and bats
- A 15.5m wide viaduct, approximately 584m in length, crossing the River Severn and its floodplain
- Two additional flood storage areas will be provided as a result of the works impinging the existing flood plain
- Combined culvert and mammal crossing points at Willow Pool and along the line of both Alkmund Stream and Hencott Stream
- Landscaping, drainage schemes, increased flood storage, planting, and environmental mitigation work including the acquisition of Hencott Pool to enable habitat improvements

- Provision of a new at-grade four arm roundabout located on the B5067 Berwick Road to provide an interface between the NWRR and the B5067 Berwick Road
- A vehicular bridge to carry the NWRR over the Shrewsbury to Chester railway line
- Construction of an overbridge to carry the Marches Way Footpath and Accommodation Track over the NWRR, providing connectivity for a number of public rights of way in the area
- Replacement of the existing at-grade five-arm A528 Ellesmere Road roundabout with two at-grade four-arm roundabouts in a 'dumb-bell' configuration.

1.2.2. Further detail on the scope of the Proposed Scheme can be found in the Strategic Case section of the FBC.

Figure 1-1 - Overview of the Proposed Scheme



1.2.3. The desired project outcomes include:

- Enhanced local and longer distance connectivity
- Reduced congestion and quicker, more reliable journey times
- Improved local and strategic network capacity, efficiency and resilience
- Supporting the delivery of the Shrewsbury Big Town Plan
- Enhancing the benefits of other transport scheme investment (e.g. the OLR and Shrewsbury ITP)
- Protecting and enhancing Shrewsbury's built and natural environment
- Improved health, wellbeing and quality of life for local communities

- Improved road safety
- Facilitating the delivery of planned housing and economic growth in Shrewsbury and Shropshire

1.2.4. Further detail on project outcomes can be found in the Strategic Case section of the FBC.

1.2.5. The carbon management objectives for this project are:

- Quantify the WLC impacts of the Proposed Scheme
- Minimise the WLC impacts of the Proposed Scheme (capital, operational and user) including carbon emissions within direct control of the project, and those which the project has influence over.

1.2.6. The following scheme objective is also included in the strategic case of the FBC:

- To minimise the greenhouse gas impacts associated with the Proposed Scheme.

1.2.7. In line with best practice carbon management, carbon has been considered throughout design development of the Proposed Scheme. This has been achieved through:

- Carbon workshops (in August 2020 and July 2024).
- Embedding carbon considerations in the design process.
- Weekly attendance of the carbon co-ordinator at FBC development meetings.

1.2.8. To-date, key design decisions influencing carbon have included:

- Removal of the climbing lane from the Severn River viaduct
- Use of PVC pipes in place of concrete
- Removal of Basin 9
- Various structures optimisation.

1.3 Note on the Oxon Link Road and Planning Condition 41

1.3.1. The proposed Oxon Link Road (OLR) involves the construction of a new 7.3m-wide single carriageway all-purpose 2.05km long road between Churncote Roundabout and the B4380 Holyhead Road, along with associated infrastructure (see Figure 1-1).

1.3.2. Further details on OLR, in particular its developmental history and association with the NWRR, can be found in the Strategic Case section of the FBC. Key, relevant events are summarised below:

- Originally, NWRR and OLR were treated as separate, adjacent schemes. The NWRR OBC was submitted in December 2017, and a planning application was submitted for the OLR in July 2018.
- Following announcement of additional funding from DfT as part of the Large Local Major (LLM) schemes programme, SC decided to withdraw the planning application for OLR in August 2019, and to pursue the two previously separate schemes as a single project. On 19 February 2021, the initial detailed planning application for the proposed NWRR scheme (incorporating the OLR) was submitted. A revised detailed planning application was then submitted on 26 August 2021.

- On 31 October 2023, planning approval was obtained subject to 63 planning conditions. The wording of these planning conditions was approved on 15 February 2024.

1.3.3. Although the OLR will be delivered at the same time as part of the broader NWRR project, as it is funded separately from the NWRR scheme, it is not included within the FBC that this CMP supports. As such, the scope of this CMP and the quantified carbon assessment herein covers the NWRR scheme only.

1.3.4. As the planning application for NWRR incorporates OLR, planning conditions apply to both schemes. Planning Condition 41 pertains to carbon:

> "No development shall commence until the Carbon Assessment Plan has been submitted for approval to the Local Planning Authority. The Carbon Assessment Plan shall include in its scope, the built design, construction phase impacts and future use scenarios for the project, how the project will demonstrate achievement of a net-zero carbon outcome, and location of carbon offsetting or removal activity within Shropshire or neighbouring local authority area. Particular attention should be paid to minimising the release of carbon embodied in the vegetation cleared from the route. Development shall not commence until the Carbon assessment plan has been approved in writing by the Local Planning Authority. The development shall be carried out in accordance with the approved Carbon Assessment Plan."

1.3.5. A separate report is being prepared to directly address these requirements and discharge Planning Condition 41.

2 Integrating Carbon Management into Decision-Making

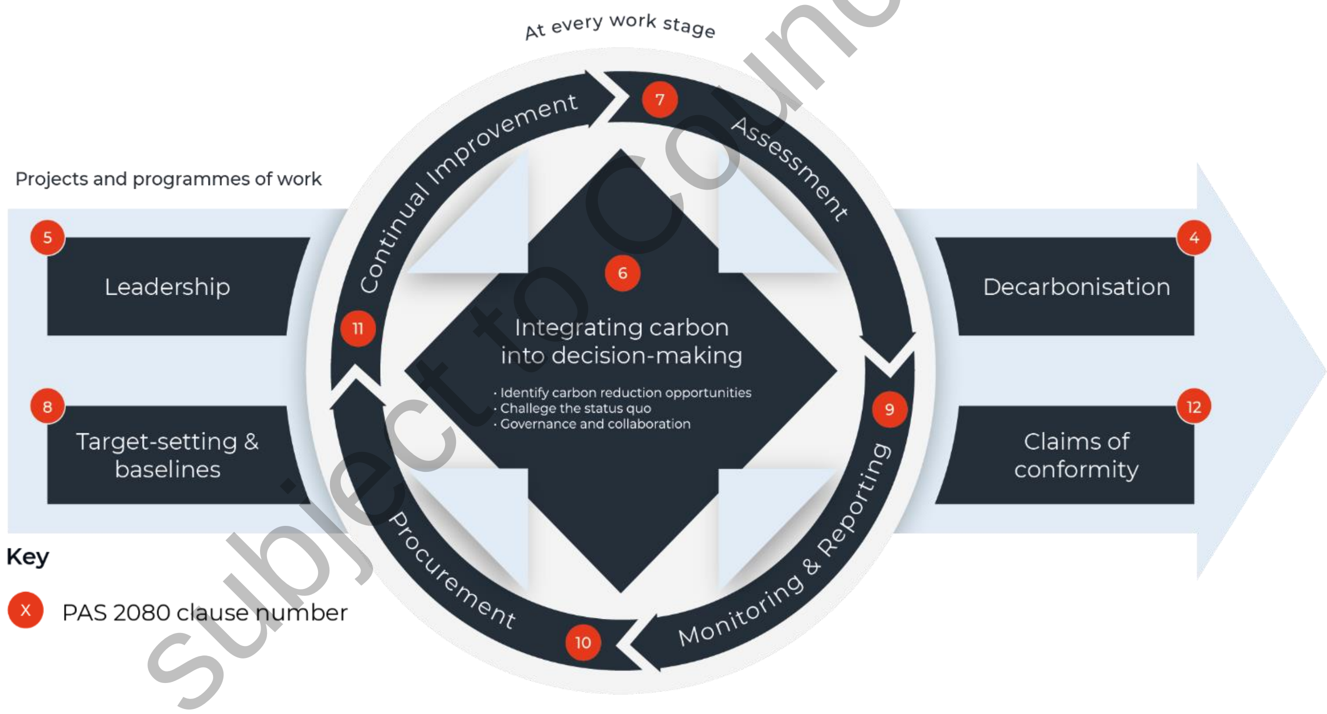
2.1 Introduction

2.1.1. Integrating whole-life carbon (WLC) into decision-making requires the development and implementation of a carbon management process. This section outlines how carbon will be managed across wider project processes to inform decision making and how options to reduce carbon can be integrated across the project lifecycle by effectively integrating carbon management into decision making processes.

2.2 The Carbon Management Process

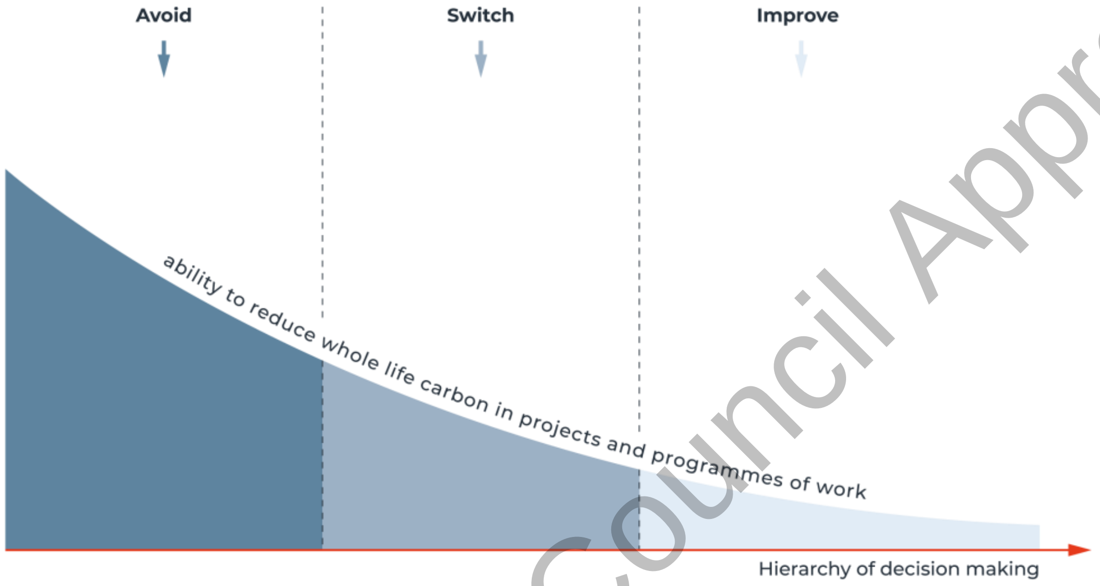
2.2.1. This CMP establishes a carbon management process aligned to the principles of PAS 2080, as shown in Figure 2-1 below.

Figure 2-1 – PAS 2080 Carbon Management Process



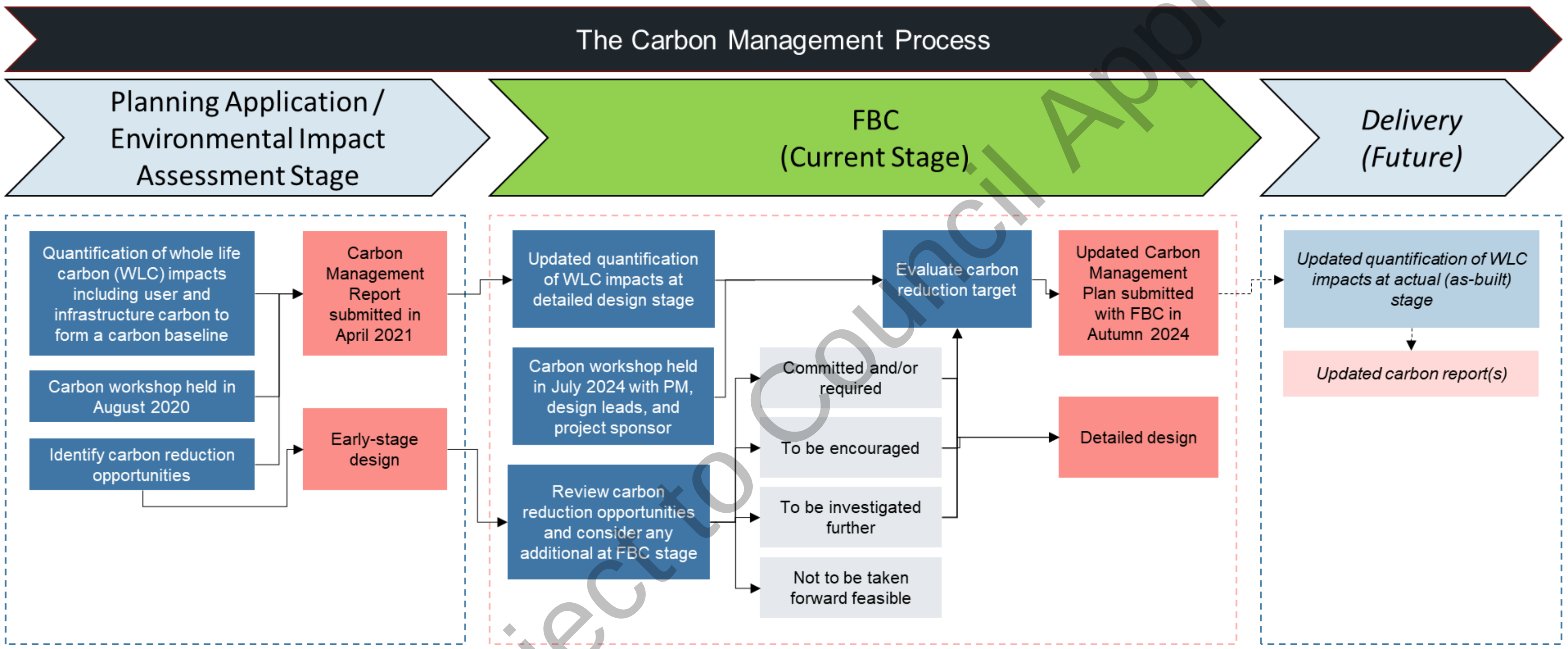
2.2.2. To optimise design and maximise carbon reduction benefits, PAS 2080:2023 – Carbon Management in Infrastructure guidance defines a carbon reduction hierarchy for decision making (detailed in Figure 2-2 and found in clause 4.3 of PAS 2080:2023). The carbon reduction hierarchy is split by three principles, Avoid, Switch, and Improve.

Figure 2-2 - Carbon Reduction Hierarchy



2.2.3. Figure 2-3 provides a high-level summary of the approach taken in the Carbon Management Process for the Proposed Scheme. Table 2-1 builds on the detail in Figure 2-1.

Figure 2-3 - The Carbon Management Process of the Proposed Scheme



2.2.4. The descriptions of the Clauses in Table 2-1 can be found in PAS 2080.

Table 2-1 - Carbon Management Phases and Activities

Clause	Activities
Leadership	It is recommended that the carbon management process is integrated into Project Management and Delivery activities, and the roles and responsibilities for this are assigned – see Chapter 6. Overall responsibilities should sit with the Project Manager, although specific tasks should be delegated. Scheme objectives and Carbon influence to date (*Sections 1.2 and 4.3*) Net Zero targets & Commitments (*Section 5.2*) Training & Upskilling (*Section 6.5*)
Integrate carbon management into decision-making	Carbon management should be considered an integral part of normal project delivery and decision-making, at each stage of the project lifecycle and each major design iteration, including construction. As this scheme is at FBC stage, most design decisions have been finalised, however there remains some limited opportunity to further reduce carbon impacts throughout construction. Carbon workshops have been held in August 2020 and July 2024. Opportunities to reduce carbon identified throughout design stages have been captured in Appendix E. Carbon is embedded through scheme level decision-making by iterative CMP and carbon assessment update at each business case or design stage, and by all stakeholders actively following the actions identified.
Whole-life carbon assessment principles	The methodology used for the carbon baseline is presented in Section 3.2.

Target setting and baselines	The baseline assessment for this CMP is presented in Section 3.2.5. The carbon reduction target is discussed throughout Chapter 5.
Monitoring & Reporting	During project development and execution, the project team will need to develop further carbon reports. The recommended scope of such reports is outlined in Section 6.2
Procurement	Carbon Management Actions in procurement are discussed in Section 6.6.
Continual improvement	The impact of implementing the carbon management process outlined in this CMP, and the final status of carbon reduction opportunities, will be updated during future carbon reports. This will be used to identify lessons learned at the end of the project and be shared beyond just those working on the Proposed Scheme where appropriate. WSP actively undertake continual improvement in technical tools, capabilities, and skills.

3 Quantified Carbon Assessments and Baseline

3.1 Introduction

3.1.1. A WLC assessment is the process of assessing (or estimating) GHG emissions and removals from all work stages of a project and/ or programme of works. WLC assessments should be reviewed and updated at each business case stage, with an increasing level of detail as the business case approval process progresses.

3.1.2. Quantification of whole-life carbon emissions with sufficient frequency and accuracy is needed to inform decision-making throughout the project lifecycle. When used as a baseline, this provides a reference against which future performance can be compared with respect to the desired outcome of decarbonisation, as specified by PAS 2080 (see above).

3.1.3. This Chapter details the Proposed Scheme's carbon baseline, other previous WLC assessments, and the detailed stage WLC assessment that has been undertaken to support submission of the NWRR FBC. This chapter also outlines the assessment methodologies and reporting for the Proposed Scheme.

3.1.4. It should be noted that all negative (-) figures represent a reduction in carbon emissions, and are therefore beneficial, while all positive (+) figures represent additional carbon and represent an adverse impact.

3.2 Methodology

3.2.1. The whole life carbon impact of the Proposed Scheme has been assessed in line with best practice methodology, using the latest relevant emission factors. The methodologies used to assess impacts in each lifecycle carbon module are detailed in Appendix B – Carbon Zero Methodology Note.

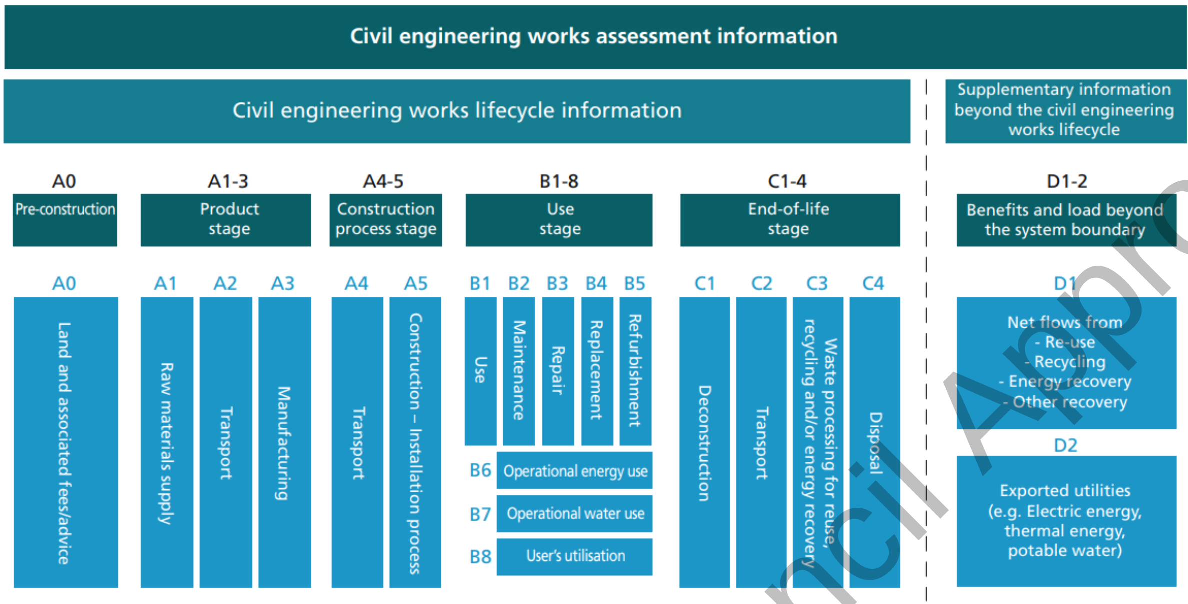
3.2.2. Note that the methodologies have varied with each assessment over time, particularly for quantification of user carbon impacts.

Module breakdown and boundaries

3.2.3. The carbon emissions from the Proposed Scheme have been assessed in line with the BS EN 17472:2022 modules shown in Figure 3-1.

3.2.4. End of life stage emissions are scoped out as road transport infrastructure tends to be used indefinitely – it is not anticipated that the Proposed Scheme would be decommissioned at the end of the 60-year assessment period.

Figure 3-1 - Modular approach developed for LCA reporting, referred to throughout PAS 2080:2023 and based on the methodology used in BS EN 17472 (Source PAS 2080:2023)



3.2.5. The Department for Transport (DfT) Transport Appraisal Guidance (TAG) Unit A3 additionally uses the following terminology as shorthand to group modules:

- Capital carbon – emissions associated with scheme construction [i.e. A1-A5]
- Operational carbon – emissions associated with scheme operation and maintenance [i.e. B1-B7]
- User carbon – emissions associated with scheme users, such as changes in emissions due to modal shift [B8/D]

3.2.6. “Infrastructure carbon” is used as shorthand for capital and operational carbon.

3.3 Previous WLC Assessments and Baseline

3.3.1. The carbon impact of the Proposed Scheme has been evaluated at multiple points throughout its development, as shown in Table 3-1. Note that past assessments have variously included or excluded the Oxon Link Road.

Table 3-1 – Scope and results of past carbon assessments of NWRR and OLR

Carbon assessment as part of…	Scope of Assessment & Notes	Capital Carbon (tCO_2e)	Operational Carbon (tCO_2e)	User Carbon (tCO_2e)	TOTAL Carbon (tCO_2e)
Dec 2017: NWRR OBC	DS (2017) – DM (2017) = Impact of NWRR only. User carbon assessment	Not assessed	Not assessed	-74,337	**-74,337***

	using TUBA. Infrastructure carbon impact not assessed.				
Feb 2021: Environmental Statement Chapter 9 – Climate Change	DS (2020) – DM (2020) = Impact of NWRR and OLR User carbon quantified using link-by-link model data and TAG datasets. Infrastructure carbon assessed using NH carbon tool.	+70,452	+3,159	-24,545	**+49,066**
Apr 2021: Carbon Management Report	DS (2020) – DM (2020) = Impact of NWRR and OLR In-depth, more detailed analysis of construction carbon impacts of NWRR and OLR. Independently reviewed and confirmed by academic experts at Birmingham University.	+68,311	[included in capital carbon figure]	Not assessed (assume unchanged from Feb 2021 assessment)	**+46,925****
Aug 2021: Supplementary Environmental Statement Chapter 9	DS (2020**) – DM (2020) = Impact of NWRR and OLR Reassessment of construction phase emissions following design change.	+48,233	+3,024	Not assessed (assume unchanged from Feb 2021 assessment)	**+26,711****

*User carbon only (based on TUBA)

**User carbon result carried forward from Feb 2021 assessment

3.3.2. The results of the Dec 2017 assessment were reported in the NWRR OBC. This assessment was undertaken using the Transport Users Benefit Appraisal (TUBA) software to assess user carbon impacts of the Proposed Scheme. This methodology is now recognised as less accurate than link-based calculations, and the result of -74,337 tCO_2e has been superseded.

3.3.3. Additionally, the Dec 2017 assessment did not include capital carbon impacts, which is now an expectation set by DfT in TAG Unit A3.

3.3.4. **As the February 2021 assessment was the first that included capital and operational carbon impacts, this assessment has been taken as the baseline.** For this assessment, user carbon impacts were assessed using a link-based calculation methodology in line with TAG Unit A3, using data from the Shrewsbury Traffic Model forecasts developed in 2020.

3.3.5. Note that the Feb 2021 assessment included impacts of OLR.

Adjustment to Exclude OLR

3.3.6. As the FBC which this CMP (and latest WLC assessment) supports pertains to NWRR only (excluding OLR), it is useful to apply an adjustment to the Feb 2021 results to approximate the impacts of NWRR only, creating a meaningful baseline against which reductions can be measured.

3.3.7. The latest (Detailed Stage) WLC Assessment described in Section 3.4 has included quantification of both NWRR and OLR impacts, however, only NWRR results are reported in this CMP. It is therefore possible to find the proportion that each scheme contributes to combined carbon impacts. **In the latest assessment, 75.7% of the combined NWRR+OLR A1-A5 and B4 impacts are attributable to NWRR** (note: the latest assessment also includes additional operational carbon modules B1, B3 and B6, which are excluded for this adjustment as the February 2021 assessment did not include these). Applying this proportion to the February 2021 infrastructure carbon (capital and operational) figures results in an adjustment from +73,611 tCO_2e to **+55,735 tCO_2e**, as shown in Table 3-2.

Table 3-2 – Adjustment to capital & operational carbon baseline to exclude OLR

Variable	Calculation	Result (tCO_2e)
[A] – Feb 2021 A1-A5 + B4 result (NWRR+OLR)	-	+73,611
[B] – Latest (Detailed Stage) A1-A5 + B4 carbon result – NWRR only (see Section 3.4)	-	+38,138
[C] – Latest (Detailed Stage) A1-A5 + B4 carbon result – NWRR and OLR	-	+50,370
[D] – Proportion attributable to NWRR	= [B] / [C]	= 75.7%
[E] – Adjusted infrastructure carbon baseline	= [D] x [A]	**= +55,735**

3.3.8. The adjusted infrastructure carbon baseline for the Proposed Scheme (excluding OLR) is therefore +55,735 tCO_2e.

3.3.9. Applying this adjustment method to user carbon impacts would not account for the combined effects of the two schemes. As such, no adjustment has been made to the baseline for user carbon.

3.4 Latest (Detailed Stage) WLC Assessment

3.4.1. **The latest carbon assessment estimates that over a 60-year appraisal period, the Proposed Scheme (NWRR only) will have an overall impact of +94,457 tCO_2e**, comprised of:

- +41,222 tCO_2e infrastructure carbon (A1-B6) impact, itself comprised of:
  - +33,317 tCO_2e capital carbon (A1-A5) impact,
  - +7,904 tCO_2e operational carbon (B1-B6) impact,
- +53,236 tCO_2e user carbon (B8/D) impact (includes -12 tCO_2e from modal shift).

3.4.2. A summary of impacts by module is provided in Table 3-3 below, and detailed analysis is provided in Appendices C (Carbon Assessment Summary Report) and D (Biogenic Carbon Assessment Report). Identified carbon hotspots are detailed in Section 4.2.

Table 3-3 – Detailed Stage WLC Assessment Breakdown

Lifecycle Stage	Quantified	Key Module/Impact	Estimated Carbon Impact (tCO_2e)
Pre-Construction Stage	Module Not Quantified	A0 – Land and associated fees/advice Design emissions	Not quantified
Product stage	Quantified	A1 – Raw material supply	+27,672
	Quantified	A2 – Transport to factory	
	Quantified	A3 – Manufacturing	
Construction process stage	Quantified	A4 – Transport to site	+3,512
	Quantified	A5 – Construction emissions	+2,133
Use stage	Quantified	B1 – In use (Land Use Change)	+2,838

	Module not quantified	B2 – Maintenance	Not quantified
	Quantified	B3 – Repair	+232
	Quantified	B4 – Replacement	+4,820
	Module not Quantified	B5 – Refurbishment	Not quantified
	Quantified	B6 – Energy use	+14
	Module not quantified	B7 – Water use	Not quantified
	Quantified	B8/D – Users' utilisation (General Traffic Changes	+53,247
	Quantified	B8/D – Users' utilisation (Modal Shift)	-12
End of life stage	Module not quantified	C1 – De-construction	Not quantified
	Module not quantified	C2 – Waste transport	
	Module not quantified	C3 – Waste processing	
	Module not quantified	C4 – Waste Disposal	
Total* Whole Life Carbon Impact over 60-year appraisal period:			**+94,457**

*Note that due to rounding the sum of the rows may not exactly equal the total.

Key Limitations and Assumptions

3.4.3. The figures presented in this WLC assessment reflect assumptions for the 'core' scenario only. User carbon impacts are quantified using TAG estimates of EV uptake, which do not currently reflect the UK government target for all new cars to be zero emission by 2035. In addition to the 'core' scenario, sensitivity tests are being prepared that align with the High Economy, Low Economy, and Regional Common Analytical Scenarios, to provide a range of potential user carbon results.

3.4.4. Change Over Time

3.4.5. Table 3-4 and Figure 3-2 show the results of WLC assessments of the Proposed Scheme over time.

3.4.6. The adjustment applied to the Feb 2021 capital and user carbon result to exclude OLR impacts (see paragraphs 3.3.6 - 3.3.9) can be similarly applied to subsequent Apr 2021 and Aug 2021 results to approximate the capital and operational carbon impacts of NWRR only.

Table 3-4 – WLC impact of project across business case stages

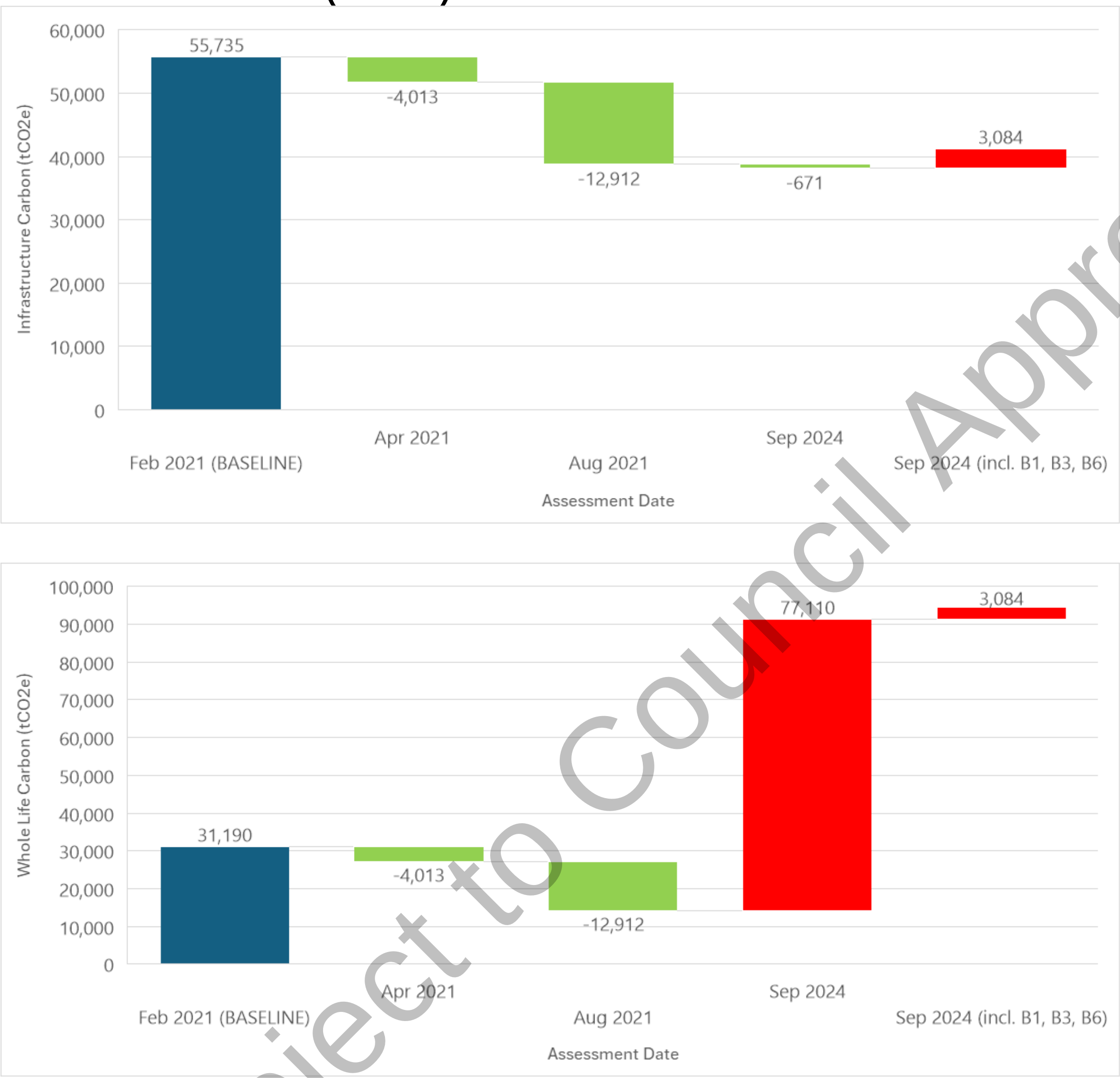
Assessment Stage	**Infrastructure Carbon** **NWRR and OLR** **(tCO_2e)**	**Infrastructure Carbon*** **Adjusted, NWRR only** **(tCO_2e)**	**User Carbon** **NWRR and OLR** **(tCO_2e)**	**Whole Life Carbon** **Adjusted**, NWRR only** **(tCO_2e)**
OBC (Dec 2017)	Not assessed	N/A	-74,337	-74,337***
Environmental Statement (Feb 2021) **(BASELINE)**	+73,611	**+55,735**	**-24,545**	**+31,190**
Carbon Management Report (Apr 2021)	+68,311	+51,722	Not assessed (assume unchanged from Feb 2021 assessment)	+27,177
Supplementary Environmental Statement (Aug 2021)	+51,257	+38,809	Not assessed (assume unchanged from Feb 2021 assessment)	+14,264
FBC (Sep 2024) **(Latest, Detailed Stage Assessment)**	N/A	+38,138 (excl. B1, B3, B6) **+41,222** (incl. B1, B3, B6)	**+53,236**	**+94,457**

*Only the latest, detailed stage assessment includes B1, B3 and B6. Past assessments have excluded these modules.

**Only the capital and operational stage carbon components are adjusted to exclude OLR – see 3.3.9. The latest, detailed stage user carbon assessment however does exclude OLR.

*** User carbon only, based on TUBA.

Figure 3-2 - Waterfall chart showing change in infrastructure carbon (top) and whole life carbon (bottom) over time



4 Carbon Hotspots and Reduction Opportunities

4.1 Introduction

4.1.1. A detailed breakdown of the Proposed scheme's carbon impact by module and material is provided in Appendix C.

4.2 Hotspots

4.2.1. Emission 'hotspots' are priority areas for carbon reduction. Table 4-1 below provides detail on the hotspots and the carbon impact for the Proposed Scheme.

4.2.2. "Infrastructure carbon" here is used as shorthand for carbon impacts across all quantified modules except for User's Utilisation (B8/D). User's Utilisation is not included in this table as remaining reduction opportunities pertain to other modules only.

Table 4-1 – Infrastructure Carbon Impacts by Material Category

Category	Description	Carbon Impact over construction and 60-year appraisal period	Proportion of infrastructure carbon total
Bulk Materials (A1-A3 + B4)	Bulk materials include ready mix concrete, fill, aggregate, and sand, asphalt, and reinforcement steel. Asphalt is the only bulk material type with use related emissions – road pavements are assumed to be replaced in years 20 and 40. Product stage (A1-A3): 10,512 tCO_2e Replacement (B4): 3,174 tCO_2e	**+13,686 tCO_2e**	35%
Civils Structures & Retaining Walls	Civils Structures & Retaining Walls includes steelwork, pre-cast concrete, decorative stone, retaining walls, and formwork/ shuttering.	**+11,152 tCO_2e**	29%

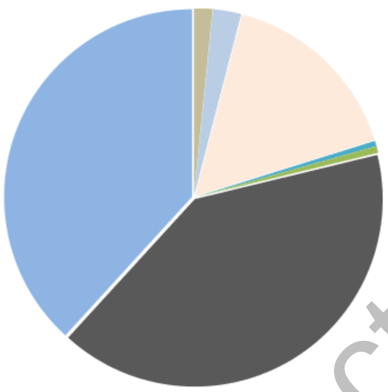
	The lifespan of these aspects is assumed to be greater or equal to the appraisal period of 60 years. Product stage (A1-A3): 11,152 tCO_2e		
Earthworks	Earthworks includes imported soil and geotextiles. Product stage (A1-A3): 4,438 tCO_2e	**+4,438 tCO_2e**	11%
Transport (Including transport of Waste)	Once processed, all materials require transportation to and from the works site. Heavy goods vehicles are required – associated tailpipe emissions contribute to the scheme's whole-life carbon appraisal. We exclude transport of materials for repair and replacement. Transport (A4): +3512 tCO_2e	**+3,512 tCO_2e**	9%
Land use, land use change, and forestry (B1)	The construction stage emissions from LULUCF are reported as the loss of carbon stored from habitats removed between the Do Something and the Do Minimum scenarios. Removal of storage: 8072 tCO_2e Sequestration: -5,234 tCO_2e	**+2,838 tCO_2e**	7%
Fencing, Barriers & Road Restraint System	Fencing, Barriers & Road Restraint System includes noise barriers, fences, and safety barriers.	**+1,562 tCO_2e**	4%

	The lifespan of these aspects is assumed to be 20 years. Product stage (A1-A3): 438 tCO_2e Replacement (B4): 1124 tCO_2e		
Drainage	Drainage includes precast concrete manholes, pipework, and inspection chambers. The lifespan of these aspects is assumed to be greater or equal to the appraisal period of 60 years. Product stage (A1-A3): 669 tCO_2e	**+669 tCO_2e**	2%
Road Pavements	Road Pavements includes road markings, kerb, and surface treatment. Note that asphalt is allocated as a bulk material. Road markings have a lifespan of 10 years, Product stage (A1-A3): 129 tCO_2e Replacement (B4): 340 tCO_2e	**+469 tCO_2e**	1%
Street Furniture & Electrical Equipment	Street Furniture & Electrical Equipment includes traffic signs, road lighting, cables, and cabinets. Product stage (A1-A3): 159 tCO_2e Replacement (B4): 182 tCO_2e	**+341 tCO_2e**	1%

Waste	Waste includes aggregate and soil, and bituminous mixtures. Product stage (A1-A3): 175 tCO_2e	**+175 tCO_2e**	0%
Energy Use (B6)	Energy use is from street lighting. Energy Use (B6): +14 tCO_2e	**+14 tCO_2e**	0%

4.2.3. Figure 4-1 shows the breakdown of product stage (A1-A3) carbon by of material category (excludes 175 tCO_2e waste).

Figure 4-1 - Breakdown of product stage (A1-A3) emissions by material category



Category	CO_2e Emissions
Fencing / RRS / barriers	437.647
Drainage	669.317
Earthworks	4,437.888
Pavements	129.107
Street furniture	158.959
Civil Structures	11,152.091
Bulk Materials	10,512.041
Total	**27,497.051**

4.2.4. Carbon management should prioritise these hotspots to achieve the most effective carbon reduction opportunities for the scheme.

4.2.5. As identified above, there are several emission hotspots that dominate the infrastructure carbon impact of the Proposed Scheme.

4.2.6. Steel, concrete, asphalt, and aggregate contribute the most significant adverse material carbon impacts of this scheme. As such, these are target areas for reducing carbon impact to meet the proposed carbon reduction target.

4.3 Carbon Reduction Opportunities

4.3.1. Opportunities to reduce carbon have been identified throughout the design process. Key influences to-date include:

- Removal of the climbing lane from the Severn River viaduct
- Use of PVC pipes in place of concrete
- Removal of Basin 9
- Various structures optimisation.

4.3.2. Appendix E outlines the status of all opportunities. Many opportunities in Appendix E were first identified in the Carbon Management Report of April 2021; the status of these opportunities has been updated where applicable.

5 Carbon Reduction Target

5.1 Introduction

5.1.1. This chapter outlines the carbon reduction targets established by this CMP, including the context in which it has been set and the methodology used. Setting a project carbon budget or carbon reduction target will help to inform decision-making in the Proposed Scheme's procurement and construction. It should also guide carbon management decisions and improve identification of carbon reduction opportunities across the project lifecycle.

5.2 Context: Aligning to the Net Zero Transition

5.2.1. It is recognised that the Proposed Scheme is part of a wider network and system; one that together must transition to a net zero carbon economy by 2050 and meet interim carbon budgets. This scheme and its carbon management process should contribute to this system level change. For this reason, the emission context at a UK, regional and local economy and surface transport level is first detailed. The Proposed Scheme's carbon impact is contextualised against this data in the next section alongside the UK carbon budgets.

5.2.2. Carbon budgets (Table 5-1) have been set by the UK Government covering 2018 to 2037. These legally binding budgets are expressed in millions of tonnes of carbon dioxide equivalents ($MtCO_2e$). The budgets can be used to contextualise the Proposed Scheme's emissions.

Table 5-1 - UK carbon budgets (2021)

Carbon Budget Period	UK Carbon Budget	Reduction Required Relative to Third Budget
Third: 2018-2022	2,544 $MtCO_2e$	N/A
Fourth: 2023-2027	1,950 $MtCO_2e$	23%
Fifth: 2028-2032	1,725 $MtCO_2e$	47%
Sixth: 2033-2037	965 $MtCO_2e$	63%

5.2.3. Shropshire Council has a vision "to become carbon net-neutral by 2030 and assist in the ambition for Shropshire as a whole to become carbon net-neutral in the same year" (Shropshire Council - Climate Strategy and Action Plan).

5.2.4. As part of the development of the Shropshire Local Transport Plan (LTP) 4, WSP has been commissioned to undertake an analysis of what would be required to decarbonise transport in Shropshire in line with carbon budgets and Net Zero by

2050. Initial analysis estimates that a business-as-usual transport future in Shropshire will produce approx. 8.64 $MtCO_2e$ over the 4th-6th carbon budget periods (2023-2037). This is 14% over the UK Net Zero Strategy Delivery Pathway (Upper) budget of 7.46 $MtCO_2e$ (localised for Shropshire) over this period, and 31% over the Climate Change Committee's (CCC) budget of 5.95 $MtCO_2e$. Substantial intervention will be required to close this emissions gap.

5.3 Setting the Target for Carbon Reduction

5.3.1. PAS 2080 recommends project specific carbon reduction targets (or carbon budgets) should be set at a programme level which align to targets set at a system or national level. The national targets and LTP context outlined in Section 5.2 have been considered in this.

5.3.2. Alongside this broader context the carbon reduction target has been informed by a process of quantifying the potential impact of remaining carbon reduction opportunities, detailed in Appendix F. This is to ensure the carbon reduction is achievable, evidence-led and reflective of the stage of design.

5.3.3. The carbon reduction target is set against the infrastructure carbon baseline of 55,735 tCO_2e, presented in Section 3.3 and Table 3-2. User carbon is excluded from the scope of the carbon reduction target on the basis of there being limited remaining opportunity to influence this, however any opportunities that do arise to influence wider scheme impacts will be properly considered as part of the ongoing carbon management process.

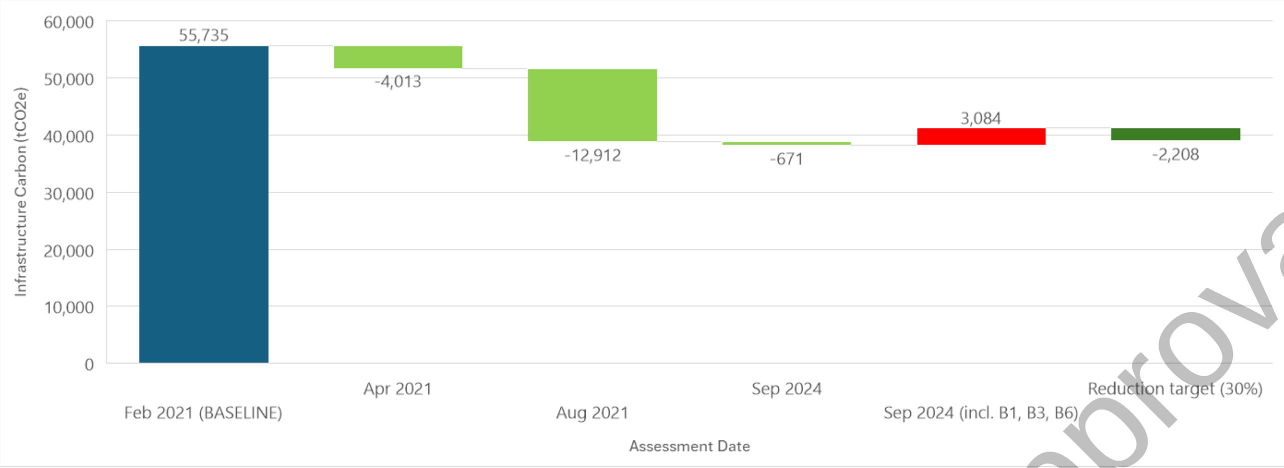
5.3.4. **The carbon reduction target has been set as a 30% reduction in infrastructure carbon (A1-B6).**

5.3.5. As outlined in Section 3.4, the latest WLC assessment has quantified infrastructure carbon impacts to be 41,222 tCO_2e – a 26% reduction from the baseline. This is largely attributable to a design change to reduce the impacts of the viaduct, which was implemented between the April 2021 and August 2021 assessments.

5.3.6. A further 4% reduction (relative to the baseline) is required to achieve this 30% target. This represents a further reduction of 2,208 tCO_2e, which is regarded as achievable given remaining carbon reduction opportunities and is reflective of a late stage of design delivery when further opportunities are limited.

5.3.7. The scale of this reduction is demonstrated in Figure 5-1 against changes in infrastructure carbon over time.

Figure 5-1 - Change in infrastructure carbon over time, and reduction required to meet target



5.4 Procedure for Amending the Project Carbon Targets

5.4.1. The project's estimated carbon targets are not expected to be changed during project delivery phases except in exceptional circumstances, such as:

- Change to the required project outcomes; or
- Change to the project operational duration.

5.4.2. For the avoidance of doubt, the project carbon targets will not be changed due to the addition or deletion of scope items or assets, unless the required project outcomes have also changed.

5.5 Tracking Progress against Project Carbon Targets

5.5.1. As the Proposed Scheme progresses to the delivery stage, further quantification of actual (as-built) carbon impacts will be undertaken in line with best practice and industry standard carbon factors, in order to report final performance against the carbon reduction target.

5.6 Risks to Achieving Carbon Reduction Target

5.6.1. A table outlining the risks to mitigating the carbon impacts of the Proposed Scheme is available in Appendix G.

5.7 Residual Impacts and Offsetting

5.7.1. Shropshire Council is considering measures to address residual impacts of the combined NWRR and OLR schemes. Details will be provided as part of the planning process addressing both schemes.

6 Carbon Management Governance

6.1 Introduction

6.1.1. This chapter outlines the leadership and governance that will be put in place to deliver and enable the process identified in Chapter 2.

6.2 Carbon Monitoring and Reporting

6.2.1. To monitor and report carbon during project development and execution, the project team will need to develop further carbon reports. These carbon reports will include:

- Quantification of actual (as-built) carbon impacts for comparison against the project carbon baseline.
- Progress of implementing the carbon reduction opportunities in Appendix E.
- Actions that reduce carbon impact, especially for the hotspots in Section 4.2
- Tracking of key carbon risks.

6.3 Roles and Responsibilities

6.3.1. It is the responsibility of all within the project team to deliver this CMP and any carbon reduction target set (see Chapter 5 for carbon reduction target).

6.3.2. As best practice, the appointment of an assigned carbon co-ordinator should be explored to take ownership of the coordination and delivery of this plan in line with PAS 2080:2023.

6.3.3. In addition to the carbon co-ordinator, Table 6-1 outlines critical roles and responsibilities for implementing carbon management throughout the project. This table should be updated over the project lifecycle with the applicable roles and responsibilities at each stage.

Table 6-1 – Roles and Responsibilities

Roles (as at FBC stage)	Responsibility
Project sponsor, asset owner/manager – Shropshire Council (Highways)	Ultimate responsibility for the project's carbon performance against targets and implementing a governance structure and culture that enables decarbonisation.
Leadership – Shropshire Council (Highways) & WSP (at FBC / Detailed Design Stage)	Working with the carbon co-ordinator to embed carbon management into the Proposed Scheme processes, whilst liaising with key project leaders and external stakeholders where necessary. The carbon co-ordinator should report the carbon baseline and savings

	updates to these key stakeholders for wider dissemination if necessary.
Designer – WSP (at FBC / Detailed Design stage)	Design experts will be required for feasibility assessments to ensure suitable opportunities are considered. Additionally, they should ensure that the opportunities committed to are included in the scheme design.
Carbon appraisal lead – WSP (at FBC / Detailed Design stage)	Analyst responsible for producing the quantified WLC estimates and calculating the monetised carbon impact appraisal in the economic dimension of the FBC.
Procurement Team – Shropshire Council	To ensure the carbon reduction targets are cascaded across the value chain, and suitable suppliers are selected who can support the scheme carbon requirements.
Constructor – TBC	Yet to be appointed but will have responsibility for implementation of carbon reduction opportunities in construction, quantifying actual (as-built) carbon impacts, and developing an updated carbon report in construction stage.
Carbon management action owners	Referenced above as a guide to those who should have responsibility for reviewing and implementing (where feasible) the opportunities for carbon reduction.

6.4 Leadership

Strategy Alignment

6.4.1. While the Proposed Scheme itself is expected to result in a net-increase in carbon emissions over the appraisal period, its delivery will result in a reduction in traffic and congestion in Shrewsbury's town centre, enabling road space reallocation and the delivery of additional public and/or active transport infrastructure. This is likely to affect a modal shift to more sustainable modes of transport; carbon reductions associated with this modal shift have not been captured in the WLC quantification presented in Section 3.4.

6.4.2. As noted in Section 5.7, Shropshire Council will undertake to identify local or wider initiatives as required, to manage to carbon impact of the project to net neutrality within 60 years of the opening date.

Collaboration

6.4.3. Weekly attendance of the carbon co-ordinator at FBC development meetings has ensured all disciplines maintain an awareness of the carbon impacts of their decisions, and potential implications of these decisions on the Proposed Scheme. In addition to representatives from project leadership, design, business case, environment, traffic modelling, procurement, and risk teams, Shropshire Council's project manager has also regularly attended to ensure awareness of any carbon risks and insights are widely understood by all.

6.4.4. Project governance and processes will be established on appointment of contractor. It is proposed that carbon will be a standard agenda item in project delivery meetings to ensure it remains a core consideration throughout the delivery phase.

6.4.5. From OBC stage onwards, there has been constant involvement from Shropshire Council's carbon team, including attendance at steering groups and other scheme development meetings, to ensure collaboration between the Council and delivery partners.

6.5 Carbon Training

6.5.1. It is recognised that a degree of upskilling may be required across the parties involved in delivery of the detailed design and construction of the Proposed Scheme. Required skill levels will vary subject to roles and responsibilities.

6.5.2. Gaps in skills or capabilities should be identified based on the actions in Table 6-1. If appointed, the identification of these gaps would be owned by the Carbon Co-ordinator, who works with the stakeholders in each area.

6.5.3. All Shropshire Council Members have undertaken carbon literacy training. Other key leaders within the Council are undertaking such training.

6.6 Procurement

Engagement and Communications

6.6.1. Engagement and communication with prospective suppliers to understand market decarbonisation capability will be further discussed with the appointed contractor from commencement of project delivery.

Procurement Strategy

6.6.2. The contract is being procured under NEC4: Engineering and Construction Contract Option C: target contract with activity schedule. Question 8 of the Technical Questions asked as part of the tender covers Social Value (and Carbon):

“Please explain, using a Social Value Plan setting out your social value commitments for each successive quarterly period throughout the term of the contract, your approach to maximising the tangible and measurable social value benefits delivered through the works.

[…]

Shropshire Council’s Requirements in respect to Social Value may be distilled to two key categories for the NWRR

Shropshire Council’s Requirements related to the environment are:

- an ambitious approach to contractors becoming carbon neutral and supporting Shropshire Council to meet this target and its vision to become carbon net-neutral by 2030;
- an approach which maximises resource efficiency including waste disposal, and to sourcing materials in terms of weighting environmental impact, initial price and performance;
- an approach which creates places that are healthy for both people and planet, such as biodiversity and clean air (particularly mitigating emissions of particulate matter (PM) and oxides of nitrogen (NOx));
- an approach which sets ambitious but achievable targets, continuous improvement and central co-ordination; and
- an approach which supports your supply chain partners in meeting these same commitments.”

Procurement Policies and Processes

6.6.3. The tender evaluation comprised of 100 marks, split into 60 for Quality and 40 for Price. Of the 60 Quality marks, 55 marks were assigned to 8 Technical Questions and 5 to Risk Transfer. One of the 8 Technical Questions covers Social Value (and carbon) and is quoted, in part, above.

6.6.4. The final score for a question was determined following a moderation process, then divided by 10 and multiplied by the weighting attributed to that question to give a final score for each Quality Question.

6.6.5. The total moderated score for the Quality Questions was out of 100. Question 8 regarding Social Value (and Carbon) had a weighting of 10.

6.6.6. The procurement process was overseen by Shropshire Council’s carbon lead, who also had input in the evaluation of tender responses.

Contract Award

6.6.7. The appointed contractor’s responses to the Technical Quality Questions will form part of the contractual requirements and Contractors will be measured against these outputs.

6.6.8. A carbon reduction workshop is expected to be held with the appointed contractor. A collaborative approach to carbon management will be promoted, in which Shropshire Council will learn from the contractor, and the contractor learn from the Council.

Appendix A

Definitions and Acronyms

Appendix A - Definitions and Acronyms

Term / Acronym	Definition
Business as Usual	Is the continuation of current arrangements as if the intervention under consideration were not to happen. This serves as a benchmark to compare alternative interventions (definition as per HMT Guide to Developing the Project Business Case, 2018)
Carbon	Carbon is used throughout this document as shorthand for greenhouse gas emissions, expressed as carbon dioxide equivalent (CO2e)
Capital emissions(i)	Greenhouse gas emissions and removals associated with the creation and end-of-life treatment of an asset, network, or system, and optionally with its maintenance and refurbishment
Carbon reduction hierarchy	The carbon reduction hierarchy presents the order of effectiveness and hence priority for implementing different carbon reduction opportunities: Avoid, switch, improve. Also refer to PAS 2080:2023 Clause 4.3 for further guidance
Carbon risk	Risks related to carbon management. E.g., risk of non-compliance with net zero legislation or risk of design change that will cause an increase in WLC
Carbon opportunity	Opportunities related to carbon management. E.g., opportunity to optimise design to reduce embodied carbon or opportunity to including bicycle infrastructure to induce mode shift from road or rail to cycling, reducing user carbon
CMP	Carbon Management Plan
Control (in context of PAS 2080)(i)	Ability to make decisions about activities that leverage carbon emissions removals
DfT	Department for Transport
FBC	Full Business Case
Greenhouse Gas emission(i)	Total mass of GHG released to the atmosphere over a specified period of time
Influence (in context of PAS 2080)(i)	Ability to support other value chain members to make low-carbon decisions

Term / Acronym	Definition
Net zero(i)	The reduction of anthropogenic greenhouse gas emissions to zero or to a residual level that is consistent with reaching net zero emissions in eligible 1.5 °C pathways (hence time-bound) and neutralizing the impact of residual emissions (if any) by removing an equivalent volume of carbon
OBC	Outline Business Case
Operational emissions(i)	Greenhouse gas emissions and removals associated with the operation of an asset, network and/or system required to enable it to operate and deliver its service
PAS 2080:2023	Publicly available specification on carbon management in buildings and infrastructure
SOBC	Strategic Outline Business Case (also referred to as SOC in other government guidance documents)
System level targets	A system level target, in the context of carbon reduction, is the rate at which carbon of the system must be reduced in order to reach national net zero targets (net zero by 2050). The system applicable to all transport projects is the transport system – including all modes. Also refer to PAS 2080:2023 Clause 8 for further guidance
TAG	Transport Analysis Guidance
User emissions(i)	Greenhouse gas emissions associated with users' utilization of an asset, network and/or system, and the service it provides during operation
Value chain (i)	Organizations and stakeholders involved in creating, operating and managing assets and/or networks (definition as per PAS2080:2023)
Whole life carbon(i)	Sum of greenhouse gas emissions and removals from all work stages of a project and/or programme of works within the specified boundaries
Definitions as per Clause 3 of PAS 2080:2030	

Appendix B

Carbon Assessment Methodology Note

Methodology Note

WSP'S CARBON ZERO APPRAISAL FRAMEWORK

1. INTRODUCTION

The Carbon Zero Appraisal Framework, developed by WSP, provides a consistent and transparent approach to whole-life carbon assessment. It is a compilation of tools and methods for the analysis of carbon impacts, both quantitatively and qualitatively. The outputs of the framework are a Carbon Zero Summary Report and this Methodology Note.

Methods adopted in the Carbon Zero Appraisal Framework adhere to industry best practice and align with relevant guidelines, as outlined in Table 1. The primary objective of this Methodology Note is to ensure complete transparency of the methodology and assumptions used during the assessment of carbon impacts, as presented in the Carbon Zero Summary Report and the Carbon Management Plan as part of the Final Business Case.

2. GUIDANCE FOLLOWED

This whole-life carbon assessment has been prepared in accordance with the requirements of the guidance documents in Table 1: Guidance Followed.

Table 1: Guidance Followed

Guidance	Relevant Requirements	How has this been addressed
Department for Transport (DfT) Transport Appraisal Guidance (TAG) Unit A3	▪ 4.1.6 – "Appraisal should consider all greenhouse gas emissions." ▪ 4.2 – Methodology ▪ 4.2.20-25 – Monetisation ▪ 4.4.10 – reporting relative to the 'without scheme' case. ▪ 4.4.10 – report a breakdown by traded and non-traded. ▪ 4.4.10 – reporting by carbon budgets	▪ See Principles of Assessment – whole-life carbon. ▪ The quantification of user carbon uses the TAG methodology and datasets referenced in 4.2 ▪ TAG carbon values are used as prescribed. See Monetised section below. ▪ Impact is reported relative to the 'without scheme' case.
DfT Local Major Schemes' Advice on the Use of the Emissions Factor Toolkit (EFT) for Road Users Carbon Appraisal	▪ See Section 5 for details	▪ See Section 5 for details
PAS 2080: 2023	▪ 7.1.1 Assessing GHG emissions over the whole life to inform decision-making at the asset, network, and system level. ▪ 7.1.2 Selecting an appropriate level of accuracy and detail. ▪ 7.1.3 Selecting a GHG assessment and methodology. ▪ Clause 9 – Monitoring and reporting.	▪ Assessment of whole-life carbon emissions including quantification of capital and operational carbon

3. PRINCIPLES OF ASSESSMENT

The following principles have been adopted in this carbon assessment:

Whole-life Carbon: All relevant impacts referenced in PAS 2080 and BS EN 17472 have been considered in our assessment.

Reporting Net-Impact: The comprehensive impact of the scheme on climate change (i.e., the concentration of GHGs in the atmosphere) is determined by the sum of individual impact assessments of various components and lifecycle stages of a scheme's influence.

Quantitative analysis whenever possible, to complement qualitative assessment: We have conducted quantitative assessments where data is available and can be proportionally applied. We provide a qualitative narrative discussing the results of the assessments, the implications of these results, and we note assumptions and limitations of the quantitative analysis. Aspects not quantified – such as reducing traffic through the Shrewsbury town centre, allowing active travel provision uptake – have been discussed qualitatively.

Without Scheme vs With Scheme: The scheme's whole life carbon impact is established by the difference between the "without scheme" and "with scheme" scenario's carbon emissions assessment. Note that carbon emissions do not remain constant in the absence of the scheme.

Assessment of the scheme in-isolation: The assessment focuses on the scheme in isolation, without considering combined or synergistic effects with other proposed schemes. Combined impacts are pertinent to the scheme's role in climate change mitigation. The potential influence of combined or system-level impacts is qualitatively examined in the Carbon Zero Summary Report.

Sensitivity testing: Our primary assessment is conducted under the core scenario, which is intended to provide a sensible, consistent basis for decision-making given current evidence. Sensitivity tests have been completed for the user carbon assessment of the scheme with modelling outputs obtained using the alternative High Economy, Low Economy, and Regional 'Common Analytical Scenarios' (CAS) growth assumptions provided from the Department for Transport.

4. HIGH LEVEL SCOPE AND METHODOLOGY

Our assessment of carbon has considered emissions over the whole lifecycle of the scheme, as depicted in Figure 1.

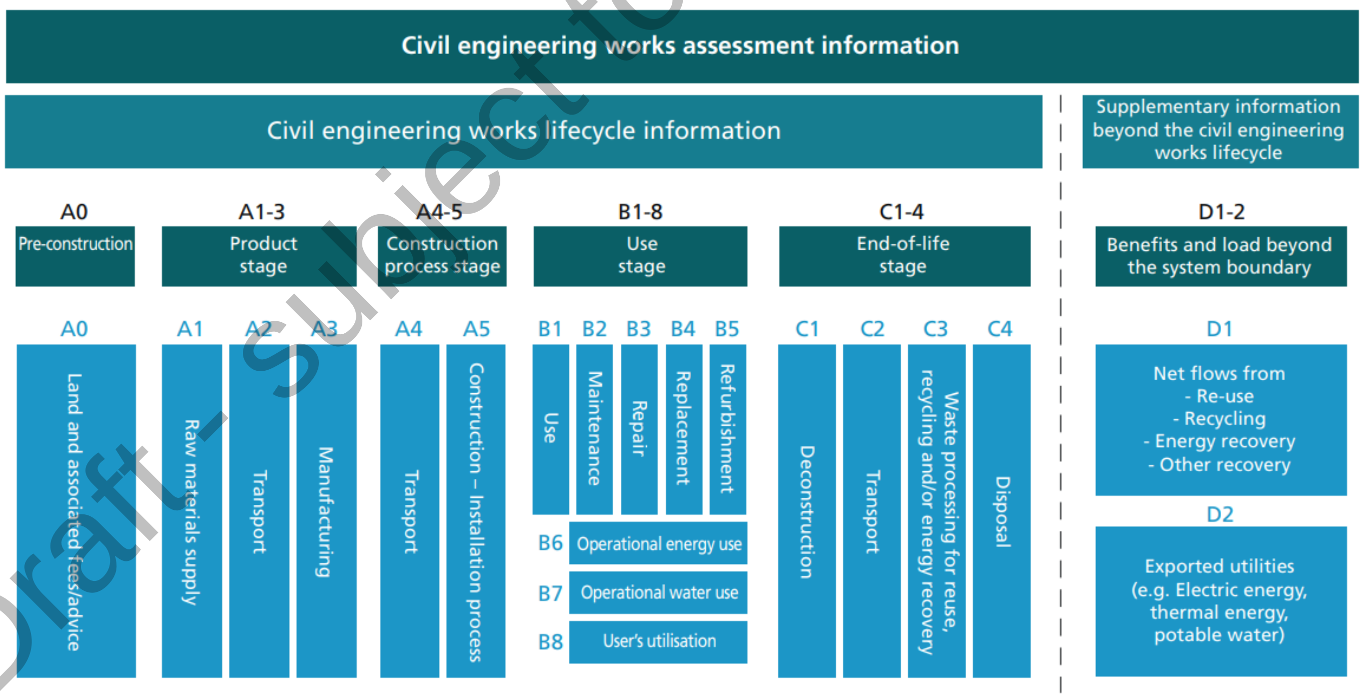


Figure 1: Modular approach developed for LCA reporting, referred to throughout PAS 2080:2023 and based on the methodology used in BS EN 17472 (Source PAS 2080:2023)

A1 – A3: Product Stage (further detail in Section 5)

The scope of assessment is that which can be assessed within the Bill of Quantities (BoQ) produced by Corderoy. We used the National Highways (NH) Carbon Tool version 2.6.1 for assessment. Items listed in the BoQ were categorised to align with the NH Carbon Tool input, with conversions applied where necessary to match the required input units, then quantified in the tool.

A4: Transport

Material suppliers have not yet been selected. We used Royal Institution of Chartered Surveyors (RICS) default scenarios for transportation distances by material type. Distances, by material type, were input into the NH Carbon Tool to quantify A4 carbon.

A5: Construction – Installation Process

Typically, A5 emissions are estimated using a factor of 1.4 tCO_2e per £100k (March 2015) of project value, from the RICS Whole Life Carbon Assessment for the Built Environment (2017). Owing to the appointment of a contractor late in the development programme, exact project costs were not available at the time of assessment. The assessment that was undertaken in April 2021 to support the planning application, however, was able to estimate A5 emissions by using emission factors provided in CESSM4 for plant use on site, and emission factors for transport of materials for transport of construction waste. This is considered a more accurate methodology than using the cost-based RICS approach. As the April 2021 estimate scope included the Oxon Link Road (OLR) as well as the North West Relief Road (NWRR), we have factored down the previous estimate of 2,674 tCO_2e to 2,133 tCO_2e. This is based on the proportion of the latest A1-A3 assessment that is attributable to NWRR (79.8%).

B1: Use (further detail in Section 5)

We have quantified the carbon impacts of land use change. Area of habitat types, both baseline and post-development, within the Red Line Boundary was used. WSP's habitat carbon calculator estimated the carbon storage of each habitat using appropriate carbon storage values sourced from Natural England and the Woodland Carbon Code. The LULUCF construction stage emissions are reported as the loss of carbon stored from habitats removed between the Do Something and the Do Minimum scenarios.

B2: Maintenance

Excluded from assessment.

B3: Repair

We assume 1% of all A1 – A4 emissions, for repairable materials only (i.e. excludes earthworks and fill, aggregate, and sand), to provide a reasonable allowance for repairing unpredictable damage.

B4: Replacement

We use an assumed reference service life for quantified items in the NH Carbon Tool, and the associated number of replacements needed over 60 years. Waste emissions are excluded from our replacement carbon assessment.

B5: Refurbishment

Excluded from assessment.

B6: Operational Energy Use

We multiply the assumed average wattage of LED lights by annual hours of operation to calculate energy usage. We use the Department for Energy Security & Net Zero's table of electricity marginal emissions factors to 2100, kgCO2e/kWh – grid average, consumption-based, commercial/ public sector column – for year-specific energy use emissions factors.

B7: Operational Water Use

Excluded from assessment.

B8/D: User's Utilisation – General Traffic Changes

For reported user carbon, we used the Emissions Factors Toolkit (EFT) to derive vehicle type-, year-, speed-, and road type-specific emissions factors (of unit gCO_2e/km). Modelled links were manually assigned road type *Motorway (not London)* if they were motorways or fast dual carriageways. Modelled links were assigned road type *Urban (not London)* where the link is fully within urban area types as defined by Rural Urban Classification (RUC) 2011. Derived EFT emission factors were applied to link level output from the transport network model for each period (AM, IP, and PM). Link length, vehicle volumes, and associated emission factors were multiplied to calculate the user carbon on each modelled link. Peak periods were expanded for annualisation. Outside-peak volumes, on each link, were derived by taking the difference between vehicle class-specific expanded annualised AADT volumes and expanded annualised peak period volumes. Outside peak carbon was assessed assuming IP period speeds on links. We cordoned the model to assess carbon impact of the area of detailed modelling and the rest of the fully modelled area.

B8/D: User's Utilisation – Modal Shift

We used changes in vehicle kms travelled as calculated through the Active Mode Appraisal Toolkit. Carbon emissions relating to this input data has been calculated using TAG data on fuel consumption and accounts for the proportions of the vehicle type (A1.3.8), fuel type (A1.3.9), forecast fuel consumption parameters (A1.3.11) and emission factors (A3.3).

C1 – C4: End of life

Excluded from assessment.

D1 – D2: Information beyond the construction works life cycle

Excluded from assessment.

5. DETAILED METHODOLOGY

Further detail is provided throughout this section for carbon modules that require a more comprehensive and complex methodology.

A1-A3: Product Stage

We included only bills relevant to the NWRR. Excluded bills were those relating to OLR, Welshpool Road, Holyhead Road, Shepherds Lane, Oxon Culvert, or Clayton Way.

Bill 6A - route wide earthworks is attributable to both the OLR and NWRR. We used the below factors to scale the quantities attributable to the NWRR:

- Excavated acceptable material excavated is 82% attributable to the NWRR
- Excavated unacceptable material is 77% attributable to the NWRR.
- Import of acceptable material (e.g. topsoil) is 81% attributable to the NWRR.
- Import of 6C is 85% attributable to the NWRR.
- Import of 6F/N is 79% attributable to the NWRR.
- Import of type B is 84% attributable to the NWRR.

B1: Use (Land Use Change)

Nature-focused Carbon Assessment Toolkit

WSP's Nature-focused Carbon Assessment Toolkit (hereafter the 'Toolkit') was used for assessment. The biogenic carbon assessment was run individually for each of the two Proposed Schemes:

- NWRR
- OLR

The shelterbelt planting area was assessed as part of the NWRR assessment.

Two values were considered in the carbon assessment: carbon storage and carbon sequestration.

1. Carbon storage refers to the amount of carbon that is 'locked up' in biomass, including vegetation and soil. It is referred to as the stock of carbon and measured in tonnes of carbon dioxide equivalent (tCO_2e). Carbon can be locked up for hundreds of years (e.g. in the case of ancient woodlands and peatlands).
2. Carbon sequestration refers to the movement of carbon dioxide from the atmosphere to living plants. The term 'carbon flux' can also be used, to refer to movements between the atmosphere and living plants (i.e. sequestration and emission). Carbon dioxide absorbed by living plants is presented as a negative value and represents an overall sequestration of carbon while positive values show overall net emissions to the atmosphere. It is measured in tonnes of carbon dioxide equivalent sequestered per X number of years (tCO_2e / X years).

Calculation method and assumptions

The carbon section of the Toolkit was completed using the data and outcomes used in the biodiversity net gain (BNG) assessment, plus the excluded habitat areas and shelterbelt planting area. The carbon assessment uses the baseline and change in habitat data to inform the baseline and changes in overall carbon storage and sequestration rates. The assessment used habitat data from a UK Habitat Classifications (UKHab) Survey undertaken in January 2021. In instances where carbon values for a specific UKHab classification were not available, best match habitats from Phase UK were used instead. In these instances, the UKHab classification and their Phase UK counterpart were not associated with carbon stocks, so there was no impact on the final carbon vale due to these substitutions. For more information about the data collection process and related limitations and assumptions, please see the Biodiversity Net Gain (BNG) report's methodology section.

To estimate the carbon storage and sequestration rates from the different habitats within the Biogenic Carbon Study Area, the areas of individual habitats were considered along with appropriate values for carbon storage and sequestration rates using best practice taken from the literature. All habitats within the Biogenic Carbon Study Area were considered as part of the baseline with post-development habitats divided into retained or created habitats.

The carbon calculations were undertaken in the Toolkit. The carbon values of the habitats within the Site were quantified in terms of tonnes of carbon dioxide equivalent (tCO_2e) for carbon storage, and tonnes of carbon dioxide equivalent per 5-year period (tCO_2e/5yrs) for sequestration rates. This is in line with current best practice and guidance from Natural England.

The values were calculated using the Toolkit. These were based on:

- The data auto populated from the BNG section of the Toolkit (for the Calculation Units, Habitat type, Area columns for pre-development; Area Retained column for during works; and After work action, Habitat Type, Area and Time to target condition for post-development);
- Our understanding of the Site and LMP; and
- Other assumptions.

Age of habitats was not known and was presumed to be 30 years. This is the Toolkit default value.

B8/D: User's Utilisation – General Traffic Changes

User carbon was assessed for two options – Do Minimum and Do Something. The scheme impact is the quantified modelled difference in emissions between the two options.

In assessing user carbon, we follow the Department for Transport (DfT)'s Local Major Schemes' Advice on the Use of the Emissions Factor Toolkit (EFT) for Road Users Carbon Appraisal – we refer to this as "the followed guidance".

Model extent and cordoning

The followed guidance states

> Promoters should demonstrate that the study area is sufficient to capture the scheme carbon impacts. As minimum, this should cover the Area of Detailed Modelling and Rest of the Fully Modelled Area as defined in Section 2.2.5 of TAG Unit M3.14. While changes may be small on individual links, the cumulative effect of the small changes can be significant.

The model developed in 2017 used a slightly different terminology. We consider:

- "Detailed study area" to be the "Area of Detailed Modelling"
- "Wider study area" to be the "Rest of the Fully Modelled Area".

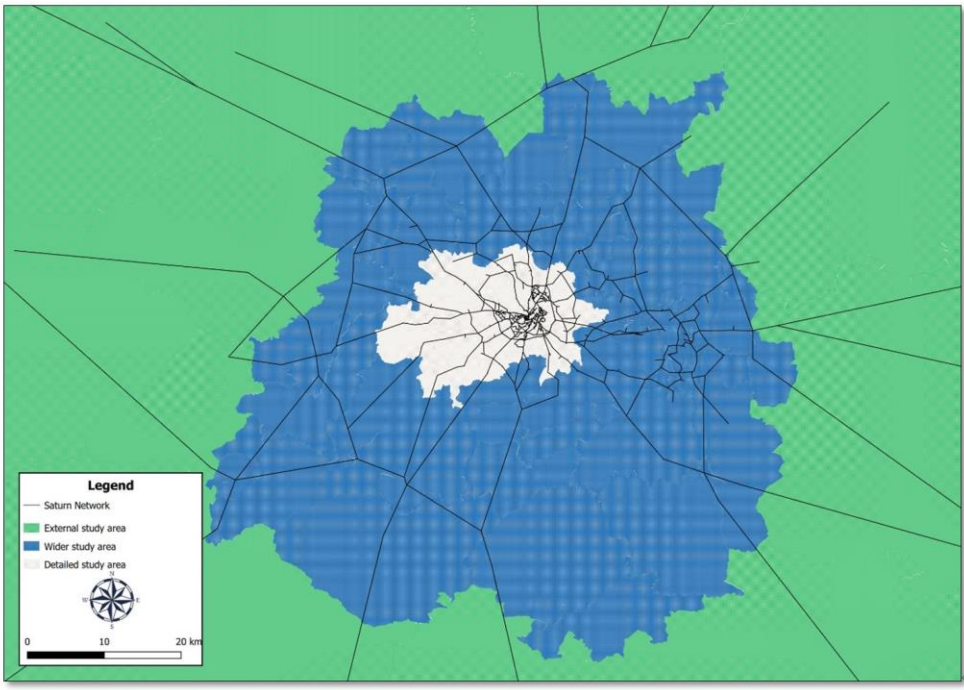


Figure 2: Study Area of the Proposed Scheme

The non-cordoned transport model includes feeder links and roads outside the wider study area. The network of non-cordoned and cordoned assessments is depicted in Figure 3.

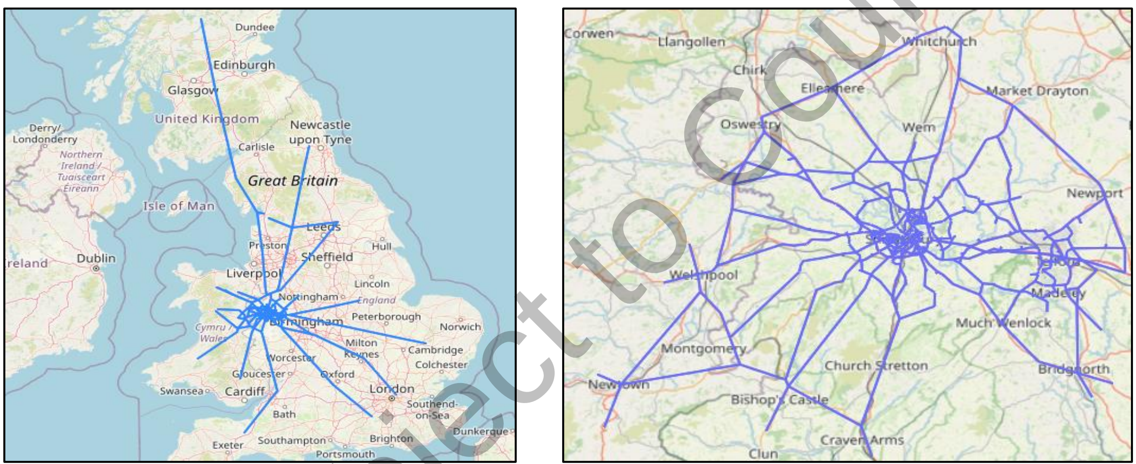


Figure 3: Non-cordoned Saturn Network model (left), Cordoned Saturn Network model (right)

Assessments undertaken

The followed guidance states

> Promoters needing to achieve a higher accuracy of the carbon impact forecast can produce additional EFT runs. Internal DfT calculations revealed that with the use of 5 years intervals between the EFT runs, the interpolation impacts are very small, well below 1% in comparison to running EFT for every appraisal year. If this is undertaken, consideration should also be made about running additional model years, as the linear interpolation of traffic flows normally used to generate intermediate years, is itself a simplification. Consistent assumptions about the change in speeds and flows should be applied for road user carbon and other impacts.

Modelled years were 2027, 2042, and 2050. Between modelled years, we linearly interpolate speeds, volumes, and heavy vehicle percentages to create interpolated year (2032, 2037, and 2047) speeds, volumes, and heavy vehicle percentages for assessment.

In addition to using the EFT process, we also completed an assessment using the TAG methodology to provide a like-for-like comparison to the previous (February 2021) assessment of user carbon. The results of the EFT process however will be used to inform the TAG GHG Workbook and other inputs to the FBC economic appraisal.

For both methodologies, user emissions have been assessed for every combination of:

- Year
    - Modelled: 2027, 2042, 2050
    - Interpolated: 2032, 2037, 2047
- Period
    - AM, IP, PM, AADT24, AAWT18
- Scenario
    - Core, High Economy, Low Economy, Regional
- Cordon
    - Cordoned, non-cordoned*

*The non-cordoned assessments have been used to provide a like-for-like comparison to the previous (February 2021) assessment of user carbon.

EFT methodology

There are 120 possible combinations of variables listed above (6x years, 5x periods, 4x scenarios). To avoid the risk of human error in running assessments manually in the EFT spreadsheet tool, emission factors were derived from the EFT spreadsheet tool and used to complete an automated assessment using Python. To derive emission factors, the EFT tool was run for each forecast year (2027, 2032, 2037, 2042, 2047, 2050) using combinations of the following inputs:

- Speed
    - Integer speeds between 5 and 140 km/h (inclusive)
- Vehicle type
    - Heavy and light vehicle types (assuming a basic split)
- Road type
    - "Urban (not London)", "Rural (not London)", and "Motorway (not London)" (see further detail below)

using the Advanced Option 'Bespoke Base Fleet' and TAG Data Book v1.2.3 Table A 1.3.9.

The followed guidance states

> EFT v12 makes it possible to use the bespoke fleet composition based on the TAG Data Book. Promoters should use the latest TAG Data Book assumptions on electric veh-kms (Table A 1.3.9) instead of the default compositions included in EFT as EFT tends to use assumptions on electric veh-kms which might not be updated with the TAG Data Book.

and

> Scheme promoters should use the Advanced Option 'Bespoke Base Fleet' in EFT.

The derived emission factors were used as the basis for assessment, which was automated in Python. A validation study was completed to ensure the same results are obtained regardless of whether the automated methodology or manual EFT spreadsheet tool was used. This study involved running six assessments using both methods. Each of the six assessments used a different combination of variables, and each variable option was used at least once. No discrepancies in results were observed.

Defining road types for EFT

Road types should be assigned based on the following criteria:

- Urban (not London) – for roads that are not motorways or similarly fast flowing roads in urban areas (by the DfT definition of an urban area with a population of 10,000 or more).
- Rural (not London) – for roads that are not motorways or similarly fast flowing roads outside urban areas.
- Motorway (not London) – for motorways and fast dual carriageways.

We use the 2011 Census Lower Super Output Area (LSOA) Rural Urban Classification (RUC) lookup table to categorise LSOAs area type. We use the 2011 Census Geography boundaries (Lower Layer Super Output Areas and Data Zones) to define the shape of the urban LSOA.

LSOA boundaries, which have RUC of type “Urban”, are depicted in Figure 4. Modelled links fully covered by these areas are assigned road type “Urban (not London)”.

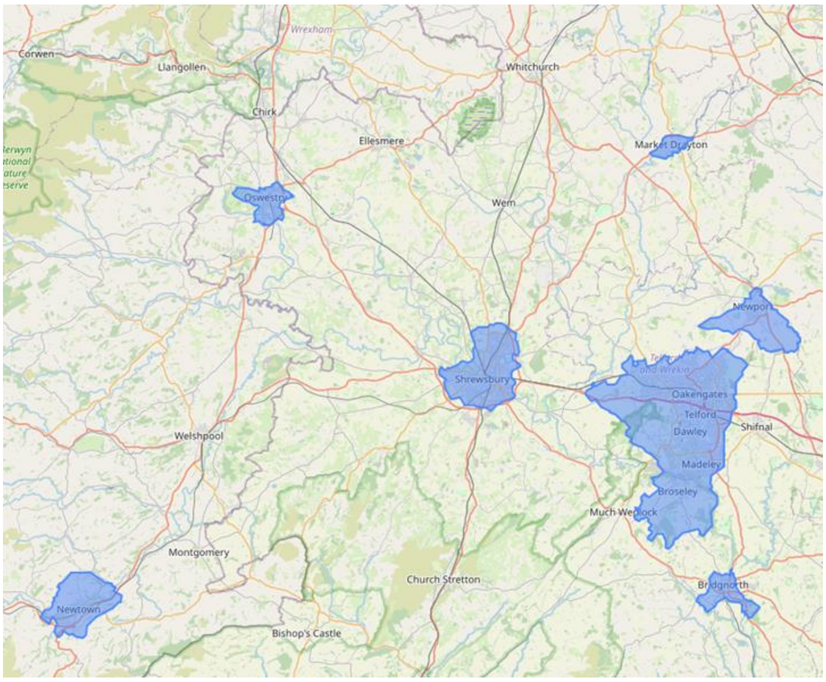


Figure 4: Urban Areas

We have assigned road type “Motorway (not London)” to the selected modelled links depicted in Figure 5.

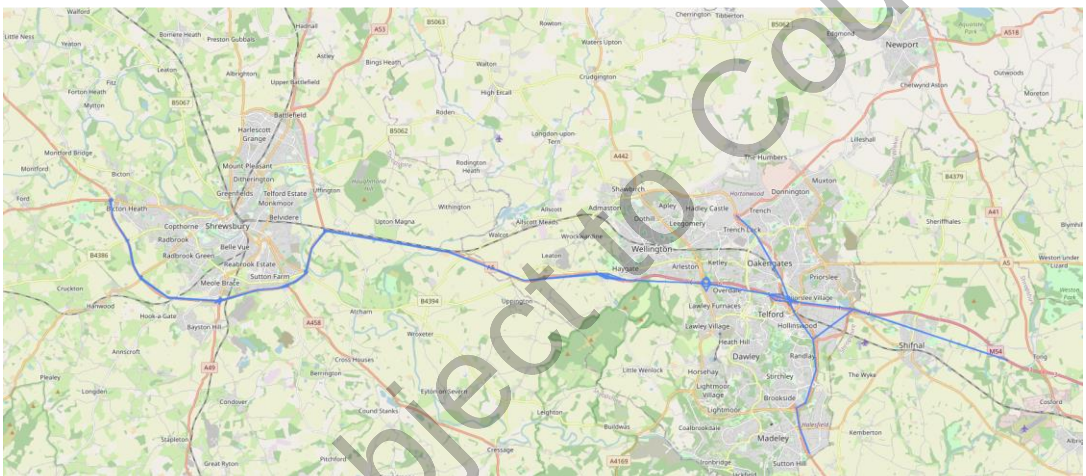


Figure 5: Links Assigned Road Type “Motorway (not London)”

All remaining links are assigned road type “Rural (not London)”.

TAG methodology

The TAG methodology assessment is undertaken using the same general method as the previous user emission assessment.

The number of class-specific (light and heavy) vehicles on each link is derived using the model total flow and the heavy vehicle percentage.

The number of light duty vehicles (LDVs) are split between vehicle type “car” and “light goods vehicle (LGV)”, with proportions taken from Road Traffic Estimates (TRA) 0101: Road traffic (vehicle miles) by vehicle type in Great Britain, annual from 1949 for year 2023 (the most recent reported year) – note that year 2018 was used in the previous assessment.

The number of heavy-duty vehicles (HDVs) are split between type ordinary goods vehicles (OGVs) and public service vehicles (PSVs), with proportions taken from TRA0101: Road traffic (vehicle miles) by vehicle type in Great Britain, annual from 1949 for year 2023 (the most recent reported year) – note that year 2018 was used in the previous assessment.

The number of OGVs are split between OGV1 and OGV2, with proportions taken from TRA3105: Heavy goods vehicle traffic (vehicle kilometres) by axle configuration in Great Britain for year 2023 (the most recent reported year) – note that year 2018 was used in the previous assessment.

All class- and type- specific vehicles numbers are then split by an assigned fuel type (petrol, diesel, and electric), with proportions taken from TAG Data Book v 1.2.3 Table A 1.3.9.

Fuel consumption is calculated for each vehicle type combination, using emission factors taken from TAG Data Book v1.2.3 Table A1.3.11 and the formula:

$L = \frac{a}{v} + b + cv + dv^2$ where

> L is consumption, expressed in litres per kilometre
>
> v is average speed in kilometres per hour
>
> a, b, c, d are parameters defined for each vehicle category and year

Once fuel consumption, by fuel type, has been calculated for each vehicle type combination, we use emission factors taken from TAG Data Book v1.2.3 Table A3.3 to calculate the user emissions.

Model expansion and deriving a modelled year

The followed guidance states

> The EFT calculation (or link-based calculation where appropriate) of carbon emissions should use modelled time period data rather than aggregate daily values, to capture the differences in the traffic flows and speeds in the modelled periods.
>
> The user should ensure that all 8,760 hours of the year are suitably represented in the analysis. Advice on using modelled data to represent non-modelled time periods is included in the TUBA guidance (TUBA v1.9.7 General Guidance and Advice), and the principles of this guidance should be applied to derive appropriate expansion factors to capture the impacts in the non-modelled time periods (as well as the modelled time periods). Reporting of the analysis should cover how modelled time period expansion factors have been calculated and applied in the greenhouse gases calculation.

Expansion factors of modelled hours used in TUBA for the economic assessment to calculate the 12-hour benefits of the weekdays are:

From	To	Factor
AM Peak	Annualised AM Peak Periods	651
Interpeak (IP) Peak	Annualised IP Peak Periods	1550
PM Peak	Annualised PM Peak Periods	657

Expansion factors of other modelled periods are assumed to be:

From	To	Factor
AADT24	Annualised Average Days	365
AAWT18	Annualised Weekday Periods	253

These factors apply to both methods of assessment – EFT and TAG.

Expansion of the AM Peak, Interpeak (IP), and PM Peak periods does not ensure that all 8,760 hours of the year are suitably represented. Annual link volumes can be found using the expanded AADT24 model output. On a link-by-link basis we subtract the class-specific expanded peak period volumes (AM, IP, and PM) from the class-specific annual link volumes. This gives the remaining annual volumes – for light and heavy vehicles – which are not captured within peak hours. These link volumes are assessed for carbon assuming IP Peak speeds. We call this assessment period "Outside Peak".

User carbon emissions over a derived modelled year is calculated by summing the expanded AM, IP, and PM Peak assessments, and the Outside Peak assessment.

6. KEY LIMITATIONS

The following are considered the key limitations of this assessment:

- The figures presented in this WLC assessment reflect assumptions for the 'core' scenario only. User carbon impacts are quantified using TAG estimates of EV uptake, which do not currently reflect the UK government target for all new cars to be zero emission by 2035.
- In addition to the 'core' scenario, sensitivity tests are being prepared that align with the High Economy, Low Economy, and Regional Common Analytical Scenarios, to provide a range of potential user carbon results.
- Proposed public transport improvements to the city centre are not modelled. Associated impacts to general traffic have not been captured in the model or the user emission carbon assessment. Drainage Basin 9 has been removed from the design. The BoQ assessed, and therefore the total infrastructure emissions, includes the carbon impact of constructing Basin 9.
- Datasets sourced from the TAG datebook have been used to assess the user emissions impact. It's important to recognise that the 2035 ban on the sale of new ICE vehicles could lead to altered future circumstances.

7. MONETISATION

The whole-life carbon impacts calculated using the methods described above have been monetised by applying the values in TAG Databook A3.4, using the TAG Greenhouse Gases (GHG) Workbook.

Most infrastructure carbon modules have been assumed as being 'non-traded,' i.e. not covered by the UK ETS scheme. In reality, a proportion of A1-A3 will be 'traded', however in the absence of clear guidance regarding which materials' manufacture is covered by the ETS, all A1-A3 emissions are classified as non-traded as a precautionary measure – by doing so, the TAG GHG Workbook will not apply an adjustment to the monetised impacts to account for 'any portion already accounted for within pricing schemes.'

Of all infrastructure carbon (A1-B6), only B6 is classified as traded, as it is certain that operational energy use (highway lighting) will draw energy from the national grid, which is covered by the ETS. Therefore, the adjustment to account for 'any portion already accounted for within pricing schemes' will be applied.

User emissions (B8/D) are split according to vehicle type. Electric vehicles (EVs) draw their energy from the national grid, which is covered by the ETS, and accordingly emissions from EVs classified as traded. Other non-electric vehicles draw their energy from fuels that are not covered by the ETS, and accordingly non-EV emissions are classified as non-traded.

8. CONTEXT METRICS

The Summary Report presents a series of context metrics intended to aid understanding of what the calculated impact in tCO_2e means. These metrics are all derived from the stated total quantified predicted impact over the full scheme lifetime.

Table 2: Context Metrics

Context Metric	Description	Methodology
Trees	The indicative number of trees you would need to plant to remove this amount of carbon from the atmosphere within the same timeframe.	Woodland Carbon Code (0.5 tCO_2e per tree over 60 years)
Carbon Cost Ratio	The carbon impact per £1 million of scheme cost	Calculated as: ([predicted carbon impact over 60 years]/ [scheme cost] * 1,000,000).
Carbon Value	The monetary value of the predicted carbon impact, based on carbon value scenarios in TAG Unit A3.4	Calculated as: [yearly predicted in emissions] * [yearly TAG A3.4 carbon value]. Undertaken for each scenario (High, Medium, and Low) for carbon value. Non-traded

		carbon values used. See section above for further information.

9. COMPARISON OF USER CARBON ASSESSMENT RESULTS TO PREVIOUS ASSESSMENT

Comparison to previous assessments results of user carbon:

- User carbon impacts associated with the Proposed Scheme have been assessed twice previously. Three key variables have changed with each assessment and have had a substantial impact on results: Scope, Cordon, and Methodology.
- The **first assessment** was undertaken to support the NWRR OBC in December 2017, using Transport users benefit appraisal (TUBA) software. This methodology is now recognised as less accurate than link-based calculations, and the result of **-74,337 tCO2e** (a reduction) has been superseded. The scope of this assessment was **NWRR only**.
- The **second assessment** of user carbon impacts was conducted in February 2021, and results were presented in Environmental Statement Chapter 9, in support of the Planning Application. This assessment was undertaken using a link-based calculation in line with the methodology prescribed by DfT's Transport Appraisal Guidance (TAG) Unit A3, using data from the full extent of the Shrewsbury Traffic Model forecasts (i.e. uncordoned output data) developed in 2020. The scope of this assessment was **NWRR with OLR** and a reduction in user emissions amounting to **(-)24,545 tCO2e** was estimated.
- The **third assessment**, for which a result of **+53,247 tCO2e** is outlined above in this report, has estimated user carbon impacts in line with the DfT LRTA Emissions Factor Toolkit (EFT) guidance. Unlike the second assessment, model output data has been cordoned to focus the assessment on the Fully Modelled Area in line with the EFT guidance. Also unlike the second assessment is that the scope of the user carbon assessment currently pertains only to **NWRR (excluding OLR)**. The user carbon impacts of both schemes will be quantified once essential additional model forecasts (for a 'do nothing' scenario) have been produced.
- As both the methodology and cordon have changed since the previous assessment, and the new assessment has produced a significantly different result, additional assessments of the latest model forecasts have been completed using the TAG methodology and uncordoned data to provide a result that is comparable to the previous assessment.

User Carbon (general traffic changes) (tCO2e)	**Latest Assessment (core scenario)**	**Latest Assessment – TAG**	**Latest Assessment – Uncordoned**	**Latest Assessment – Uncordoned & TAG**	**Previous (Feb 2021) Result**
Scope	NWRR	NWRR	NWRR	NWRR	NWRR+OLR
Cordon	Yes – Cordoned to Fully Modelled Area	Yes – Cordoned to Fully Modelled Area	No cordon – Full model extent	No cordon – Full model extent	No cordon – Full model extent
Methodology	EFT	TAG	EFT	TAG	TAG
User Carbon Impact	**53,247**	**11,134**	**13,972**	**- 20,992**	**- 24,545**

- Note that when the methodology *or* the cordon is changed to align with the previous assessment, the estimated user carbon impact using the latest modelling forecast data drops from +53,247 tCO2e to between ~+11,000 and ~+14,000 tCO2e. This indicates that both variables have a significant impact on the result.
- When both variables are changed to align with the previous assessment (i.e. uncordoned, TAG methodology), the impact of both variables in combination on the latest modelling data is cumulative, and

the net impact is a reduction in user carbon over the 60-year appraisal period, as in the previous February 2021 assessment. This implies that both the decision to use the EFT methodology, and the decision to cordon the model data to the Fully Modelled Area, are both behind the significant change in result since the previous assessment.

- **Note:** the February 2021 and September 2024 assessments are not directly comparable as the previous assessment included OLR, whereas the latest assessment does not – i.e. the third variable: scope. A comparison will be made once the necessary model data is available.

Appendix C

Carbon Assessment Summary Report

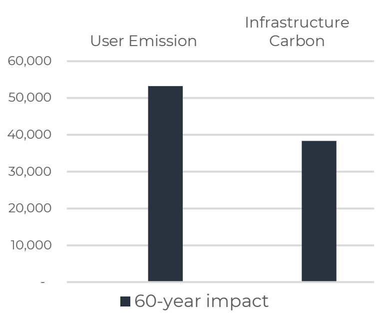
Carbon Zero Summary Report

Scheme:	North West Relief Road	WLC Assessment Stage:	Detailed Stage Forecast

Net Impact (tCO2e)		
94,457		
User Emissions	Infrastructure Carbon	LULUCF
53,236	38,384	2,838

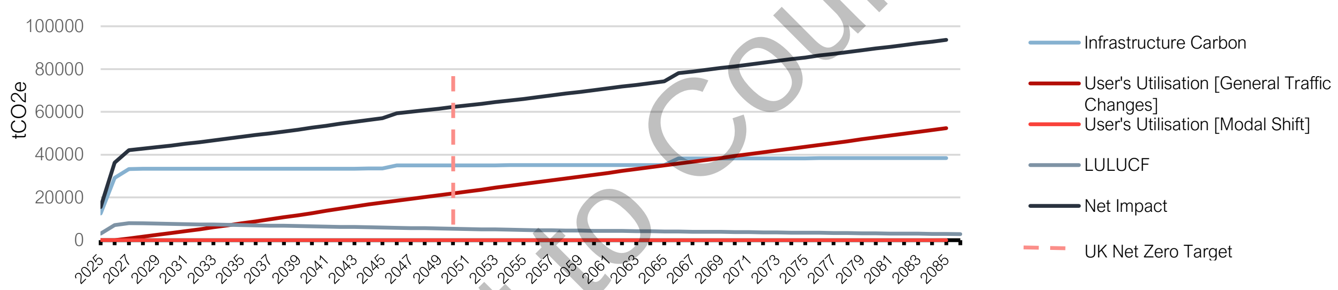
Carbon Value (£)	
Low	-5,322,080
Central	-10,680,977
High	-16,046,415

Carbon Efficiency Metric (tCO2e/£100k)
126.7
Equivalent Trees
188,914

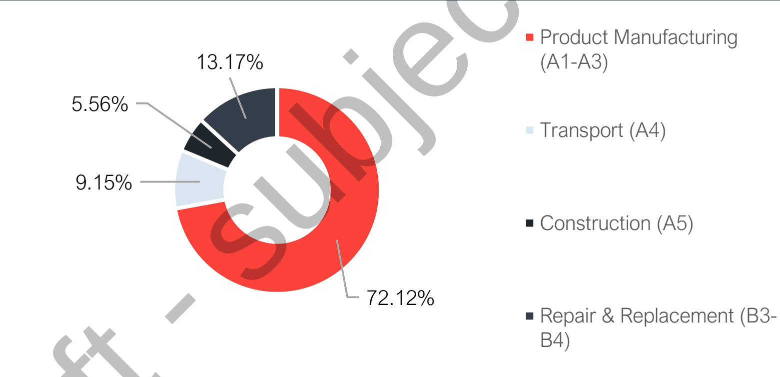


Milestones	4th CB	5th CB	6th CB	Local Commitment	National Net Zero Target	Appraisal Period + Construction
	2025-2027	2028-2032	2033-2037	2024-2050	2024-2050	2024-2085
Scheme Impact: Core Scenario (tCO2e)	42,075	3,780	4,104	62,244	62,244	93,643
Impact on National Carbon Budget	0.002%	<0.001%	<0.001%	NA	NA	NA
Carbon Impact on Local Transport Budget (User Emissions) - NZS Lower	0.043%	0.202%	0.497%	NA	NA	NA

Whole Life Carbon Impact (tCO2e)



Infrastructure Carbon by Lifecycle Module



Overview

The scheme has an estimated whole-life carbon impact of +94,457 tCO2e of which 91,251 tCO2e is non-traded and 3,206 is traded. This impact is made up of: User emissions (B8/D) - an estimated increase of +53,236 tCO2e over 60 years as quantified using strategic model outputs and Defra's EFT tool, and also accounting for a slight reduction in vehicle kilometres due to modal shift (using outputs of the AMAT). This increase in user emissions is associated with additional vehicle kilometres travelled with the scheme, which outweigh potential savings from alleviation of congestion. Capital carbon - an estimated impact of +33,317 tCO2e during the construction phase, inclusive of product (A1-A3) and construction process (A4-A5) impacts. Operational carbon - an estimated impact of +5,066 tCO2e over 60 years, inclusive of repair (B3), replacement (B4), and operational energy use (B6) impacts. Land use change (B1) - an estimated net impact of +2,838 tCO2e over the construction and operational phases (62 years).

Business Case Stage:	Final Business Case	Design Stage:	Detailed

Prepared: TP | Reviewed: CL | Approved: TG | Date: 30/11/24

Carbon Zero Summary Report

Shrewsbury North West Relief Road (NWRR)

Scope of Assessment																	
Product Stage			Construction Process Stage		Use Stage								End of Life Stage				Benefits and Loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	B8	C1	C2	C3	C4	D
Q	Q	Q	Q	Q	Q	MNQ	Q	Q	MNQ	Q	MNQ	Q	MNR	MNR	MNR	MNR	Q

Q Quantified
MNQ Module Not Quantified (But Relevant) – Qualitative Assessment
MNR Module Not Relevant

Net-Impact

As outlined in Section 3.4 of the Carbon Management Plan (CMP) to which this summary report is attached, **the latest carbon assessment estimates that over the 60-year appraisal period, the Proposed Scheme (NWRR only) will have an overall impact of +94,457 tCO2e,** comprised of:

- +41,222 tCO2e infrastructure carbon (A1-B6) impact, itself comprised of:
  - +33,317 tCO2e capital carbon (A1-A5) impact,
  - +7,904 tCO2e operational carbon (B1-B6) impact,
- +53,236 tCO2e user carbon (B8/D) impact (includes -12 tCO2e from modal shift).

Further detail regarding these impacts is provided below. The construction phase is assumed to take place over the two years between April 2025 and March 2027, beyond which the scheme becomes operational. Scheme impacts are assessed over this 2-year construction phase plus a 60-year appraisal period extending to 2086. End of life stage emissions are scoped out as road transport infrastructure tends to be used indefinitely – it is not anticipated that the Proposed Scheme would be decommissioned at the end of the 60-year appraisal period.

It should be noted that all negative (-) figures represent a reduction in carbon emissions, and are therefore beneficial, while all positive (+) figures represent additional carbon and represent an adverse impact.

Infrastructure Carbon (A1-B6)

Capital Carbon (A1-A5) impacts are estimated to amount to **+33,317 tCO2e**.

- This includes a product stage (A1-A3) impacts of +27,672 tCO2e, which encompasses the carbon 'embodied' in materials from the supply of raw materials, transport of these raw materials to factories, and manufacturing. The material types that contribute most to this impact include those used for civil structures (steelwork, pre-cast concrete, etc.), bulk materials (ready mix concrete, fill, aggregate & sand, asphalt, reinforcement steel), and earthworks (imported soil etc.).
- The transport of these materials to site (A4) accounts for +3,512 tCO2e.
- Installation process emissions (A5) are estimated as +2,133 tCO2e, based on factoring down a previous estimate to the proportion of the latest A1-A3 assessment that is attributable to NWRR (79.8%).

Operational Carbon (B1-B6) impacts are estimated to amount to **+7,904 tCO2e**.

- Repair and replacement (B3 & B4) associated with the materials used in construction over the 60-year appraisal period accounts for +5,052 tCO2e over the 60-year appraisal period. This is largely attributable to the replacements of X as this has a service life of Y years.
- The net impact of land use change (B1) as a result of the Proposed Scheme is estimated to be +2,838 tCO_2e. This comprises an initial loss of 8,072 tCO2e stored in existing habitats during the construction phase (i.e. an adverse (+) impact), however, new habitat creation is expected to result in additional sequestration of 5,234 tCO2e over the 60-year appraisal period (i.e. a beneficial (-) impact). The initial impact is largely due to the large loss of carbon stocks associated with removed cropland, as well as insufficient creation of carbon sequestering habitats such as woodland. Further detail is provided in Appendix D of the CMP – the Biogenic Carbon Assessment Report.
- The operational energy impacts (B6) of highway lighting have also been assessed over the 60-year appraisal period and is expected to result in a small impact of +14 tCO2e.

A breakdown of key infrastructure carbon hotspots is provided in Chapter 4 of the CMP.

User Carbon (B8/D)

User Carbon (B8/D) impacts are estimated to amount to **+53,236 tCO2e.**

- Traffic model output data for the 'core' scenario indicates that changes to general traffic (B8/D) following delivery of the Proposed Scheme will result in an additional (+) 53,247 tCO2e over the 60-year appraisal period.

  This result is consistent with the model forecasts indicating a net *increase* in overall vehicle kilometres travelled (vkm) within the Fully Modelled Area should the Proposed Scheme be built. There are some notable reductions in vkm forecasted on many of Shrewsbury's radial routes, but these reductions are overshadowed by vkm introduced on the new NWRR and an increase in vkm on the roads that directly adjoin it at either end. Much of the vkm expected along the NWRR (and reduction on radial routes) can be attributed to rerouting to avoid Shrewsbury's town centre. However, as the forecasted vkm introduced on the NWRR is higher the forecasted reductions in vkm on town centre and radial routes, at least some of this additional vkm must be due to additional demand, induced by the introduction of the new road.
- Modal shift (B8/D) associated with the construction of the shared footway/cycleway along the length of the NWRR is estimated in the Active Mode Appraisal Toolkit (AMAT) to slightly reduce vkm over the 60-year appraisal period, with an associated carbon benefit of (-) 12 tCO2e.

User carbon benefits of enabling of other schemes not captured:

- While the Proposed Scheme itself is expected to result in a net-increase in user carbon over the appraisal period, its delivery will result in a reduction in traffic and congestion in Shrewsbury's town centre, enabling road space reallocation and the delivery of additional public and/or active transport infrastructure. This is likely to affect a modal shift to more sustainable modes of transport; carbon reductions associated with this modal shift have not been captured in this WLC assessment.

Scheme assessed in isolation:

- As is the case with any transport scheme, benefits or disbenefits of the Proposed Scheme may be magnified or diluted when considered in combination with any other schemes being delivered during the Proposed Scheme's 60-year appraisal period – i.e. the overall user carbon impacts of multiple schemes being delivered may be different from the sum of the impacts of each scheme assessed in isolation of one another. Of particular note is the simultaneous development of the

Oxon Link Road (NWRR) scheme. A separate assessment of user carbon impacts of implementing both NWRR and OLR in combination is underway.

Sensitivity tests:

- The above estimates for the user carbon impacts of general traffic changes are based on the traffic model forecasts using 'Core' scenario model assumptions and inputs provided in DfT's TAG databook. In addition to this, traffic forecasts were also produced for three other plausible future scenarios, using the alternative model assumptions and inputs provided in DfT's Common Analytical Scenarios (CAS) databook. The 'High Economy,' 'Low Economy,' and 'Regional' scenarios were modelled. User carbon impacts were quantified for each additional scenario, providing sensitivity tests of the Core scenario result.
- A fourth sensitivity test was also completed, using the Core scenario model outputs, but substituting in the mileage splits from the Vehicle Led (VL1) CAS dataset. The annual mileage split forecast in this dataset is considered to more closely reflect the likely rate of future electric vehicle (EV) uptake than the standard mileage split forecast in the TAG databook. The user carbon impact quantified based on this scenario data is therefore lower than in the Core Scenario, as the user carbon impact of the Proposed Scheme will be less pronounced in a future with a higher proportion of EVs.
- The user carbon impacts in each of these four alternative future scenarios is shown in the table below (in tCO2e), with percentages in brackets showing variance from the 'Core' scenario:

	Core	**High Economy**	**Low Economy**	**Regional**	**Core with VL1 EV Uptake**
User Carbon (General Traffic Changes) Impact	**53,247**	54,404 (+2%)	40,072 (-25%)	53,569 (+1%)	33,524 (-37%)
User Carbon (Modal Shift) Impact	***-11***	*-11*	*-11*	*-11*	*-11*
Infrastructure Carbon Impact	***41,222***	*41,222*	*41,222*	*41,222*	*41,222*
Net Impact	**94,457**	95,614 (+1%)	81,282 (-14%)	94,779 (+ <0.5%)	74,734 (-21%)

- While the impact of general traffic changes in the core scenario is estimated to be 53,247 tCO2e (with a corresponding net impact of 94,457 tCO2e), user carbon impacts may be as low as 33,524 tCO2e should EV uptake follow the VL1 mileage split forecasts. This would result in a net impact that is 21% lower than the core scenario, at 74,734 tCO2e. It is possible that EV uptake will take place at an even faster rate than the VL1 forecast, reducing net impact further still, as impacts of the Zero Emission Vehicle (ZEV) mandate, which bans new diesel and petrol cars from 2035, are not considered in the mileage split dataset.

Appendix D

Biogenic Carbon Assessment Report

Shropshire Council

Shrewsbury North West Relief Road and Oxon Link Road

Biogenic Carbon Assessment Report

Shropshire Council

SHREWSBURY NORTH WEST RELIEF ROAD AND OXON LINK ROAD

Biogenic Carbon Assessment Report

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70056211

OUR REF. NO. 001

DATE: AUGUST 2024

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Signature			
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Signature			
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Report number			
File reference			

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APPENDICES

EXECUTIVE SUMMARY

WSP was commissioned by Shropshire Council to undertake a biogenic carbon assessment in relation to both the North West Relief Road (NWRR) and the Oxon Link Road (OLR), hereafter referred to as the 'Proposed Schemes', to complement the existing Biodiversity Net Gain (BNG) assessment. Biogenic carbon refers to the carbon that is stored in biological materials, such as plants or soil. The Proposed Schemes are located north-west of Shrewsbury, within an area dominated by agricultural land, grassland, and urban areas.

This assessment was undertaken in line with the Woodland Carbon Code[1] and the Natural England Carbon Storage and Sequestration by Habitat report[2].

The aims of the biogenic carbon assessments were to:

- Quantify the potential biogenic carbon impacts of the Proposed Schemes by calculating the baseline carbon storage (tCO_2e) and carbon sequestration rates (tCO_2e/5yrs);
- Assess the extent of net loss in biogenic carbon storage and carbon sequestration rates as a result of the Proposed Schemes; and
- Assess the change in biogenic carbon storage and carbon sequestration rates as a result of habitat creation and enhancement which will be undertaken in-line with the post-development Landscape Management Plan (LMP)[3], compared to a baseline scenario of no intervention.

This report details the methodology and results of the biogenic carbon assessment for the Proposed Schemes.

For the NWRR scheme, this assessment concludes that following the loss in land carbon stocks due to construction, the scheme and its associated LMP would achieve a decrease in biogenic carbon storage and sequestration capacity across the first 60 years, predicted to be 26,451 tCO_2e of carbon stored by 2055 (30 years post-development, compared to 31,107 tCO_2e in the no-intervention scenario); and 28,262 tCO_2e of carbon stored by 2085 (60 years post-development, compared to 31,100 tCO_2e in the no-intervention scenario). **It is estimated that scheme-wide habitat-based biogenic carbon neutrality will not be achieved within the 200 years following construction, with 1,185 tCO2e less than would have been stored if no interventions had occurred.**

For the OLR scheme, this assessment concludes that following the loss in land carbon stocks due to construction, the scheme and its associated LMP would achieve a decrease in biogenic carbon storage and sequestration capacity across the first 60 years, predicted to be 11,616 tCO_2e of carbon stored by 2055 (30 years post-development, compared to 12,279 tCO_2e in the no-intervention scenario); and 12,417 tCO_2e of carbon stored by 2085 (60 years post-development, compared to 12,664 tCO_2e in the no-intervention scenario). **It is estimated that scheme-wide habitat-based biogenic carbon neutrality will be achieved between 120 and 150 years after construction, storing marginally more carbon (93 tCO2e) in the long term than would have happened if no interventions had occurred.**

[1] Woodland Carbon Code, Version 2.2 (2022)

[2] Natural England – Carbon Storage and Sequestration by Habitat 2021, NERR094 (2021)

[3] WSP (2024) Shrewsbury North West Relief Road: Landscape Management Plan

INTRODUCTION

1.1 BACKGROUND INFORMATION

1.1.1. WSP was commissioned by Shropshire Council to undertake a biogenic carbon assessment for the North West Relief Road (NWRR) and the Oxon Link Road (OLR), hereafter referred to as the 'Proposed Schemes'. The Proposed Schemes constitute a single carriageway road, link road, and associated infrastructure, hereafter referred to as 'the Site', located north-west of Shrewsbury and linking the northern and western parts of Shrewsbury. This report complements and should be read alongside Shropshire Council's Biodiversity Net Gain (BNG) Assessment Report (herein referred to as the BNG report).

1.1.2. The detailed planning application for the Proposed Scheme, consisting of a single carriageway road, the OLR, and two bridges was approved by Shropshire Council's Northern Planning Committee in February 2024.

1.1.3. The Proposed Schemes are located north-west of Shrewsbury, on an area dominated by cropland, modified grassland, sparsely vegetated land, and urban sealed surface. Areas of woodland and forest, mixed scrub, and other neutral grassland are also present, including some veteran trees.

1.1.4. A biogenic carbon assessment considers the changes in carbon stored within the biological materials such as habitats or soils as a result of the Proposed Schemes. Carbon accumulates naturally within healthy habitats as they age and therefore disturbance to baseline habitats can result in additional carbon emissions.

1.1.5. This assessment utilised the data collected as part of the BNG assessment. The BNG assessment took information from a 2018 Joint Nature Conservation Committee (JNCC) Survey, which had been translated into UK Habitat Classifications (UKHab) habitat types for the Site.

1.1.6. The Biogenic Carbon Assessment Study Area is larger than the BNG Study Area as it includes an additional habitat area (planting shelterbelt on agricultural land and grassland) that has since been incorporated into the Site's redline boundary, plus baseline areas which were recorded in the UKHab Survey but excluded from the BNG Study Area as the habitats were within an ancient tree root protection area. The biogenic carbon assessment uses the change in habitat which will arise through the LMP (and as per the BNG assessment, plus the shelterbelt planting area) to inform the changes in overall biogenic carbon storage and sequestration.

1.1.7. The biogenic carbon baseline and post-development value has been quantified using WSP's Nature-focused Carbon Assessment Toolkit (hereafter the 'Toolkit').

1.1.8. Recommendations are provided in line with the Woodland Carbon Code[4].

1.1.9. This assessment has been completed by a consultant capable in habitat-related carbon assessments.

[4] Woodland Carbon Code, Version 2.2 (2022). Available at: https://woodlandcarboncode.org.uk/images/PDFs/Woodland_Carbon_Code_V2.2_April_2022.pdf [Accessed January 2024]

1.2 SCOPE OF REPORT

1.2.1. This report uses the Toolkit to produce an assessment report that:

- Includes a biogenic carbon assessment of the Proposed Schemes and LMP enhancement/creation areas (Biogenic Carbon Study Area) shown in **Appendix A**;
- Quantifies and compares the baseline biogenic carbon storage and sequestration rates of existing habitats and the proposed post-development to provide an indication of the overall predicted change in carbon storage and sequestration rates; and
- Assesses the change in biogenic carbon storage and sequestration rates as a result of habitat creation and enhancement which will be undertaken in line with the LMP.

1.3 SHROPSHIRE COUNCIL'S CARBON AMBITION

1.3.1. As detailed in the Shropshire Council Climate Change Action Plan[5], Shropshire Council declared a climate emergency in May 2019 and in December 2020 adopted a Climate Strategy and Action Plan, which established the objective of achieving net-zero carbon performance for Shropshire Council by 2030 and aims for an annual carbon reduction of 10% per year.

[5] Shropshire Council Climate Change Action Plan available from: https://www.shropshire.gov.uk/shropshire-climate-action/what-have-we-achieved/policies-strategies-and-guides/climate-strategy-and-action-plan/

2 METHODOLOGY

2.1 CARBON ASSESSMENT OVERVIEW

2.1.1. A summary of the biogenic carbon assessment methodology and the data sources specific to the Proposed Schemes, assessment limitations, and assumptions, are provided in this methodology section. This report should be read in conjunction with the Toolkit, provided separately.

2.1.2. The biogenic carbon assessment was run individually for each of the two Proposed Schemes:

- NWRR
- OLR

2.1.3. The shelterbelt planting area was assessed as part of the NWRR assessment.

2.1.4. Any amendments to the Proposed Schemes, LMP creation areas, or assumptions that were used for this carbon assessment will necessitate re-running the carbon calculations, to provide accurate numbers.

2.1.5. Two values were considered in the carbon assessment, carbon storage and carbon sequestration. These are described below.

2.1.5.1 Carbon storage refers to the amount of carbon that is 'locked up' in biomass, including vegetation and soil. It is referred to as the stock of carbon and measured in tonnes of carbon dioxide equivalent (tCO_2e). Carbon can be locked up for hundreds of years (e.g. in the case of ancient woodlands and peatlands). A positive value represents carbon that has been stored; a negative value represents carbon that has been emitted from storage.

2.1.5.2 Carbon sequestration refers to the movement of carbon dioxide from the atmosphere to living plants. The term 'carbon flux' can also be used, to refer to movements between the atmosphere and living plants (i.e. sequestration and emission) – however, for clarity this report refers to sequestration rates. Carbon dioxide absorbed by living plants is presented as a negative value and represents an overall sequestration of carbon while positive values show overall net emissions to the atmosphere. It is measured in tonnes of carbon dioxide equivalent sequestered or absorbed per X number of years (tCO_2e/Xyrs).

2.2 CARBON CALCULATIONS AND ASSOCIATED ASSUMPTIONS

2.2.1. To undertake the carbon assessment, the carbon section of the Toolkit was completed using the data and outcomes used in the BNG assessment, plus the excluded habitat areas and shelterbelt planting area. The carbon assessment uses the baseline and change in habitat data to inform the baseline and changes in overall carbon storage and sequestration rates. The assessment used habitat data from a UKHab Survey undertaken in January 2021. In instances where carbon values for a specific UKHab classification were not available, best match habitats from Phase UK were used instead. In these instances, the UKHab classification and their Phase UK counterpart were not associated with carbon stocks, so there was no impact on the final carbon vale due to these substitutions. For more information about the data collection process and related limitations and assumptions, please see the BNG report's methodology section.

2.2.2. In order to estimate the carbon storage and sequestration rates from the different habitats within the Biogenic Carbon Study Area, the areas of individual habitats were considered along with appropriate values for carbon storage and sequestration rates using best practice taken from the literature. All habitats within the Biogenic Carbon Study Area were considered as part of the baseline with post-development habitats divided into retained or created habitats.

2.2.3. The carbon calculations were undertaken in the Toolkit. The carbon values of the habitats within the Site were quantified in terms of tonnes of carbon dioxide equivalent (tCO_2e) for carbon storage, and tonnes of carbon dioxide equivalent per 5-year period (tCO_2e/5yrs) for sequestration rates. This is in line with current best practice and guidance from Natural England[6].

2.2.4. The values were calculated using the Toolkit. These were based on:

- The data auto-populated from the BNG section of the Toolkit (for the Calculation Units, Habitat type, Area columns for pre-development; Area Retained column for during works; and After work action, Habitat Type, Area and Time to target condition for post-development);
- Our understanding of the Site and LMP; and
- Assumptions made.

2.2.5. Age of habitats was not known and was presumed to be 30 years. This is the Toolkit default value as outlined in the guidance.

[6] Natural England (2021) The Natural England Report: Carbon Storage and Sequestration by Habitat (NERR094). Available at: https://publications.naturalengland.org.uk/file/6257983284838400 [accessed January 2024]

3 RESULTS

3.1.1. This section provides a summary of the carbon quantitative assessments for both the NWRR and OLR schemes.

3.1.2. Details about each habitat is provided in the BNG report and the LMP.

3.2 BASELINE CARBON: NWRR

3.2.1. **Overall, the NWRR Biogenic Carbon Study Area has a baseline carbon storage value of 30,399 tCO2e, and baseline sequestration rate of -525 tCO2e/5yrs.**

3.2.2. **If no interventions were to take place, it is predicted that the amount of carbon stored within the NWRR Biogenic Carbon Study Area will gradually increase over the next 30 years, before consistently decreasing from 30-180 years.** Over the next 30 years a net estimated 708 of stored tCO2e would be gained, followed by a net emission of 7 of stored tCO2e over the subsequent 30–60-year period. This means that total carbon storage in 30 years would be 31,107 tCO2e, and in 60 years would be 31,100 tCO2e. This results in a predicted net increase from the current baseline in biogenic carbon present throughout the NWRR Biogenic Carbon Study Area within a 60-year timeframe.

3.2.3. Table 1 provides a summary of the baseline carbon storage by habitat:

Table 1 – NWRR baseline carbon storage by habitat type (UKHab or Phase UK)

Habitat type	Area / Length (ha / km)	Carbon Storage (tCO_2e) – Baseline, 0yrs	Carbon Storage (tCO_2e) – Baseline, 30yrs	Carbon Storage (tCO_2e) – Baseline, 60yrs
Cropland - Cereal crops	40.04	17,579	17,231	16,883
Grassland - Modified grassland	21.44	10,368	10,368	10,368
Grassland - Other neutral grassland	0.04	9	9	9
J1.2 : Cultivated/disturbed land : Amenity grassland	0.49	246	252	257
Lakes - Ponds (Priority habitat)	0.12	0	0	0
Sparsely vegetated land - Ruderal/Ephemeral	1.61	0	0	0
Urban - Developed land; sealed surface	3.16	0	0	0
Woodland and forest - Lowland mixed deciduous woodland	1.98	837	1,298	1,444
Woodland and forest - Other woodland; broadleaved	2.27	955	1,481	1,648

Habitat type	Area / Length (ha / km)	Carbon Storage (tCO_2e) – Baseline, 0yrs	Carbon Storage (tCO_2e) – Baseline, 30yrs	Carbon Storage (tCO_2e) – Baseline, 60yrs
Woodland and forest - Other woodland; mixed	0.07	20	35	42
Native Hedgerow	1.46	233	233	233
Native Hedgerow with trees	0.55	70	108	120
Native Species Rich Hedgerow	0.38	61	61	61
Native Species Rich Hedgerow with trees	0.16	20	31	35
Rivers and lakes – Other rivers and streams (Medium)	0.57	0	0	0
TOTAL (subject to rounding errors)	**71.22 / 3.11**	**30,399**	**31,107**	**31,100**

3.3 POST-DEVELOPMENT CARBON NWRR

3.3.1. **During construction, the NWRR Biogenic Carbon Study Area is predicted to lose the carbon stored in the 31 ha and 1 km of habitats on the Site as well as its carbon sequestration capacity**, due to habitats beings removed permanently within the development footprint and habitats being temporarily removed to facilitate construction but that will be reinstated. This consists of a carbon storage loss of 12,677 tCO2e.

3.3.2. **Post-development, it is predicted that after an initial drop due to construction, carbon storage will increase over the longer term, but not greater than the 60 years baseline prediction if there had been no intervention**. Overall, 1-year post-construction carbon storage of the Biogenic Carbon Study Area is 22,327 tCO2e, which is a 27% decrease compared to the baseline. This will then increase to 26,451 tCO2e (15% decrease compared to the baseline), 30 years after construction; and 28,262 tCO2e (9% decrease compared to the baseline), 60 years after construction.

3.3.3. **The change in carbon stored can be broken down as follows:**

3.3.4. In the Site, built features are replacing 7.70 ha and 0.28 km of habitat, including 4.98 ha Cereal crops, 2.29 ha Modified grassland, and 0.22 ha Woodland and forest - Lowland mixed deciduous woodland.

3.3.5. The largest carbon store lost due to construction is 8,678 tCO2e from Cereal crop loss, followed by 3,226 tCO2e Modified grassland, and 376 tCO2e Lowland mixed deciduous woodland. Cereal crops and Modified grassland are not considered permanent carbon stocks, unlike woodland.

3.3.6. The largest gains in habitat post-construction are for 10.97 ha of Other neutral grassland, 6.99 ha of Urban land, 3.15 ha Lowland mixed deciduous woodland, 2.93 ha of Other woodland; broadleaved, 2.95 ha of Mixed scrub, 4.66 km of Native species rich hedgerow with trees.

3.3.7. In the baseline (60 years) scenario, Cereal crops (16,883 tCO2e), Modified grassland (10,368 tCO2e), Other woodland; broadleaved (1,647 tCO2e), and Lowland mixed deciduous woodland (1,444 tCO2e) would have been the habitats with the largest total carbon stocks. In the post-development (60 years) scenario, Cereal crops (8,549 tCO2e), Modified grassland (7854 tCO2e), Other woodland; broadleaved (3,358 tCO2e), and Lowland mixed deciduous woodland (2,853 tCO2e), Other neutral grassland (2,453 tCO2e), and Mixed scrub (1,570 tCO2e) will have the largest total carbon stocks.

3.3.8. There are notable increases in predicted carbon stores between the baseline (60 years) and post-development (60 years) scenarios for Other neutral grassland, Mixed scrub, Other woodland; broadleaved, Lowland mixed deciduous woodland, and Native species rich hedgerows with trees. Other neutral grassland carbon stocks increase from 9 to 2453 tCO2e, Mixed scrub stocks increase from 0 to 1570 tCO2e, Other woodland; broadleaved stocks increase from 1,648 to 3,358 tCO2e, Lowland mixed deciduous woodland stocks increase from 1,444 to 2,853 tCO2e, and Native species rich hedgerows with trees stocks increase from 35 to 920 tCO2e.

3.3.9. Habitats accounting for carbon sequestration rates totalling 122 tCO2e per 5-year period are lost during construction.

3.3.10. Largely due to the creation of new habitats, the Site's post-development carbon sequestration is estimated to be 1,032 tCO2e / 5yrs and 252 tCO2e/5yrs respectively 30 and 60 years after construction, compared to the 79 tCO2e / 5yrs and 13 tCO2e / 5yrs for the baseline projections.

3.3.11. Table 2 provides a summary of the post-development carbon storage by habitat, after 30 years and 60 years.

Table 2 – 30 years and 60 years post-development predicted carbon storage by habitat type

Habitat type	Area / Length (ha / km)	Carbon Storage (tCO_2e) – 30 Years post-dev	Carbon Storage (tCO_2e) – 60 Years post-dev
Cropland - Cereal crops	20.27	8,725	8,549
Grassland - Modified grassland	16.24	7,854	7,854
Grassland - Other neutral grassland	11.02	2,453	2,453
Heathland and shrub - Mixed scrub	2.95	1,570	1,570
Lakes - Ditches	0.01	0	0
Lakes - Ponds (Non- Priority Habitat)	0.02	0	0
Lakes - Ponds (Priority habitat)	0.36	0	0
Sparsely vegetated land - Ruderal/Ephemeral	0.80	0	0
Urban - Amenity grassland	0.12	60	62

Habitat type	Area / Length (ha / km)	Carbon Storage (tCO_2e) – 30 Years post-dev	Carbon Storage (tCO_2e) – 60 Years post-dev
Urban - Developed land; sealed surface	9.54	0	0
Urban - Vacant/derelict land/ bareground	0.48	0	0
Wetland - Reedbeds	0.23	31	44
Woodland and forest - Lowland mixed deciduous woodland	4.24	2,042	2,853
Woodland and forest - Other woodland; broadleaved	4.91	2,532	3,358
Woodland and forest - Other woodland; mixed	0.06	35	42
Native Hedgerow (linear)	1.46	233	233
Native Hedgerow with trees (linear)	0.55	108	120
Native Species Rich Hedgerow (linear)	1.29	206	206
Native Species Rich Hedgerow with trees (linear)	4.66	602	920
Rivers and lakes – Other rivers and streams (Medium) (linear)	0.26	0	0
Urban - Developed land; sealed surface (linear)	0.28	0	0
TOTAL (subject to rounding errors)	**71.3 / 8.5**	**26,451**	**28,262**

3.4 SUMMARY OF CARBON CHANGE: NWRR

3.4.1. Plate 1-1 shows the dashboard results from the Toolkit and summarises the changes in carbon storage generated for the combination of the NWRR development and LMP within the Biogenic Carbon Study Area.

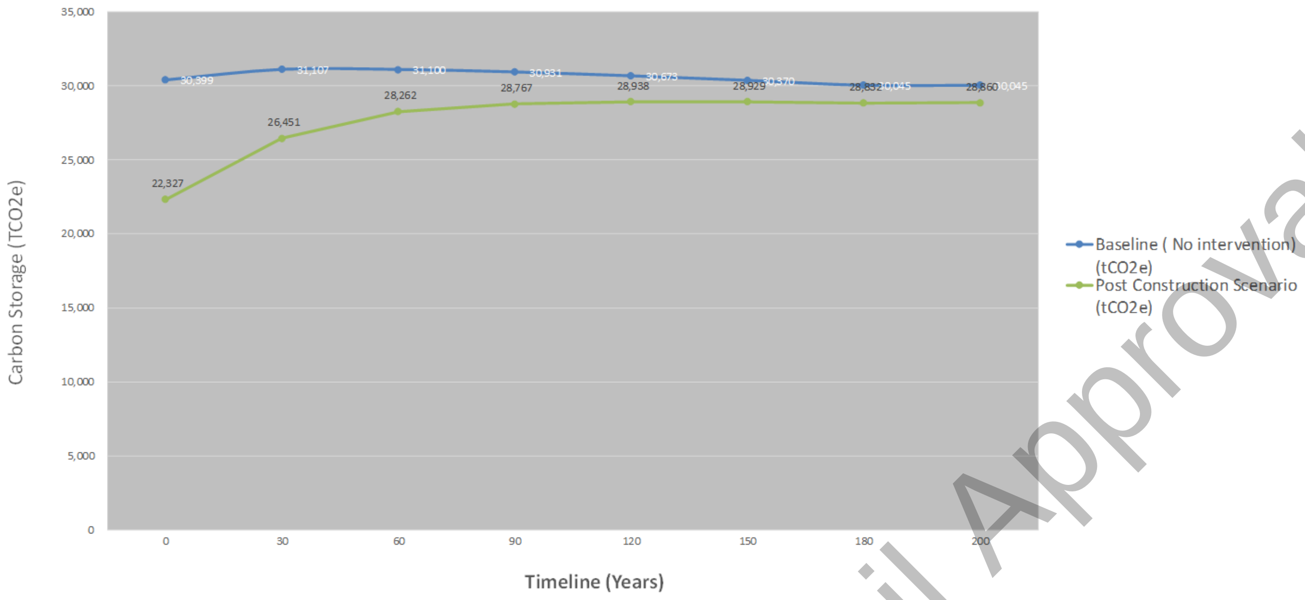


Plate 1-1: Toolkit dashboard for the NWRR development and LMP Enhancements

3.4.2. Overall, it is predicted that the project will not achieve biogenic carbon neutrality between 30 and 60 years after construction.

3.4.3. It is predicted that in the long term, this project will store less biogenic carbon than what would have happened if no interventions had occurred. This is largely due to the large loss of carbon stocks associated with removed cropland, as well as insufficient creation of carbon sequestering habitats such as woodland. By year 200 post construction, a non-intervention scenario is estimated to store 30,045 tCO2e whereas a post-construction scenario is estimated to store 28,860 tCO2e. This represents a loss of 1,185 tCO2e biogenic carbon stored, which is a decrease of 4% compared to a non-intervention scenario.

3.5 BASELINE CARBON: OLR

3.5.1. **Overall, the OLR Biogenic Carbon Study Area has a baseline carbon storage value of 10,999 tCO_2e, and baseline sequestration rate of -717 tCO_2e/5yrs.**

3.5.2. **If no interventions were to take place, it is predicted that the amount of carbon stored within the OLR Biogenic Carbon Study Area will consistently increase with time.** Over the next 30 years an estimated 1,280 of stored tCO_2e would be gained, followed by an additional 385 of stored tCO_2e over the subsequent 30-year period. This means that total carbon storage in 30 years would be 12,279 tCO_2e, and in 60 years would be 12,664 tCO_2e. This results in a predicted net increase from the current baseline in biogenic carbon present throughout the OLR Biogenic Carbon Study Area with time.

3.5.3. Table 3 provides a summary of the baseline carbon storage by habitat:

Table 3 – OLR baseline carbon storage by habitat type (UKHab or Phase UK)

Habitat type	Area / Length (ha / km)	Carbon Storage (tCO_2e) – Baseline, 0yrs	Carbon Storage (tCO_2e) – Baseline, 30yrs	Carbon Storage (tCO_2e) – Baseline, 60yrs
Cropland – Cereal crops	8.70	3,821	3,745	3,669
Grassland – Modified grassland	6.97	3,376	3,376	3,376
Grassland - Bracken	0.05	17	17	17
Grassland – Other neutral grassland	0.46	103	103	103
Heathland and shrub – Mixed scrub	0.96	509	509	509
Lakes – Ponds (Priority habitat)	0.15	0	0	0
Sparsely vegetated land – Ruderal/Ephemeral	15.05	0	0	0
J1.2 : Cultivated/disturbed land : Amenity grassland	0.54	271	277	283
Urban – Developed land; sealed surface	13.11	0	0	0
Woodland and forest – Lowland mixed deciduous woodland	2.02	854	1,324	1,473
Woodland and forest – Other woodland; broadleaved	2.44	1,032	1,599	1,779
Woodland and forest – Other woodland; mixed	0.64	211	373	452
J2.4 : Boundaries : Fence (linear)	0.43	0	0	0
Native Hedgerow (linear)	2.38	380	380	380
Native Hedgerow with trees (linear)	1.84	233	362	402
Native Species Rich Hedgerow (linear)	0.98	156	156	156
Native Species Rich Hedgerow with trees (linear)	0.30	38	59	66

Habitat type	Area / Length (ha / km)	Carbon Storage (tCO_2e) – Baseline, 0yrs	Carbon Storage (tCO_2e) – Baseline, 30yrs	Carbon Storage (tCO_2e) – Baseline, 60yrs
Rivers and lakes – Other rivers and streams (Medium) (linear)	0.05	0	0	0
J2.5 : Boundaries : Wall (linear)	0.01	0	0	0
TOTAL (subject to rounding errors)	**51.08 / 5.99**	**10,999**	**12,279**	**12,664**

3.6 POST-DEVELOPMENT CARBON: OLR

3.6.1. **During construction, the OLR Biogenic Carbon Study Area is predicted to lose the carbon stored in the 51 ha and 5.99 km of habitats on the Site as well as its carbon sequestration capacity**, due to habitats beings removed permanently within the development footprint and habitats being temporarily removed to facilitate construction but that will be reinstated. This consists of a carbon storage loss of 5,412 tCO_2e.

3.6.2. **Post-development, it is predicted that after an initial drop due to construction, carbon storage will increase over the longer term, but not greater than the 60 years baseline prediction if there had been no intervention.** Overall, 1-year post-construction carbon storage of the Biogenic Carbon Study Area is 9,793 tCO_2e, which is a 11% decrease compared to the baseline. This will then increase to 11,616 tCO_2e (5% decrease compared to the baseline), 30 years after construction; and 12,417 tCO_2e (2% decrease compared to the baseline), 60 years after construction.

3.6.3. **The change in carbon stored can be broken down as follows:**

- In the Site, built features are replacing 5.62 ha of habitat, including 1.26 ha Modified grassland, 1.3 ha Cereal crops; 0.28 ha Lowland mixed deciduous woodland, 0.18 ha Other woodland; broadleaved, and 0.12 ha Mixed scrub.
- The largest carbon store lost due to construction is 2,341 tCO2e from Cereal crop loss, followed by 1,847 tCO2e Modified grassland, and 571 tCO2e Lowland mixed deciduous woodland. Cereal crops and Modified grassland are not considered permanent carbon stocks, unlike woodland.
- The largest gains in habitat post-construction are for 9.19 ha of Other neutral grassland, 5.53 ha of Urban land, 2.42 ha mixed scrub, and 3.67 km of Native species rich hedgerow with trees.
- In the baseline (60 years) scenario, Cereal crops (3,669 tCO2e), Modified grassland (3,376 tCO2e), and Other woodland; broadleaved (1,779 tCO2e) would have been the habitats with the largest total carbon stock. In the post-development (60 years) scenario, Modified grassland (2,307 tCO2e), Other neutral grassland (2,140 tCO2e), and Other woodland; broadleaved (1,996 tCO2e) will have the largest total carbon stock.
- There are notable increases in predicted carbon stores between the baseline (60 years) and post-development (60 years) scenarios for Mixed scrub and Native species rich hedgerows with trees. Mixed scrub carbon stocks increase from 509 to 1,624 tCO2e, whilst Native species rich hedgerows with trees stocks increase from 66 to 805 tCO2e.

- Habitats accounting for carbon sequestration rates totalling 271 tCO2e per 5-year period are lost during construction.
- Largely due to the creation of new habitats, the Site's post-development carbon sequestration is estimated to be 406 tCO2e / 5yrs and 130 tCO2e/5yrs respectively 30 and 60 years after construction, compared to the 171 tCO2e / 5yrs and 84 tCO2e / 5yrs for the baseline projections.

3.6.4. Table 4 provides a summary of the post-development carbon storage by habitat, after 30 years and 60 years.

Table 4 – 30 years and 60 years post-development predicted carbon storage by habitat type

Habitat type	Area / Length (ha / km)	Carbon Storage (tCO_2e) – 30 Years post-dev	Carbon Storage (tCO_2e) – 60 Years post-dev
Grassland – Modified grassland	4.76	2306.77	2306.77
Cropland – Cereal crops	3.37	1450.62	1421.30
J1.2 : Cultivated/disturbed land : Amenity grassland	0.31	156.05	159.40
Grassland - Bracken	0.01	3.31	3.31
Grassland - Other neutral grassland	9.59	2140.49	2140.49
Heathland and shrub - Mixed scrub	3.06	1623.66	1623.66
J1.2 : Cultivated/disturbed land : Amenity grassland	0.31	0	0
Lakes - Ponds (Priority habitat)	0.58	0	0
Sparsely vegetated land - Ruderal/Ephemeral	7.96	0	0
Urban - Developed land; sealed surface	17.10	0	0
Wetland - Reedbeds	0.32	42.67	60.95
Woodland and forest - Lowland mixed deciduous woodland	0.67	439.16	488.53
Woodland and forest - Other woodland; broadleaved	2.84	1609.78	1996.27
Woodland and forest - Other woodland; mixed	0.51	297.28	360.00
J2.4 : Boundaries : Fence (linear)	0.43	0	0
Native Species Rich Hedgerow with trees (linear)	4.06	535.89	804.98

Habitat type	Area / Length (ha / km)	Carbon Storage (tCO_2e) – 30 Years post-dev	Carbon Storage (tCO_2e) – 60 Years post-dev
Native Species Rich Hedgerow (linear)	1.68	269.49	269.49
Native Hedgerow with trees (linear)	1.84	361.81	402.49
Native Hedgerow (linear)	2.38	379.52	379.52
Rivers and lakes – Other rivers and streams (Medium) (linear)	0.05	0	0
J2.5 : Boundaries : Wall (linear)	0.01	0	0
TOTAL (subject to rounding errors)	**51.08 / 10.46**	**11,616**	**12,417**

3.7 SUMMARY OF CARBON CHANGE: OLR

3.7.1. **Plate 1-2** shows the dashboard results from the Toolkit and summarises the changes in carbon storage generated for the combination of the OLR development and LMP within the Biogenic Carbon Study Area.

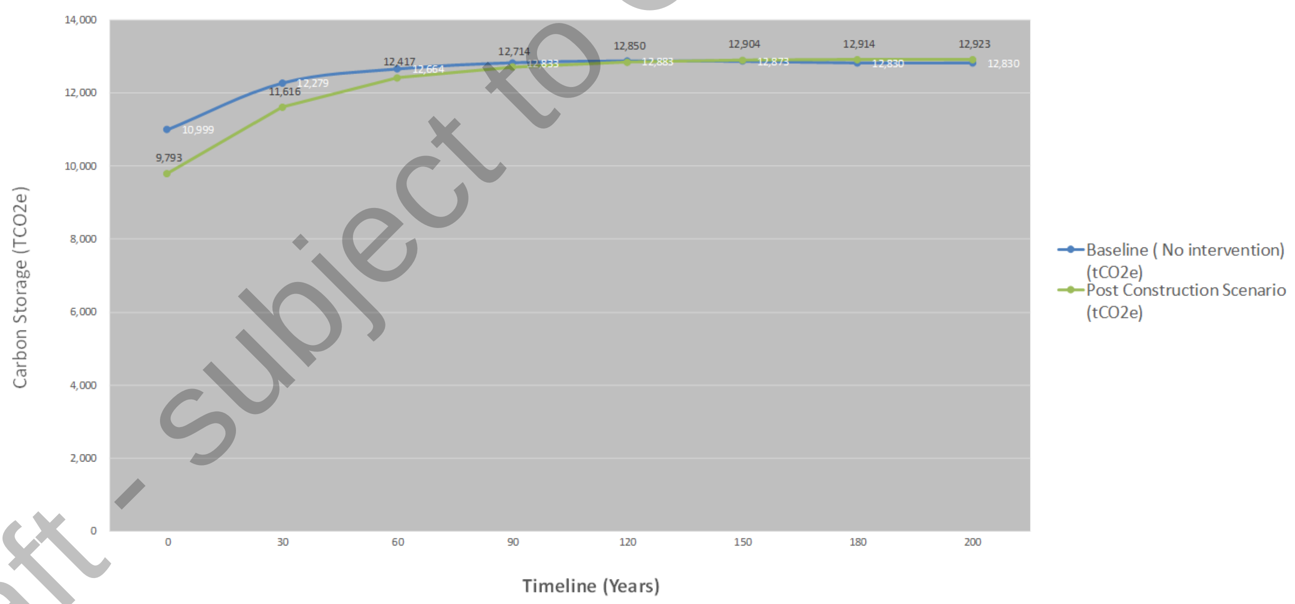


Plate 1-2: Toolkit dashboard for the OLR Development and LMP enhancements

3.7.2. Overall, it is predicted that the project will not achieve biogenic carbon neutrality between 30 and 60 years after construction.

3.7.3. **It is predicted that in the long term, this project will store** marginally **more biogenic carbon than what would have happened if no interventions had occurred.** This is largely due to the scheme's woodland and treed hedgerow planting, and the continued long-term carbon sequestration of trees. By year 200 post construction, a non-intervention scenario is estimated to store 12,830 tCO_2e whereas a post-construction scenario is estimated to store 12,923 tCO_2e. This represents an additional 93 tCO_2e stored, which is an increase of 0.7% compared to a non-intervention scenario.

4 DISCUSSION AND CONCLUSIONS

4.1.1. In conclusion, the NWRR carbon assessment recorded a baseline carbon storage value of 30,399 tCO2e in the Biogenic Carbon Study Area. The construction works is expected to reduce this to a 1-year post-development value of 22,327 tCO2e, corresponding to a net loss of 8,072 tCO2e. However, due to the Proposed Schemes' habitat creation, this net loss of biogenic carbon stock will decrease over time to 4,656 tCO2e after 30 years and 2,838 tCO2e by 60 years. Figures 1 and 2 representing an overall summary of change in carbon storage and sequestration rates are available in Appendix A.

4.1.2. **In the long term, it is predicted that the NWRR project will store less biogenic carbon than would have happened if no interventions had occurred. By year 200 after construction, habitat-based carbon neutrality will not have been achieved by the scheme**, with a deficit of 1,185 tCO2e, which is a decrease of 4% compared to a non-intervention scenario.

4.1.3. For OLR, the carbon assessment recorded a baseline carbon storage value of 10,999 tCO2e in the Biogenic Carbon Study Area. The construction works is expected to reduce this to a post-development value of 9,793 tCO2e carbon in the year following construction, corresponding to a net loss of 1,206 tCO2e. However, due to the Proposed Schemes' habitat creation, this net loss of biogenic carbon stock will decrease over time to 663 tCO2e after 30 years and 247 tCO2e by 60 years. Figures 3 and 4 representing an overall summary of change in carbon storage and sequestration rates are available in Appendix A.

4.1.3.1 **In the long term, it is predicted that the OLR project will store more carbon than would have happened if no interventions had occurred.** By year 200 after construction, the scheme will successfully mitigate the construction impacts on the baseline carbon stocks through post-construction habitat planting and will eventually result in an estimated gain of 93 tCO2e once all habitats have reach maturity. This is an increase of 0.7% compared to a non-intervention scenario, with **habitat-based carbon neutrality predicted to be achieved in the 120-150 years timeframe.**

Appendix A

FIGURES

Figure 1 – Overall summary of change in carbon storage for NWRR *(available in Tab '6. Carbon DASHBOARD' of the Nature-focused Carbon Toolkit)*

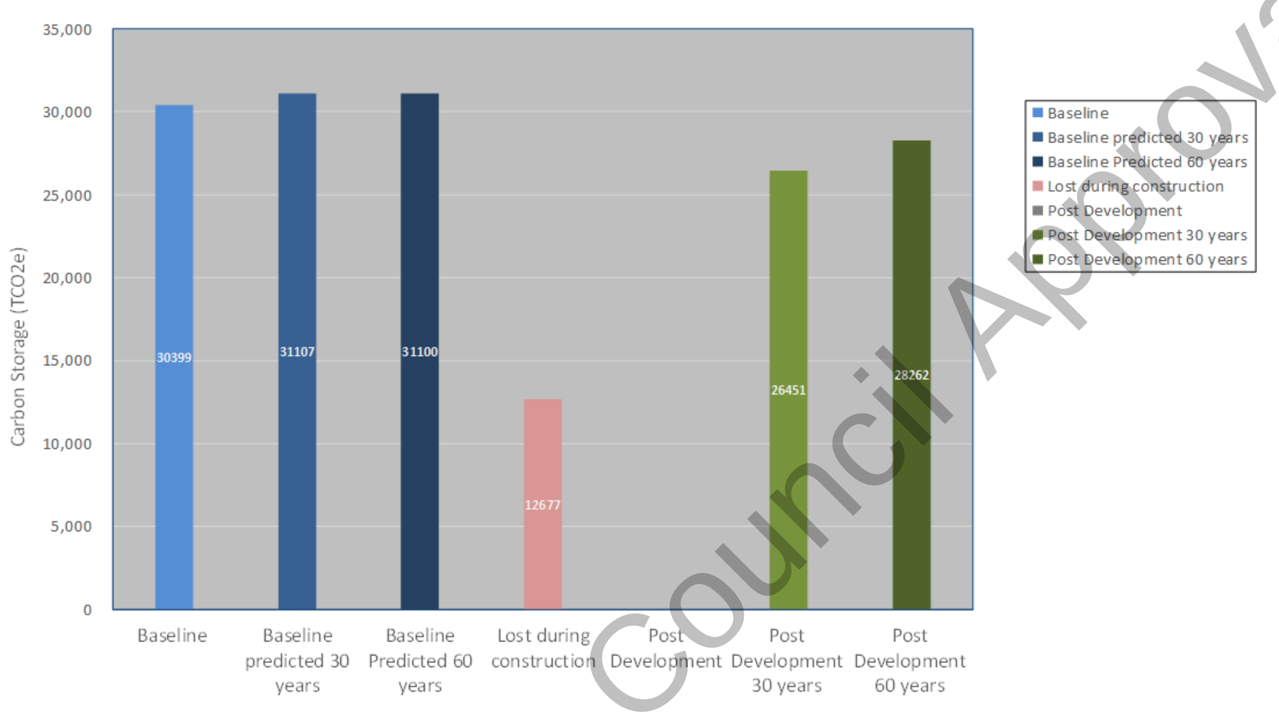


Figure 2 - Overall summary of change in carbon sequestration rates for NWRR *(available in Tab '6. Carbon DASHBOARD' of the Nature-focused Carbon Toolkit)*

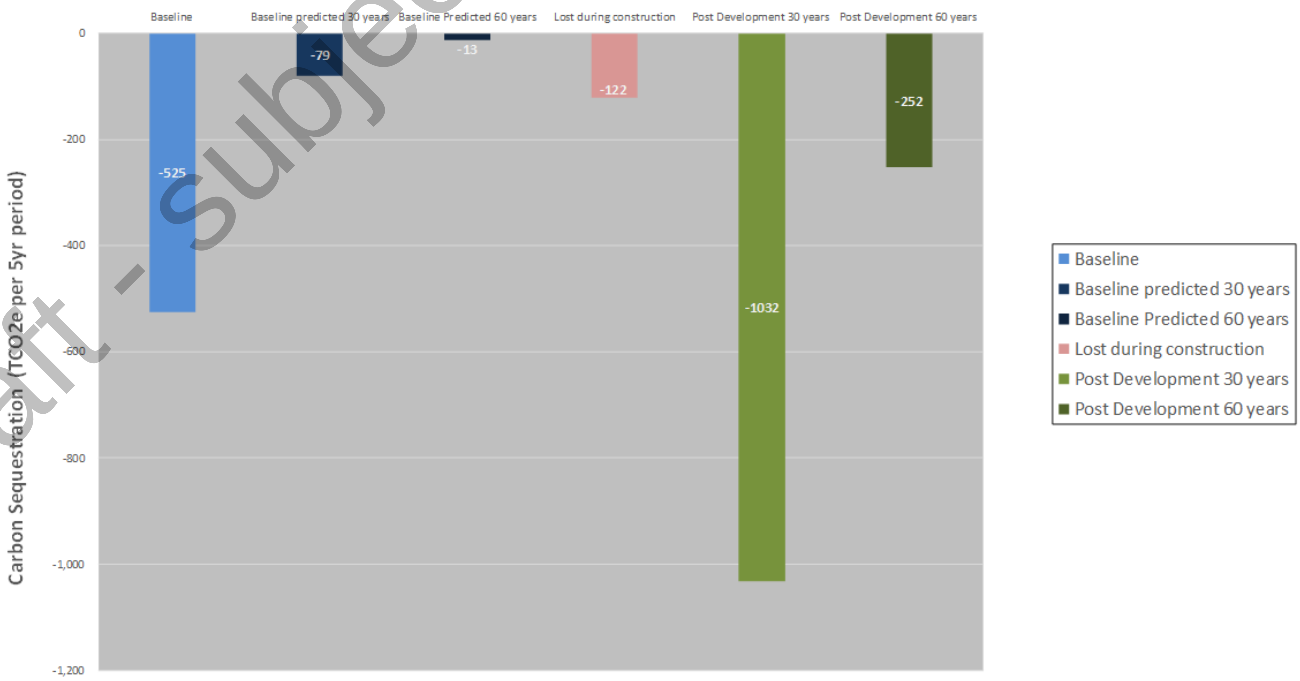


Figure 3 – Overall summary of change in carbon storage for OLR *(available in Tab '6. Carbon DASHBOARD' of the Nature-focused Carbon Toolkit)*

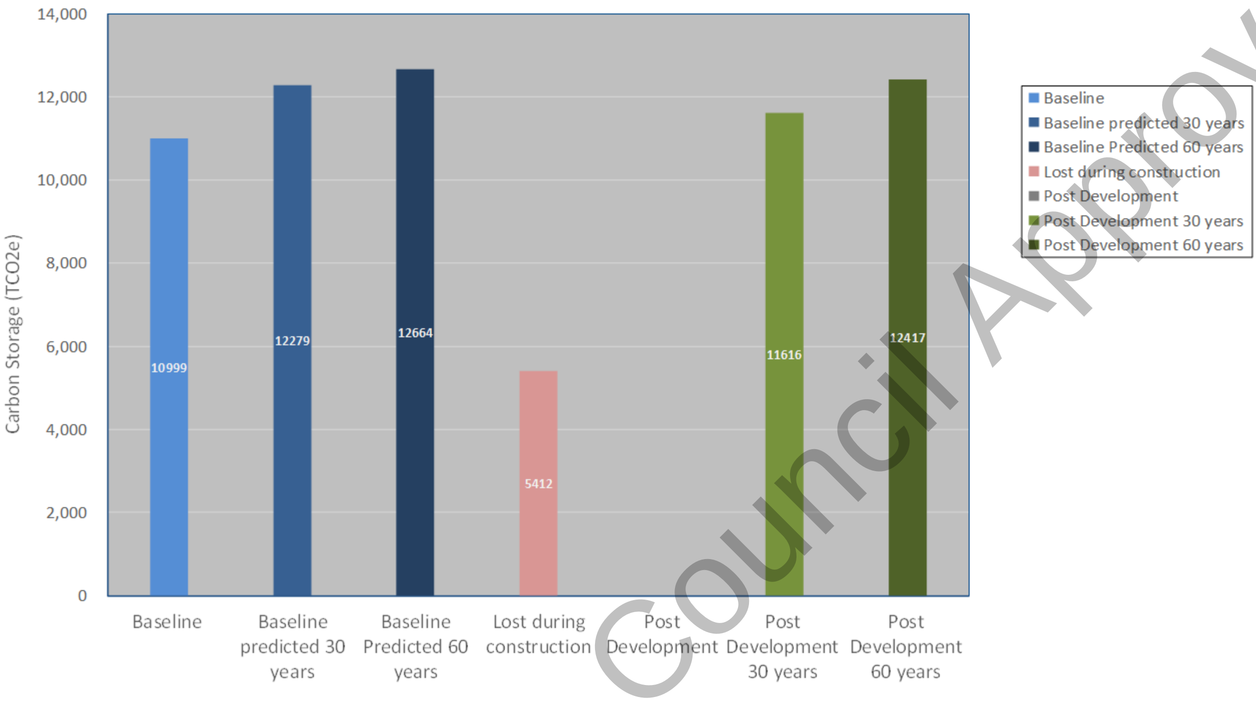
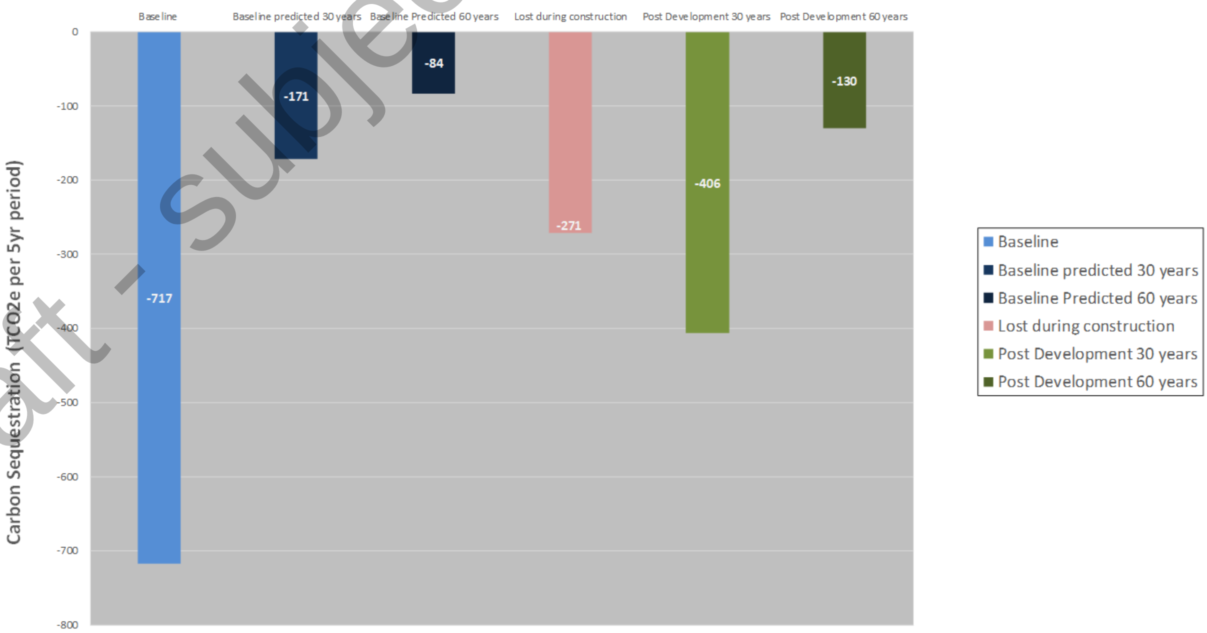


Figure 4 - Overall summary of change in carbon sequestration rates for OLR *(available in Tab '6. Carbon DASHBOARD' of the Nature-focused Carbon Toolkit)*



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Appendix E

Carbon Reduction Opportunities

Appendix E – Carbon Reduction Opportunities

Key:	Implemented in design	For further consideration	Not feasible

Area / Discipline	Opportunity	Benefit	Status / Design Stage (April 2021)	Responsibility	Feasibility Notes (April 2021)	Updated Status (September 2024)
Drainage	**Filter drains / French drains considered where feasible**	Reduced concrete kerbing lowers carbon footprint	Implemented	Principal Designer / Principal Contractor	The use of filter drains has already been included in the design where feasible. They cannot be used on southern side of project due to requirement for kerb between footway/cycleway and the carriageway. However northern side filter drains have been used wherever a kerb is not required.	Implemented
Drainage	**Creation of wetlands as drainage**	Carbon offsetting benefits and wetlands act as a carbon sink	Detailed design	Principal Designer / Client	Available land. Proposed ponds are already ear marked as wet land areas for mitigation purposes. Whether this can be expanded on a detailed design stage needs to be reviewed by environment team in liaison with drainage team.	In progress

Drainage	**PVC pipes not concrete**	Plastic pipes are less carbon intensive than concrete	Construction	Principal Designer	Plastic pipes used extensively as drainage solution and offer more benefits than just carbon offsetting in terms of H&S and ease of laying. Will spec the available use of Table 5/1 from the MCHW which allows the use of various materials at detailed design. Contractor to determine preference which would likely be plastic due to weight and ease of laying for most sections.	The drainage specification 5/1 states that the contractor shall use plastic pipes for carrier drains and filter drains. In some areas concrete pipes may be required to avoid crushing from soil and surcharge loading. Captured in the BoQ. PVC Pipes are used for the quantification according to the dimensions i.e. radius and lengths.
Earthworks	**Ironbridge power station - export of large quantity of materials fuel ash**	Waste material used and material would be sourced from a local area so decreased transport emissions	Construction	N/A	This is a totally independent party, and we would need to check that the material is of the right grade and that it can be used. We then need to arrange the business collaboration. Fuel ash is a low-quality fill and therefore would be challenging to incorporate into the earthworks. Earthwork side slopes would likely need to be slackened if we were to use fuel ash. In addition, if you are importing material it would make sense for it to be of high quality & locally sourced as there is currently a need to import high quality fill.	Ironbridge power station has since been demolished and is being redeveloped. As a result, this is no longer possible.
Earthworks	**Local granular fill**	Material sourced from local area decreasing transport emissions	Construction	Principal Contractor	Desk study and mineral assessment to try and find a local source of material. There are several sources of high-quality granular fill in Shropshire.	Criggon quary is 10miles from Churncote Roundabout. Bayston Hill Asphalt Plant is 5miles from Churncote Roundabout. Breedon Leaton Quarry is

						13miles from Churncote Roundabout. The Contract could specify the requirement to use these local quarries unless this is not possible.
Earthworks	**Reuse excavated material**	Reduced imported fill needed	Implemented	Principal Contractor	Ground investigation currently being undertaken. The preliminary design considers reusing excavated material minimising the amount of fill to be imported	A comprehensive earthworks balance analysis has been undertaken to maximise the reuse of suitable excavated material and minimise the need to export excess.
Earthworks	**Surplus of topsoil removed from site to a local opportunity**	Condover Quarry could be an option for restoration in existing mineral workings in the immediate area.	Contractor	Principal Contractor	Need to find a location that is in the need of and will accept topsoil.	TBC by Contractor.
Earthworks	**Slacken 1 in 2 slopes of noise bunds (Ch500 to Ch1400)**	Do not need to import high quality granular fill.	Detailed Design	Principal Designer / Principal Contractor	Increased earthwork footprint but by slackening the slopes it reduces the need to import high quality fill.	The slopes of the noise bund have been designed such that site won fill can be used to construct them.
Earthworks	**Slacken 1 in 2 slopes of false cuttings (Ch800 to Ch1100)**	Do not need to import high quality granular fill to reinforce cutting slope.	Detailed Design	Principal Designer / Principal Contractor	Increased earthwork footprint & increased span of Shepherds Lane Footbridge but by slackening the slopes it reduces the need to import high quality fill.	Slopes with a gradient of 1in2 or shallower are constructed using site won fill. Imported fill has been utilised locally around the bridge structure where slope gradients are steeper than 1in2. This is to minimise the span of the footbridge which in turn minimises the quantity of

						materials required to construct the bridge itself.
Earthworks	**Slacken 1 in 2 slopes of cuttings (Ch1400 to Ch1850)**	Do not need to import high quality granular fill to reinforce cutting slope.	Detailed Design	Principal Designer / Principal Contractor	Increased earthwork footprint & increased span of Clayton Way Bridge but by slackening the slopes it reduces the need to import high quality fill.	Where possible the slopes have been slackened to a gradient that allows use of site won fill. Where this was not possible imported fill has been used at these locations.
Pavements	**Thickness of pavement**	Reduced materials required	Detailed Design	Principal Designer	Already addressed for the footway using Shropshire council standard not DMRB so couldn't go further with the footway. Pavement durability and materials trade off. Preliminary design is not based on CBR from latest GEO therefore thicknesses currently proposed could be reduced.	5 separate thicknesses have been identified and the different pavement options have been optimised to be as close as required. Foundation thickness could be reduced through on site CBR/surface modulus testing (currently within spec), although any reductions on thickness would need to be agreed by the NEC PM, advised by the Pavement Team.
Pavements	**Lower temperature asphalt**	Decreased embodied CO2	Detailed Design	Principal Designer / Principal Contractor	To be looked at in detailed design to offer up to 10% carbon reduction in pavement	Warm mix asphalt specified for both base and binder materials (but not surface course).
Pavements	**Anti-skid surfacing**	Decreased embodied CO2	Closed (not feasible and justified)	Principal Designer / Principal Contractor	Probably on approach to junctions but not a lot. Any HFS identified is in line with standards and safety overrides carbon reduction.	This has been reduced to one location only, driven by DMRB standards.

Pavements	**Process and reuse tar bound material of the existing road**	Even if it doesn't benefit a massive carbon saving it has wider sustainability benefits	Construction	Principal Contractor	To be looked at by contractor as to whether feasible.	Currently not embed within the design. There are safety limitations, the main carriageway of the NWRR is over 60msa, so not suitable for having a Cl. 948 type material. It could be used as a substitute for base course on any section containing pavement option 1 to 4, although currently not proposed. As the road is mainly new, site clearance does not provide with enough materials to re-utilise within site, so imported materials would be required regardless, plus blending operations on site. If tar bound, there are storage limitations linked to leakage provided by the Environmental Agency (the Contractor would need to sort this). A calculation on carbon impact between importing recycled materials and imported new materials could be undertaken by winning Contractor.
Pavements	**Using recycled materials on access tracks not the road**	Currently using 250mm type 1, using recycled would reduce materials required and therefore decrease embodied CO2	Detailed Design	Principal Designer / Principal Contractor	If there is an abundance of available suitable recycled material this could be investigated further by designer / contractor.	Not further investigated.
Kerbs, Footways	**Integrated drainage kerbs**	Plastic has a lower level of embodied carbon compared to concrete	Detailed Design	Principal Designer	May be feasible on southern side of NWRR where footway/cycleway is present,	The cycleway is intended to be drained via a filter drain where possible, with a plastic pipe.

and Paved Areas					kerbing to northern side is only present where positive drainage system is required, and the use of plastic kerbs may be feasible at these locations also.	Where a kerb up-stand is present then Plastic integrated drainage kerbs can be considered. Further update required.
Kerbs, Footways and Paved Areas	**Replace concrete edgings with timber**	Decreased embodied CO2	Detailed Design	Principal Designer / Principal Contractor	Could only be replaced in rural locations. It's also already been considered in most places. Rural locations and locations identified that could be kept more in keeping with rural setting could have timber edgings applied which could be further reviewed at detailed design.	Due to the improved durability, and therefore the increased life span of concrete edging, concrete edging is proposed for the majority of the scheme. The MCHW specifies concrete edging for highway schemes. Additionally concrete edging complies with the DMRB (CD 239 Clauses 3.21 and 3.22 and Table 4.1h). Some 'off-highway' infrastructure, such as the viaduct access tracks to the east of the river and diverted footpaths make use of timber edging.
Structures	**Steel composite structures used throughout the project**	Decreased embodied CO2	Implemented	Principal Contractor	Already implemented.	Implemented Captured in the BoQ
Structures	**Weathered steel used**	Decrease maintenance needs	Implemented	Principal Contractor	Already implemented.	Implemented Captured in the BoQ; Allocated as General steelworks in the NH

						Carbon Tool rather than Galvanised steel.
Structures	**In situ concrete - GGBS and pulverised fuel ash (PFA) in the spec where required - In situ wingwalls - 2 concrete piers - Deck area**	Decreased embodied CO2	Detailed Design	Principal Contractor	Will be implemented during detailed design.	Implemented Captured in the BoQ; Concrete is assigned in the NH Carbon Tool as per the descriptions of the Grades.
Structures	**Haunched girders**	Reduced materials required	Implemented	Principal Contractor	Already implemented.	Implemented Allocated as Steelworks in NH Carbon Tool
Structures	**Consider other materials for the retaining wall**	Decrease embodied CO2	Detailed Design	Principal Contractor	Wingwalls need to be cast in situ concrete	Implemented Captured in the BoQ with correct descriptions.
Structures	**Glue laminated timber frame footbridge rather than steel**	Decreased embodied CO2	Closed (not feasible and justified)	N/A	Challenges for span and constraints at site	Not feasible

Structures	**Structures changed to single span and abutments moved back**	Reduced materials required	Implemented	Principal Contractor	Unlikely to be able to reduce road restraint systems further	Implemented Captured in the BoQ
Structures	**Include an extended earthwork embankment to reduce viaduct length.**	Reduced materials required	Detailed Design	Principal Designer	To be reviewed at detailed design.	Not feasible
Contractor	**Compound - using existing hard standing as part of the park and ride.**	Don't need to build a new compound - reduced materials required	Detailed Design	Principal Designer / Principal Contractor	Needs to be in-line with Shropshire Council's decommissioning of the park and ride and in-line with the construction programme.	The Park and Ride site is to be used for the main site compound. The P&R will still be under operation and the contractor shall make use of the space available to them.
Structures	**Use of high grade S460 steel for the viaduct to reduce material quantities**	Reduced materials required	Detailed Design	Principal Contractor	Implemented at detailed design	Implemented Captured in the BoQ; Allocated as General steelworks in the NH Carbon Tool rather than Galvanised steel.
Structures	**Reduction of size of pier columns and crossheads on the**	Reduced materials required	Detailed Design	Principal Contractor	Implemented at detailed design	Implemented Captured in the BoQ with correct descriptions of the concrete grades.

	smaller spans of the viaduct to reduce concrete materials					
Drainage	**Removal of Basin 9**	Reduction in materials and reduction in need to remove excess earthworks. Retention of existing trees. Additional planting to be implemented.	0	Principal Designer	N/A – Introduced after April 2021	Currently being assessed
Structures	**Removal of Climbing Lane**	Substantial design change to reduce the impacts of the viaduct in response to stakeholder requirements. This and the opportunities in the following two rows were implemented between the April 2021 and August 2021 WLC assessments. The difference in capital and operational carbon between these two assessments is 12,819 tCO_2e; this reduction is largely attributable to these changes.	ES Addendum	Principal Designer	N/A – Introduced after April 2021	Implemented
Structures	**Height of viaduct parapet has**	See above	ES Addendum	Principal Designer	N/A – Introduced after April 2021	Implemented

	reduced on north side					
Structures	**Viaduct parapet materials have changed from concrete to steel**	See above	ES Addendum	Principal Designer	N/A – Introduced after April 2021	Implemented

Appendix F

Carbon Reduction Target Setting

Appendix F – Carbon Reduction Target Setting

DATE:	06 September 2024	**CONFIDENTIALITY:**	Restricted
SUBJECT:	Appendix F – Carbon Reduction Target Setting		
PROJECT:	Shrewsbury NWRR	**AUTHOR:**	CL
CHECKED:	TG	**APPROVED:**	SP

APPENDIX F – CARBON REDUCTION TARGET SETTING

Introduction

This appendix reports the methodology and results of analysis used to inform the carbon reduction target setting for the Shrewsbury North West Relief Road (NWRR) Scheme, hereafter referred to as the Proposed Scheme.

In summary, the carbon reduction target pertains to infrastructure carbon and is informed by a process of quantifying the potential impact of remaining carbon reduction opportunities.

Methodological Approach

The methodical approach to developing the carbon reduction target is presented in Figure F-1 and is summarised below.

Figure F-1 - Methodocial Approach

Step One - Develop a Carbon Baseline

An **infrastructure carbon baseline of 55,735 tCO_2e** is established in Section 3.3 of the Carbon Management Plan (CMP) to which this document is appended.

Since the whole life carbon (WLC) assessment that informs the baseline was undertaken in February 2021, several updated WLC assessments of the Proposed Scheme have been completed. **The latest, detailed stage assessment establishes the infrastructure carbon impact of the Proposed Scheme to be 41,222 tCO_2e**, as detailed in Section 3.4 of the CMP.

The National Highways Carbon Tool was used to convert the construction materials and quantities shown in Bills of Quantities into an estimate greenhouse gas emission (tCO_2e). Further detail on this methodology is provided in Appendix B of the CMP.

Appendix F – Carbon Reduction Target Setting

DATE:	06 September 2024	**CONFIDENTIALITY:**	Restricted
SUBJECT:	Appendix F – Carbon Reduction Target Setting		
PROJECT:	Shrewsbury NWRR	**AUTHOR:**	CL
CHECKED:	TG	**APPROVED:**	SP

The Proposed Scheme's carbon 'hotspots' were reviewed to understand which aspects of the design are the most carbon intensive. This review included hotspots by material type, and by BS EN 17472:2022 Module. Chapter 4 and Appendices C and D of the CMP provide further detail.

Step Two – Carbon Workshops

Carbon reduction workshops were held with the design leads, project managers, and scheme promoters in August 2020 and July 2024 to discuss the likely carbon hotspots and capture both committed and potential opportunities and design decisions that influence a reduction in carbon.

A list of opportunities was included in the Carbon Management Report of April 2021. As part of the carbon scope supporting the FBC and detailed design, the status of these opportunities was updated, and the revised list is appended to the CMP (Appendix E). Further opportunities for carbon reduction identified as part of detailed design were also added to this list.

Each of the opportunities was recorded as:

- 'Implemented in design,'
- 'For further consideration, or
- 'Not feasible.'

A total of 19 opportunities were classified as 'Implemented in design', 10 were classified as 'For further consideration', and 3 were classified as 'Not feasible'.

Step Three – Assessment of Opportunities

Of the ten opportunities for further consideration, the two that are considered the most likely to be implemented were modelled in the National Highways Carbon Tool to estimate the likely carbon reduction from the baseline if implemented.

The assessment process and estimated impact of these two opportunities is outlined in Table F-1.

Appendix F – Carbon Reduction Target Setting

DATE:	06 September 2024	**CONFIDENTIALITY:**	Restricted
SUBJECT:	Appendix F – Carbon Reduction Target Setting		
PROJECT:	Shrewsbury NWRR	**AUTHOR:**	CL
CHECKED:	TG	**APPROVED:**	SP

Table F-1 - Assessment process and estimate impact of selected opportunities

Opportunity	Assessment Process	Estimated Impact
Local Granular Fill	The standard assumption for transport distance for fill, aggregate & sand is 50km. This distance was set to 10km instead, and the calculated transport (A4) carbon was compared with the original result. Quantity of fill, aggregate & sand was unchanged.	Reduction of 843 tCO_2e (A4)
Using recycled materials on access tracks	The standard assumption of 'general mixture' was substituted with 'recycled resources' for fill, aggregate & sand, and the calculated product stage (A1-A3) carbon was compared with the original result.	Reduction of 159 tCO_2e (A1-A3)

These two opportunities alone are estimated to reduce infrastructure carbon impacts by approximately 1,000 tCO_2e if implemented.

Step Four – Setting the target

The latest estimate of infrastructure carbon is 41,222 tCO_2e, which is a 26% reduction against the baseline of 55,735 tCO_2e.

A further reduction of 1,000 tCO_2e would result in an impact of 40,222 tCO_2e; a 28% reduction against the baseline.

Given the assessment above has considered two of ten remaining opportunities to be considered, it is reasonable to expect that a reduction greater than 1,000 tCO_2e is achievable. It is also likely that additional opportunities to reduce carbon will be identified by the contractor during project delivery.

With this considered, an infrastructure carbon reduction target of 30% against the baseline is recommended.

Achieving this would require reducing the infrastructure carbon impacts to 39,014 tCO_2e; a reduction of 2,208 tCO_2e compared with the latest estimate of infrastructure carbon.

Appendix G

Carbon Risk Register

Appendix G - Carbon Risk Register

Annex 5 of the HM Treasury Green Book states that “effective risk management helps the achievement of wider aims, such as effective change management, the efficient use of resources, better project management, minimising waste and fraud, and supporting innovation”.

A risk register was initially developed to consider risks associated with the packages of interventions and to provide up-to-date input to risk management. Risks were identified by specialists in highways and structural engineering, geotechnics, transport planning, quantity surveying and the environmental disciplines. The identified risks were then entered into the Risk Register.

The risk register for the Proposed Scheme is a live document. The document is continuously updated to include project risks as they are identified by specialists as the scheme progresses.

This CMP builds upon the risk register to and qualitatively assesses the potential impact of the top project risks through a carbon lens. Only High and Medium risks that have a potential impact on carbon, have been considered in this Carbon Management Plan and are summarised below.

The carbon risks have been measured in two ways, firstly by assessing the likelihood (or probability) of them occurring and secondly the severity of impact on the project. The likelihood of each risk has been scored using a 5-scale point system, taken from the project risk register. The scale ranges from 1 (very low/unlikely) to 5 (very high/probable).

The impact of the risk is the potential impact on the carbon emissions from the Proposed Scheme. This has been estimated using expert judgement based on it’s the effect to the project. This has also been scored on a 5-scale point system ranging from 1 (very low impact/unlikely) to 5 (very high impact/probable)

These scores are multiplied by each other to determine total risk score, which ranges from 0-25. Risks categorised as ‘High’ are scored between 15-25, ‘Medium’ between 8-12, and ‘Low’ 1-6. Risks may impact the successful delivery of this Carbon Management Plan by influencing the ability for the Proposed Scheme to meet or exceed the Carbon Reduction Target. The carbon risks will therefore be updated alongside the project risks as the scheme progresses.

Risk Category / Area	Risk Description	Overall Project Risk Rating	Impact on Carbon	Likelihood	Carbon Risk Rating	Justification
Project Capital Cost	National Highways refuse consent to discharge project drainage into National Highways drainage system at Churncote	4	May cause the use of petrol interceptors on the NH framework.	13%	Low	Use of interceptors unlikely to significantly increase carbon.
Programme	Additional sensitivity testing: Traffic Modelling	2	Additional sensitivity testing would necessitate further carbon modelling, which may alter the carbon impact positively or negatively.	3%	Low	Low risk as additional sensitivity tests are more likely to include tests that more accurately represent future EV uptake, which will reduce carbon impact results.
Programme	Unknown buried services	4	May cause additional works to be required.	13%	Low	Unlikely to significantly increase carbon.

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