Environmental product declaration

in accordance with ISO 14025:2006 and EN15804:2012+A2:2019/AC:2021

Pre-stressed concrete sleeper RN-150-18

Programme: The International EPD® System **www.environdec.com**
Programme operator: EPD International AB
Regional Programme: EPD Australasia **www.epd-australasia.com**
EPD Registration no. EPD-IES-0025162:001
Date of issue 2025-09-30 | Validity date 2030-09-30

EPD of a single product from a manufacturer (from one location)

An EPD may be updated or depublished if conditions change.

To find the latest version of the EPD and to confirm its validity, see www.environdec.com

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Disclaimer

EPDs within the same product category but published in different EPD programmes, may not be comparable. For two EPDs to be comparable, they shall be based on the same PCR (including the same first-digit version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have identical scope in terms of included life-cycle stages (unless the excluded life-cycle stage is demonstrated to be insignificant); apply identical impact assessment methods (including the same version of characterisation factors); and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

General information

An Environmental Product Declaration (EPD) is a standardised way of quantifying the potential environmental impacts of a product or system. EPDs are produced according to a consistent set of rules – Product Category Rules (PCR) – that define the requirements within a given product category. These rules are a key part of ISO 14025 as they enable transparency and comparability between EPDs. This EPD provides environmental indicators for Vossloh's RN-150-18 concrete sleepers produced in Rockhampton, Queensland. This EPD is a "cradle-to-gate with modules C1-C4, D" declaration covering cradle-to-gate production of the products, plus their end-of-life. This EPD is verified to be compliant with EN 15804+A2. EPDs of construction products may not be comparable if they do not comply with EN15804. EPDs within the same product category but from different programs or utilising different standards or PCRs may not be comparable. Vossloh Sleeper Technologies Australia Pty Ltd is part of the Vossloh Group (Vossloh). Vossloh, as the EPD owner, has the sole ownership, liability, and responsibility for the EPD.

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EPD registration number:	EPD-IES-0025162:001		
Published:	2025-09-30	**Valid until:**	2030-09-30 (5 years)
Reference year for data:	2021-01-01 – 2021-12-31 (manufacturing process data) Note: product designs and compositions are representative for 2025		

Product Category Rules	**CEN standard EN 15804 served as the core Product Category Rules (PCR)**
PCR:	PCR 2019:14 Construction Products, Version 2.0.1, 2025-06-05, valid until 2030-04-07
PCR review was conducted by:	The Technical Committee of the International EPD® System. See www.environdec.com for a list of members. Review chair: Rob Rouwette | start2see (chair), Noa Meron | thinkstep-anz (co-chair) The review panel may be contacted via the Secretariat: www.environdec.com/contact.
c-PCR:	c-PCR-003 (to 2019:14) Concrete and concrete elements, version 2025-04-08

Third-party verification:	Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: ☒ Individual EPD verification without a pre-verified LCA/EPD tool
Third party verifier: Approved by EPD Australasia Ltd	Andrew D. Moore, Life Cycle Logic www.lifecyclelogic.com.au andrew@lifecyclelogic.com.au +61 4 2432 0057 Life Cycle Logic
Procedure for follow-up of data during EPD validity involves third-party verifier:	☐ Yes ☒ No

Information about the EPD owner

Vossloh Sleeper Technologies Australia (VSTA) has become a world leader in the design and manufacture of precast concrete sleepers, and the largest concrete sleeper manufacturer in Australia. Since 2018 VSTA has been wholly owned by the Vossloh Group whose core business is rail infrastructure.

Vossloh Sleeper Technologies Australia is focused on offering the best in sleeper design and manufacture while providing clients in Australia a channel to the Vossloh Group suite of rail solutions. At our core we are railway people.

"Throughout the world Vossloh offer integrated rail solutions from a single source; significantly contributing to the safe, reliable and sustainable movement of people and commodities around the world"

This EPD covers RN-150-18 sleepers that Vossloh supplies from Rockhampton in Australia.

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Product information

Prestressed concrete sleepers are installed in rail networks on a bed of ballast and function is to evenly transfer load from rolling stock to the ballast and hold the rail at the correct gauge. Concrete sleepers are comprised of steel wire, Portland Cement, supplementary cementitious materials, sand and aggregates along with chemical admixtures to aid production.

This EPD covers a prestressed, Narrow Gauge, 'Timber-Replacement Sleeper' (TRS) sleeper design manufactured by Vossloh in Rockhampton, QLD.

Product code: RN-150-18

The Narrow Gauge TRS is designed as a direct replacement for timber railway sleepers on ballasted, broad-gauge track and has a reduced height profile compared to standard monoblock concrete sleepers.

Figure 1. RN-150-18 Concrete sleeper – fastenings and shoulders not shown

Fastening attachment components comprised of steel or plastic are used to secure steel rail to the sleeper body and are typically cast into the concrete during production. However, each monoblock sleeper design can be customised with a range of fastening designs options depending on the rail network design requirements. The environmental footprints of specific fastening configurations have been omitted from this EPD and should be evaluated separately to the concrete sleeper body.

Physical Properties

Technical data	RN-150-18	Units
Length	2 150	mm
Width	210	mm
Height (At Rail Seat Centre)	150	mm
Nominal Weight per sleeper*	149	kg
Track Gauge**	1 067	mm
Design Life	50	years
Fastening System	client-specified***	

Table 1: Physical properties of RN-150-18 sleepers

** Excludes fastening system.*

*** Narrow Gauge track width.*

**** A range of fastening options are available, including e-Clip, FastClip and Vossloh fastening systems*

Product codes

The product code for sleepers is **UN CPC 37550** (Prefabricated structural components for building or civil engineering, of cement, concrete or artificial stone) and **ANZSIC 20340** (Railway sleepers manufacturing – concrete).

Technical compliance

Vossloh sleeper products comply with relevant technical specifications such as AS1085.14:2019 (Railway Track Material, Part 14: Prestressed concrete sleepers).

Geographical scope

The processes in modules A1-A3 have been modelled to represent concrete sleeper production in Rockhampton, Queensland, Australia. The raw materials are mostly sourced from within Australia, with only reinforcement steel being predominantly sourced from overseas. The products are sold on the Australian market, and therefore the end-of-life (module C) of the product has been modelled to represent Australia as well (based on the default scenario).

Content declaration

The product composition is presented in Table 2. For reasons of confidentiality, a range is provided.

Product Components	Mass, kg	Post-consumer recycled material (weight-% of product)	Biogenic material, (weight-% of product)	Biogenic material, kg C/product or declared unit
Cement	19 to 24	0%	0%	0
Fly ash	4 to 9	0%	0%	0
Coarse aggregates	58 to 63	0%	0%	0
Natural sand	43 to 51	0%	0%	0
Admixtures*	0 to 1	0%	0%	0
Water	7 to 10	0%	0%	0
Reinforcement steel wire**	3 to 7	0%	0%	0
Total	**150**	**0%**	**0%**	**0**

Table 2: Product Composition, concrete sleepers per Declared Unit (1 unit of precast concrete sleeper)

** Although admixtures (set accelerator, water reducer) are below the mass cut-off, they have been considered in this LCA.*

*** Reinforcement steel wire contains recycled content, but our suppliers do not necessarily report the overall share of recycled content, and whether this is pre-consumer or post-consumer recycled content. The PCR requires declaration of zero percent if unknown.*

Timber gluts are used beneath concrete sleepers during storage and transport to keep them off the ground, preventing damage from impact or moisture, and to allow space for forklifts or lifting equipment to handle the sleepers safely and efficiently. The quantity per sleeper is shown in Table 3.

Packaging materials	Mass, kg	Mass -% (versus the product)	Biogenic material, kg C/product or declared unit
Timber gluts	1.69	1.13%	0.76

Table 3: Packaging Composition, per Declared Unit (1 unit of precast concrete sleeper)

In this LCA, fly ash is considered a secondary material. The sleepers do not contain any biogenic carbon. The biogenic carbon present in the timber gluts is balanced in module A1-A3.

The product included in this EPD does not contain any substances of very high concern as defined by European REACH regulation* in concentrations >0.1% (m/m) (ECHA 2025). Dust from this product is classified as Hazardous according to the Approved Criteria for Classifying Hazardous Substances 3rd Edition (NOHSC 2004). Concrete products are classified as non-dangerous goods according to the Australian Code for the Transport of Dangerous Goods by Road and Rail. When concrete products are cut, sawn, abraded or crushed, dust is created which contains crystalline silica, some of which may be respirable (particles small enough to go into the deep parts of the lung when breathed in), and which is hazardous. Exposure through inhalation should be avoided.

** Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals.*

LCA information

Declared unit

The declared unit is “1 unit of precast reinforced concrete sleeper”.

The declared unit covers a sleeper of specific dimensions (see the Product information section). The mass of RN-150-18 sleepers is 150 kg per unit.

The sleepers can be set up with various types of clips and shoulders (i.e. “jewellery”). This EPD covers a concrete sleeper without clips and shoulders. For the environmental impact of jewellery, please check with the manufacturer of these materials.

Scope of the Environmental Product Declaration

This EPD covers the cradle-to-gate with modules C1–C4 and module D (modules A1-A3, C1-C4, D).

Construction and use stages have not been included as we cannot define a typical scenario for our range of Concrete sleepers. These impacts are best determined at project level.

The modules declared, geographical scope, share of specific data (in GWP-GHG indicator) and data variation are shown in Table 4.

Stages	Product Stage			Construction Stage		Use Stage							End-of-life Stage				Benefits beyond system boundary
	Raw Materials	Transport	Production	Transport	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/Demolition	Transport	Waste Processing	Disposal	Reuse, recovery, recycling potential
Modules	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
				Scenario		Scenario							Scenario				Scenario
Modules Declared	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	AU, CN	AU, GLO	AU										AU	AU	AU	AU	AU
Share of primary data	48%																
Variation products	0% (n/a)																
Variation sites	0% (n/a)																

Table 4: Scope of the EPD

X = module is included in this study
ND = module is not declared. When a module is not accounted for, the stage is marked with “ND” (Not Declared)
ND is used when we cannot define a typical scenario

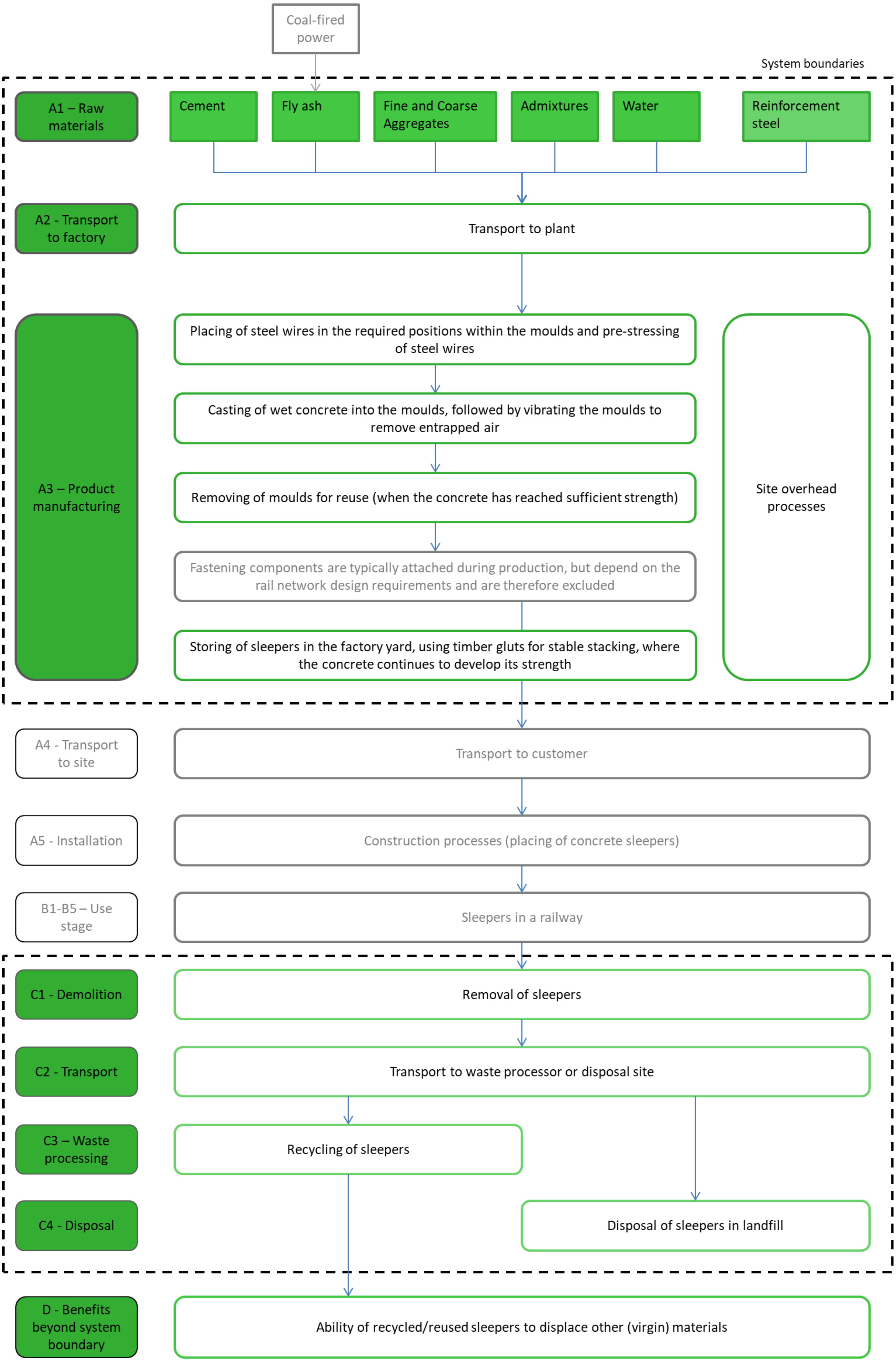

Figure 2: System Boundary Diagram of Sleeper Products

Description of Life cycle stages

Raw Material Supply (A1)

Extraction and processing of raw materials results in environmental impacts from the use of energy and resources, as well as from process emissions and waste. The two main inputs used to produce reinforced concrete sleepers are concrete and steel reinforcement wire (refer to Table 2 for specific product components). Concrete is a mixture of cementitious binders (cement and fly ash), coarse and fine aggregates (crushed rock and sand), water and admixtures. Cement is produced from limestone and gypsum, aggregates and natural sand are extracted from quarries, fly ash is a rest product from electricity generation, and admixtures are specialised chemical formulations that are typically produced by blending selected ingredients. These materials are manufactured by Vossloh's suppliers.

Transport (A2)

Most materials and components used to produce concrete sleepers are sourced from suppliers in Australia. Reinforcement steel is mainly sourced from China. Local transport (by truck) from Australian supplier to Vossloh is included. For overseas suppliers, transport (by truck) from overseas suppliers to a local port, shipping from overseas ports to Australia and transport (by truck) from Australian ports to site. Transport of raw materials has been included in the LCA based upon actual transport modes and distances relevant to the site, where available.

Manufacturing (A3)

Vossloh sleepers are manufactured in dedicated precast concrete factories.

The process starts with placing steel wires in the required positions within the moulds. The wires are anchored at one end and then pulled from the other end using hydraulic jacks. This process prestresses the steel wires, which results in a stronger product (or material savings) compared to non-prestressed reinforced concrete.

Wet concrete is cast into the moulds and vibrated to remove entrapped air from the concrete and thereby achieve the required quality (density and strength). When the concrete has reached sufficient strength, the moulds are removed (and used again). Fastening systems can now be mounted onto the sleepers. Finally, the sleepers are stored in the factory yard, using timber gluts for stable stacking, where the concrete continues to develop its strength.

The **"Construction process stage (A4-A5)"** and **"Use stage (B1-B7)"** have been excluded from the life cycle assessment, as the ready-mix concrete can be used for a range of different applications for which the use scenarios are unknown. The impacts of these stages are best determined at project level.

End of Life (C1-C4)

The end-of-life modules for reinforced concrete sleepers are based on generic scenarios. The scenarios included are currently in use and are representative for one of the most probable alternatives.

Module C1 covers demolition of reinforced concrete sleepers at the end of their service life. We have used the end-of-life scenario representative for Australian building & demolition materials based on the National Waste Report 2022 (NWR 2022). This scenario implies that 80% of the reinforced concrete is recycled and the remaining 20% of the reinforced concrete is sent to landfill. Additional (module C3, C4 and D) results for alternative scenarios representing 100% recycling and 100% landfill are declared in Table 15 and Table 16.

Module C2 comprises the transport from the demolition site to a recycling centre or landfill site (80km). Module C3 encompasses the recycling process (i.e. crushing of reinforced concrete; separating steel and concrete), while Module C4 represents disposal of reinforced concrete in a landfill site. The concrete and steel in module C3 reach end-of-waste status when sleepers have been crushed and concrete is stockpiled as "recycled crushed concrete" (RCC) aggregates, while steel is stockpiled or collected in a bin.

We have used the default values from Table 4 in PCR 2019:14 to model the end-of-life impacts for sleepers, based on the product mass defined in Table 1 of this EPD.

Due to high uncertainty in the parameters and lack of data, CO_2-uptake (carbonation) has not been included at end-of-life.

Loads and Benefits Beyond the System Boundaries (D)

Module D sits outside the system boundaries and includes any benefits and loads from net flows leaving the product system (that have passed the end-of-waste state). For this EPD, any material collected for recycling and processed in Module C3, is considered to go through to Module D. We have assumed that Recycled Crushed Concrete aggregates (the output of module C3) replace virgin aggregates (crushed rocks) in module D. Similarly, steel scrap separated from concrete in module C3 is assumed to replace virgin steel in module D.

Per sleeper type RN-150-18, module D credits the avoided impacts for 120 kg of crushed aggregates and 3.85kg of virgin steel.The net flow calculation is not affected by fly ash.

Processes	Quantity per sleeper	Unit
Collection process specified by type	150 0	kg collected separately kg collected with mixed construction waste
Transport from demolition site to recovery / disposal sites	80	km transport
Recovery system specified by type	0 120 0	kg for re-use kg for recycling kg for energy recovery
Disposal to landfill	30	kg product or material for final deposition
Assumptions for scenario development	The default values from PCR 2019:14 (v2.0.1) table 4 have been used to model modules C1, C2, C3 and C4	

Table 5: End-of-life scenario parameters

Module and processes	Quantity	Energy carrier / transport means
C1: Demolition/deconstruction of concrete/reinforced concrete	10 kWh/t	Diesel
C2: Transport (for products/materials not to be incinerated)	80 km	16-32 tonne lorry (EURO 5)
C3: Loading and unloading at sorting facility C3: Mechanical sorting C3: Crushing of concrete	1.8 kWh/t 2.2 kWh/t 2.0 kWh/t	Diesel electricity diesel
C4: Compacting of inert construction waste for landfills (including backfilling)	1.6 kWh/t	Diesel

Table 6: Default data for modelling modules C1, C2, C3 and C4

Background Data

Vossloh has supplied primary data from their production facility in Rockhampton, covering the 2021 calendar year. Data pertaining to the product design and composition are representative for the current (2025) period.

Data for cement has been sourced from our supplier's EPD (confidential). The GCCA-tool that underpins the cement data does not deliver sufficient information for the indicators HWD, NHWD and RWD as defined in EN 15804+A2, but only refer to the foreground system. This results in underreporting of these indicators. Data for admixtures has been sourced from EPDs published by EFCA (EFCA 2021a, 2021b). EPDs based on an old EF version (EF 3.0) have been used as a data source, and it was assessed to yield identical or conservative results compared to using the EF3.1. Data for steel are mostly from ecoinvent v3.10 (Steel, low-alloyed {RoW}| steel production, converter, low-alloyed | Cut-off, U).

Background data (e.g. for energy and transport processes, and materials/component for which we don't have supplier specific data) have predominantly been sourced from AusLCI and the AusLCI shadow database (v1.42) and ecoinvent (v3.10 cut-off). As a result, the vast majority of the environmental profile of our products is based on life cycle data less than five years old. Background data used is less than 10 years old.

Methodological choices have been applied in line with EN 15804:2012+A2:2019; deviations have been recorded.

Data quality assessment

Process	Source type	Source	Reference year	Data category	Share of primary data (GWP-GHG; A1-A3)
Manufacturing of sleepers	Collected data	EPD owner	2021	Primary data	0-2%
Generation of electricity used in manufacturing of sleepers	Database	AusLCI v1.42	2023	Primary data	2-7%
Transport of raw materials to manufacturing site	Database	EPD owner	2024	Primary data	2-10%
Production of steel reinforcement wire	Database	ecoinvent v3.10	2023	Secondary data	0%
Production of cement	EPD	Supplier EPD	2023	Primary data, Secondary data	43-65%
Production of coarse aggregates and natural sand	Database	AusLCI v1.42	2023	Secondary data	0%
Production of admixtures	EPD	EFCA EPDs	2021	Proxy data	0%
Other	Database	AusLCI v1.42	2023	Secondary data	0%
Total share of primary data, of GWP-GHG results for A1-A3*					**48%**

Table 7: Data quality assessment

** The share of primary data is calculated based on GWP-GHG results. It is a simplified indicator for data quality that supports the use of more primary data, to increase the representativeness of and comparability between EPDs. Note that the indicator does not capture all relevant aspects of data quality and is not comparable across product categories.*

The reported share of primary data is associated with uncertainty, as one or more EPDs used as data source lack information on the share of primary data.

This EPD covers a sleeper product from one plant. Vossloh provided energy and waste data for the site for the period January - December 2021. The product designs, concrete mix designs, raw material sources, and supply chain details are current (2025). The concrete ingredients are mixed in the plant and poured into moulds fitted with pre-stressed steel wire. The sleepers are stored in the site's yard where they further develop strength. The EPD covers end-of-life in Australia, although the default factors from the PCR are used to model module C (see Table 6). Background data was sourced from EPDs, the AusLCI v1.42 and ecoinvent v3.10 databases. Data quality was assessed according to EN 15804:2012+A2:2019, Annex E (Table E.1 - UN Environment Global Guidance on LCA database development).

The use of very poor and poor data in module A1-A3 is disclosed in Table 8, together with fair data with more than 30% impact.

Data set	Criteria	Data quality level	Reason for level	Reason for using	Relevance
Production of steel reinforcement wire	Geographical Technical	Fair Fair	Generic background data	Best available data	>70% of ADPm&m; 25-30% of GWP; 0-30% of other core impact indicators

Table 8: Data quality information

Key assumptions

The key choices and assumptions in the LCA are:

- The product design and concrete composition is provided by Vossloh and has been accepted as is.
- Cement and admixture data are taken from supplier-specific and generic EPDs respectively. This is expected to greatly improve the accuracy of Vossloh's EPD results.
- Additional environmental impact indicators are not declared in the admixture EPDs, which results in underreporting of these indicators.
- Allocation approaches may have a material effect on sleeper products containing fly ash.
- For core processes, electricity has been modelled using adjusted AusLCI data to represent the estimated residual electricity grid mix in Queensland, Australia. This is done by removing renewables from the Australian Energy Statistics 2024 data for the electricity mix in FY23 (Table O.4). The GWP-GHG of the electricity is 0.88 kg CO_2e / kWh. The proxy residual grid mix is made up of black coal (80.7%), natural gas (17.0%), and oil products (2.3%). Given the limited contribution of manufacturing electricity consumption to the GWP emissions, the selection of market-based or location-based reporting only has a minor (<2%) impact on the carbon footprint results.
- For other processes, electricity has been modelled using a location-based approach, mostly based on Australian average electricity generation as per AusLCI.
- The end-of-life scenario is based on landfill and recycling rates for building and demolition materials in Australia, as per the National Waste Report 2022 (NWR 2022), table 37. The default values from Table 4 in PCR 2019:14 have been used to model the end-of-life impacts for sleepers, based on the product mass defined in Table 1 of this EPD.

Cut-off criteria

- The cut-off criteria applied are 1% of renewable and non-renewable primary energy usage, 1% of the total mass input of a process and 1% of environmental impacts.
- The contribution of capital goods (production equipment and infrastructure) and personnel is excluded, as these processes are non-attributable and they contribute less than 10% to GWP-GHG.

Allocation

The materials, products and processes in the life cycle of Vossloh's products that require allocation are:

- Co-production of RN-150-18 and other sleeper products: Vossloh manufactures a range of sleeper products at its sites. Production waste and energy use for sleeper production has been allocated to the products based on a mass basis (total tonnage of products produced). Timber gluts have been assigned to the products based on the number of sleepers produced.
- Co-production of sleepers and steel offcuts collected for recycling. The steel offcuts are a waste output from the production process (even though they may have a positive value), thus requiring waste allocation. We have applied cut-off allocation, assigning all impacts to the sleepers. This approach is conservative, respects the main purpose of the process, reflects the polluter-pays-principle, and ensures consistency in allocation with scrap entering the product system.
- Scrap used in the production of steel reinforcement products: The process used in the model comes with 17.5% scrap input, estimated to be made up of 70% post-consumer and 30% pre-consumer scrap. The transport of scrap, sorting, and pressing is included within the system boundary of the receiving life cycle, but the inputs are treated as burden free (without prior environmental impacts from the previous life cycle). The use of cut-off allocation for incoming scrap is justified in the LCA and has no material effect on the results.
- Co-production of electricity and fly-ash: As around half of all the fly ash generated in Australia is not used but stored in ponds, economic allocation was applied with zero value assigned to the fly ash. In effect, all environmental impacts of the power plant have been allocated to the main product: electricity. Fly ash has only received the burdens of transport to our site.

Life Cycle Assessment (LCA) indicators

An LCA serves as the foundation for this EPD. An LCA analyses the production systems of a product. It provides comprehensive evaluations of all upstream and downstream energy inputs and outputs. The results are provided in a form which covers a range of environmental impact categories.

Core indicators	Acronym	Unit
Climate change – total	GWP-total	kg CO_2 equivalent
Climate change – fossil	GWP-fossil	kg CO_2 equivalent
Climate change – biogenic	GWP-biogenic	kg CO_2 equivalent
Climate change – land use and land use change	GWP-luluc	kg CO_2 equivalent
Ozone layer depletion	ODP	kg CFC-11 equivalent
Acidification	AP	mol H^+ equivalent
Eutrophication aquatic freshwater	EP-freshwater	kg P equivalent
Eutrophication aquatic marine	EP-marine	kg N equivalent
Eutrophication terrestrial	EP-terrestrial	mol N equivalent
Photochemical ozone formation	POCP	kg NMVOC equivalent
Abiotic depletion potential – elements[1]	ADP minerals & metals	kg Sb equivalent
Abiotic depletion potential – fossil fuels[1]	ADP fossil	MJ, net calorific value
Water use[1]	WDP	m^3 world equivalent deprived
Additional indicators	**Acronym**	**Unit**
Global Warming Potential – Greenhouse gases	GWP-GHG	kg CO_2 equivalent
Particulate matter emissions	PM	disease incidence
Ionising radiation, human health[2]	IRP	kBq U235 equivalent
Ecotoxicity (freshwater)[1]	ETP-fw	CTUe
Human toxicity, cancer effects[1]	HTP-c	CTUh
Human toxicity, non-cancer effects[1]	HTP-nc	CTUh
Land use related impacts / soil quality[1]	SQP	- (dimensionless)
Additional GHG indicator	**Acronym**	**Unit**
Carbon footprint in line with IPCC AR5[3]	**GWP-GHG (IPCC AR5)**	**kg CO_2 eq**

Table 9: Environmental indicators legend (EN 15804+A2)

[1] The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.
[2] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and some construction materials, is also not measured by this indicator.
[3] **Note regarding various GWP indicators:** GWP-total is calculated using the European Union's Joint Research Centre's characterisation factors (CFs) based on the "EF 3.1 package" for CFs to be used in the EU's Product Environmental Footprint (PEF) framework. CFs listed by JRC include indirect radiative forcing, which results in higher numerical Global Warming Potential (GWP) values than the CFs in the internationally accepted (IPCC 2021). The GWP-GHG indicator is identical to GWP-total except that the CFs for biogenic CO_2 are set to zero. The GWP-GHG indicator in PCR 2019:14 v2.0.1 differs from the GWP-GHG in earlier (pre v1.3) PCR 2019:14 versions. The IPCC AR 5 (IPCC 2013) indicator is determined using the IPCC AR5 Global Warming Potentials (GWP) with a 100-year time horizon. This indicator is aligned with Australia's greenhouse gas reporting frameworks.

Parameter	Acronym	Unit
Parameters describing resource use		
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	MJ_{NCV}
Use of renewable primary energy resources used as raw materials	PERM	MJ_{NCV}
Total use of renewable primary energy resources	PERT	MJ_{NCV}
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ_{NCV}
Use of non-renewable primary energy resources used as raw materials	PENRM	MJ_{NCV}
Total use of non-renewable primary energy resources	PENRT	MJ_{NCV}
Use of secondary material	SM	kg
Use of renewable secondary fuels	RSF	MJ_{NCV}
Use of non-renewable secondary fuels	NRSF	MJ_{NCV}
Use of net fresh water	FW	m^3
Waste categories		
Hazardous waste disposed	HWD	kg
Non-Hazardous waste disposed	NHWD	kg
Radioactive waste disposed	RWD	kg
Output flows		
Components for re-use	CRU	kg
Materials for recycling	MFR	kg
Materials for energy recovery	MER	kg
Exported energy	EE	MJ

Table 10: Legend for parameters describing resource use, waste and output flows

Indicator	Acronym	Unit
Global warming potential	GWP	kg CO_2 equivalent
Ozone layer depletion potential	ODP	kg CFC-11 equivalent
Acidification potential	AP	kg SO_2 equivalent
Eutrophication potential	EP	kg PO_4^{3-} equivalent
Photochemical oxidation (Photochemical ozone creation) potential	POCP	kg ethylene equivalent
Abiotic depletion potential - elements	ADPE	kg Sb equivalent
Abiotic depletion potential – fossil fuels	ADPF	MJ_{NCV}

Table 11: Legend for EN 15804+A1 indicators

Environmental performance

The following section presents the results for each Life Cycle Assessment module. The results have been calculated based on the EFv3.1 set of characterisation factors with SimaPro software v9.6.0.1.

Water flows have been disaggregated using the 36 ALCAS water catchments for which characterisation factors are available for both Pfister WSI and the AWARE method.

To separate the use of primary energy into energy used as raw material and energy used as energy carrier, Option B from Annex 3 of PCR 2019:14 has been applied. In option B, the energy used as raw material is declared as an input to the module where it enters the product system (often in module A1) and as an output from the product system if it exits the product system as useful energy (often from modules A5 or C3).

(Note: As module A5 is not declared, balancing has occurred in modules A1-A3.) Energy content that is wasted (e.g. in landfill), remains as part of the indicator for energy used for raw materials, and is not reported as an input of energy used for energy carriers.

Please consider the following mandatory statements when interpreting the results:

” The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks”.

“*The results of the end-of-life stage (modules C1-C4) should be considered when using the results of the product stage (modules A1-A3)*”.

Environmental Indicator	Unit	Module A1-A3	Module C1	Module C2	Module C3	Module C4	Module D
Core Indicators							
GWP-total	kg CO_2-eq.	4.19E+01	4.66E-01	1.65E+00	3.46E-01	1.49E-02	-4.43E+00
GWP-fossil	kg CO_2-eq.	4.14E+01	4.66E-01	1.65E+00	3.45E-01	1.49E-02	-4.43E+00
GWP-biogenic	kg CO_2-eq.	4.29E-01	3.09E-05	1.11E-04	4.61E-04	9.89E-07	-1.14E-03
GWP-luluc	kg CO_2-eq.	5.20E-02	2.23E-07	7.41E-07	7.39E-08	7.14E-09	4.96E-05
ODP	kg CFC11-eq.	6.09E-07	7.45E-08	3.09E-07	2.30E-08	2.38E-09	-3.96E-08
AP	mol H+ eq.	1.70E-01	5.12E-03	5.78E-03	2.36E-03	1.64E-04	-1.49E-02
EP-freshwater	kg P eq.	4.47E-03	6.20E-08	1.09E-07	1.33E-07	1.98E-09	3.72E-04
EP-marine	kg N eq.	2.27E-02	2.23E-03	2.11E-03	8.10E-04	7.13E-05	-2.04E-03
EP-terrestrial	mol N eq.	3.89E-01	2.44E-02	2.33E-02	8.86E-03	7.82E-04	-3.66E-02
POCP	kg NMVOC eq.	1.06E-01	6.52E-03	5.63E-03	2.36E-03	2.09E-04	-1.05E-02
ADP minerals & metals[1]	kg Sb eq.	1.17E-04	5.49E-10	1.44E-09	1.74E-10	1.76E-11	-4.95E-05
ADP fossil[1]	MJ (NCV)	2.76E+02	6.50E+00	2.20E+01	4.90E+00	2.08E-01	-4.13E+01
WDP[1]	m^3 world eq. deprived	1.55E+01	4.11E-02	1.41E-01	2.46E-02	1.32E-03	-6.25E+00
Additional indicators							
GWP-GHG	kg CO_2-eq.	4.18E+01	4.66E-01	1.65E+00	3.46E-01	1.49E-02	-4.43E+00
PM	Disease incidence	2.12E-06	1.36E-07	5.42E-08	4.81E-08	4.34E-09	-2.60E-07
IRP[2]	kBq U235 eq.	6.75E+01	9.50E-06	3.34E-05	3.02E-06	3.04E-07	2.10E-02
ETP-fw[1]	CTUe	4.68E+02	1.44E+00	4.29E+00	4.63E-01	4.61E-02	-1.54E+02
HTP-c[1]	CTUh	1.30E-06	1.80E-11	4.57E-12	1.57E-11	5.77E-13	-5.55E-07
HTP-nc[1]	CTUh	1.14E-06	9.59E-11	1.38E-10	9.17E-11	3.07E-12	2.79E-07
SQP[1]	-	5.24E+02	3.12E-02	1.56E-01	5.64E-01	9.99E-04	-2.97E+01
Carbon footprint							
GWP-GHG (IPCC AR5)	**kg CO_2 eq**	42	0.5	1.6	0.35	0.01	-4.44

Table 12: Environmental indicators EN 15804+A2, RN-150-18, per unit (excluding fastenings)

Footnotes (Table 12):

[1] The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

[2] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and some construction materials, is also not measured by this indicator.

Parameter	Unit	Module A1-A3	Module C1	Module C2	Module C3	Module C4	Module D
PERE	MJ_{NCV}	5.42E+01	1.01E-02	3.05E-02	2.08E-01	3.22E-04	-4.81E+00
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	5.42E+01	1.01E-02	3.05E-02	2.08E-01	3.22E-04	-4.81E+00
PENRE	MJ_{NCV}	2.72E+02	6.50E+00	2.20E+01	4.90E+00	2.08E-01	-4.13E+01
PENRM	MJ_{NCV}	3.24E+00	0.00E+00	0.00E+00	-2.59E+00	0.00E+00	0.00E+00
PENRT	MJ_{NCV}	2.75E+02	6.50E+00	2.20E+01	2.31E+00	2.08E-01	-4.13E+01
SM	kg	6.98E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	7.95E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	8.46E+01	9.42E-04	3.24E-03	6.90E-04	3.01E-05	-4.38E+01
HWD	kg	7.56E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	1.52E-01	2.98E-05	9.02E-05	6.18E-04	2.99E+01	-2.43E-03
RWD	kg	2.67E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	2.93E+00	0.00E+00	0.00E+00	1.20E+02	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 13: Parameters, RN-150-18, per unit (excluding fastenings)

Environmental Indicator	Unit	Module A1-A3	Module C1	Module C2	Module C3	Module C4	Module D
GWP	kg CO_2 eq	4.16E+01	4.65E-01	1.64E+00	3.44E-01	1.49E-02	-4.41E+00
ODP	kg CFC11 eq	4.24E-07	5.88E-08	2.44E-07	1.82E-08	1.88E-09	-3.33E-08
AP	kg SO_2 eq	1.18E-01	3.64E-03	4.22E-03	1.30E-03	1.16E-04	-1.01E-02
EP	kg PO_4^{3-} eq	2.22E-02	7.48E-04	7.29E-04	2.73E-04	2.39E-05	9.47E-04
POCP	kg C_2H_4 eq	1.13E-02	3.57E-04	1.25E-04	1.22E-04	1.14E-05	-1.70E-03
ADPE	kg Sb eq	1.11E-04	5.57E-10	1.46E-09	3.19E-10	1.78E-11	-4.95E-05
ADPF	MJ_{NCV}	2.74E+02	6.50E+00	2.20E+01	4.90E+00	2.08E-01	-4.21E+01

Table 14: EN 15804+A1 indicators*, RN-150-18, per unit (excluding fastenings)

** Note: the indicators and characterisation methods are from EN 15804:2012+A1:2013, but other LCA rules (system boundaries, allocation, etc.) are according to EN 15804:2012+A2:2019; i.e., the results of the “A1 indicators” shall not be claimed to be compliant with EN 15804:2012+A1:2013*

Additional scenarios

Environmental Indicator	Unit	Module C3	Module C4	Module D	Module C3	Module C4	Module D
Core Indicators		100% recycling			100% landfill		
GWP-total	kg CO_2-eq.	4.32E-01	0.00E+00	-3.86E+01	0.00E+00	7.45E-02	6.40E+00
GWP-fossil	kg CO_2-eq.	4.31E-01	0.00E+00	-3.86E+01	0.00E+00	7.45E-02	6.40E+00
GWP-biogenic	kg CO_2-eq.	5.76E-04	0.00E+00	-9.14E-03	0.00E+00	4.94E-06	-1.58E-03
GWP-luluc	kg CO_2-eq.	9.23E-08	0.00E+00	4.38E-04	0.00E+00	3.57E-08	-9.31E-05
ODP	kg CFC11-eq.	2.88E-08	0.00E+00	-3.34E-07	0.00E+00	1.19E-08	9.63E-09
AP	mol H+ eq.	2.94E-03	0.00E+00	-1.30E-01	0.00E+00	8.19E-04	2.10E-02
EP-freshwater	kg P eq.	1.66E-07	0.00E+00	3.28E-03	0.00E+00	9.92E-09	-6.97E-04
EP-marine	kg N eq.	1.01E-03	0.00E+00	-1.77E-02	0.00E+00	3.57E-04	2.67E-03
EP-terrestrial	mol N eq.	1.11E-02	0.00E+00	-3.20E-01	0.00E+00	3.91E-03	5.61E-02
POCP	kg NMVOC eq.	2.95E-03	0.00E+00	-9.21E-02	0.00E+00	1.04E-03	1.64E-02
ADP minerals & metals[1]	kg Sb eq.	2.18E-10	0.00E+00	-4.37E-04	0.00E+00	8.79E-11	9.25E-05
ADP fossil[1]	MJ (NCV)	6.13E+00	0.00E+00	-3.58E+02	0.00E+00	1.04E+00	5.03E+01
WDP[1]	m^3 world eq. deprived	3.08E-02	0.00E+00	-5.20E+01	0.00E+00	6.58E-03	-9.24E-01
Additional indicators		100% recycling			100% landfill		
GWP-GHG	kg CO_2-eq.	4.32E-01	0.00E+00	-3.86E+01	0.00E+00	7.45E-02	6.39E+00
PM	Disease incidence	6.01E-08	0.00E+00	-2.28E-06	0.00E+00	2.17E-08	4.29E-07
IRP[2]	kBq U235 eq.	3.78E-06	0.00E+00	1.86E-01	0.00E+00	1.52E-06	-3.96E-02
ETP-fw[1]	CTUe	5.78E-01	0.00E+00	-1.36E+03	0.00E+00	2.30E-01	2.86E+02
HTP-c[1]	CTUh	1.96E-11	0.00E+00	-4.90E-06	0.00E+00	2.88E-12	1.04E-06
HTP-nc[1]	CTUh	1.15E-10	0.00E+00	2.46E-06	0.00E+00	1.53E-11	-5.23E-07
SQP[1]	-	7.05E-01	0.00E+00	-2.52E+02	0.00E+00	4.99E-03	1.67E+01
Carbon footprint		100% recycling			100% landfill		
GWP-GHG (IPCC AR5)	kg CO_2 eq	4.32E-01	0.00E+00	-3.87E+01	0.00E+00	7.45E-02	6.42E+00

Table 15: Environmental indicators EN 15804+A2, 100% end-of-life scenarios, RN-150-18, per unit (excluding fastenings)

Footnotes (Table 15):

[1] The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.

[2] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and some construction materials, is also not measured by this indicator.

Parameter	Unit	Module C3	Module C4	Module D	Module C3	Module C4	Module D
`Parameters		100% recycling			100% landfill		
PERE	MJ_{NCV}	2.60E-01	0.00E+00	-4.21E+01	0.00E+00	1.61E-03	7.47E+00
PERM	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ_{NCV}	2.60E-01	0.00E+00	-4.21E+01	0.00E+00	1.61E-03	7.47E+00
PENRE	MJ_{NCV}	6.13E+00	0.00E+00	-3.58E+02	0.00E+00	1.04E+00	5.03E+01
PENRM	MJ_{NCV}	-3.24E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ_{NCV}	2.89E+00	0.00E+00	-3.58E+02	0.00E+00	1.04E+00	5.03E+01
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ_{NCV}	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	8.62E-04	0.00E+00	-3.87E+02	0.00E+00	1.51E-04	8.18E+01
HWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NHWD	kg	7.72E-04	0.00E+00	-2.03E-02	0.00E+00	1.50E+02	0.00E+00
RWD	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.50E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 16: Parameters, 100% end-of-life scenarios, RN-150-18, per unit (excluding fastenings)

Abbreviations

Abbreviation	Definition
AusLCI	Australian Life Cycle Inventory (database)
CEN	European Committee for Standardization
CPC	Central Product Classification
EF	Environmental Footprint
EFCA	European Federation of Concrete Admixtures Associations
EN	European Norm (Standard)
EPD	Environmental Product Declaration
GPI	General Programme Instructions
ISO	International Organization for Standardization
kg	kilogram
km	kilometre
kWh	kilo Watt hour
LCA	Life Cycle Assessment
m^3	cubic metre
ND	Not Declared
NWR	National Waste Report
OHS	Operational Health and Safety
PCR / c-PCR	Product Category Rules / complimentary Product Category Rules
SVHC	Substances of Very High Concern
t	tonne
UN	United Nations

Version history

Version	Notes
1	Original version of the EPD, published 2025-09-30

References

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AusLCI 2023	Australian Life Cycle Inventory database v1.42 published by the Australian Life Cycle Assessment Society (ALCAS), 2023
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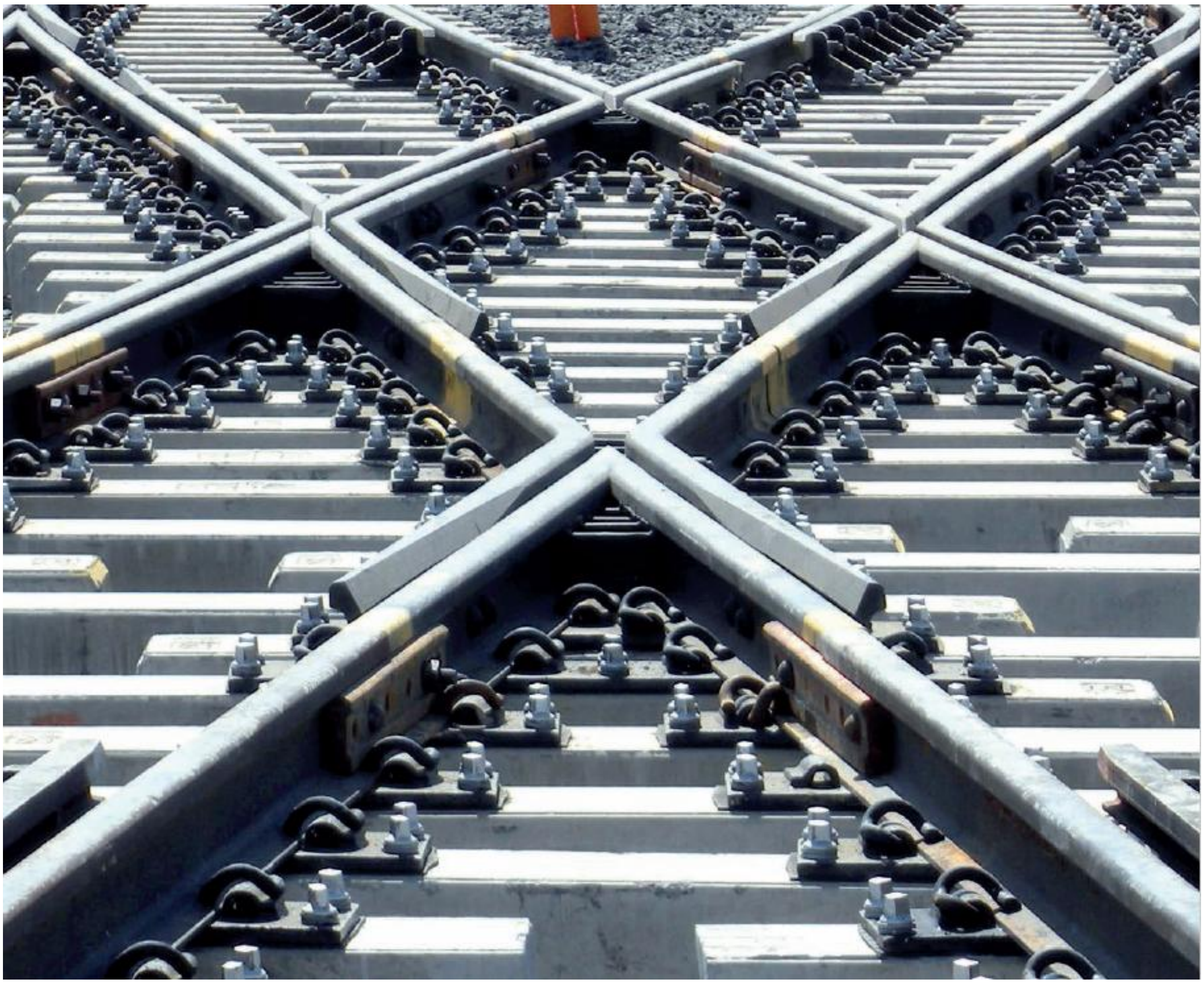

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