Environmental Product Declaration

ASTM INTERNATIONAL

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

Concrete Pipe, Box Structures & Manholes/Catch Basins as Manufactured by Members of the Canadian Concrete Pipe & Precast Association (CCPPA)

CCPPA

Canadian Concrete Pipe & Precast Association

Build on our strength

About The CCPPA

The Canadian Precast Pipe and Precast Association was established in November 2013 to represent concrete pipe producers and manufacturers of precast concrete products used for a wide range of sewer and drainage infrastructure applications, and suppliers to the precast concrete industry. The not-for-profit association was established to protect and advance the interests of the concrete pipe and precast concrete products industry in Canada.

The key activities of the CCPPA are:

- Specifications and Standards development and consultation with regulators, specifiers and designers,
- Education of professionals involved in specifying materials and products of gravity pipeline and transportation systems,
- Government relations,
- Promotion of the application of precast concrete products and systems, and
- Research to advance the knowledge of materials used for constructing precast concrete pipeline systems and culverts.

ASTM International Certified EPD

This is a Canadian industry-average business-to-business Type III environmental product declaration (EPD) for concrete pipe, box structures and manholes/catch basins as manufactured by Canadian Concrete Pipe & Precast Association (CCPPA) members. 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 precast concrete infrastructure products available in Canada in accordance with international standards.

Program Operator	
ASTM INTERNATIONAL	**ASTM International** Environmental Product Declarations 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 www.astm.org
Owner of the EPD	
CCPPA Canadian Concrete Pipe & Precast Association *Build on our strength*	**Canadian Concrete Pipe & Precast Association (CCPPA)** 447 Frederick St, Kitchener, Ontario, Canada N2H 2P4 http://www.ccppa.ca/ A complete list of CCPPA producer members is available at http://www.ccppa.ca/ABOUT/Members.aspx
EPD Information	
Product Names Concrete Pipe, Box Structures and Manholes/Catch basins **Product Group** Precast Concrete (UN CPC 3755)	**Product Definition** Precast concrete is a construction product produced by casting concrete in a reusable mold or "form" which is then cured in a controlled environment, transported to the construction site and lifted into place. Precast concrete is used in building or civil engineering

	works and is primarily composed of cement, aggregates and reinforcement materials.
Declared Unit 1 metric tonne	**Declaration Number** #065

Declaration Type

A "cradle-to-gate" EPD for Concrete Pipe, Box Structures and Manholes/Catch basins manufactured by CCPPA members across Canada. 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. This EPD (UN CPC 3755) is an average product EPD, as an average from several CCPPA manufacturers' facilities as listed under "CCPPA Producer Member-companies – http://www.ccppa.ca/ABOUT/Members.aspx

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 Precast Concrete, March 2015.

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: 2015:

- 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.

Applicable Countries	**Date of Issue**	**Period of Validity**
Canada	September 1, 2017	5 years

EPD Prepared by Athena Sustainable Materials Institute	Jamie Meil Athena Sustainable Materials Institute 119 Ross Avenue, Suite 100 Ottawa, Ontario, K1Y 0N6, Canada info@athenasmi.org
This EPD was independently verified by ASTM in accordance with ISO 14025: Internal — External X	Timothy Brooke ASTM International 100 Barr Harbor Dr. West Conshohocken, PA 19428 cert@astm.org

EPD Project Report Information

EPD Project Report

A Canadian Industry-Average Cradle-to-Gate Life Cycle Assessment of On and Below Grade Precast Concrete Products, August 2017. The report is available upon request at *cert@astm.org*.

EPD Project Prepared by	Jamie Meil Athena Sustainable Materials Institute 119 Ross Avenue, Suite 100 Ottawa, Ontario, K1Y 0N6, Canada

Athena Sustainable Materials Institute	info@athenasmi.org
This EPD and EPD project report were independently verified by in accordance with ISO 14025 and the reference PCR:	Thomas P. Gloria, Ph. D. Industrial Ecology Consultants 35 Bracebridge Rd. Newton, MA 02459-1728 tel: 617.553.4929
PCR Information	
Reference PCR	ASTM International, Product Category Rules For Preparing an Environmental Product Declaration For Precast Concrete
Date of Issue	March 2015
PCR review was conducted by:	Nicholas Santero, PE International (Chairperson) Christine Subasic, Consulting Architectural Engineer Juan Tejeda, ORCO Block Company Contact information available upon request at *cert@astm.org*.

1. PRODUCT IDENTIFICATION

This EPD reports industry-average environmental information for products broadly called either "Concrete Pipe", "Box Structures" or "Manholes/Catch Basins", produced by CCPPA members at their facilities located across Canada. See Figure 1 for a visual representation of a typical Products.

Figure 1: Precast Product Examples, concrete pipe (upper photo), box structure (lower left photo), manhole (lower right photo)

For the purposes of this EPD the following broad descriptions for each product group is as follows:

Concrete Pipe | Depending on the application concrete pipe may or may not be conventionally reinforced. Precast concrete pipe is used in conveying wastewater and stormwater through complex underground infrastructure systems, preserving groundwater quality and ensuring a sanitary environment. Reinforced concrete pipe is available in a variety of sizes and strength classes to meet any need.

Box Structures | Precast boxes are a structural product used primarily for drainage, but versatile enough to use in a variety of configurations such as vertical access chambers or lift stations, and horizontal tunnels, pedestrian underpasses and onsite detention systems.

Industry standards for box structures such as OPSS 1821 or ASTM C1443 provide a cost-effective product while ensuring a consistently high quality. Box units are designed to meet Canadian Highway Bridge Design Code requirements and can be engineered to accommodate specialized loading conditions or almost any application that an engineer or designer can imagine.

Manholes and Catch Basins | Precast concrete manholes are the standard product used to provide vertical access to buried pipelines, vaults, detention tanks and various other linear infrastructure. They are manufactured using modern concrete technology. Manholes are typically installed with rubber gaskets to provide a watertight product and to reduce infiltration into storm or sanitary systems. Circular manholes are provided with cast-in lifting inserts for safe installation, ladder rungs for access, and are available in standard sizes and components that can be configured for any depth.

Precast catch basins collect surface-level stormwater runoff that is then diverted into underground infrastructure. Precast catch basins can be manufactured in a variety of sizes to meet required standards and customized for any project.

2. DECLARED UNIT

The declared unit is 1 metric tonne of product.

3. REFERENCE SERVICE LIFE

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

4. MATERIAL CONTENT

Table 1 below presents the industry-average material content by input material for the three precast products, as derived by the CCPPA and the Athena Sustainable Materials Institute.

Table 1: Weighted-average Material Content of Precast Products

Material Inputs/metric tonne	Unit	Precast Product Groups		
		Pipe	Box Structure	Manhole/ Catch Basin
Portland Cement	kg	109.5	99.1	122
Fine Aggregate - natural sand	kg	76.9	81.0	81.0
Fine Aggregate - manufactured	kg	307.6	324.0	324.1
Coarse Aggregate - natural gravel	kg	128.5	136.3	136.4
Coarse Aggregate - crushed	kg	223.7	237.2	237.4

Material Inputs/metric tonne	Unit	Precast Product Groups		
		Pipe	Box Structure	Manhole/ Catch Basin
SCM - Fly Ash	kg	5.0	4.2	3.3
SCM - Slag Cement	kg	37.7	36.8	24.5
Chemical Admixture (CA) - Air Entraining	litre	0.0	0.001	0.0
CA - Water Reducer/Plasticizer	litre	0.0	0.16	0.16
Chemical Admixture - Accelerator	litre	0.0	0.005	0.005
CA - High Range Water Reducer (HRWR)/Super Plasticizer and/or Viscosity Modifying Admixture (VMA)	litre	0..35	0.19	0.19
Form Release Agent	litre	0.35	0.19	0.16
Rebar	kg	0.0	0.0	8.6
Welded Wire Reinforcement (WWR)	kg	0.0	27.5	6.6
Cold Drawn Wire Reinforcement (CDW)	kg	52.4	0.0	0.0
Steel Anchors	kg	0.12	0.19	0.21
Spacers (steel)	kg	0.49	0.68	0.47
Total Batch Water Use	litre	57.9	53.2	55.4

5. 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 the precast concrete product groups.

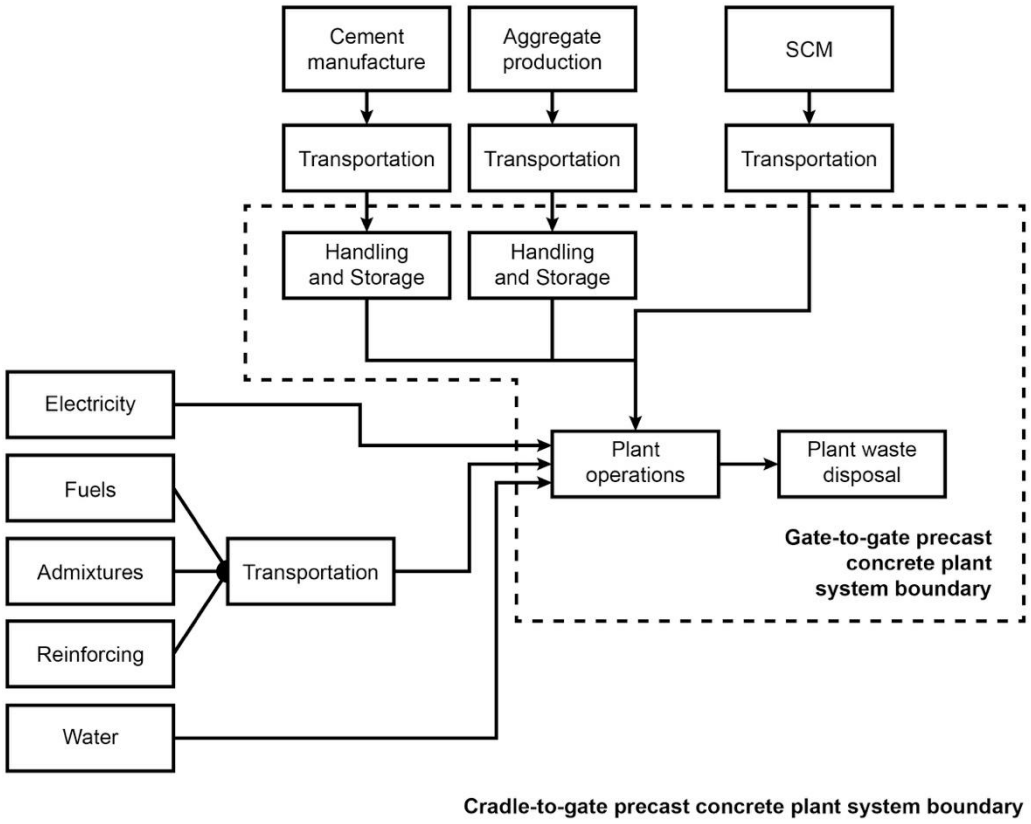

Figure 2: Product Stage (module A1 to A3) System Boundary

6. LIFE CYCLE INVENTORY

6.1. Primary LCI Data

CCPPA represents 14 member companies operating 21 precast manufacturing facilities in the provinces of British Columbia, Alberta, Saskatchewan, Manitoba and Ontario. Primary data is based on 14 surveys of precast facilities deemed representative of CCPPA member-companies, taking into consideration regional production, plant size and product type.

The following primary data were obtained from CCPPA member-companies, for either 2016 calendar or fiscal year:

- Product group and other product production amounts, and average concrete batch wastage;
- Inbound transportation distances and modes for raw materials, and ancillary and packaging materials;
- Facility electricity and fuel consumption, and product and wash water use;
- Ancillary and packaging material use;
- Process air emissions;
- Waste outputs and outbound transportation distances and modes.

In instances where plant data were missing for a particular parameter of interest, that plant's data was removed from the horizontal averaging for that parameter.

6.2. Secondary LCI Data

See Table 3 for a summary of secondary LCI data sources used to complete a production stage LCA model for the two CMU products.

Table 2: Secondary LCI Data Sources Summary

Item	Source
A1 - Raw Material Supply	
▪ Portland cement, fly ash, slag cement	Athena LCI database
▪ Crushed and natural aggregates, pumice, batch water	ecoinvent 3.1 database
▪ Admixtures	European Federation of Concrete Admixtures Associations
A2 - Transport	
▪ Truck, rail, barge, ocean freighter	US LCI database
A3 - Manufacturing	
▪ Ancillary materials, including form release agent, road dust control chemicals, oil and lubricants, grease	ecoinvent 3.1 database
▪ Purchased electricity	Athena LCI database
▪ Natural gas, diesel, gasoline, liquefied petroleum products	US LCI database
▪ Water discharges	Quantis Water Database
▪ Outbound waste transport (truck)	US LCI database
▪ Non-hazardous waste to landfill, hazardous waste to incinerator	ecoinvent 3.1 database

6.3. Cut-off and Allocation

All input/output flow data reported by the facility were included in the LCI modelling.

Allocation procedures observed the requirements and guidance of ISO 14044:2006, clause 4.3. and those specified in ASTM PCR for precast concrete, Section 7.5. Precast plant LCI environmental flows (inputs and outputs) were allocated across the three product groups on a mass basis.

6.4. Data Quality

Data quality requirements, as specified in ASTM PCR: 2015, Section 7.3, were observed. This section describes the achieved data quality relative to the ISO 14044:2006 requirements.

Precision: CCPPA members, through measurement and calculation, collected primary data on their production of the three product groups. For accuracy, the LCA team individually validated these plant gate-to-gate input and output data.

Completeness: All relevant, specific processes, including inputs (raw materials, energy, and ancillary materials) and outputs (emissions and production volume) were considered. The relevant background materials and processes were generally taken from the Athena LCI Database, US LCI Database (adjusted for known data placeholders, and ecoinvent v3.1 LCI database, and modeled in SimaPro software v.8.1.3, July 2017.

Consistency: System boundaries, and allocation and cut-off rules have been uniformly applied across the product life cycles and the three precast product groups. The study predominantly relies on two sources of secondary data (US LCI and ecoinvent databases); adjustments were uniformly applied to all electricity, fuel, and transport processes. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted.

Reproducibility: Internal reproducibility is possible since the data and the models are stored and available in Athena LCI database developed in SimaPro, 2016. A high level of transparency is provided throughout the report as the LCI profile is presented for the declared product groups.

Representativeness: The representativeness of the data is summarized as follows:

- Time related coverage: *primary* collected data for precast manufacturing process: 2016; all *secondary* data has been validated within the past 8 years.
- Geographical coverage: the geographical coverage is Canada.
- Technological coverage: typical or average.

7. 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 for one metric tonne of

concrete pipe, box structures and manholes/catch basins (Tables 4, 5 and 6 respectively). 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 as they provide a North American context 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: Concrete Pipe LCIA, Resource Use and Waste Generated Results - per metric tonne

Category Indicator	Unit	Raw Material Supply	Transport	Manufacturing	Weighted Average Total
		A1	A2	A3	
Global warming potential	kg CO_2 eq.	174	9	38	221
Acidification potential	kg SO_2 eq.	0.847	0.069	0.242	1.158
Eutrophication potential	kg N eq.	0.0645	0.0039	0.0096	0.0781
Smog creation potential	kg O_3 eq.	11.1	1.9	1.2	14.2
Ozone depletion potential	kg CFC-11	2.01E-06	3.85E-10	4.09E-07	2.42E-06
Primary Energy Consumption					
Total Primary Energy	MJ, HHV	2,098	141	676	2,914
Non-renewable (fossil, nuclear)	MJ, HHV	1,980	140	643	2,763
Renewable (solar, wind, biomass	MJ, HHV	118	0	33	151
Material resources consumption					
Total Material Resource	kg	1,053	0	14	1,068
Non-renewable materials	kg	1,050	0	14	1,064
Renewable materials	kg	4.04	0.00	0.21	4.25
Fresh water	L	1,276	0	510	1,786
Waste generated					
Non-hazardous	kg	0.6	0.1	11.3	12.1

Category Indicator	Unit	Raw Material Supply	Transport	Manufacturing	Weighted Average Total
		A1	A2	A3	
Hazardous	kg	0.004	0.000	0.157	0.161

Table 4: Box Structures LCIA, Resource Use and Waste Generated Results - per metric tonne

Category Indicator	Unit	Raw Material Supply	Transport	Manufacturing	Weighted Average Total
		A1	A2	A3	
Global warming potential	kg CO_2 eq.	136	7	38	181
Acidification potential	kg SO_2 eq.	0.672	0.053	0.242	0.967
Eutrophication potential	kg N eq.	0.0560	0.0030	0.0096	0.0686
Smog creation potential	kg O_3 eq.	9.1	1.5	1.2	11.8
Ozone depletion potential	kg CFC-11	1.90E-06	2.94E-10	4.09E-07	2.31E-06
Primary Energy Consumption					
Total Primary Energy	MJ, HHV	1,481	107	676	2,264
Non-renewable (fossil, nuclear)	MJ, HHV	1,379	107	643	2,129
Renewable (solar, wind, biomass	MJ, HHV	102	0	33	135
Material resources consumption					
Total Material Resource	kg	1,050	0	14	1,065
Non-renewable materials	kg	1,047	0	14	1,062
Renewable materials	kg	3.12	0.00	0.21	3.33
Fresh water	L	891	0	510	1,400
Waste generated					
Non-hazardous	kg	0.4	0.1	11.3	11.8
Hazardous	kg	0.003	0.000	0.157	0.160

Table 5: Manholes and Catch Basins LCIA, Resource Use and Waste Generated Results - per metric tonne

Category Indicator	Unit	Raw Material Supply	Transport	Manufacturing	Weighted Average Total
		A1	A2	A3	
Global warming potential	kg CO_2 eq.	141	6	38	185
Acidification potential	kg SO_2 eq.	0.643	0.046	0.242	0.931
Eutrophication potential	kg N eq.	0.0615	0.0026	0.0096	0.0738
Smog creation potential	kg O_3 eq.	9.6	1.3	1.2	12.1
Ozone depletion potential	kg CFC-11	1.91E-06	2.48E-10	4.09E-07	2.32E-06
Primary Energy Consumption					
Total Primary Energy	MJ, HHV	1,302	91	676	2,068
Non-renewable (fossil, nuclear)	MJ, HHV	1,189	90	643	1,922
Renewable (solar, wind, biomass	MJ, HHV	113	0	33	146
Material resources consumption					
Total Material Resource	kg	1,055	0	14	1,070
Non-renewable materials	kg	1,052	0	14	1,066
Renewable materials	kg	3.40	0.00	0.21	3.61
Fresh water	L	756	0	510	1,266
Waste generated					
Non-hazardous	kg	0.3	0.1	11.3	11.7
Hazardous	kg	0.004	0.000	0.157	0.161

8. REFERENCES

Athena Sustainable Materials Institute, A Canadian Industry-Average Cradle-to-Gate Life Cycle Assessment of On and Below Grade Precast Concrete Products, August 2017

ASTM International, Product Category Rules For Preparing an Environmental Product Declaration For Precast Concrete, March 2015.

ISO 21930: 2007 Building construction – Sustainability in building construction – Environmental declaration of building products.

ISO 14025: 2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.

ISO 14044: 2006 Environmental management - Life cycle assessment - Requirements and guidelines.

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

ISO 14021:1999 Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling)

Quantis Water Database Technical Report version 1, 2012