

# ENVIRONMENTAL PRODUCT DECLARATION



A cradle-to-gate EPD according to ISO 14025 and ISO 21930



**NORMAL-WEIGHT AND LIGHT-WEIGHT CONCRETE MASONRY UNITS  
MANUFACTURED USING CARBOCLAVE TECHNOLOGY**



## ASTM INTERNATIONAL CERTIFIED EPD

This is a business-to-business Type III environmental product declaration (EPD) for concrete masonry unit (CMU) products, as manufactured by Boehmers. This declaration has been prepared in accordance with ISO 14025 and ISO 21930, and the ASTM product category rules (PCR) and EPD program operator rules.

The intent of this document is to further the development of environmentally compatible and more sustainable construction products by providing comprehensive environmental information related to potential impacts of CMU.

### PROGRAM OPERATOR



**ASTM International**  
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### OWNER OF THE EPD



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### EPD INFORMATION

**Product Names**

Normal-weight & light-weight concrete masonry unit (CMU)

**Product Definition**

Manufactured masonry unit made of concrete in which the binder is a combination of water and cementitious materials

**Declared Unit**

1 m<sup>3</sup> CMU

**Declaration Number**

EPD-088

**Declaration Type**

A “cradle-to-gate” EPD for normal-weight and light-weight concrete masonry units manufactured by Boehmers in Kitchener, Ontario. Activity stages or information modules covered include production (modules A1 to A3). The declaration is intended for use in Business-to-Business (B-to-B) communication.

**Content of the Declaration**

The declaration follows Section 11, Content of the EPD, ASTM International, Product Category Rules For Preparing an Environmental Product Declaration For Manufactured Concrete and Concrete Masonry Products.

**Declaration Comparability Limitation Statement**

The following ISO statement indicates the EPD comparability limitations and intent to avoid any market distortions or misinterpretation of EPDs based on the ASTM’s PCR: 2014:

- EPDs from different programs (using different PCR) may not be comparable.
- Declarations based on the ASTM PCR are not comparative assertions; that is, no claim of environmental superiority may be inferred or implied.

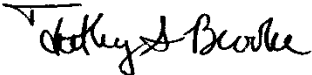
**EPD INFORMATION**

<b>Applicable Countries</b> Canada	<b>Date of Issue</b> January 7 <sup>th</sup> 2019	<b>Period of Validity</b> 5 years
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<b>EPD Prepared by</b>	Matt Bowick Athena Sustainable Materials Institute 280 Albert St., Suite 404 Ottawa, Ontario, K1P 5G8 matt.bowick@athenasmi.org
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**Athena**  
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This EPD was independently verified by ASTM in accordance with ISO 14025:		 Timothy Brooke ASTM International 100 Barr Harbor Dr. West Conshohocken, PA 19428 <a href="mailto:cert@astm.org">cert@astm.org</a>
Internal	<u>External</u>	
	X	

**EPD PROJECT REPORT INFORMATION**

<b>EPD Project Report</b> <i>Cradle-to-gate Life Cycle Assessment of Two Carboclave CMU Products, November, 2018.</i> The report is available upon request at <a href="mailto:cert@astm.org">cert@astm.org</a> .
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This EPD and EPD project report were independently verified by in accordance with ISO 14025 and the reference PCR:	Thomas Gloria, Ph.D. (LCACP ID: 2008-03) Industrial Ecology Consultants Email: <a href="mailto:info@industrial-ecology.com">info@industrial-ecology.com</a>
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**PCR INFORMATION**

<b>Reference PCR</b>	ASTM International, Product Category Rules For Preparing an Environmental Product Declaration For Manufactured Concrete and Concrete Masonry Products
<b>Date of Issue</b>	December 2014
<b>PCR review was conducted by:</b>	Nicholas Santero, PE International (Chairperson) Christine Subasic, Consulting Architectural Engineer Juan Tejada, ORCO Block Company  Contact information available upon request at <a href="mailto:cert@astm.org">cert@astm.org</a> .

## PRODUCT IDENTIFICATION

This EPD reports environmental information for normal- and light-weight concrete masonry units (CMUs) produced by Boehmers using Carboclave technology, at their facility in Kitchener, ON. See Figure 1 for a visual representation of a typical CMU.



**Figure 1: Concrete Masonry Unit**

CMUs are typically used in load-bearing and partition wall construction. The blocks are laid in horizontal rows; successive rows are bound by mortar beds and optionally reinforced with steel reinforcing and/or concrete grout. CMUs are also used in masonry columns and beam construction.

CMUs typically have a length of 390 mm, a height of 190 mm, and a gross thickness of either 90 mm, 140 mm, 190 mm, 240 mm, or 290 mm<sup>1</sup>

The applicable Canadian product standard for CMUs (UN CPC 3755) is *CSA A165.1-04 - Concrete block masonry units*.

Table 1 below summarizes the specifications for CMU products that are applicable to this EPD, according to the CSA A165.1-04 "Four Facet" system.

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<sup>1</sup> The noted thicknesses correspond to size codes 10, 15, 20, 25, and 30. The size code refers to the nominal thickness of the block in centimetres.

**Table 1: CMU Products Applicable to this EPD**

FACET	SPECIFICATION IDENTIFICATION		COMMENTS
	NORMAL-WEIGHT	LIGHT-WEIGHT	
<b>First:</b> Identifies the percentage content of the unit.	H, S, or Sc		The symbols H, S and Sc indicate less than 75%, greater than 75% but less than 100%, and 100% solid content respectively.
<b>Second:</b> Identifies the minimum concrete material strength, in MPa.	15	15	The specified strength of the unit is based on test results of three units with a minimum strength as noted.
<b>Third:</b> identifies oven dry concrete density and the allowable absorption maximum as a percentage of concrete density.	A	B	A and B refer to CMUs with oven dry densities of >2,000 and 1,800-2,000 kg/m <sup>3</sup> , and absorption maximums of 175 and 200 kg/m <sup>3</sup> , respectively.
<b>Fourth:</b> identifies the maximum moisture, expressed as a percentage of actual absorption as it relates to relative humidity and linear shrinkage of the concrete unit.	M, O		M refers to a known moisture content maximum (See CSA A165.1-04 for further information). O refers to no limits on moisture content maximum.

Carboclave CMU is a next-generation, patent-pending masonry product that utilizes recovered carbon dioxide as a curing agent in lieu of typical steam curing. Molded blocks are loaded into Boehmers’ autoclave and pressurized with CO<sub>2</sub> (typically 10 psi). The CO<sub>2</sub> causes the carbonation reaction to occur, which produces calcium carbonate (CaCO<sub>3</sub>) in the concrete. As CO<sub>2</sub> is consumed, the pressure in the autoclave reduces to 0 psi and the process is repeated multiple times until the blocks are fully cured. Since converting operations from autoclave steam curing to Carboclave, Boehmers has eliminated their use of energy for curing and now sequester a minimum of 0.5 lbs (0.227 kg) CO<sub>2</sub> into each 20 cm block produced.

Some of the observed characteristics of Carboclave CMU are:

- Higher compressive strength;
- Better freeze/thaw resistance;
- Improved sulphate attack resistance;
- Greater resistance to drying and atmospheric shrinkage;
- Reduced sorptivity/permeability;
- Reduced efflorescence effect; and
- Consistent colour in production.



## DECLARED UNIT

The declared unit is 1 m<sup>3</sup> of CMU.

## REFERENCE SERVICE LIFE

The reference service life of CMU is dependent on its end-use and therefore not declared herein.

## MATERIAL CONTENT

Table 2 presents the material content by input material for the two products.

**Table 2: Material Content of CMU Products**

MATERIAL	MASS, kg/m <sup>3</sup>	
	NORMAL-WEIGHT	LIGHT-WEIGHT
Portland Limestone Cement (GUL)	200	255
Slag Cement (GGBFS)	36.0	45.0
Crushed Coarse Aggregate	325	0
Natural Fine Aggregate	1,800	300
Expanded Slag	0	1,576
Air Entraining Admixture	0.0622	0.0439
Recovered Carbon Dioxide	28.8	28.8
Batch Water	45.4	53.8
<b>TOTAL</b>	<b>2,435</b>	<b>2,259</b>

## SYSTEM BOUNDARY

As per the ASTM PCR, the system boundary is the product stage, which includes the following modules:

- A1 Raw material supply;
- A2 Transport (to the manufacturer); and
- A3 Manufacturing.

Figure 2 shows the production stage system boundary for CMU.

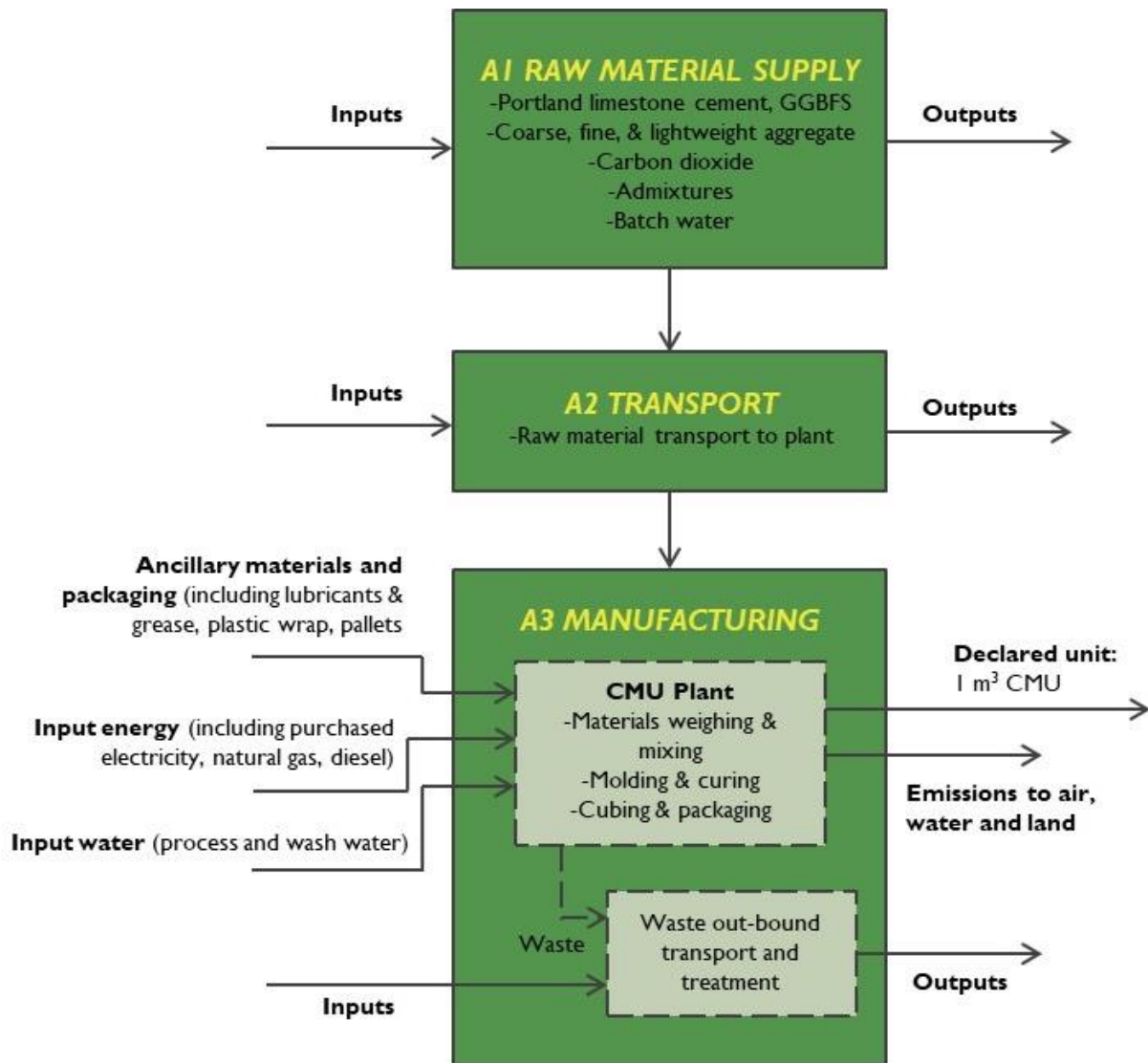


Figure 2: Product Stage (module A1 to A3) System Boundary

## LIFE CYCLE ASSESSMENT

This section summarizes the results of the life cycle impact assessment (LCIA) based on the cradle-to-gate life cycle inventory inputs and outputs analysis. The results are calculated on the basis of 1 m<sup>3</sup> concrete masonry product (Table 4 and 5). The production results are delineated by information modules A1 through A3.

As per the ASTM PCR, Section 8, US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI, version 2.1) impact categories are used for the mandatory category indicators to be included in this EPD. These are relative expressions only and do not predict category impact end-points, the exceeding of thresholds, safety margins or risks. Total primary and sub-set energy consumption was compiled using a cumulative energy demand model. Material resource consumption and generated waste reflect cumulative life cycle inventory flow information.

**Table 3: LCA results – Normal-weight CMU, per m<sup>3</sup>**

ENVIRONMENTAL INDICATOR	UNIT	A1	A2	A3	TOTAL
<b>TRACI 2.1 IMPACT CATEGORIES</b>					
Global warming potential	kg CO <sub>2</sub> eq.	158	3	34	196
Acidification potential	kg SO <sub>2</sub> eq.	0.87	0.02	0.25	1.14
Eutrophication potential	kg N eq.	0.0442	0.0013	0.0045	0.0500
Smog creation potential	kg O <sub>3</sub> eq.	13.6	0.6	1.1	15.3
Ozone depletion potential	kg CFC-11 eq.	3.20E-06	1.45E-10	2.96E-08	3.23E-06
<b>TOTAL PRIMARY ENERGY CONSUMPTION</b>					
Non-renewable fossil	MJ (HHV)	1,177	52	565	1,794
Non-renewable nuclear	MJ (HHV)	184	1	230	415
Renewable (non-biomass)	MJ (HHV)	76	0	35	111
Renewable (biomass)	MJ (HHV)	99	0	9	108
<b>MATERIAL RESOURCES CONSUMPTION</b>					
Non-renewable material resources	kg	2,580	0	0	2,581
Renewable material resources	kg	4.68	0.00	3.83	8.51
Net fresh water	l	792	0	73	865
<b>WASTE GENERATED</b>					
Non-hazardous waste generated	kg	0.3	0.0	40.6	41.0
Hazardous waste generated	kg	0.006	0.000	0.111	0.117



Table 4: LCA results – Light-weight CMU, per m<sup>3</sup>

ENVIRONMENTAL INDICATOR	UNIT	A1	A2	A3	TOTAL
<b>TRACI 2.1 IMPACT CATEGORIES</b>					
Global warming potential	kg CO <sub>2</sub> eq.	206	16	34	256
Acidification potential	kg SO <sub>2</sub> eq.	1.39	0.11	0.25	1.75
Eutrophication potential	kg N eq.	0.0628	0.0060	0.0045	0.0732
Smog creation potential	kg O <sub>3</sub> eq.	16.7	2.8	1.1	20.6
Ozone depletion potential	kg CFC-11 eq.	3.36E-06	6.87E-10	2.96E-08	3.39E-06
<b>TOTAL PRIMARY ENERGY CONSUMPTION</b>					
Non-renewable fossil	MJ (HHV)	1,443	248	565	2,256
Non-renewable nuclear	MJ (HHV)	265	3	230	498
Renewable (non-biomass)	MJ (HHV)	82	1	35	118
Renewable (biomass)	MJ (HHV)	127	0	9	136
<b>MATERIAL RESOURCES CONSUMPTION</b>					
Non-renewable material resources	kg	733	0	0	733
Renewable material resources	kg	5.95	0.00	3.83	9.78
Net fresh water	l	609	0	73	682
<b>WASTE GENERATED</b>					
Non-hazardous waste generated	kg	0.5	0.2	40.6	41.3
Hazardous waste generated	kg	0.008	0.000	0.111	0.118

## ADDITIONAL ENVIRONMENTAL INFORMATION

Table 5 reports two additional environmental indicators:

- *Recovered materials* sums the mass of recovered materials used in the CMU formulations (i.e. the mass after processing has occurred);
- *Respiratory effects* is a TRACI 2.1 impact category.

**Table 5: Additional Cradle-to-gate Environmental Indicator Results**

<b>ENVIRONMENTAL INDICATOR</b>	<b>UNIT</b>	<b>NORMAL-WEIGHT</b>	<b>LIGHT-WEIGHT</b>
Recovered materials	kg	64.8	1,649
Respiratory effects	kg PM2.5 eq.	0.0926	0.301

