READY-MIX CONCRETE

Environmental Product Declaration (EPD)

NSW - Sydney Metro - Westlink M7 - M12 Project Mix Designs - NS602FBP2 - S60 20mm 120mm B80 BRIDGE CONCRETE - State Main Roads

In accordance with ISO 14025 and EN15804:2012+A2:2019/AC:2021
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AUSTRALASIA EPD® INTERNATIONAL EPD SYSTEM

EPD INTERNATIONAL EPD SYSTEM

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Programme-related information and verification

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Valid Until	13/4/2031	
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Geographical Scope	Australia	
Reference Year for Data	2022 Plant Data, 2026 Mix/Materials Data	

CEN standard EN 15804:2012+A2:2019/AC:2021 serves as the core Product Category Rules (PCR)

Product category rules	PCR 2019:14 Construction Products, Version 2.0.1, 2025-06-05 c-PCR-003 Concrete and Concrete Elements, 2025-04-08
PCR review was conducted by	The Technical Committee of the International EPD System. A full list of members is available on www.environdec.com Review chair: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat www.environdec.com/contact
Independent third-party verification of the declaration and data, according to ISO 14025:2006:	☒ EPD process certification* without a pre-verified LCA/EPD tool * EPD process certification involves an accredited certification body certifying and periodically auditing the EPD process and conducting external and independent verification of EPDs that are regularly published. More information can be found in the General Programme Instructions on www.envrondec.com.
Process certification	Epsten Group, Inc., Megan Blizzard, is an approved certification body accountable for third-party verification. Third-party verifier is accredited by: A2LA, Certificate #3142.03
Procedure for follow-up of data during EPD validity involves third party verifier:	☐ Yes ☒ No

Programme-related information and verification:

The EPD owner has the sole ownership, liability, and responsibility for the EPD. 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.

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Revision Number	Revision Date	Description of Changes
1	13/4/2026	

INTRODUCTION

Currently, the building environment account for 39% of global CO_2 emissions, with construction materials comprising 11% of global CO_2 emissions (World Green Building Council). By 2030, the embodied carbon of all construction materials needs to be at least 40% lower. By 2050, all new construction materials need to be net zero (World Green Building Council).

Environmental Product Declarations (EPDs) play a crucial role in promoting transparency and sustainability in the construction industry. By providing comprehensive and standardised information about the environmental performance of products, EPDs enable informed decision-making among stakeholders, including architects, engineers, builders, and consumers.

EPDs include data on a product's life cycle impacts, such as its carbon footprint, energy consumption, and resource use. This transparency empowers stakeholders to make informed selections of products.

EPDs also serve as valuable tools for benchmarking environmental performance and driving the decarbonation of construction materials. Demand for low carbon products backed by an EPD drives and rewards the decarbonisation of the entire supply chain.

As a result, EPDs will play a key role in our mission to decarbonise construction materials and the built environment.

ABOUT HOLCIM

Holcim Australia is a leading supplier of construction materials in Australia, dating back to 1901. Today Holcim continues to supply essential construction materials including aggregates, sand, ready-mix concrete, engineered precast concrete and prestressed concrete solutions to a range of customers and projects throughout Australia.

Holcim operates right across the Australian continent supplying concrete from a network of concrete plants, quarries, precast and concrete pipe places, and mobile and on-site project facilities.

Sustainability is at the core of our strategy, with our industry's first 2050 net-zero targets, endorsed by the Science Based Targets initiative (SBTi).

Globally, Holcim is 63,000 people around the world who are passionate about building progress for people and the planet through four business segments: Cement, Ready-Mix Concrete, Aggregates and Solutions & Products.

A FIRST FOR READY-MIX CONCRETE IN AUSTRALIA

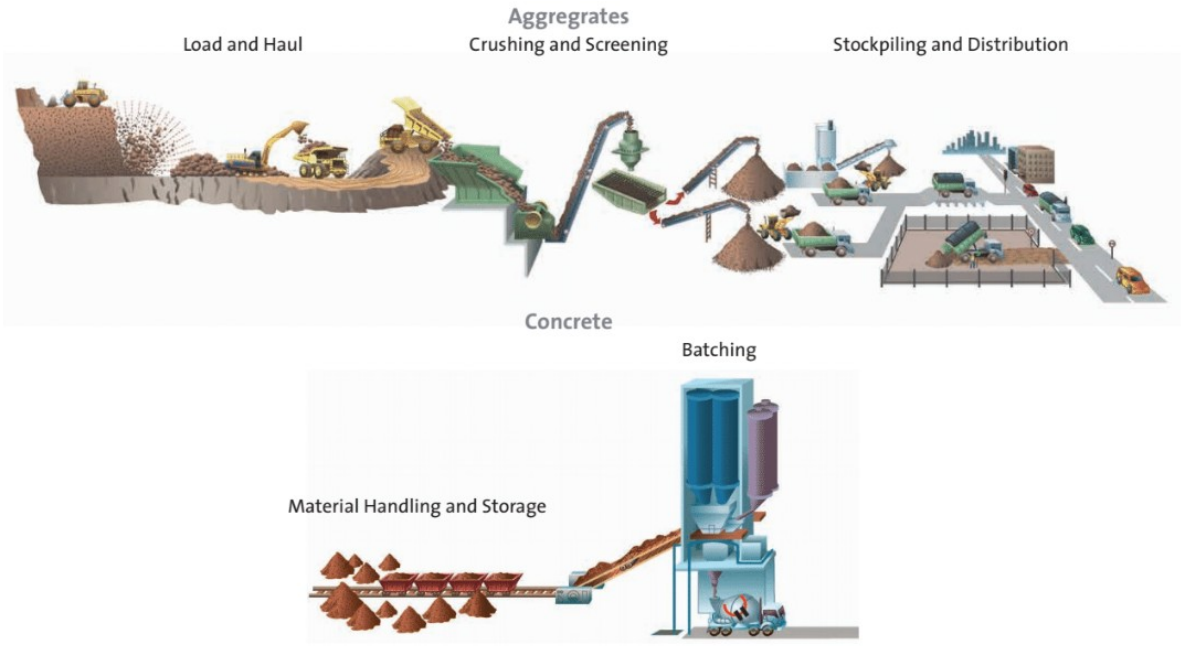
In 2019, Holcim published the first EPD for ready-mix concrete. This was an Australian first for ready-mix concrete and covered Holcim's Normal-class concrete range across Australia. The EPD had 147 datasets for normal-class concrete that representative of over 4,000 mix designs. The EPD also provided Special-class concrete data for a major Infrastructure Sustainability and Green Star building project. This EPD heralded the introduction of rigorously verified life cycle impact data, setting a new benchmark in transparency and accountability within the Australian construction sector.

Fast forward to 2021, Holcim achieved Process EPD Certification, a first not just within the concrete industry but across all sectors in Australia. This certification empowers Holcim to develop and register EPDs on demand for ready-mix concrete.

To achieve EPD Process Certification, Holcim integrated Life Cycle Assessment (LCA) processes and procedures into its Management Systems. We then undergo ongoing rigorous third-party verification in accordance with internationally recognized ISO standards and guidelines.

This EPD has been developed using our EPD Process Certification with production occurring at the following sites.

READY-MIX CONCRETE



Summary of properties and classes

Concrete is prepared by mixing cement, coarse and fine aggregates, and water, with or without the addition of auxiliary agents and additives. The fresh concrete is placed on the building site or prefabricated in factory moulds, compacted and hardened in the desired shape by the hydration of cement to form concrete.

General Australian Standard AS 1379 sets out ways of specifying and ordering concrete to promote uniformity, efficiency and economy in production and delivery. It refers to two classes of concrete: normal-class and special-class.

- **Normal-class –** designed for everyday applications such as residential and commercial foundations, driveways and footpaths.
- **Special-class –** typically supplied to major construction projects from high rise buildings, dams and spillways, roads, bridges to public works infrastructure etc.

Special-class concrete is typically specified in accordance with the technical parameters and performance requirements, which can include high-strength/high-performances concrete, high durability, or marine application, post-tensioned, high-pumpability, super workable, piling concrete, architectural off-form finishes and other decorative applications.

LCA INFORMATION

Declared Unit

1 m^3 of ready-mix concrete.

Scope

The scope of this EPD is cradle to gate (modules A1-A3) with options, modules A4-A5, modules C1-C4 and module D.

Technical Lifetime

The reference service life is not specified as the scope of Holcim's operational control is from cradle to delivery. Instead, AS 3600, the Australian Standard for concrete structures, typically specifies a design life of 50 years. For structures with a 100-year design life, like bridges, AS 5100 is the relevant standard.

Time Representativeness

The plant data for the LCA is based on 2022 calendar year production data. The mix data for the LCA is based on 2026 calendar year production data.

LCA Methodology

This EPD has been produced in conformance with the requirements of:

- c-PCR-003 Concrete and concrete element
- Product Category Rules (PCR) 2019:14 v2.0.1.
- EN 15804+A2
- General Program Instructions (GPI) v5.0.1
- Instructions of EPD Australasia v4.2
- EN 14040 and EN 14044

Databases and LCA Software Used

SimaPro® LCA software (v10.2) was used for the LCA modelling which developed the LCA Calculator, used as per the certified EPD Process. It uses background data with the following preferences:

1. Product specific EPDs for cements, admixtures, pigments and fibres
2. The Australian National Life Cycle Inventory Database (AusLCI v2.45) (2025)
3. Ecoinvent 3.11 and EN15804+A2 package (2024).

The environmental impacts modelled from the existing EPDs do not include impacts for EN15804+A1, and the additional Green Star (v1.3) impact categories included in the environmental impact tables. These indicators are modelled separately based on generic processes. The following impact categories were calculated manually for the foreground data:

- Use of renewable primary energy resources used as raw materials
- Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
- Use of secondary material
- Use of renewable secondary fuels
- Use of non-renewable secondary fuels

Allocation

Allocation was necessary to proportion inputs and outputs to intermediate flows at the quarry and processes at the batching plant level.
As much as possible, intermediate flows were allocated physically based on weight (quarries) or based on m^3 of concrete (at the batching plant).
The impacts of fly ash, granulated blast furnace slag, and silica fume are allocated based on the economic values. Please refer to the "Recycled Material" section for further detail.

Cut-Off Criteria

In accordance with the PCR 2019:14 v2.0.1, the following system boundaries are applied to manufacturing equipment and employees:

- The infrastructure associated with electricity and heating supply in Module A3, and infrastructure in the manufacturing site operated by Holcim, where impacts such as those from the construction of power plants and manufacturing plants, are included.
- Environmental impact from other infrastructure, construction, production equipment, and tools that are not directly consumed in the production process are not accounted for in the LCI. Capital equipment and buildings typically account for less than a few percent of nearly all LCIs and this is usually smaller than the error in the inventory data itself. For this project, it is assumed that capital equipment makes a negligible contribution to the impacts as per Frischknecht et al. (2007) with no further investigation.
- Personnel-related impacts, such as transportation to and from work, are also not accounted for in the LCI. The impacts of employees are also excluded from inventory impacts on the basis that if they were not employed for this production or service function, they would be employed for another. It is very hard to decide what proportion of the impacts from their whole lives should count towards their employment. For this project, the impacts of employees are excluded.

Based on this guidance, no energy or mass flows, except packaging of materials were excluded. All materials required for manufacturing are delivered via trucks and ships without packaging.

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Data Quality

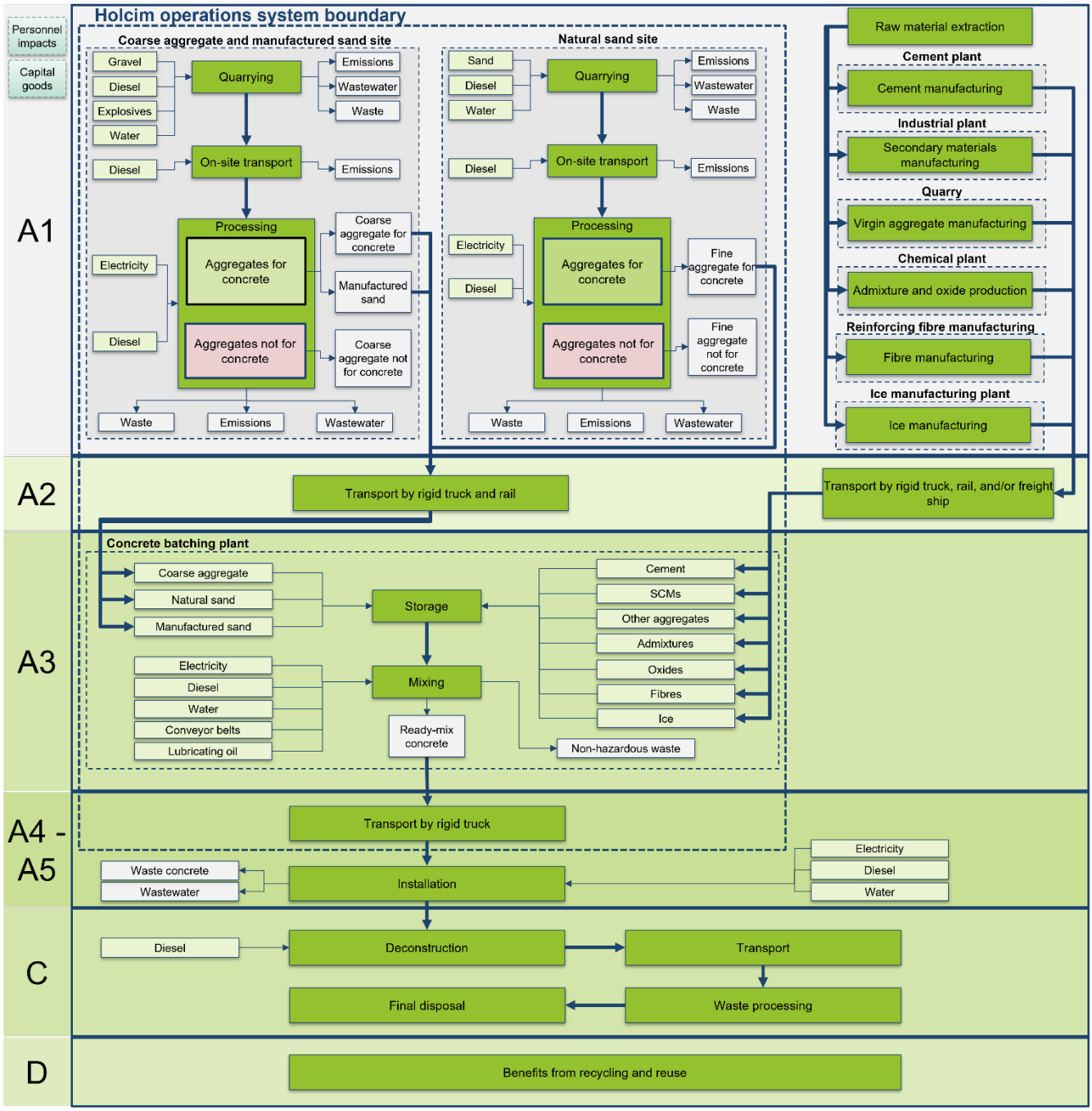
Data quality was assessed in terms of geographic, technical and temporal representativeness. All data sources were scored good or very good.

Background data sources were also assessed with respect to their timeliness, with all data sources being updated within the 3 years required under PCR 2019:14.

Module	Input/ outputs	Sub-processes	Data source & LCA Factor	Temporal scope	Technical scope	Geographic scope
A1	Cementitious materials	Cement	Supplier data and EPD factors	Very good	Very good	Very good
		Supplementary cementitious materials	Supplier data and database factors	Very good	Good	Good
	Coarse aggregate	Electricity	Invoices and database factors	Very good	Very good	Very good
		Diesel	Invoices and database factors	Very good	Good	Good
		LPG	Invoices and database factors	Very good	Good	Good
		Pollutants	National Pollution Inventory (NPI) data and database factors	Very good	Very good	Very good
	Manufactured sand	Mains water	Invoices and database factors	Very good	Very good	Very good
		Water – other sources	Metered and database factors	Very good	Very good	Very good
	Fine aggregate	Water discharge from site	Metered and database factors	Very good	Very good	Very good
		Explosives	Supplier data and database factors	Very good	Good	Good
		Gravel	Production data	Very good	Very good	Very good
	Other aggregates	Recycled aggregates	Database factors	Very good	Good	Good
	Admixture	Admixtures	Supplier data and database factors	Very good	Good	Good
	Oxide	Oxides	Invoices and database / EPD factors	Very good	Good	Good
	Fibre	Plastic and steel fibres	Invoices and database / EPD factors	Very good	Good	Good
A2	Raw material transport	Background data used to model	Holcim and supplier actual transport distances and loads per trip and database factors	Very good	Good	Good
A3	Concrete batching plant	Electricity	Invoices and database factors	Very good	Very good	Very good
		Diesel	Invoices and database factors	Very good	Good	Good
		Mains water	Water meters, with utility invoices as a back-up and database factors	Very good	Very good	Very good
		Water – other sources	Estimate based on water balance and database factors	Very good	Very good	Very good
		Water discharge from site	Estimate based on Holcim site performance metrics and database factors	Very good	Very good	Very good
		Lubricating oil	Invoices and database factors	Very good	Good	Good
		Conveyor belt				
	Concrete mix designs	Background data used to model	Holcim internal technical database containing mix designs	Very good	Good	Good
A4	Distribution	Background data used to model	Actual transport data and database factors	Very good	Good	Good
A5	Installation	Electricity	Typical scenario & database factors	Very good	Good	Good
		Diesel				
		Water				
C1	Deconstruction	Excavation	Typical scenario & database factors	Very good	Good	Good
C2	Transport	Background data used to model	Typical scenario & database factors	Very good	Good	Good
C3	Waste processing	Concrete recycling	Typical scenario & database factors	Very good	Good	Good
C4	Final disposal	Inert waste landfilling	Typical scenario & database factors	Very good	Good	Good
D	Benefits and loads beyond	Crushed gravel	Typical scenario & database factors	Very good	Good	Good

System Diagram

The processes included in the LCA are presented in a process diagram in the figure below.



Description of System Boundaries and Excluded Lifecycle Stages

The scope of the LCA and EPD is from cradle to gate (A1-A3) with options, modules A4-A5, modules C1-C4 and module D. The following life cycle stages have not been declared (marked as ND), as they are deemed not applicable for Holcim's ready-mix concrete ranges: Material emissions from usage (B1); Maintenance (B2); Repair (B3); Replacement (B4); Refurbishment (B5); Operational energy use (B6), and Operational water use (B7).

	Product Stage			Construction Stage		Usage Stage							End of Life Stage				Benefits & loads for the next product system
	Raw Material Supply	Transport	Manufacturing	Transport	Construction/installation process	Use	Maintenance incl.	Repair incl. transport	Replacement incl.	Refurbishment incl.	Operational Energy Use	Operational Water Use	De-construction & demolition	Transport	Re-use recycling	Final Disposal	Reuse, Recovery Recycling potential
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Modules declared	X	X	X	X	X	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography	GLO	AU	AU	AU	AU	-	-	-	-	-	-	-	AU	AU	AU	AU	AU
Share of specific data*	9.15 %			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	<10%			-	-	-	-	-	-	-	-	-	-	-	-	-	-

* 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 several EPDs used as data source lack information on the share of primary data.

Upstream processes

The upstream processes include those involved in Module A1 – Raw material supply. This module includes:

- Extraction, transport, and manufacturing of raw materials.
- Generation of electricity from primary and secondary energy resources, also including their extraction, refining and transport for Modules A1.

Core Processes

The core processes include those involved in Module A2 and Module A3, including:

- External transportation of materials to the core processes and internal transport.
- Manufacturing of concrete (excluding mixing, which occurs in the mixing truck and is considered part of the A4 module).
- Treatment of waste and wastewater generated from the manufacturing processes.

Downstream Processes

The downstream processes include those involved in Module A4 to D, including:

- Distribution of concrete mixes.
- Installation of the ready-mix concrete on the site.
- Wastage of construction products (This is accounted for in module A5. This includes waste concrete on site).
- Transport of equipment and use of materials for deconstruction at the end of life.
- Transport of waste generated at the end of life.
- Treatment of waste generated at the end of life.

Other Environmental Information

Other environmental information includes process involved in Module D. This module indicates the environmental benefits from reuse, recovery, and recycling of wastes.

EPD PRODUCT DESCRIPTION AND USE

NSW - Sydney Metro - Westlink M7 - M12 Project Mix Designs - NS602FBP2 - S60 20mm 120mm B80 BRIDGE CONCRETE - State Main Roads

UN CPC code: 375 (articles of concrete, cement and plaster). ANZSIC Classification: 2033 Ready Mix Concrete Manufacturing.

Product lifespan: The product lifespan is not declared because the lifespan of the product can vary significantly depending on its application, usage and maintenance. Additionally, according to Section 4.2.2 of the PCR for Construction Products version 2.0.1, the product lifespan is not relevant since the use stage modules are not declared.

Product description: A generic description of ready-mix concrete has been provided on page 5. A detailed breakdown of the functional properties of the ready-mix concrete, including the mix design covered in this EPD, is provided below.

Product environmental information should only be compared when the products are functionally equivalent and used in the same context.

Strength (MPa)	Mix Code	Weight (kg/m^3)	Mix Description	Applications / intended use
60	NS602FBP2	2310	S60 20mm 120mm B80 BRIDGE CONCRETE	State Main Roads

Production Sites
Rooty Hill, Liverpool, Emu Plains, Narellan, Lidcombe

Content Declaration

The gross weight of this declared material is 2310 kg per cubic meter makes up a minimum of 99% of the products covered by this EPD. The following table provides a summary of the materials included in Holcim ready-mix concrete and their relative composition by weight.

Material	% by weight	Post-consumer recycled material, weight % of product	Biogenic material, weight-% of product	Biogenic material, kg C/m^3
General purpose cement	5 - 21	0	0	0
Aggregate	67 - 84	0	0	0
Supplementary cementitious materials	0 - 11	0	0	0
Water	11.6 - 12	0	0	0
Admixtures	0	0	0	0

Holcim Ready-mix concrete is classified as Non-Dangerous Goods according to the Australian Code for the Transport of Dangerous Goods by Road and Rail. The safety data sheet for pre-mixed concrete lists all associated hazard phrases. None of the products contain one or more substances that are listed in the “Candidate List of Substances of Very High Concern for authorisation”. According to the PCR 2019:14, if one or more substances of the “Candidate List of Substances of Very High Concern (SVHC) for authorisation” are present in a product and their total content exceeds 0.1% of the weight of the product, they need to be reported.

Packaging

Holcim ready-mix concrete is delivered in bulk with no packaging.

Recycled Material

BS EN 16757:2017 specifically lists the following materials relevant to the study as co-products:

- Fly ash,
- Ground granulated blast furnace slag; and
- Silica fume.

As such, the above materials are considered as co-products of their production process and the impacts for their production process are allocated according to PCR 2019:14 Construction Products and Construction Services (co-produced goods, multi-output allocation).

According to PCR 2019:14, economic allocation shall be used for processes producing co-products for use in cement and concrete. It should be based on market prices, preferably in long-term averages (≥3 years). While assessing the environmental burden of the high value co-products (e.g., steel, electricity, silicon), the environmental burden allocated to the low value co-products used in cement and concrete can be omitted as a conservative estimate. Therefore, the economic allocation method is applied to the below materials:

- Fly ash: It is sourced directly from coal fired electricity generation. The environmental impact of fly ash is derived from coal-fired electricity, converted from the heating value of coal on a per-kWh basis.
- Ground granulated blast furnace slag: The environmental impact is allocated to blast furnace slag at the point of generation during pig iron production, based on both production volumes and market prices. However, the specific energy and processing impacts associated with grinding the slag into ground granulated blast furnace slag are included in stage A1.
- Silica fume: It is sourced as a co-product of ferrosilicon production. The raw material impact of silica fume is allocated directly from ferrosilicon, considering the relative production volumes and market prices.

Since SCM market price fluctuate and full datasets are often confidential and not disclosed by upstream suppliers, economic allocation has been based on the mix of primary and secondary data, from Holcim internal records, the AusLCI database and values reported in a peer-reviewed Australian LCA study (Mohammadi & South, 2017). The AusLCI dataset conforms to EN 15804+A2 when applying allocation to its various processes and sub-processes.

Cradle to Gate (Modules A1 – A3)

Raw materials for producing Holcim's ready-mix concrete include cementitious materials, aggregates, admixtures, oxides, fibres, water, and ice. These raw materials are generally transported from various locations around Australia, China, Indonesia, and Europe. The raw materials are stored in silos, hoppers, ground bins or tanks. The materials are feed to batching plant hopper with calibrated scale. Then all the raw materials are discharged via a chute into the ready-mix concrete truck. Water is then weighed, or volume metered and discharged into the mixer truck through the same charging tank.

Holcim's ready-mix concrete is manufactured across ACT, NSW, QLD, SA, VIC, and WA, Australia. State-specific residual electricity mix available in the AusLCI database is used to model electricity in the foreground processes. The AusLCI dataset was last updated in 2025 to reflect the latest residual electricity mix source from the FY2023.

State	Energy source in residual electricity mix	GWP-GHG (kg CO_2 eq./kWh)
NSW&ACT	69% black coal, 12% solar, 6% wind, 5% hydro, and 8% others	8.6E-01
QLD	71% black coal, 13% solar, 10% natural gas, and 6% others	9.3E-01
SA	34% wind, 31% natural gas, 24% solar, 9% brown coal, and 2% others	1.6E-01
VIC	64% brown coal, 15% wind, 8% solar, 7% hydro, and 6% others	1.0E+00
WA	44% natural gas, 30% black coal, 13% solar, 13% wind, and <1% others	7.2E-01

Gate to Site (Module A4)

Distribution is dependent on the market requirements of ready-mix concrete products. All Holcim ready-mix concrete products transported in Australia is by EURO5 28t – 32t trucks. The transport distances from manufacturing gate to the site is 11.77 km. The product weight for 1m^3 ready-mix concrete is the sum of weights from all raw material inputs.

Vehicle	Fuel use (L/tkm)	Fuel type	Carrying capacity	Density of products	Average load factor	Volume capacity utilization factor
EURO 5 Truck	2.3E-02	Diesel	28 t – 32 t	2310 kg/m^3	50%	<1

Installation (Module A5)

As Holcim does not have operational control over the installation of ready-mix concrete at the construction site, assumptions for construction inputs and installation waste are made based on industrial expertise and experience, and the GCCA tool. The inputs account for the pouring of concrete from a ready-mix truck and pump, excluding any pre-installation activities such as site work and forms. The concrete slabs are then manually finished, and no additional inputs are required to be modelled.

Construction inputs and waste	Value	Unit
Concrete losses that go to landfill	3.0E+00	%
Water use	6.7E+02	L
Electricity use	2.8E+00	kWh
Diesel, in building machine	1.7E+00	L
Wastewater	6.7E-01	L

Deconstruction and End of Life (Modules C1 – C4)

EN 15804 (chapter 7.2.3.3) and applicable PCRs discourage the use of the results of modules A1-A3 & (A1-A5 for services) without considering the results of module C.

Following the supply of ready-mix concrete products, Holcim has no control over the end-of-life fate for their products. The recommended cradle to gate environmental profile will be based on the most common scenario as the majority of construction products are generally deconstructed and transported for recycling. The following assumptions have been used in this study to model deconstruction and end of life scenarios of Holcim's ready-mix concrete:

- Deconstruction is modelled as the physical process of drilling and removing the concrete. Hydraulic excavator is assumed as the operating tool for deconstruction. This process is based on ecoinvent v3.11 (2024) database and the diesel used is extracted from the process.
- 100% of the products (2310 kg) are assumed to be separately collected during deconstruction.
- 25 km delivery distance to landfilling as well as reprocessing facility is assumed for waste collection process since there was no primary data available.
- This EPD assumes 100% of the product is reprocessed/recycled as Module C3. The National Waste Report (DCCEEW, 2023) notes that the current recycling and recovery rate of waste aggregate and concrete is 80%. However, as PCR 2.0.1 requires that if any declared scenario is a mix of end-of-life alternatives (reuse, recycling, incineration with energy recovery, landfill, etc.), a 100% scenario must be declared (e.g., 100% reuse, 100% recycling, 100% incineration with energy recovery, or 100% landfill), a 100% recycling scenario has been used for Module D of this EPD.
- The remaining waste concrete undergoes inert waste landfill as Module C4.

Vehicle	Fuel use (L/tkm)	Fuel type	Carrying capacity	Average load factor	Volume capacity utilization factor
EURO 5 Truck	2.2E-02	Diesel	40 t	50%	<1

Module	Parameter	Value	Unit
C1 – Deconstruction	Diesel	1.3E-01	L
C2 – Transportation	Distance to processing	2.5E+01	km
C3 – Waste processing	Concrete recycling	1.9E+03	kg
C4 – Final disposal	Inert waste landfill	4.8E+02	kg

Benefits and loads beyond the system boundary (Module D)

The end-of-life recyclers process the waste concrete into a recycled aggregate, which can be replaced with virgin coarse aggregate for a range of applications depending on the product's performance requirements. This EPD assumes 100% of the product is reprocessed/recycled as Module C3. The National Waste Report (DCCEEW, 2023) notes that the current recycling and recovery rate of waste aggregate and concrete is 80%. However, as PCR 2.0.1 requires that if any declared scenario is a mix of end-of-life alternatives (reuse, recycling, incineration with energy recovery, landfill, etc.), a 100% scenario must be declared (e.g., 100% reuse, 100% recycling, 100% incineration with energy recovery, or 100% landfill), a 100% recycling scenario has been used for Module D of this EPD.

For Holcim’s internal aggregate production, waste concrete coarse and fine aggregates are able to be recycled and repurposed as recycled coarse aggregate and sand. The environmental benefits from avoiding the use of virgin materials are fully accounted for.

In the consideration of Module C, the end-of-life recyclers process the waste concrete into a recycled aggregate, which can be replaced with virgin coarse aggregate for a range of applications depending on the products performance requirements.

ENVIRONMENTAL PERFORMANCE

The environmental impacts considered in this EPD are listed in the table below. EN 15804+A2 reference package based on EF 3.1 (Environmental Footprint) or a later version has been used. All further tables from this point will contain abbreviation only.

Impact Category	Abbreviation	Measurement Unit
Potential Environmental Impact indicators		
Total global warming potential	GWP – T	kg CO_2 equivalents (GWP100)
Global warming potential (fossil)	GWP – F	kg CO_2 equivalents (GWP100)
Global warming potential (biogenic)	GWP – B	kg CO_2 equivalents (GWP100)
Global warming potential (land use/ land transformation)	GWP – Luluc	kg CO_2 equivalents (GWP100)
Ozone depletion potential	ODP	kg CFC 11 equivalents
Acidification potential	AP	mol H+ eq.
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 creation potential	POCP	kg NMVOC equivalents
Abiotic depletion potential (elements)*	ADPE	kg Sb equivalents
Abiotic depletion potential (fossil fuels)*	ADPF	MJ net calorific value
Water Depletion Potential*	WDP	m^3 equivalent deprived
Resource use indicators		
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	PERE	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	PERM	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PERT	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	PENRM	MJ, net calorific value
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PENRT	MJ, net calorific value
Use of secondary material	SM	kg
Use of renewable secondary fuels	RSF	MJ, net calorific value
Use of non-renewable secondary fuels	NRSF	MJ, net calorific value
Use of net fresh water	FW	m^3

Impact Category	Abbreviation	Measurement Unit
Waste categories and Output flows indicators		
Hazardous waste disposed	HWD	kg
Non-hazardous waste disposed	NHWD	kg
Radioactive waste disposed/stored	RWD	kg
Components for reuse	CFR	kg
Materials for recycling	MFR	kg
Materials for energy recovery	MFEE	kg
Exported energy	EE - e	MJ per energy carrier
Exported energy, thermal	EE - t	MJ per energy carrier
Additional environmental impact indicators		
Global warming potential, excluding biogenic uptake, emissions and storage	GWP-GHG	kg CO_2 equivalents (GWP100)
Global warming potential, aligned with the IPCC 2013 Fifth Assessment Report *	GWP-GHG (AR5)	kg CO_2 equivalents (GWP100)
Particulate matter	PM	disease incidence
Ionising radiation – human health	IRP	kBq U-235 eq
Eco-toxicity (freshwater)*	ETP-fw	CTUe
Human toxicity potential – cancer effects*	HTP-c	CTUh
Human toxicity potential – non cancer effects*	HTP-nc	CTUh
Soil quality*	SQP	dimensionless
Potential environmental Impact Indicators (EN15804+A1)		
Global warming (GWP100a) – A1	GWP (A1)	kg CO_2 equivalents
Ozone layer depletion (ODP) – A1	ODP (A1)	kg CFC-11 equivalents
Acidification – A1	AP (A1)	kg SO_2 equivalents
Eutrophication – A1	EP (A1)	kg PO_4^{3-} equivalents
Photochemical oxidation – A1	POCP (A1)	kg C_2H_4 equivalents
Abiotic depletion – A1	ADPE (A1)	kg Sb equivalents
Abiotic depletion (fossil fuels) – A1	ADPF (A1)	MJ, net calorific value
Global warming (GWP100a) – A1	GWP (A1)	kg CO_2 equivalents
Additional Greenstar v1.3 Indicators		
Human Toxicity cancer Green Star	HTc (GS)	CTUh
Human Toxicity non-cancer Green Star	HTnc (GS)	CTUh
Land use Green Star	LU (GS)	kg C deficit equivalents
Ionising radiation Green Star	IR (GS)	kBq U-235 equivalents
Particulate Matter Green Star	PM (GS)	kg PM2.5 equivalents
WSI Green Star	WSI (GS)	m^3 equivalents

**Disclaimer – The results of these environmental impact indicators shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.*

***Disclaimer – 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 from some construction materials is also not measured by this indicator.*

**** - GWP-GHG (IPCC AR5) is an additional GWP100 indicator that is aligned with the Intergovernmental Panel on Climate Change (IPCC) 2013 Fifth Assessment Report (AR5) (IPCC 2013), national greenhouse gas reporting frameworks in Australia and New Zealand and previous versions of the Construction Products PCR (PCR2019:14). It excludes biogenic carbon and indirect radiative forcing.*

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The use of results of modules A1-A3 or A1-A5, without considering the results of module C may mislead the communication and decision-making. 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.

PRIMARY ENVIRONMENTAL INDICATORS (in accordance with EN 15804:2012**+A2**:2019) – **1m³ of ready-mix concrete**

Abbreviation	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
GWP-Total	kg CO_2 eq.	394	2.55	20.3	0.522	4.29	10.3	0	-18.4
GWP-Fossil	kg CO_2 eq.	394	2.55	20.3	0.522	4.29	10.3	0	-18.4
GWP-Biogenic	kg CO_2 eq.	0.116	0.0000884	0.00871	0.0000223	0.000149	0.00862	0	-0.0149
GWP-Luluc	kg CO_2 eq.	0.0585	0.0000652	0.0107	0.0000184	0.000110	0.00807	0	-0.0168
ODP	kg CFC 11 eq.	5.57E-6	3.36E-8	2.67E-7	7.80E-9	5.66E-8	1.32E-7	0	-8.97E-9
AP	mol H+ eq.	1.88	0.0132	0.131	0.00491	0.0223	0.0911	0	-0.104
EP-F	kg P eq.	0.0755	1.89E-6	0.00227	4.73E-7	3.18E-6	0.0000221	0	-0.000712
EP-M	kg N eq.	0.0556	0.00347	0.0316	0.00231	0.00585	0.0384	0	-0.0265
EP-T	mol N eq.	3.74	0.0387	0.439	0.0253	0.0652	0.421	0	-0.291
POCP	kg NMVOC eq.	0.975	0.0146	0.126	0.00748	0.0246	0.125	0	-0.0927
ADPE	kg Sb eq.	0.00678	8.55E-8	0.000204	2.15E-8	1.44E-7	1.68E-6	0	-2.28E-6
ADPF	MJ	2428	33.1	167	6.89	55.8	120	0	-242
WDP	m^3 equivalent deprived	49.1	0.0121	44.4	0.00925	0.0203	2.40	0	-32.5

RESOURCE USE PARAMETERS (in accordance with EN 15804:2012**+A2**:2019) – **1m³ of ready-mix concrete**

Abbreviation	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	84.8	0.0554	7.66	0.0129	0.0934	4.40	0	-23.3
PERM	MJ	0	0	0	0	0	0	0	0
PERT	MJ	84.8	0.0554	7.66	0.0129	0.0934	4.40	0	-23.3
PENRE	MJ	2497	33.1	169	6.89	55.8	120	0	-242
PENRM	MJ	0	0	0	0	0	0	0	0
PENRT	MJ	2497	33.1	169	6.89	55.8	120	0	-242
SM	kg	174	0	5.21	0	0	0	0	0
RSF	MJ	27.8	0	0.833	0	0	0	0	0
NRSF	MJ	92.9	0	2.79	0	0	0	0	0

FW	m^3	1.08	0.000421	0.686	0.000222	0.000709	0.0415	0	-0.781

WASTE CATEGORIES AND OUTPUT FLOWS (in accordance with EN 15804:2012**+A2**:2019) – **1m^3 of ready-mix concrete**

Abbreviation	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
HWD	kg	0.828	0.000227	0.0254	0.0000113	0.000382	0.000767	0	-0.000837
NHWD	kg	31.8	0.000849	70.3	2.19E-6	0.00143	0.115	0	-0.234
RWD	kg	0.0000711	1.25E-6	6.53E-6	0	2.11E-6	7.42E-6	0	-0.000516
CRU	kg	0	0	0	0	0	0	0	0
MFR	kg	0.0834	0	0.00250	0	0	2310	0	0
MFRE	kg	0	0	0	0	0	0	0	0
EE - e	MJ	0	0	0	0	0	0	0	0
EE - t	MJ	0	0	0	0	0	0	0	0

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (in accordance with EN 15804:2012**+A2**:2019) – **1m^3 of ready-mix concrete**

Abbreviation	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
GWP-GHG	kg CO_2 eq.	394	2.55	20.3	0.522	4.29	10.3	0	-18.4
GWP-GHG (AR5)	kg CO_2 eq.	407	2.55	20.7	0.523	4.30	10.3	0	-18.4
PM	disease incidence	0.0000323	2.31E-7	2.79E-6	1.41E-7	3.89E-7	2.35E-6	0	-1.66E-6
IRP	kBq U-235 eq	2878	0.00241	86.3	0.000526	0.00407	0.0126	0	-0.797
ETP-fw	CTUe	238	1.23	10.4	0.250	2.08	5.16	0	-33.4
HTP-c	CTUh	7.97E-7	1.02E-10	2.44E-8	2.81E-11	1.72E-10	8.59E-10	0	-2.07E-9
HTP-nc	CTUh	0.0000217	5.15E-9	6.64E-7	5.14E-10	8.69E-9	1.80E-8	0	-7.88E-8
SQP	dimensionless	775	0.0492	32.9	0.0133	0.0830	31.6	0	-155

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS (in accordance with EN 15804:2012**+A1**:2013) – **1m³ of ready-mix concrete**

Abbreviation	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
GWP (A1)	kg CO_2 eq.	406	2.55	20.7	0.522	4.29	10.3	0	-18.4
ODP (A1)	kg CFC 11 eq.	5.57E-6	3.36E-8	2.67E-7	7.80E-9	5.66E-8	1.32E-7	0	-8.97E-9
AP (A1)	kg SO_2 eq.	1.88	0.0132	0.131	0.00491	0.0223	0.0911	0	-0.104
EP (A1)	kg PO_4^{3-} eq.	0.172	0.00120	0.0153	0.000779	0.00203	0.0131	0	-0.0113
POCP (A1)	kg C_2H_4 eq.	0.975	0.0146	0.126	0.00748	0.0246	0.125	0	-0.0927
ADPE (A1)	kg SO_2 eq.	0.00678	8.55E-8	0.000204	2.15E-8	1.44E-7	1.68E-6	0	-2.28E-6
ADPF (A1)	MJ	2428	33.1	167	6.89	55.8	120	0	-242

ADDITIONAL GREEN STAR (V1.3) IMPACT INDICATORS – **1m³ of ready-mix concrete**

Abbreviation	Unit	A1-A3	A4	A5	C1	C2	C3	C4	D
HTc (GS)	CTUh	1.46E-8	2.38E-11	5.13E-10	3.60E-12	4.02E-11	1.04E-10	0	-4.72E-10
HTnc (GS)	CTUh	5.51E-10	2.61E-12	1.93E-11	2.08E-13	4.40E-12	4.72E-12	0	-2.18E-11
LU (GS)	kg C deficit eq.	37.7	0.0271	1.46	0.00637	0.0458	2.96	0	-492
IR (GS)	kBq U235 eq.	0.177	0.00242	0.0131	0.000526	0.00409	0.0126	0	-0.802
PM (GS)	kg PM2.5 eq.	0.0000323	2.31E-7	2.79E-6	1.41E-7	3.89E-7	2.35E-6	0	-1.66E-6
WSI (GS)	m^3	2.23	0.000410	2.30	0.000309	0.000691	0.121	0	-1.04

OTHER LIFE CYCLE STAGES NOT INCLUDED IN THIS EPD

While the LCA study and EPD only consider the cradle to gate (modules A1-A3) with options modules A4-A5, modules C1-C4 and module D of the environmental impacts of Holcim's ready-mix concrete, practitioners using the EPD for the purpose of whole-of-life building studies or the functional comparison of different building products on a whole-of-life basis will consider concrete's other life cycle stages. Some of the environmental impacts of benefits associated with other life cycle stages not included in this EPD are described in the following sections.

Lifetime absorption of CO_2

Carbonation is a natural process whereby concrete absorbs carbon dioxide (CO_2) from the atmosphere through a chemical reaction between the CO_2 in the ambient air and hydration products within the concrete ($CaOH_2$). Ready-mix concrete can be subject to carbonation from the use stage onward (i.e. after construction and curing). From a life cycle impact accounting perspective, this process can also be referred to as 'reabsorption', since the CO_2 emitted during the cement manufacturing process can be partly offset by the lifetime absorption of CO_2, therefore reducing the net CO_2 emissions associated with concrete over its lifetime.

The carbonisation process is a commonly known process in building design and is typically taken into consideration by engineers when specifying special-class concrete.

The total amount of CO_2 absorption during the life cycle of concrete is subject to a range of factors and varies over time. The calculation has been standardised in the British and European Standard BS EN 16757:2017 *Sustainability of construction works – Environmental Product Declarations – Product Category Rules for concrete and concrete elements.* It is recommended that practitioners make use of this standard when conducting whole-of-life building studies and if the building materials include substantial amounts of concrete. Please note that CO_2 absorption has not been considered in this EPD and is not reflected in the EPD results tables.

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