

READY MIXED CONCRETE PRODUCED BY: Brannan Companies

FACILITY:	Plant 13 Sedalia
STRENGTH:	4000 psi @ 28 days
MIX NAME:	840805

IMPACT INDICATOR		PER YD3	PER M3
Global Warming Potential	kg CO2e	239.06	312.67
Ozone Depletion	kg CFC11e	5.17E-06	6.76E-06
Acidification	kg SO2e	0.74	0.96
Eutrophication	kg Ne	0.27	0.35
SFP (Smog)	kg O3e	15.59	20.39
Non-renew. energy	MJ, NCV	1452.28	1899.51

GENERAL INFORMATION		
Declared Product	Ready-mixed concrete produced by Brannan Companies	
Date of Issue	August 18, 2022	
Period of Validity	5 years; April 12th, 2027	
EPD Holder	Brannan Companies 2500 East Brannan Way Denver, CO 80229	
Program Operator	ASTM International 100 Bar Harbor Drive West Conshohocken, PA 19428-2959, USA	 ASTM INTERNATIONAL Helping our world work better
LCA and EPD Developer	Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, ON K1P 5G8, Canada	 Athena Sustainable Materials Institute
Core PCR	ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products	
Sub-category PCR	NSF International Product Category Rule (PCR) for Concrete Version 2.1 (August 2021), Verified by Thomas P. Gloria, Ph.D., Industrial Ecology Consultants	
Independent LCA Reviewer and EPD Verifier	Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006	
	<input type="checkbox"/> Internal <input checked="" type="checkbox"/> External Thomas P. Gloria, Ph.D. • Industrial Ecology Consultants	

The declared product meets the following product specifications:

- ACI 211: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- ACI 318: Building Code Requirements for Structural Concrete.
- ASTM C94 Standard Specification for Ready-Mixed Concrete.
- CSI Masterformat Division 03-30-00: Cast-in-Place Concrete.
- UNSPSC Code 30111500: Ready Mix

Disclaimer:

EPDS are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

This EPD was calculated using industry average cement data. Cement LCA impacts can vary depending upon manufacturing process, efficiency and fuel source by as much as 50% for some environmental impact categories. Cement accounts for as much as 90% of the impacts of the concrete mixes included in this EPD and thus manufacturer specific cement impacts could result in variation of as much as 45%.

METHODOLOGICAL FRAMEWORK

DECLARED UNIT

The declared unit is 1 cubic meter (1 cubic yard) of ready mixed concrete product. Key product variables include:

- Compressive strength - Compressive strengths are represented in the mix design and include the number of days after pouring as a part of the reference value: e.g., 3,000 psi @ 28 days; 4,000 psi @ 56 days; 6,000 psi @ 90 days; etc.
- Water to cementitious materials ratio (w/cm) – Varies but generally lower for a higher strength non-air entrained mix design (above 5,000 psi (34.5 MPa)) in accordance with ACI 211.1 recommendations.
- SCM use – various mix designs call for Portland cement displacement by incorporating fly ash (FA) and/or slag cement (SL).
- Admixtures use – Admixtures used was specified for the mix design that was modeled. These admixtures included an air-entraining admixture, water reducing and accelerating admixtures, and high range water reducer admixtures
- The ready mixed concrete products represented in this EPD are comprised of (in order of greatest mass per mix): natural and crushed aggregates, portland cement, slag cement, batch water, and admixtures.

SYSTEM BOUNDARY

A summary of life cycle stages included in the EPD is identified in the figure below. This EPD covers A1-A3 life cycle stages (Cradle-to-Gate). A summary of activities excluded from the EPD is as follows:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure.
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment.
- Personnel-related activities (travel, furniture, and office supplies)
- Energy and water se related to company management and sales activities.

BUILDING LIFE CYCLE INFORMATION MODULES (X: Included in LCA; MND: Module Not Declared)

Production State				Construction Stage		Use Stage							End-Of-Life Stage			
Extraction	Production	Transport to Facility	Manufacturing	Transport to Site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	De-Construction/ Demolition	Transport to Disposal	Waste Processing	Disposal of Waste
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

CUT-OFF RULES

The cut-off criteria for all activity stage flows considered within the system boundary conform with ISO 21930: 2017 Section 7.1.8. Specifically, the cut-off criteria were applied as follows:

- All inputs and outputs for which data are available are included in the calculated effects and no collected core process data are excluded.
- A one percent cut-off is considered for renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process. The sum of the total neglected flows does not exceed 5% of all energy consumption and mass of inputs.
- All flows known to contribute a significant impact or to uncertainty (e.g., portland cement and admixtures) are included.
- The cut-off rules are not applied to hazardous and toxic material flows – all of which are included in the life cycle inventory.
- Proxy data was used for admixtures used that did not align with any of the admixture categories published in the European Federation of Concrete Admixtures Associations (EFCA) EPDs. In those cases, the Water Reducing Admixture data was selected as a conservative assumption as per the NSF PCR Appendix A.

ALLOCATION

The allocation of co-products or secondary flows cross the system boundary conforms with the ISO 21930: 2017 Section 7.2.4. Specifically, the allocation criteria were applied as follows:

- Allocation was not applied to any of the gate-to-gate production facilities.
- For Secondary Data sources, the NSF PCR default allocation selection (i.e., "Cut-off" or "Alloc Rec") was applied.
- The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.
- A portion (30%) of the reported fleet energy use for truck mixing plants was allocated to the mixing facility.

CALCULATED RESULTS A1- A3

CORE MANDATORY IMPACT INDICATOR			PER YD3	PER M3
Global warming potential	GWP	kg CO ₂ e	239.06	312.67
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	5.17E-06	6.76E-0
Acidification potential of soil and water sources	AP	kg SO ₂ e	0.74	0.96
Eutrophication potential	EP	kg Ne	0.27	0.35
Formation potential of tropospheric ozone	SFP	kg O ₃ e	15.59	20.39
Abiotic depletion potential for fossil resources	ADP _f	MJ, NCV	585.44	765.73
Abiotic depletion potential for non-fossil mineral resources	ADP _{ne}	kg Sbe	1.52E-04	1.99E-0
Fossil fuel depletion	FFD	MJ Surplus	72.96	95.43
USE OF PRIMARY RESOURCES				
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	16.93	22.14
Renewable primary energy carrier used as material	RPRM	MJ, NCV	0.00	0.00
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	1452.28	1899.51
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV	0.00	0.00
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY				
Secondary material	SM	kg	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	116.47	152.34
Recovered energy	RE	MJ, NCV	0.00	0.00
MANDATORY INVENTORY PARAMETERS				
Consumption of freshwater resources	FW	m ³	1.93	2.53
Calcination and carbonation emissions	CCE	kg CO ₂ e	106.89	139.81
INDICATORS DESCRIBING WASTE				
Hazardous waste disposed	HWD	kg	2.90E-03	3.79E-03
Non-hazardous waste disposed	NHWD	kg	69.75	91.23
High-level radioactive waste, conditioned, to final repository	HLRW	m ³	3.29E-09	4.31E-09
Intermediate- and low-level radioactive waste, to final repository	ILLRW	m ³	6.06E-08	7.92E-08
Components for re-use	CRU	kg	0.00	0.00
Materials for recycling	MR	kg	0.00	0.00
Materials for energy recovery	MER	kg	0.00	0.00
Recovered energy exported from the product system	EE	MJ, NCV	0.00	0.00

DATA SOURCES

This EPD is based on foreground LCI data collected from the participating company's production facilities for the calendar year 2021. All upstream material, resource and energy carrier inputs have been sourced from various industry-average datasets and literature. Many of these data sets are defaulted to those specified for use in the NSF PCR 2021. The following Table describes each LCI data source and includes the data quality assessment.

MATERIALS	LCI DATA SOURCE	YEAR	GEOGRAPHY	DATA QUALITY ASSESSMENT
Portland Cement and Limestone Cement, ASTM C595, AASHTO M240, or CSA A3001	Portland Cement Association EPD of Portland Cement and Portland Limestone Cement (2021)	2021	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Slag Cement, ASTM C989	Slag Cement Association EPD of North America Slag Cement (2021)	2021	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Fly Ash, ASTM C618	None, no incoming burden, only inbound transport is considered*	N/A	N/A	N/A
Silica Fume, ASTM C1240	None, no incoming burden, only inbound transport is considered*	N/A	N/A	N/A
Crushed Aggregates, coarse and fine, ASTM C33	ecoinvent 3.4: "Gravel, crushed {RoW} production Cut-off, U" (2018), modified with US average electricity	2001	World/US	Technology: very good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Natural Aggregates, coarse and fine, ASTM C33	ecoinvent 3.4: "Gravel, round {RoW} gravel and sand quarry operation Cut-off, U" (2018), modified with US average electricity	2001	World/US	Technology: very good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Manufactured Lightweight Aggregates, ASTM C330	ecoinvent 3.4: Expanded clay {RoW} production Cut-off, U (2018), modified with US average electricity	2000	World/US	Technology: good, Time: poor, Geography: good, Completeness: very good, Reliability: very good
Admixtures, ASTM C494	EFCA EPDs for Air Entrainers, Plasticisers and superplasticisers, Hardening Accelerators, Set Accelerators, Water Resisting Admixtures, and Retarders (2015)	2015	North America	Technology: very good, Time: very good, Geography: fair, Completeness: very good, Reliability: very good
Batch and Wash Water, ASTM C1602	ecoinvent 3.4: Tap water {RoW} market for Cut-off, U (2018), modified with US average electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good
Road Transport	USLCI 2014: Transport, combination truck, short-haul, diesel powered/tkm/RNA (2014)	2010	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Rail Transport	USLCI 2014: Transport, train, diesel powered /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Ocean Transport	USLCI 2014: Transport, ocean freighter, average fuel mix/US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Electricity	ecoinvent 3.4: Electricity, low voltage {XX} market for Cut-off, U (2018)	2015	North America	Technology: very good, Time: very good, Geography: very good, Completeness: very good, Reliability: very good
Diesel	USLCI 2014: Diesel, combusted in industrial boiler /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Gasoline	USLCI 2014: Gasoline, combusted in equipment /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Liquefied Propane Gas	USLCI 2014: Liquefied petroleum gas, combusted in industrial boiler /US U (2014)	2007	North America	Technology: very good, Time: fair, Geography: very good, Completeness: very good, Reliability: very good
Hazardous Solid Waste	ecoinvent 3.4: Hazardous waste, for incineration {RoW} treatment of hazardous waste, hazardous waste incineration Alloc, Rec, U (2018), modified with US electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good
Non-Hazardous Solid Waste	ecoinvent 3.4: Inert waste {RoW} treatment of, sanitary landfill Alloc Rec, U (2018), modified with US average electricity	2011	World/US	Technology: very good, Time: good, Geography: good, Completeness: very good, Reliability: very good

* The product category rules for this EPD recognize fly ash, silica fume and slag as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a concrete material input.

REFERENCES

American Concrete Institute (2009) ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

American Concrete Institute (2008) ACI 318: Building Code Requirements for Structural Concrete.

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National Renewable Energy Laboratory (2019) U.S. Life Cycle Inventory Database <http://www.nrel.gov/lci/>

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American Concrete Institute (2009) ACI 211.2: Standard Practice for Selecting Proportions for Structural Lightweight Concrete

ASTM International (2018) ASTM C94: Standard Specification for Ready-Mixed Concrete.

Construction Specifications Institute (CSI) MasterFormat Division 03-30-00 Cast-in- Place Concrete

CSA Group (2014) CSA A23.1-09/A23.2-14 - Concrete materials and methods of concrete construction / Test methods and standard practices for concrete.

EN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.

ISO 14044:2006/AMD 1:2017/ AMD 2:2020 Environmental Management – Life cycle assessment – Requirements and guidelines

ISO 14040:2006 Environmental Management - Life cycle assessment - Principles and framework