Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Circular Economy in Roads Projects

Circular Economy in Roads Projects

What is circular economy?

TII aims to adopt a circular economy approach to standards, operations, and TII delivered and funded projects and programmes. The circular economy seeks to keep materials, components, and products in use for as long as possible. The TII approach to circular economy aims to:

- Reduce resource consumption;
- Keep assets, components, and materials at their highest value;
- Maintain safety and technical function of services, assets, and components;
- Promote restorative and regenerative design; and
- Reduce emissions.

What road asset types are in this guide?

- Pavement;
- Geometry;
- Earthworks;
- Structures;
- Drainage; and
- Other Assets.

How is circular economy applied to National Roads?

The 9Rs are a categorisation system proposed for circular economy by the European Commission and can be applied to national roads as shown below.

R1 Refuse	Ensure a clear need is demonstrated for National Road assets. Consider alternatives in detail and maximise use of existing infrastructure.
R2 Rethink	Intensify the use of existing asset e.g., by delivering infrastructure for multiple transport user groups including those in shared vehicles, and in particular buses.
R3 Reduce and Design for Deconstruction	Ensure design for disassembly, and maintenance, is central to development. Employ lean design during national road development.
R4 Re-use	Re-use assets, components, and materials within road development (e.g., re-use pavement materials such as asphalt).
R5 Repair	Continue to repair and maintain National Road assets and components as appropriate to prevent asset deterioration or degradation.
R6 Refurbish	Recover used road network assets and components as appropriate to current standards to extend their useful life.
R7 Remanufacture	Incorporate remanufactured materials and components (re-used and repaired with new parts) into National Roads development.
R8 Repurpose	Incorporate repurposed materials and components into National Roads development.
R9 Recycling	Incorporate recycled materials into National Roads development.

Note: Adapted from the European Commission Categorisation System for the Circular Economy, 2020.

Why do we need to implement circular economy for national roads?

Circular economy strategies for roads present practical means to support TII's contribution to the following national carbon and circular economy objectives.

Climate Action Plan (CAP) 2023

- Contribution to industry carbon emission reductions from 7 $MtCO_2eq$ (2018) to 4 $MtCO_2eq$ in 2030;
- Decrease embodied carbon in construction materials produced and used in Ireland by at least 30% by 2030; and
- Achieve a reduction in demand for construction materials: 20% less than a 'do nothing' scenario in 2025 and 30% less in 2030.

National Investment Framework for Transport in Ireland (NIFTI)

At project and programme level, through application of strategies, such as the 9Rs above, Circular economy supports application of the Intervention Hierarchy:

(1) Maintain;
(2) Optimise;
(3) Improve; and
(4) New.

The value of existing assets, components and materials is maximised and supplemented which keeps existing materials in circulation and minimises the embodied carbon that is associated with producing new materials and assets.

National Circular Economy Legislation and Strategy

The Circular Economy and Miscellaneous Provisions Act 2022 underpins Ireland's move towards a more sustainable pattern of production and consumption. It gives statutory footing to the Department of Environment, Climate and Communication's Whole of Government Circular Economy Strategy. Circular economy can also contribute to the preliminary sectoral actions included in the Whole of Government Circular Economy Strategy, which include the following:

Actions to increase resource efficiency and re-use in construction:

- Increased use of offsite design and manufacture;
- Modular building design;
- Refurbishment and retrofitting of existing stock;
- Tackling dereliction and bringing stock back into occupancy; and
- Increased use of Construction & Demolition Waste as a secondary construction material.

Actions to increase resource efficiency and re-use in transport

- Increased use of telecommuting, as well as of local and regional hubs.
- Prioritising resource efficient personal mobility, e.g., walking and cycling.
- Expanding public transport capacity and promoting shared mobility schemes.

How circular economy can help TII deliver on these objectives

- Reduce environmental impacts of assets and materials by applying life cycle thinking and assessment techniques in planning and decision making;
- Reduce environmental impact of construction by supporting selection and specification of low carbon materials;
- Reduce demand for construction materials by enabling re-use and life extension of existing assets, materials and components;
- Support early-stage planning to enable re-use of materials, particularly pavement, soils and ancillary components;
- Design for maximum value for communities in a systemic manner through increasing access to active mobility and reinvigorating local and regional hubs.

How can circular economy be implemented on national roads projects?

The adjacent diagram represents the circular life cycle of a road. It shows the flow of materials, components and resources through each life cycle stage. Retention of resources is an essential part of the circular economy. Re-use should take place at the highest possible value.

Maintain digital material logs

- Retain material data and sources in an easily accessible format for operation and maintenance;
- Maintain records of all changes in an asset management system; and
- Use and maintain standardised forms for gathering data on materials. Ensure data is made available to necessary stakeholders including as part of the as-built drawings and reports pack.

Upgrades and decommissioning

- Assess any upgrades to the asset against the same circular principles as during initial design and apply the same recommendations; and
- Ensure that where decommissioning is unavoidable the impact to the environment is minimised and reusability of decommissioned assets is maximised

Roads projects often have the space and capacity in terms of land and resources, to add natural capital and social value to projects. Actions can be taken on linear projects, subject to local needs and planning requirements, to integrate them with and enhance local ecosystems and communities.

Social value and habitat creation

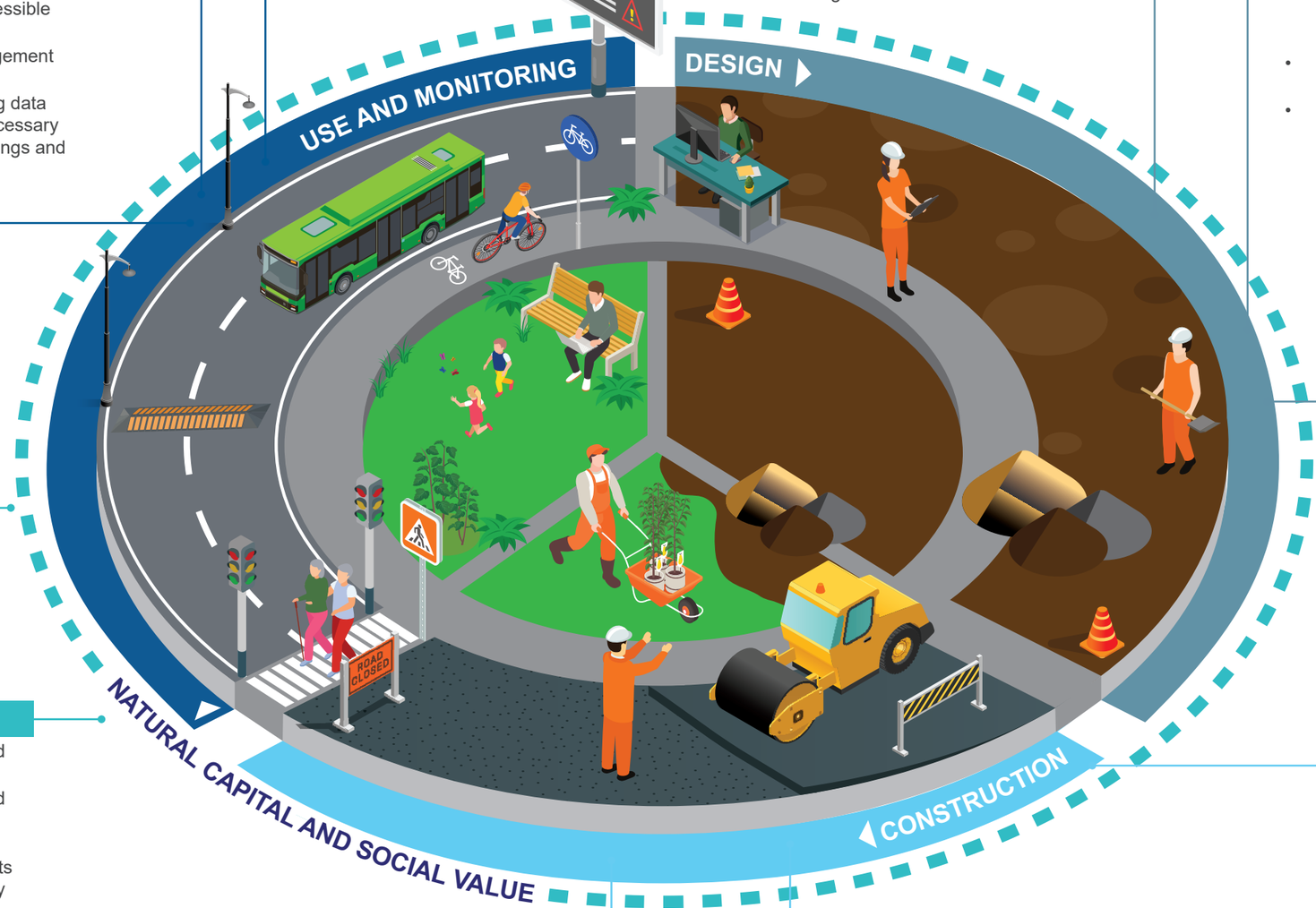
- Incorporate public transport hubs, active travel and connections to enable modal shift;
- Incorporate active travel, public transport hubs and connections to enable modal shift;
- Identify opportunities to increase the size and enhance the condition of core conservation habitats and create better connectivity between high quality core habitats;
- Identify and implement opportunities to create habitat, and manage habitats sensitively such as through “Low mow” regimes for maintenance of grassed areas;
- Consider native species planting and habitat connectivity (e.g. through the use of wildlife bridges and badger passes);
- Utilise landscaping to integrate soft features and mitigate visual impacts; and
- Adopt soft solutions where possible, such as integrated wetlands over traditional retention ponds.

Maintain for the life cycle

- Undertake preventative maintenance and inspection in accordance with circular principles; and
- Assess repairs and upgrades against circular principles.

Design for the life cycle

- Aim to refuse new construction and functional inefficiency by utilising existing assets and simulating multiple uses and future scenarios;
- Adopt design for disassembly concepts to maximise circularity;
- Consider adaptability for future technological advances (e.g., relating to publicly-accessible charging stations for electric vehicles); and
- Choose materials, elements and components considering durability for expected life, fit for intended use, maintenance and repair, standardisation, design methodology and considering use of local materials.



Collect data on materials

- Incorporate data on material sources, re-use and recyclability in the digital project environment to allow use of the information during and after operation and maintenance;
- Update digital material logs with as-built data during construction and handover; and
- Facilitate high quality construction execution and data collection to enable disassembly.

Low impact construction methodology

- Create a circular design strategy for the project in consultation with the contractor, construction and project management teams;
- Consider modular construction practices and precast methods for civil structures to increase potential for material re-use; and
- A register of materials in and out from the project should be created along the lifecycle of the asset.

Minimise material use by design

- Maximise recycled content of pavement, civil structures and drainage considering each material and component;
- Minimise use of non-sustainable, virgin, carbon intensive, non-renewable, polluting and scarce raw materials;
- Specify materials with longevity and predictable life and consider the accompanying test strategies;
- To minimise required earthworks, design site layout and alignment to use existing topography and features including natural slopes;
- Gather geotechnical ground investigation data at Option Selection Phase to understand the properties of materials associated with each option for potential sources and destinations of material;
- Apply performance-based methods such as the Irish Analytical Pavement Design Method (IAPDM); and
- Select material families, manufacturing processes and construction processes which deliver the highest circularity (e.g. Warm Mix Asphalts over Hot Mix Asphalts, Cold mixes over Hot or Warm mixes, cold recycling of pavements, and using recycled/ secondary aggregates in unbound applications where appropriate).

Plan for material re-use

- Identify and assess opportunities for re-use of earthworks, pavement and concrete materials and by products from the existing site;
- Identify and assess opportunities for re-use of earthworks, pavement and concrete materials and by products from the local area; and
- Create opportunities to use bio-based materials where appropriate.

Effective material management

- Embed circular economy requirements and decarbonisation objectives for materials in procurement; and
- Plan for storing of materials components and assets for re-use.

The table on the right describes key actions for navigating regulation around material re-use on road projects during planning and design stages. Scoping, Concept and Feasibility activities (Phases 0-1) and Construction/ Implementation stage activities (Phases 5-7) are also considered, however impactful actions for material re-use do not sit in these stages.

Implementing circular economy principles occasionally requires deviation from existing specifications or standard elements (e.g. drainage, lighting, fencing) as knowledge, skill, and a new suite of standards and construction processes emerge. It is important that project scoping, preliminary appraisal and feasibility studies promote innovation and circular economy thinking to achieve national carbon and circular economy objectives.

Updates are underway to TII specifications as part of TII Publications Specification for Road Works Series 600 - Earthworks and Series 900 - Road Pavements - Bituminous Materials.

Navigating circularity in regulations, standards and specifications

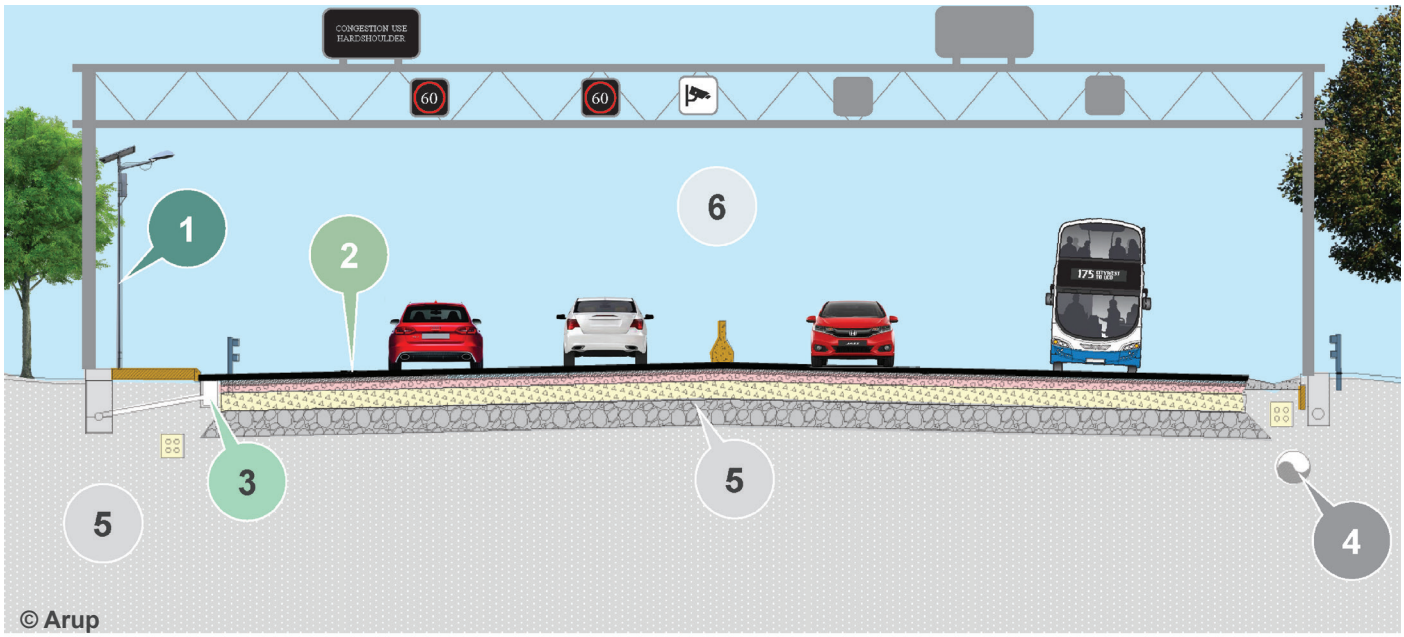
	Materials or Product Standards	Supply Chain Consideration	PMG Deliverables Documentation	Article 27 By Products & 28 End of Waste
Phase 2 Option Selection	• Identify material standards for re-use (e.g. TII Specification for Road Works Series 600 Earthworks, Series 800 Road Pavements - Unbound and Hydraulically Bound Mixtures); • Identify clause within standards which permit re-use of material and allowable % by weight of re-used materials. If re-used product is not permitted, consider if a departure application is required; and • Identify ground investigation test requirements for each option.	• Review the facility permits/ licences of the materials and products source sites; • Desk study on locations of relevant facilities for processing and/or storage near the options; and • Understand the market need for each expected re-used material.	• Estimate quantity of material required in tonnes for each option. Consider quantity of materials required during options assessment; and • Estimate storage required for each option and potential locations. Consider during options assessment.	• Identify market need for expected by products and end of use waste materials.
Phase 3 Design & Environmental Evaluations	• Undertake earthworks materials assessment as part of ground investigation; • Capture decisions and changes made and document circularity aspects in the Options Selection Report; • Undertake hazardous or scarce material testing or risk assessment; • Begin type testing to ensure re-used materials meet specifications; and • Undertake more detailed earthworks and pavement materials assessment as part of ground investigation.	• Understand expected costs for processing, storage and transport of products and materials; • Understand what technology is in place for processing of materials; and • Seek certification by Market Surveillance Authority if required.	• Detail quantity of material required in tonnes for the development; • Detail storage required for the design (i.e., volume, location etc.); • Size and identify storage site locations for materials or components. Ensure it is identified in the planning consent application documentation; and • Set destination site locations and detail in the planning consent application documentation.	• Identify if risk assessments are required for each material; • Identify if there is a precedent where similar Article 27 By Products has been determined; • Identify if Article 28 End of Waste rules for the product or material are in place; and • Identify if further processing is required and if a permit/licence is required.
Phase 4 Statutory Processes	• Refer to material and product standards within the planning application.		• For re-used and recycled content, note source site location in the planning application & ensure it has required consents; • Apply for, or ensure necessary storage sites have, permits/ licence.	• Ensure that regulatory processes around material re-use are aligned with planning documentation and include details in planning consent documentation.

Note: sequence of actions can vary between projects and is linked to contract form and risk allocation.

Layers-based Approach for Circular Economy in Road Assets

As road assets, materials and components are complex, a layers-based approach is taken to help identify the most impactful design interventions for circular economy. The layers-based approach is a design tool to help apply the 9Rs thinking to roads. Different circular strategies can be applied for long and short life assets Road assets are a part of a wider road network system which in turn is part of a larger system (i.e., transport, economic, city systems). See below layers-based approach and considerations:

Figure 1 Layers-based approach for road assets



1 The items next to or around the carriageway, and how the carriageway is laid out, e.g. road markings, gantries and guardrails.

5-25 years

2 The wearing course, median barriers and any verge material packed on top of the lower layers (typically fill).

10-50 years

3 Shallow services are those services closer to the surface which are maintained more often such as internal drainage, ducting and cables

10-25 years

4 Deep services are those services that are typically maintained or replaced less often, and often have their own access system through the layers, e.g. sewers and external drainage

10-50 years

5 The formation of the road - a combination of earthworks and structures.

50-200 years

6 Site is the fixed location of the road and the geographical setting.

Outlasting All

System is the wider network the road is part of, e.g. a transport, economic or city network.

How will you make circular economy a reality on your project?

Circular economy outcomes and the resulting sustainability and project delivery benefits can be achieved through technical and commercial understanding.