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Development of Guidance for Local Authorities on Climate Adaptation of Regional & Local Roads Project

Phase 4.3.1 – Carbon Tool Development (CTD) Pilot Project

Case Study: Application of the TII Carbon Tool to the 2024 Roads Programme at Offaly County Council

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Executive Summary

This report presents the findings from Offaly County Council’s participation in the *Carbon Development Tool Pilot Project*, part of the initiative to develop guidance for climate adaptation in regional and local roads. The pilot aims to assess the Transport Infrastructure Ireland (TII) Carbon Tool for its suitability in evaluating carbon emissions associated with road maintenance and improvement works by Local Authorities.

To evaluate the tool’s usability, functionality, performance, scalability, and overall fitness for purpose, Offaly County Council used its 2024 Restoration Improvement (RI) and Restoration Maintenance (RM) programme as a study model. This programme was delivered across Edenderry, Tullamore, and Birr Municipal Districts. RM works were largely executed using the Council’s own fleet, which operates on Hydrotreated Vegetable Oil (HVO), achieving approximately 90% carbon reduction¹ in fuel-related emissions.

The input data included detailed project specifications, material quantities, transport distances, and construction activities. Assumptions were made based on PAS 2080:2016 standards, focusing on Product Stages (A1–A3) and Construction Process

Stages (A4–A5). Emission factors were derived from a custom spreadsheet developed for this pilot.

The Carbon Tool enabled comparative analysis across six distinct road options, revealing insights into embodied carbon emissions by material type and construction method. Graphical outputs and pie charts illustrated emissions breakdowns, supporting data-driven decision-making in material selection and project planning.

Key findings indicate that the tool is user-friendly and effective when baseline data is well-organized. However, enhancements in data input granularity and industry-wide Environmental Product Declarations (EPDs) are needed to improve accuracy. The tool shows promise for annual benchmarking of carbon performance and supports climate action planning through quantifiable emissions data.

This pilot demonstrates the potential of the TII Carbon Tool to inform sustainable practices in road infrastructure delivery and highlights the importance of structured data management and integration of green public procurement resources for optimal implementation.

¹ SEAI

Acknowledgements

We acknowledge the innovation, work and commitment of Offaly County Council Roads & Transport Department during the pilot project.

We note the efforts of Mr. Barry Lennon, Senior Engineer and Mr. Thomas Fitzpatrick, Executive Engineer in applying the carbon measurement methodology to the 2024 Offaly County Council Roads Programme. Their experience is the basis for this case study.

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1 Introduction

This case study showcases work done on Carbon Tool Development Pilot Project initiated on foot of recommendations from Phase 3 of the Development of Guidance for Local Authorities on Climate Adaptation of Regional & Local Roads Project managed by the Atlantic Seaboard South Climate Action Regional Office (ASBS CARO).

A scoping report prepared for Phase 3 identified key technical concepts and methodologies, for future projects in carbon management.

Local Authority (LA) Roads Departments need the capability to measure, optimise and report on carbon emitted from road construction projects. The tools and knowledge to assess the carbon emitting potential of construction materials and methodologies and make informed decisions on appropriate low-carbon solutions in the maintenance and improvement of our roads is a key factor going forward.

Recommendations in the scoping report identified carbon projects including the development of a Life Cycle Assessment (LCA) tool or Carbon Measuring Tool for Local Authorities. The project entitled 'Carbon Tool Development' was commenced with the aim of:

'Developing a Life Cycle Assessment (LCA) Tool (or Carbon Emissions Measurement Tool) and user manual to assist the LA Roads Sector in quantifying and reducing carbon emissions while delivering their regional and local roads functions'.

Following an initial desktop study of carbon management, it was agreed that the Transport Infrastructure Ireland's (TII) Carbon Tool (the Tool) would be trialled in an LA road works context.

The pilot project entitled 'Carbon Tool Development Pilot Project' is a small-scale trial that tests the use of the Tool at Local Authority level to measure carbon emissions from the maintenance and improvement construction on Regional & Local Road assets.

Offaly County Council's (OCC) Roads and Transport Department participated in the project and applied the Tool to their 2024 Road Improvement and Maintenance Programme.

The work they completed assisted in the implementation of action T3.4.1 of OCC's Climate Action Plan 2024-2029 regarding the 'Adaptation and Implementation of a Carbon Calculator' to assist in increasing the resilience of road transport infrastructure.

This case study represents OCC's experience with the Tool and their recommendations to the LA sector.

2 Project Objectives

This project uses the ‘Tool’ as the carbon emission calculator. The Pilot Project objectives were defined as:

1. provide tools to assist the LA Sector to respond to the challenges of climate adaptation in the transport sector,
2. assess the knowledge and training required for LAs to embed carbon management in the daily duties of LAs.
3. enable the assessment of carbon impacts of road works completed annually across all LA jurisdictions
4. support decision making when considering low carbon construction techniques.
5. evaluate the functionality and user friendliness of the Tool from an LA perspective.

Additionally, OCC integrated their objectives into the pilot setting a requirement to capture baseline road emissions data to measure against in future years.

3 Methodology

OCC used the Tool to assess the 2024 Road Improvement (RI) and Road Maintenance (RM) schemes across the whole county i.e. in

the municipal districts of Edenderry, Tullamore, and Birr.

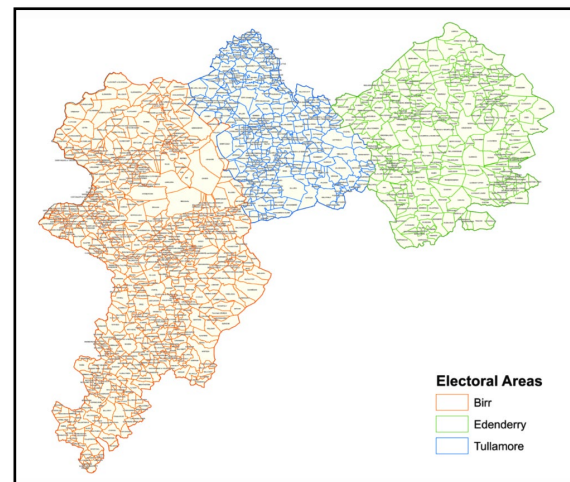


Figure 1 – OCC Municipal Districts

Input to the Tool requires data in the form of

- i. material tonnages e.g. stone chips and bitumen emulsion,
- ii. distances from manufacturing plant to site or depot,
- iii. distance to depot to site,
- iv. construction plant fuel usage or hours of plant operation, and
- v. workforce travel distances.

RI and RM projects are completed in the ‘Use’ or ‘Operations’ stage (B substages) in a road asset’s lifecycle. see Figure 2. Each intervention triggers the reapplication of a scaled-down ‘Product, Construction and End of Life Process’ (A & C substages) so its carbon is accounted for similarly the initial construction².

² Assuming initial construction assessed similarly

The RI/RM projects involve the installation of various materials using construction methods e.g. surface dressing ‘trains’ that install bitumen emulsion and stone chips in proportions defined in a design process. The bitumen emulsion and stone chips are the ‘products’ during the ‘construction process’.

Products are represented in substages A1 to A3 of the asset’s life cycle and the construction process is represented by substages A4 and A5.

The ‘Tool’ assists with calculating the embodied carbon emissions of construction work (sum of lifecycle stage emissions). This is done by multiplying the quantity of each product by a carbon factor³ in each of the life cycle stages being considered. (Eqn 1).

$$\text{Eqn 1... material quantity (kg) x carbon emissions factor (kgCO}_2\text{e/kg) = embodied carbon (kgCO}_2\text{e)}$$

The output unit is measured as a quantity of carbon dioxide equivalents (CO₂e).

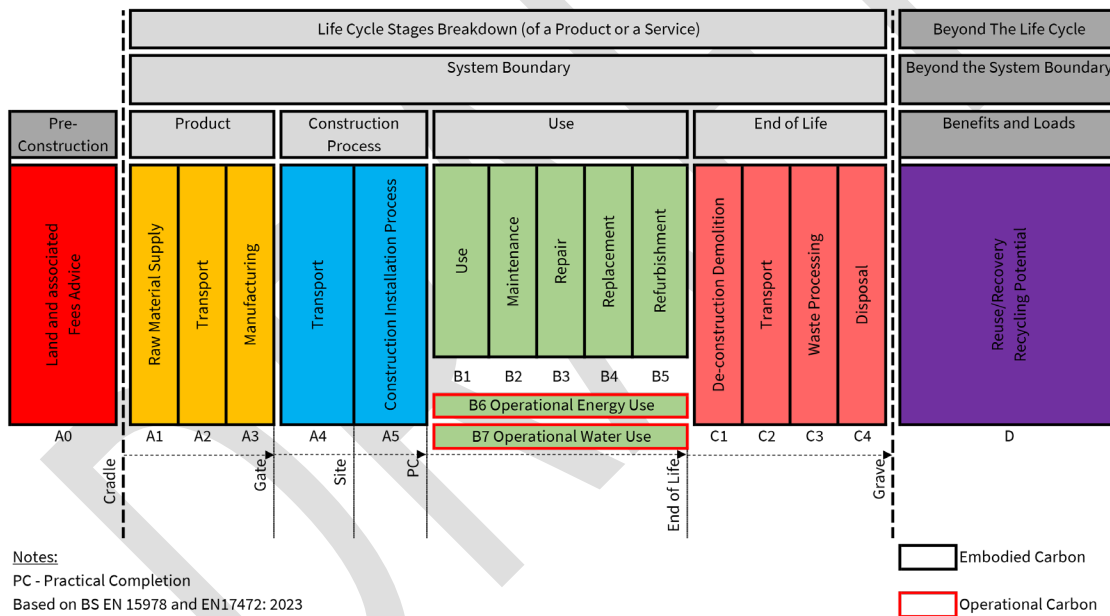


Figure 2 – Breakdown of Lifecycle Stages

OCC’s Municipal Districts Area teams were given the task of gathering the input data for the Tool. The RM programme is delivered by OCC’s internal resources and plant while the RI programme is delivered by external civil

engineering contractors procured for the task.

³ Carbon factors are based on published data until specific product or project based EPDs are more commonplace

Information from the Area teams included the following:

- i. Project Location for each scheme,
- ii. Description of the works,
- iii. Length & Width of each project,
- iv. Quantity and description of materials used for each project,
- v. Locations of Material Depots
- vi. Information on Plant, Machinery, Vehicles, Labour, Supervision and site travel distances during construction.,

Area teams use spreadsheets (Appendix A and C) as a tool to determine and record material quantities in the preparation of their final returns to the DoT. Therefore, much of the information requested is readily available and can be easily prepared for use as input in the Tool.

The Tool allows the creation of ‘Road Options’ so different construction solutions are assessed and compared in terms of carbon emissions.

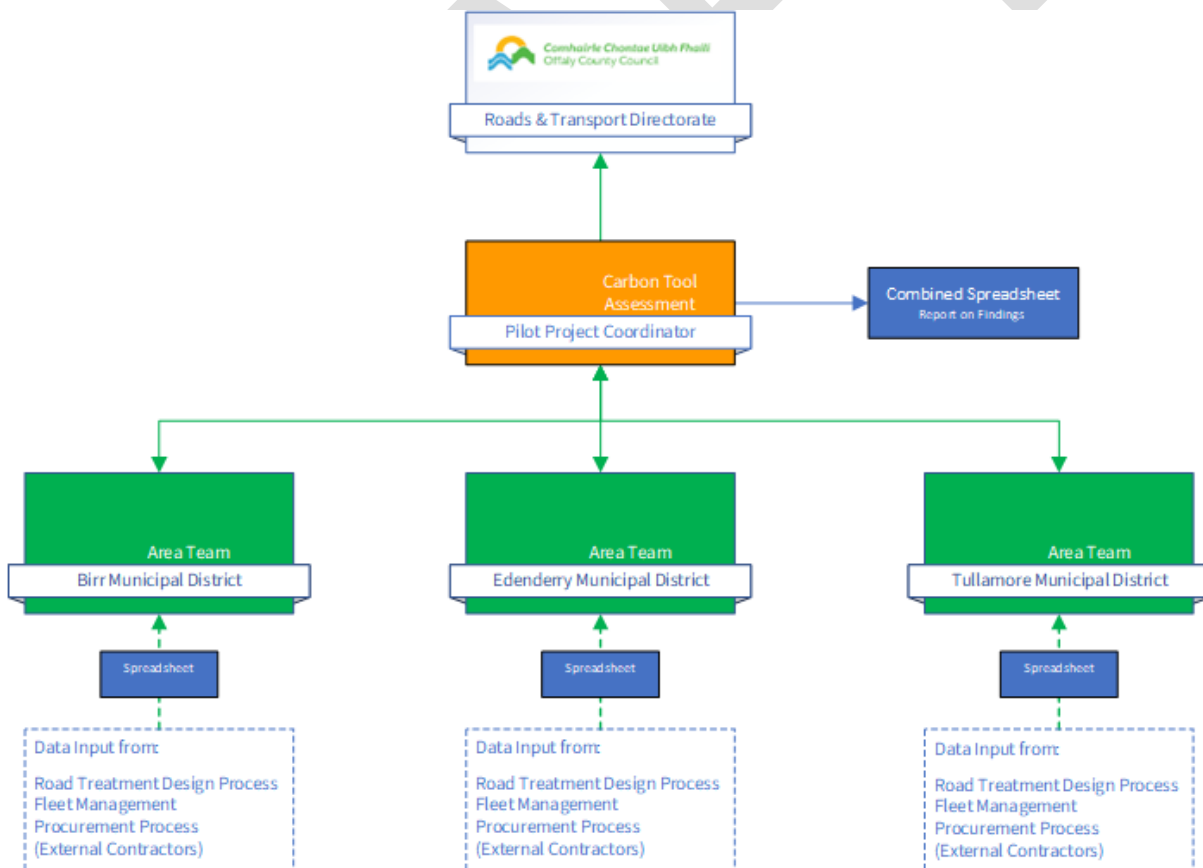


Figure 3 – Data Gathering Workflow

In the pilot, OCC used this function to create options for RI & RM information from each Municipal District Areas in a single Carbon Tool file.

The ‘Road Option’s created are as follows:

- Road Option 1: Edenderry MD Area RM/SD
- Road Option 2: Edenderry MD Area RI
- Road Option 3: Tullamore MD Area RM/SD
- Road Option 4: Tullamore MD Area RI
- Road Option 5: Birr MD Area RM/SD
- Road Option 6: Birr MD Area RI

The Tool includes a built-in database of carbon factors that align with the TII Specification for Road Works series. They are accessible using drop down options in input tables for each lifecycle stage.

The user must enter material quantities as required.

The accumulated mass of embodied carbon is automatically calculated once the data gathered is imputed in the Tool and the carbon factor for the material chosen.

Carbon emissions can be represented in tabular or in graphical formats and output including in terms of tonnes CO₂e/km of road or tonnes CO₂e/€ spent.

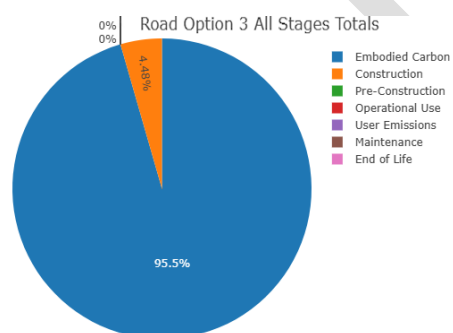


Figure 4 – Sample Output: Total Carbon, % by Life Cycle Stage

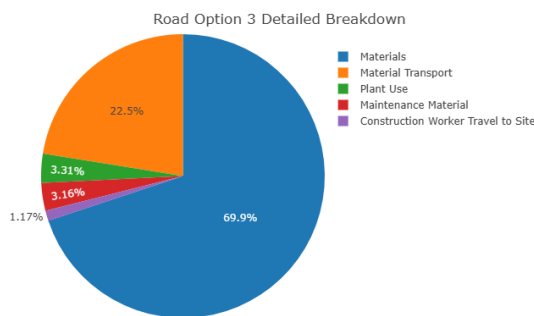


Figure 5 – Sample Output: Total Carbon, % by Process

See Appendix B for more examples of the outputs available from the Tool. Throughout the input process the opportunity to note carbon saving potential of considered construction interventions is available to the user. This feature is accessed throughout the ‘Road Options’ sub menus.

OCC has moved its entire fleet to Hydrotreated Vegetable Oil (HVO) as its primary fuel source. This reduces emissions by ~90% (considering upstream emissions and biogenic nature of HVO raw materials). The Tool’s carbon factor database catered for HVO fuel in calculations.



Photo 1 – OCC HVO fuelled vehicle

4 Key Findings

The key findings of Offaly County Councils pilot with the Tool are as follows:

1. Usability: simple interface and clear outputs (tables, graphs, pie charts).
2. Follows a recognised standard (PAS 2080: 2016)
3. Data sources: The data required for input is readily available from the following processes and systems:
 - Road Design
 - Procurement
 - Fleet Management

Standardising data within existing processes will assist in having the data available more readily.

4. Data Gathering: the sourced data requires pre-preparation prior to inputting to the Carbon Tool given the number of projects delivered across the roads programme. A construction methodology focused breakdown of inputs e.g., for a 'surface dressing train' would make the Tool more intuitive to LA users and reduce input time.
5. The Tool assisted in obtaining the following outputs of carbon emitted/m² for the following construction installations:

Solution	Carbon Emitted (kg CO ₂ e)
Surface Dressing ⁴	0.73
AC20 Dense Binder	76.31
Polymer Modified SMA (40mm)	7.59

Table 1 – Output from Carbon Tool

⁴ the average emissions from single, double and racked in surface dressing treatments with PMB emulsion

6. Alternative Fuels: OCC's HVO-fuelled fleet can be included in the calculation and compared to ordinary diesel fuel in terms of carbon savings.
7. Comparisons: the Tool facilitated benchmarking for Municipal Districts and the construction methods used.

5 Implications

1. OCC can determine carbon intensities of common road treatments going forward.
2. The exercise demonstrated that the carbon reduction value of low-carbon fuels and potential for RAP and warm-mix asphalt can be captured in future road programmes.
3. The exercise provided an evidence baseline to track annual carbon savings going forward.

6 Recommendations

Based on the work completed by OCC the following recommendations were made:

1. A standardised data gathering system is needed to reduce time and resources required for data preparation. A standardised template and guidance note relating to data input and assessment boundaries should be included in training materials.
2. A centralised reporting and record system for carbon emissions for annual RI/RM works should be established and maintained for future data evaluation

- Continue exploring low-carbon materials and using the Tool’s comparative function to test future construction scenarios.
- Environmental Product Declarations (EPD) relevant to products available in the Irish construction sector are required for accurate carbon emissions calculations. Green public

procurement practices should encourage the preparation of EPDs in tender processes.

- Table 2 gives the breakdown of carbon emissions for all OCC MD Road works completed in 2024. The data is extracted from the Carbon Tool for each of the ‘Road Options’ considered.

Name	Materials	Material Transport	Construction Water Use	Plant Use	Construction Worker Travel to Site	Maintenance Material	Total	Total Per Area
Edenderry MD Area RM/SD	57.69	16.55	0.000	3.85	1.23	0.84	80.16	
Edenderry MD Area RI	214.71	174.90	0.002	95.70	3.54	0.00	488.85	569.01
Tullamore MD Area RM/SD	47.77	15.36	0.000	2.89	0.80	2.16	68.97	
Tullamore MD Area RI	149.81	111.01	0.004	67.77	1.53	0.00	330.13	399.10
Birr MD Area RM/SD	114.48	41.04	0.000	9.87	3.15	6.45	174.99	
Birr MD Area RI	693.46	155.26	0.010	198.50	5.41	0.00	1052.63	1227.63
Total							2195.73	1002e

Table 2 – Total Embodied Carbon for OCC Municipal Districts

7 Conclusion

The OCC pilot project confirmed the TII Carbon Tool’s suitability for use by Local Authorities, enabling quantifiable measurement, benchmarking, and assisting with carbon reduction planning across road maintenance activities.

Carbon emissions values⁵ per material or work solution could be determined⁶ and applied to FORM A end of year returns as a simple multiplier in time.

To assist LAs in increasing the efficiencies of the carbon measurement, data gathering should be standardised, aligning it with the calculation process e.g. in a structured or tabular format like that of a bill of quantity document. Standardised data gathering should be integrated into LA green public procurement processes where possible.

Additionally, with the availability of verified product/manufacture EPDs, greater efficiencies and

data accuracy will be achieved in measuring carbon emissions in roadworks projects.

⁵ carbon emissions factors published with the Tool are taken from published data and not specific to Irish manufacturing conditions.

⁶ assuming a full geographical spread of results

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Appendix A - Extracts from Data Integrating Spreadsheet prepared by Offaly County Council

Tullamore Municipal District - Restoration Improvement 2024 Surface Dressing Works

							Embodied Carbon - Materials																				
							Raw Materials										Transport										
Code No.	Road No.	Description / Location of Works	Eircode / Google Pin	Length (m)	Width (m)	Area (m2)	Surface Dressing Type	Binder Type	Rate of Spread	Total	1st Chips Size	Conv. Factor	1st Chips	1st Chips	1st Chips	2nd Chips Size	Conv. Factor	2nd Chips	2nd Chips	2nd Chips	Dist. from Quarry to Chip Depo	Dist. from Binder Plant to Depo	Dist. From Chip Depo to Site	Dist. from Binder Depo to Site	No. of Trips - Chip	No. of Trips - Binder	Total Travel
									U/m2	Tonne	mm		U/m2	kg/m2	Tonne	mm		U/m2	kg/m2	Tonne	km	km	km	km			Km
B3013040	R436	R436 Grogan Ballycumber	https://maps.a	885	7.1	6283.5	Racked-In Surface Dressing	Pol 80%	2.04	13.21	6/10 (10mm)	1.5	10.50	15.75	98.97	2/6 (6mm)	1.5	3.00	4.50	28.28	89	113	10	10	12	2	1434.00
B4013210	L-6009	Cappincur	https://maps.a	1125	5.5	6187.5	Racked-In Surface Dressing	Pol 80%	2.46	15.69	10/14 (14mm)	1.45	10.50	15.23	94.20	6/10 (10mm)	1.6	3.00	4.80	29.70	89	113	5	6	12	2	1366.00
B3013041	R421	Rr421 Killananny	https://maps.a	3650	6.4	23360	Racked-In Surface Dressing	Pol 80%	2.10	50.57	10/14 (14mm)	1.45	10.50	15.23	355.66	2/6 (6mm)	1.6	3.00	4.80	112.13	89	113	5	5	43	5	4632.00
B4013209	L-6007	Gorteen	https://maps.a	2536	4.85	12299.6	Single Surface Dressing	Pol 80%	2.10	26.63	6/10 (10mm)	1.5	8.50	12.75	156.82	Select	Select	0.00	0.00	0.00	89	113	10	10	15	3	1854.00
B4013211	L-2007	Ballinamire, Rahan	https://maps.a	2165	5.2	11258	Single Surface Dressing	Pol 80%	2.10	24.37	6/10 (10mm)	1.5	8.50	12.75	143.54	Select	Select	0.00	0.00	0.00	89	113	13	11	14	3	1800.00
B4013212	L-2010	Ballincanty,	https://maps.a	1175	4.5	5287.5	Single Surface Dressing	Pol 80%	2.10	11.45	6/10 (10mm)	1.5	8.50	12.75	67.42	Select	Select	0.00	0.00	0.00	89	113	13	8	7	2	956.00
B4013213	L-6025	Gortacur, Mountbolus	https://maps.a	889	4	3556	Single Surface Dressing	Pol 80%	2.10	7.70	6/10 (10mm)	1.5	8.50	12.75	45.34	Select	Select	0.00	0.00	0.00	89	113	19	16	5	1	669.00
B4013214	L-2015	Erry, Clara	https://maps.a	1080	4.9	5292	Single Surface Dressing	Pol 80%	2.10	11.46	6/10 (10mm)	1.5	8.50	12.75	67.47	Select	Select	0.00	0.00	0.00	89	113	10	11	7	2	941.00

Figure A1 – Data Integration Spreadsheet for Tullamore SD Programme 2024 Part 1

Construction Activities Emissions

Construction Activities

Road Sweep	Fuel Type	Usage / hr	Time	Time	Bitumens Spraying	Fuel Type	Usage / hr	Time	Time	Phoenix Gritter	Fuel Type	Usage / hr	Time	Time	Lorries (chips)	Fuel Type	Usage / hr	Time	Time	Pneumatic Roller	Fuel Type	Usage / hr	Time	Time	Shuttle system	Fuel Type	Usage / hr	Time	Time
		l / hr	hrs	days			l / hr	hrs	days			l / hr	hrs	days			l / hr	hrs	days			l / hr	hrs	days			l / hr	hrs	days
	HVO	28.7	1	1		HVO	33.18	3	1		HVO	22.43	2	1		HVO	35.41	2	1		HVO	24.44	3	1		HVO	4.2	6	1
	HVO	28.7	1	1		HVO	33.18	3	1		HVO	22.43	2	1		HVO	35.41	2	1		HVO	24.44	3	1		HVO	4.2	6	1
	HVO	28.7	1	3		HVO	33.18	3	3		HVO	22.43	2	3		HVO	35.41	2	3		HVO	24.44	3	3		HVO	4.2	6	3
	HVO	28.7	1	2		HVO	33.18	3	2		HVO	22.43	2	2		HVO	35.41	2	2		HVO	24.44	3	2		HVO	4.2	6	2
	HVO	28.7	1	2		HVO	33.18	3	2		HVO	22.43	2	2		HVO	35.41	2	2		HVO	24.44	3	2		HVO	4.2	6	2
	HVO	28.7	1	1		HVO	33.18	3	1		HVO	22.43	2	1		HVO	35.41	2	1		HVO	24.44	3	1		HVO	4.2	6	1
	HVO	28.7	1	1		HVO	33.18	3	1		HVO	22.43	2	1		HVO	35.41	2	1		HVO	24.44	3	1		HVO	4.2	6	1
	HVO	28.7	1	1		HVO	33.18	3	1		HVO	22.43	2	1		HVO	35.41	2	1		HVO	24.44	3	1		HVO	4.2	6	1

Figure A2 – Data Integration Spreadsheet for Tullamore SD Programme 2024 Part 2

Construction Worker Travel

Pick-up Truck	Trip	No. Trips	Distance	Car	Trip	No. Trips	Distance	Pick-up Truck	Trip	No. Trips	Distance
	km		km		km		km		km		km
Labours * 2 Vehicles	14	4	56	GSS & Engineer	14	4	56	TTM Team * 2 Vehicles	30	4	120
Labours * 2 Vehicles	14	4	56	GSS & Engineer	14	4	56	TTM Team * 2 Vehicles	30	4	120
Labours * 2 Vehicles	14	12	168	GSS & Engineer	14	12	168	TTM Team * 2 Vehicles	30	12	360
Labours * 2 Vehicles	14	8	112	GSS & Engineer	14	8	112	TTM Team * 2 Vehicles	30	8	240
Labours * 2 Vehicles	14	8	112	GSS & Engineer	14	8	112	TTM Team * 2 Vehicles	30	8	240
Labours * 2 Vehicles	14	4	56	GSS & Engineer	14	4	56	TTM Team * 2 Vehicles	30	4	120
Labours * 2 Vehicles	14	4	56	GSS & Engineer	14	4	56	TTM Team * 2 Vehicles	30	4	120
Labours * 2 Vehicles	14	4	56	GSS & Engineer	14	4	56	TTM Team * 2 Vehicles	30	4	120

Figure A 3 – Data Integration Spreadsheet for Tullamore SD Programme 2024 Part 3

Tullamore Municipal District - 2024 RESTORATION IMPROVEMENT

							Embodied Carbon - Materials										
							Aggregate / Asphalt Raw Materials					Aggregate / Asphalt Transport					
Code No.	Road No.	Description / Location of Works	Eircode / Google Pin	Length (m)	Width (m)	Area (m2)	Treatment	Paver lay CI 804 Tonne	Recycling CI 804 Tonne	80mm AC32 Dense Base Tonne	60mm AC20 Dense Binder Tonne	40 mm PMSMA Tonne	Dist. from Quarry to Agg. Depo km	Dist. From Agg. Depo to Site km	Dist. from Asphalt Plant to Site km	No. of Trips - Agg	No. of Trips - Asphalt
	L-6014	Kilbride	pp.google.com/maps/place/622.3,+7.5000000000000006	622.3	7.50	4667	Recycling & Double Surface Dressing	366.00	840.11	0.00	0.00	0.00	107	11	114	34	0
	L-6014	Lissanisky	pp.google.com/maps/place/987.22,+4.0000000000000004	987.22	4.00	3949	Recycling & Double Surface Dressing	322.00	710.80	0.00	0.00	0.00	107	11	112	30	0
	L-2016	Ballina	pp.google.com/maps/place/1054.26,+5.1000000000000005	1054.26	5.10	5377	Recycling & Double Surface Dressing	579.00	967.81	0.00	0.00	0.00	107	10	117	53	0
	L-2009	Cartron Tara	pp.google.com/maps/place/953.94,+4.5000000000000004	953.94	4.50	4293	Recycling & Double Surface Dressing	500.00	772.69	0.00	0.00	0.00	107	6.5	108	46	0
	L-20131	Aharney Balkilmurray	pp.google.com/maps/place/550.01,+3.5000000000000003	550.01	3.50	1925	Recycling & Double Surface Dressing	242.00	346.51	0.00	0.00	0.00	107	5.5	113	22	0
	L-2007	Tullybeg	pp.google.com/maps/place/1250,+5.7000000000000006	1250	5.70	7125	AC20 & Double Surface Dressing	500.00	1,282.50	0.00	1,164.00	0.00	107	8	119	46	106
	L-30012	Rabbitburrow	pp.google.com/maps/place/1317.04,+5.0000000000000005	1317.04	5.00	6585	Recycling & Double Surface Dressing	616.00	1,185.34	0.00	0.00	0.00	107	12	123	56	0
	L-6011	Mountpleasant	pp.google.com/maps/place/1325.61,+4.0000000000000004	1325.61	4.00	5302	Recycling & Double Surface Dressing	328.00	954.44	0.00	0.00	0.00	107	13	128	30	0
	L-2004	Gorteen	pp.google.com/maps/place/922.03,+4.3000000000000004	922.03	4.30	3965	Recycling & Double Surface Dressing	560.00	713.65	0.00	0.00	0.00	107	13	123	51	0
	L-60112	Brocca	pp.google.com/maps/place/242.52,+3.5000000000000003	242.52	3.50	849	Recycling & Double Surface Dressing	112.00	152.79	0.00	0.00	0.00	107	7	122	11	0
	L-60112	Clonmore_canal	pp.google.com/maps/place/1179.39,+3.6500000000000004	1179.39	3.65	4305	Recycling & Double Surface Dressing	372.00	774.86	0.00	0.00	0.00	107	7	116	34	0
	L-20025	Cappancur GAA	pp.google.com/maps/place/436,+3.5000000000000004	436	3.50	1526	AC20 & Double Surface Dressing	194.00	274.68	0.00	144.00	0.00	107	5	115	18	14
	L-2025	Tullybeg	pp.google.com/maps/place/1009.41,+5.7000000000000006	1009.41		0	AC20 & Double Surface Dressing	450.00	0.00	0.00	1,164.00	0.00	107	8	119	41	106
	L-20113	Agall	pp.google.com/maps/place/287.84,+4.0000000000000004	287.84	4.00	1151	AC20 & Double Surface Dressing	104.00	207.24	0.00	276.00	0.00	107	8	119	10	26

Figure A 4 – Data Integration Spreadsheet for Tullamore RI Programme 2024 Part 1

Area	Chip Sizes	Binder Type	Rate of Spread 1	Rate of Spread 2	Total	1st Chips Size	Conv. Factor	1st Chips	1st Chips	1st Chips	2nd Chips Size	Conv. Factor	2nd Chips	2nd Chips	2nd Chips	3rd Chips Size	Conv. Factor	3rd Chips	3rd Chips	3rd Chips	Dist. from Quarry to Chip Depo	Dist. from Binder Plant to Depo	Dist. From Chip Depo to Site	Dist. from Binder Depo to Site	No. of Trips - Chip	No. of Trips - Binder	Total Travel
			l/m2	l/m2	Tonne	mm		l/m2	kg/m2	Tonne	mm		l/m2	kg/m2	Tonne	mm		l/m2	kg/m2	Tonne	km	km	km	km			Km
4667	6_10_6	Pol 80%	0.90	1.80	12.99	2/6 (6mm)	1.6	8.00	12.80	59.74	6/10 (10mm)	1.5	5.00	7.50	35.00	2/6 (6mm)	1.6	5.00	8.00	37.34	86	114	11	12	9	2	1125.00
3849	10_6	Pol 80%	0.90	1.80	10.99	6/10 (10mm)	1.5	8.00	12.00	47.39	2/6 (6mm)	Select	5.00	0.00	0.00	Select	Select		0.00	0.00	86	114	11	12	5	1	611.00
5377	10_6	Pol 80%	0.90	1.80	14.97	6/10 (10mm)	1.5	8.00	12.00	64.52	2/6 (6mm)	1.6	5.00	8.00	43.01	Select	Select		0.00	0.00	86	114	10	9	10	2	1206.00
4293	10_6	Pol 80%	0.90	1.80	11.95	6/10 (10mm)	1.5	10.50	15.75	67.61	2/6 (6mm)	1.6	5.00	8.00	34.34	Select	Select		0.00	0.00	86	114	6.5	7.5	10	2	1168.00
1925	10_6	Pol 80%	0.90	1.80	5.36	6/10 (10mm)	1.5	10.50	15.75	30.32	2/6 (6mm)	1.6	5.00	8.00	15.40	Select	Select		0.00	0.00	86	114	5.5	5	5	1	576.50
7125	10_6	Pol 80%	0.90	1.80	19.83	6/10 (10mm)	1.5	4.00	6.00	42.75	2/6 (6mm)	1.6	7.00	11.20	79.80	Select	Select		0.00	0.00	86	114	8	7	12	2	1370.00
6585	10_6	Pol 80%	0.90	1.80	18.33	6/10 (10mm)	1.5	10.50	15.75	103.72	2/6 (6mm)	1.6	5.00	8.00	52.68	Select	Select		0.00	0.00	86	114	12	11.5	15	2	1721.00
5302	10_6	Pol 80%	0.90	1.80	14.76	6/10 (10mm)	1.5	10.50	15.75	83.51	2/6 (6mm)	1.6	5.00	8.00	42.42	Select	Select		0.00	0.00	86	114	13	11	12	2	1438.00
3965	10_6	Pol 80%	0.90	1.80	11.04	6/10 (10mm)	1.5	10.50	15.75	62.44	2/6 (6mm)	1.6	5.00	8.00	31.72	Select	Select		0.00	0.00	86	114	13	11	9	2	1141.00
849	10_6	Pol 80%	0.90	1.80	2.36	6/10 (10mm)	1.5	10.50	15.75	13.37	2/6 (6mm)	1.6	5.00	8.00	6.79	Select	Select		0.00	0.00	86	114	7	7.5	2	1	307.50
4305	10_6	Pol 80%	0.90	1.80	11.98	6/10 (10mm)	1.5	10.50	15.75	67.80	2/6 (6mm)	1.6	5.00	8.00	34.44	Select	Select		0.00	0.00	86	114	7	7.5	10	2	1173.00
1526	10_6	Pol 80%	0.90	1.80	4.25	6/10 (10mm)	1.5	10.50	15.75	24.03	2/6 (6mm)	1.6	5.00	8.00	12.21	Select	Select		0.00	0.00	86	114	5	6	4	1	484.00
0	10_6	Pol 80%	0.90	1.80	0.00	6/10 (10mm)	1.5	4.00	6.00	0.00	2/6 (6mm)	1.6	7.00	11.20	0.00	Select	Select		0.00	0.00	86	114	8	7	0	0	0.00
1151	10_6	Pol 80%	0.90	1.80	3.20	6/10 (10mm)	1.5	4.00	6.00	6.91	2/6 (6mm)	1.6	7.00	11.20	12.90	Select	Select		0.00	0.00	86	114	8	7	2	1	309.00

Figure A 5 – Data Integration Spreadsheet for Tullamore RI Programme 2024 Part 2

Construction Activities Emissions

Construction Activities																													
Road Recycler	Fuel Type	Usage / hr	Time	Time	Grader	Fuel Type	Usage / hr	Time	Time	Paver	Fuel Type	Usage / hr	Time	Time	Steel Pneumatic Roller	Fuel Type	Usage / hr	Time	Time	Water Tanker	Fuel Type	Usage / hr	Time	Time	Lorries (chips)	Fuel Type	Usage / hr	Time	Time
		l/hr	hrs	day			l/hr	hrs	day			l/hr	hrs	day			l/hr	hrs	day			l/hr	hrs	day			l/hr	hrs	day
	Diesel	99.45	2.50	1.00		Diesel	22.64	3.50	1.00		Diesel	18.9	3.00	1.00		Diesel	24.58	3.00	1.00		Diesel	29.25	1	1.00		Diesel	35.41	3	1.00
	Diesel	99.45	2.50	2.00		Diesel	22.64	3.50	2.00		Diesel	18.9	3.00	2.00		Diesel	24.58	3.00	2.00		Diesel	29.25	1	2.00		Diesel	35.41	3	2.00
	Diesel	99.45	2.50	2.00		Diesel	22.64	3.50	2.00		Diesel	18.9	3.00	2.00		Diesel	24.58	3.00	2.00		Diesel	29.25	1	2.00		Diesel	35.41	3	2.00
	Diesel	99.45	2.50	2.00		Diesel	22.64	3.50	2.00		Diesel	18.9	3.00	2.00		Diesel	24.58	3.00	2.00		Diesel	29.25	1	2.00		Diesel	35.41	3	2.00
	Diesel	99.45	2.50	1.00		Diesel	22.64	3.50	1.00		Diesel	18.9	3.00	1.00		Diesel	24.58	3.00	1.00		Diesel	29.25	1	1.00		Diesel	35.41	3	1.00
	Diesel	99.45	2.50	2.00		Diesel	22.64	3.50	2.00		Diesel	18.9	3.00	2.00		Diesel	24.58	3.00	2.00		Diesel	29.25	1	2.00		Diesel	35.41	3	2.00
	Diesel	99.45	2.50	2.00		Diesel	22.64	3.50	2.00		Diesel	18.9	3.00	2.00		Diesel	24.58	3.00	2.00		Diesel	29.25	1	2.00		Diesel	35.41	3	2.00
	Diesel	99.45	2.50	2.00		Diesel	22.64	3.50	2.00		Diesel	18.9	3.00	2.00		Diesel	24.58	3.00	2.00		Diesel	29.25	1	2.00		Diesel	35.41	3	2.00
	Diesel	99.45	2.50	1.00		Diesel	22.64	3.50	1.00		Diesel	18.9	3.00	1.00		Diesel	24.58	3.00	1.00		Diesel	29.25	1	1.00		Diesel	35.41	3	1.00
	Diesel	99.45	2.50	2.00		Diesel	22.64	3.50	2.00		Diesel	18.9	3.00	2.00		Diesel	24.58	3.00	2.00		Diesel	29.25	1	2.00		Diesel	35.41	3	2.00
	Diesel	99.45	2.50	1.00		Diesel	22.64	3.50	1.00		Diesel	18.9	3.00	1.00		Diesel	24.58	3.00	1.00		Diesel	29.25	1	1.00		Diesel	35.41	3	1.00
	Diesel	99.45	2.50	2.00		Diesel	22.64	3.50	2.00		Diesel	18.9	3.00	2.00		Diesel	24.58	3.00	2.00		Diesel	29.25	1	2.00		Diesel	35.41	3	2.00
	Diesel	99.45	2.50	1.00		Diesel	22.64	3.50	1.00		Diesel	18.9	3.00	1.00		Diesel	24.58	3.00	1.00		Diesel	29.25	1	1.00		Diesel	35.41	3	1.00

Figure A 6 – Data Integration Spreadsheet for Tullamore RI Programme 2024 Part 3

Surfacing - Construction Activities

Road Sweep	Fuel Type	Usage / hr	Time	Time	Bitumen Spraying	Fuel Type	Usage / hr	Time	Time	Phoenix Gritter	Fuel Type	Usage / hr	Time	Time	Lorries (chips)	Fuel Type	Usage / hr	Time	Time	Pneumatic Roller	Fuel Type	Usage / hr	Time	Time	Shuttle system	Fuel Type	Usage / hr	Time	Time
		l/hr	hrs	day			l/hr	hrs	day			l/hr	hrs	day			l/hr	hrs	day			l/hr	hrs	day		l/hr	hrs	day	
	Diesel	28.7	1	1.00		Diesel	33.38	1	1.00		Diesel	22.56	2	1.00		Diesel	35.41	2	1.00		Diesel	24.58	3	1.00		Diesel	4.2	6	1.00
	Diesel	28.7	1	2.00		Diesel	33.38	1	2.00		Diesel	22.56	2	2.00		Diesel	35.41	2	2.00		Diesel	24.58	3	2.00		Diesel	4.2	6	2.00
	Diesel	28.7	1	2.00		Diesel	33.38	1	2.00		Diesel	22.56	2	2.00		Diesel	35.41	2	2.00		Diesel	24.58	3	2.00		Diesel	4.2	6	2.00
	Diesel	28.7	1	2.00		Diesel	33.38	1	2.00		Diesel	22.56	2	2.00		Diesel	35.41	2	2.00		Diesel	24.58	3	2.00		Diesel	4.2	6	2.00
	Diesel	28.7	1	1.00		Diesel	33.38	1	1.00		Diesel	22.56	2	1.00		Diesel	35.41	2	1.00		Diesel	24.58	3	1.00		Diesel	4.2	6	1.00
	Diesel	28.7	1	2.00		Diesel	33.38	1	2.00		Diesel	22.56	2	2.00		Diesel	35.41	2	2.00		Diesel	24.58	3	2.00		Diesel	4.2	6	2.00
	Diesel	28.7	1	2.00		Diesel	33.38	1	2.00		Diesel	22.56	2	2.00		Diesel	35.41	2	2.00		Diesel	24.58	3	2.00		Diesel	4.2	6	2.00
	Diesel	28.7	1	2.00		Diesel	33.38	1	2.00		Diesel	22.56	2	2.00		Diesel	35.41	2	2.00		Diesel	24.58	3	2.00		Diesel	4.2	6	2.00
	Diesel	28.7	1	2.00		Diesel	33.38	1	2.00		Diesel	22.56	2	2.00		Diesel	35.41	2	2.00		Diesel	24.58	3	2.00		Diesel	4.2	6	2.00
	Diesel	28.7	1	1.00		Diesel	33.38	1	1.00		Diesel	22.56	2	1.00		Diesel	35.41	2	1.00		Diesel	24.58	3	1.00		Diesel	4.2	6	1.00
	Diesel	28.7	1	2.00		Diesel	33.38	1	2.00		Diesel	22.56	2	2.00		Diesel	35.41	2	2.00		Diesel	24.58	3	2.00		Diesel	4.2	6	2.00
	Diesel	28.7	1	1.00		Diesel	33.38	1	1.00		Diesel	22.56	2	1.00		Diesel	35.41	2	1.00		Diesel	24.58	3	1.00		Diesel	4.2	6	1.00
	Diesel	28.7	1	2.00		Diesel	33.38	1	2.00		Diesel	22.56	2	2.00		Diesel	35.41	2	2.00		Diesel	24.58	3	2.00		Diesel	4.2	6	2.00
	Diesel	28.7	1	1.00		Diesel	33.38	1	1.00		Diesel	22.56	2	1.00		Diesel	35.41	2	1.00		Diesel	24.58	3	1.00		Diesel	4.2	6	1.00

Figure A 7 – Data Integration Spreadsheet for Tullamore RI Programme 2024 Part 4

Construction Worker Travel

Pick-up Truck	Trip	No. Trips	Distance	Car	Trip	No. Trips	Distance	Pick-up Truck	Trip	No. Trips	Distance
	km		km		km		km		km		km
Labours * 2 Vehicles	14	4	56	GSS & Engineer	14	4	56	TTM Team * 2 Vehicles	30	4	120
Labours * 2 Vehicles	14	8	112	GSS & Engineer	14	8	112	TTM Team * 2 Vehicles	30	8	240
Labours * 2 Vehicles	14	8	112	GSS & Engineer	14	8	112	TTM Team * 2 Vehicles	30	8	240
Labours * 2 Vehicles	14	8	112	GSS & Engineer	14	8	112	TTM Team * 2 Vehicles	30	8	240
Labours * 2 Vehicles	14	4	56	GSS & Engineer	14	4	56	TTM Team * 2 Vehicles	30	4	120
Labours * 2 Vehicles	14	8	112	GSS & Engineer	14	8	112	TTM Team * 2 Vehicles	30	8	240
Labours * 2 Vehicles	14	8	112	GSS & Engineer	14	8	112	TTM Team * 2 Vehicles	30	8	240
Labours * 2 Vehicles	14	8	112	GSS & Engineer	14	8	112	TTM Team * 2 Vehicles	30	8	240

Figure A 8 – Data Integration Spreadsheet for Tullamore RI Programme 2024 Part 4

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Appendix B – Examples of Outputs from TII Carbon Tool prepared by Offaly County Council

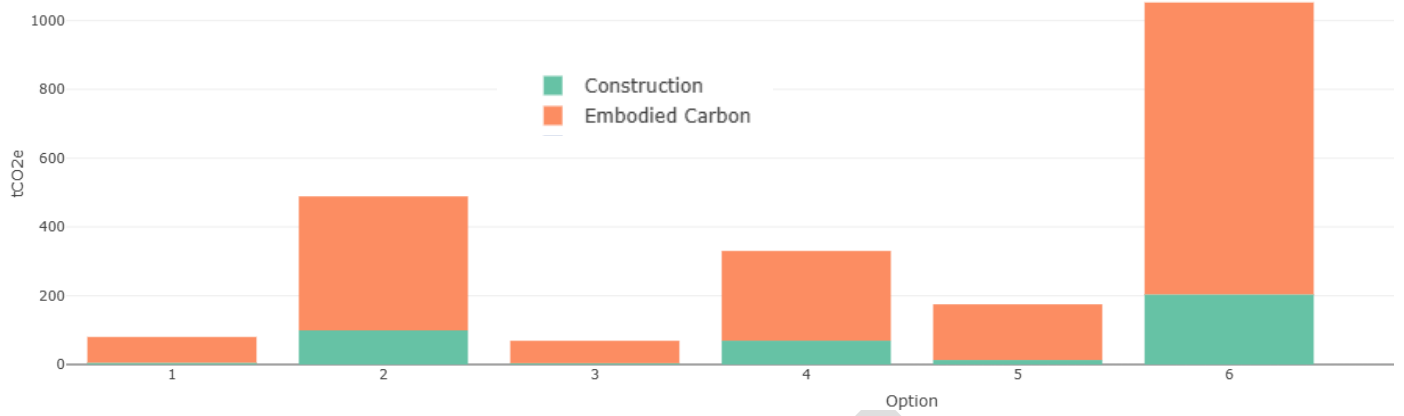


Figure B 1- Total Embodied Carbon Breakdown by Emission Source for each Road Option

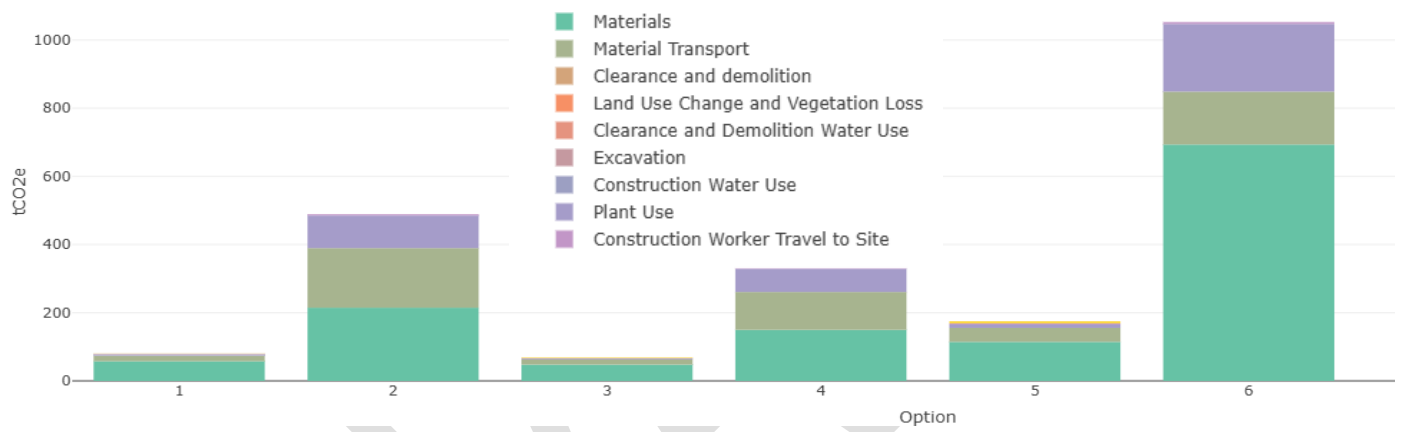


Figure B 2 - Total Embodied Carbon Breakdown for Series 800 and 900 for each Road Option

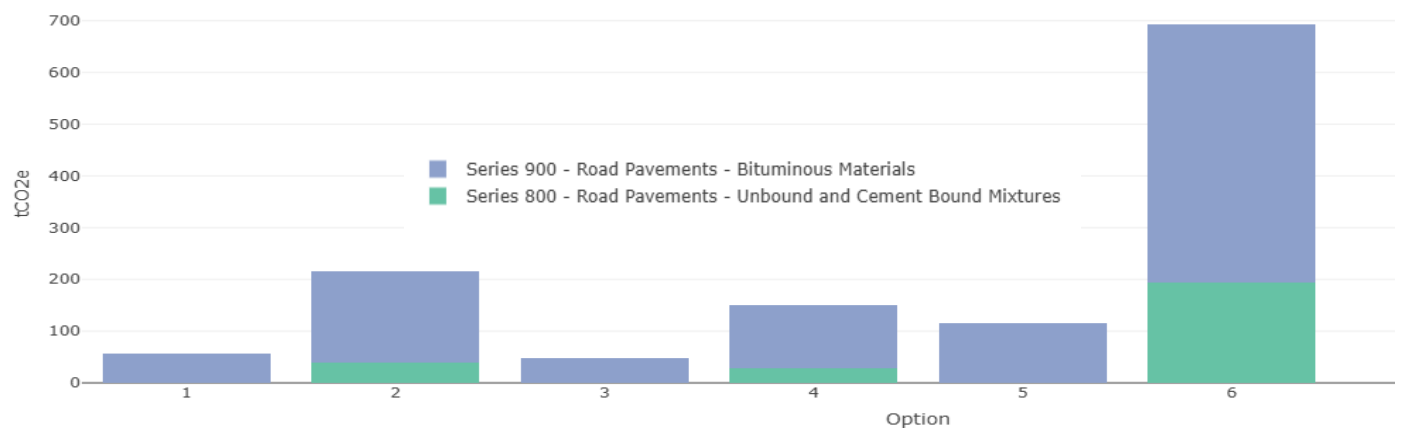


Figure B 3 - Total Embodied Carbon Breakdown for Series 800 and 900 Materials for each Road Option

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***Appendix C – Data Sources for inputs to Carbon Tool prepared by Offaly
County Council***

Item No.	Input Data	Source
Integrated Input Spreadsheet		
Embodied Carbon: Raw Material Quantities		
1	Paver laid Cl 804	Municipal District Area Team - Treatment Designs
2	Dry Recycling Cl 804	Municipal District Area Team - Treatment Designs
3	80mm AC32 Dense Base	Municipal District Area Team - Treatment Designs
4	60mm AC20 Dense Binder	Municipal District Area Team - Treatment Designs
5	40 mm PMSMA	Municipal District Area Team - Treatment Designs
Embodied Carbon: Material Transport (Travel Distances & Vehicle Type)		
6	Aggregate - Quarry	Municipal District Area Team
7	Asphalt Plant	Municipal District Area Team
8	Bitumen, Binder Plant	Municipal District Area Team
9	Local Authority, Chip Depot	Municipal District Area Team
10	Local Authority, Binder Depot	Municipal District Area Team
Construction: Construction Activities		
11	Plant Type	Municipal District Area Team
12	Operating Time	Municipal District Area Team
13	Vehicle Fuel Usage per hour	Generic Carbon Emission Values prepared by ASBS CARO
14	Bitumen Storage Tank Heater: KW/h	Generic Carbon Emission Values prepared by ASBS CARO
Construction: Construction Worker Travel to Site (Travel Distances & Vehicle Type)		
15	Travel Distances & Vehicle Type	Municipal District Area Team
TII Carbon Tool Input		
Embodied Carbon: Raw Material		
16	Single Surface Dressing	TII Carbon Tool Internal Database
17	Racked-in Surface Dressing	Generic Carbon Emission Values prepared by ASBS CARO
18	Aggregates - Type 1 depth 60-100mm	TII Carbon Tool Internal Database
19	60mm AC20 Dense Binder	Generic Carbon Emission Values prepared by ASBS CARO
20	Polymer Modified SMA 40mm	Generic Carbon Emission Values prepared by ASBS CARO
21	Double Surface Dressing	TII Carbon Tool Internal Database
Embodied Carbon: Material Transport (Vehicle Emission Factors)		
22	HGV - Articulated - Average	TII Carbon Tool Internal Database
Construction: Construction Activities		
23	Vehicle Fuel Usage per hour	Generic Carbon Emission Values prepared by ASBS CARO
24	Bitumen Storage Tank Heater: KW/h	Generic Carbon Emission Values prepared by ASBS CARO
Construction: Water Usage (RI Works Only)		
25	Water Use - UK Average	TII Carbon Tool Internal Database
Construction: Construction Worker Travel to Site (Vehicle Emission Factors)		
25	Van - Average	TII Carbon Tool Internal Database
26	Car - Average	TII Carbon Tool Internal Database

Figure C 1 - Input Data and Source Information used to inform the Carbon Tool input