

PRODUCT CATEGORY RULES FOR PREPARING
AN ENVIRONMENTAL PRODUCT DECLARATION
FOR PRECAST CONCRETE



Program Operator - NSF International
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PCR

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Precast Concrete (UN CPC 3755)

The product group includes structural, architectural, specialty, utility, and drainage precast concrete products used on, above, and below ground excluding concrete pavers and concrete masonry.

REFERENCED PCR:

The Norwegian EPD Foundation, NPCR 20, Product-Category Rules (PCR) for preparing an environmental declaration (EPD) for Product Group Precast Concrete Products, March 2012



Precast Concrete

Scope of Validity of these PCR

The product group includes structural, architectural, specialty, utility, and drainage precast concrete products used on, above, and below ground excluding segmental concrete pavers and concrete masonry.

Program Operator

ASTM International

Interested Parties

Representatives of the following organizations participated in development of the PCR:

American Concrete Pipe Association (ACPA), Canadian Precast/Prestressed Concrete Institute (CPCI), National Precast Concrete Association (NPCA), Precast/Prestressed Concrete Institute (PCI), and their member companies: M. E. Hachborn Engineering, Lafarge Construction Materials, Lindsay Concrete, Oldcastle Precast Building Systems, and Resource Management Associates, Inc.

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Appendix A Product Definitions

1.0 General Information

These product category rules (PCR) have been developed under the general program instructions for ASTM International's Environmental Product Declaration (EPD) Program. The PCR are intended for use by North American organizations and other interested parties that use the standards referenced in Section 5.2 for preparing EPDs for structural, architectural, specialty, utility, and drainage precast concrete products, for industrial, commercial, residential, and institutional applications, including but not limited to, architectural and structural products such as walls, columns, floors, roofs, facades, bridge substructure, and superstructure products; and underground utility and drainage products such as pipe, utility structures, manholes, septic tanks, and other related applications.

The referenced PCR – The Norwegian EPD Foundation, NPCR 20, Product-Category Rules (PCR) for preparing an environmental declaration (EPD) for Product Group Precast Concrete Products, March 2012 – are inappropriate for adoption or direct adaptation as PCR for precast concrete in the North American context. The referenced PCR document lists and refers to European technical data, standards and impact characterization methods that are not applicable in North America. The referenced document specifically notes that: “This PCR is a common European PCR with an appendix A1 giving specific guidelines according to Norwegian requirements.”

The following related PCR documents were also reviewed during development of these PCR but either deal more broadly with concrete or cement, and do not address the final precast products.

- UN CPC 3744 Cement, version 2.0, Centre for the Development of Product Sustainability in co-operation with AITEC, 2013-05-16
- UN CPC 375 Concrete Product Category Rules, version 1.0, dated February 2013, developed for the WBCSD Cement Sustainability Initiative—global scope, http://www.wbcdcement.org/pdf/pcr1302_CPC_375_Concrete_1_0.pdf
- Carbon Leadership Forum (CLF), Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) of Concrete, Revised Version 1.1, December 4, 2013 <http://www.carbonleadershipforum.org/clf-pcr-v11-2013-12-04.pdf>
- Product Category Rules for Cement, developed by the Centre for the Development of Product Sustainability in co-operation with AITEC and Buzzi Unicem, dated September 15, 2010, with drafts for a revision dated October 15, 2012, (under development). <http://www.environdec.com/PCR/Detail/?Pcr=5942#.Uu-g1NGYab8>
- Product Category Rules for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, ASTM International, September 2014. http://www.astm.org/CERTIFICATION/filtrexx40.cgi?-P+PROG+7+cert_detail.frm

1.1 | GOAL AND SCOPE

This PCR document specifies rules, requirements, and guidelines for developing EPDs for precast concrete and underlying requirements of related life-cycle assessments (LCAs). These PCR are valid for, and provide requirements for, Business-to-Business (BtoB) EPDs. A BtoB EPD covers the cradle-to-gate production stage with the product packaged and ready for shipment at the plant gate.

An EPD prepared under these PCR shall present results for the following phases of the life cycle:

- raw materials acquisition;
- transportation; and

- manufacturing.

These PCR are consistent with and comply with the mandatory requirements contained in the following standards:

- International Organization for Standardization (ISO) 21930: 2007 *Sustainability in building construction—Environmental declaration of building products*.
- ISO 14025: 2006 *Environmental labels and declarations—Type III environmental declarations—Principles and procedures*.
- ISO 14040: 2006 *Environmental management—Life cycle assessment—Principles and framework*.
- ISO 14044: 2006 *Environmental management—Life cycle assessment—Requirements and guidelines*.

While not necessarily complying with the CEN EN 15804 standard, it is referenced in Section 12 and has been consulted with regard to selected requirements and presentation details that go beyond or expand on the above-noted ISO standards.

1.2 | EPD OWNERSHIP/RESPONSIBILITY

The producers or group of producers who develop an EPD following these PCR maintain sole ownership and have responsibility and liability for their EPD.

2.0 Period of Validity

This PCR document is effective for five (5) years from the latest date of publication. If after five years, relevant changes in the product category or other relevant factors have occurred (for example, LCA methodology), the document will be revised.

An EPD created under these PCR shall be valid for a five (5) year period from the date of issue after which it shall be reviewed and verified. An EPD shall only be reassessed and updated after five years as necessary to reflect changes in technology or other circumstances that could alter the content and accuracy of the declaration. The process for verification and establishing the validity of an EPD shall be in accordance with ISO 14025 and ISO 21930.

3.0 Category Definitions

For the purposes of this document, the definitions given in ISO 6707-1, ISO 14025, ISO 14044, ISO 14050, ISO 21930 and the following apply. Further product descriptions are provided in Appendix A.

structural precast products | superstructure bridge products such as bridge decks, girders, and parapets; substructure bridge products such as abutments, piers, footings, and pile caps; building products such as columns, beams, interior solid bearing and shear walls, double tees, hollowcore, spandrels, and solid slabs; stairs and stadia seating; and other items such as piles, footings, barriers, retaining walls, rail ties, and the like. Structural precast products can be conventionally reinforced or prestressed.

architectural precast | single-wythe exterior wall panels and architectural trim products. Architectural precast products can be conventionally reinforced or prestressed concrete that will be permanently exposed to view and therefore require special care in selection of the concrete materials, forming, placing, and finishing to obtain the desired architectural appearance.

insulated architectural precast products | two conventionally reinforced or prestressed concrete wythes with a continuous layer of rigid insulation placed between.

underground precast | pipe and culvert products, man-holes, tanks, chambers, and related products such as electrical utility products. Underground precast products are typically conventionally reinforced.

Note: The term ‘conventionally reinforced’ used throughout this document refers to concrete reinforced with a reinforcing material of significant tensile strength, (steel, fiberglass or carbon fiber, etc.) where the concrete and the reinforcing material in the concrete is not subjected to prestressing load prior to the element being placed in service.

4.0 Informed Comparison

EPDs may enable comparison between products but do not themselves compare products, as stated in ISO 14025, Sections 4 and 6.7.2. It shall be stated in EPDs created using these PCR that only EPDs prepared from cradle-to-grave life-cycle results and based on the same function, reference service life, and quantified by the same functional unit, and meeting all the conditions in ISO 14025, Section 6.7.2, can be used to assist purchasers and users in making informed comparisons between products.

EPDs based on cradle-to-gate information modules shall not be used for comparisons unless using a functional unit, and complying with all of the requirements set out in ISO 14025, Section 6.7.2 and ISO 21930, Section 5.6, when the product is used in buildings. EPDs based on a declared unit shall not be used for comparisons.

Since an EPD prepared using this PCR only covers BtoB, the following shall be stated in the EPD: This EPD covers only the cradle-to-gate impacts of precast concrete using a declared unit, and the results cannot be used to compare between products.

5.0 Company/Organization, Product, and Product Category

5.1 | DESCRIPTION OF COMPANY/ORGANIZATION

The name of the company/organization as well as the place(s) of production shall be provided in the EPD. The EPD may also include general information about the company/organization such as the existence of quality systems, an environmental management system according to ISO 14001, or any other environmental management systems in place.

5.2 | DEFINITION OF PRODUCT CATEGORY

These PCR address UN CPC Class 3755 – Prefabricated structural components for building or civil engineering, of cement, concrete or artificial stone and the specific precast concrete products, produced from the materials shown in Table 1, which also shows the ASTM and CSA standards that provide detailed descriptions and specifications for each material potentially used in the product.

TABLE 1: Precast Concrete Materials

Materials	Description/Specification
Portland Cement	ASTM C150, ASTM C1157, AASHTO M 85, or CSA A3001
Blended Hydraulic Cements	ASTM C595, ASTM C1157, AASHTO M 240, or CSA A3001
Portland-limestone Cement	ASTM C595, ASTM C1157, AASHTO M 240, or CSA A3001
Performance-based Hydraulic Cement	ASTM C1157
Fine Aggregate - natural sand	CSA A23.1, ASTM C33/C33M
Fine Aggregate - manufactured	CSA A23.1, ASTM C33/C33M
Coarse Aggregate - natural gravel	CSA A23.1, ASTM C33/C33M
Coarse Aggregate - crushed	CSA A23.1, ASTM C33/C33M
Lightweight Aggregates	ASTM C330/C330M
Supplementary Cementitious Materials (SCMs)-Fly Ash	CSA A3000, ASTM C618
SCMs - Silica Fume	CSA A3000, ASTM C1240
SCMs - Blast Furnace Slag	CSA A3000, ASTM C989/C989M
Chemical Admixture - Air Entraining Agent	ASTM C260/C260M, ASTM C494/C494M
Chemical Admixture - Plasticizer	ASTM C494/C494M, ASTM C1017/C1017M
Chemical Admixture - Coloring	ASTM C979/C979M
Chemical Admixture – Corrosion Inhibitors	ASTM G109
Form Release Agent	Not Applicable (N/A)
Reinforcing bars, welded wire fabric (WWF), bolts, studs, coatings, prestressing strand, etc.	CAN/CSA-G30.18, CAN/CSA-G40.20/G40.21, CAN/CGSB-1.40, CAN/CGSB-1.181, ASTM A108, ASTM A123/A123M, ASTM A153/A153M, ASTM A1064/A1064M, ASTM A307, ASTM A416/A416M, ASTM A555/A555M, ASTM A666, ASTM A775/A775M, ASTM A615/A615M, ASTM A706/A706M, ASTM A184, ASTM A767/A767M, ASTM A884/A884M, ASTM A934/A934M, ASTM A36/A36M, ASTM 820/A820M
Fiber and Glass Reinforcement	ASTM C1116
Fibre-Reinforced Polymer (FRP)	CSA S806
Expanded Polystyrene	N/A
Extruded Polystyrene	N/A
Thin Brick	N/A
Granite	N/A
Pigments	ASTM C979/C979M
Net Consumables	N/A

Materials	Description/Specification
Batch Water	ASTM C1602
Wash Water	N/A

5.3 | DESCRIPTION OF PRODUCT

The EPD shall provide a narrative description of the product that will enable the user to clearly and unambiguously identify the product. This description shall include, where relevant:

- Product identification by brand name (if applicable), material type, and simple example visual representation, which may be by photograph or graphic illustration;
- List of the standards and other product specifications to which the products comply;
- Details regarding reinforcement, thicknesses, and colors;
- Flow diagram illustrating main unit processes by life-cycle stage according to the scope of the declaration;
- Materials and substances to be declared.; and
- Any additional information that will assist in identifying the product.

Material contents of the finished product, including packaging, shall be declared in terms of the main components. Intentionally added substances officially classified as hazardous according to relevant national or international regulations shall be stated. Product specific data that is confidential because of the competitive business environment, intellectual property rights, or similar legal restrictions need not be declared except where such data involves regulated hazardous substances, which must always be disclosed.

6.0 Requirements for the Underlying LCA

The underlying LCA shall be conducted in accordance with ISO 14040 and ISO 14044

6.1 | FUNCTIONAL AND DECLARED UNIT

The functional unit of a product provides the quantitative normalization for comparing products of equivalent function (functional unit) or equivalent specification. A functional unit is defined for EPDs covering the complete cradle-to-grave life cycle or the cradle-to-gate life cycle with a use stage scenario.

A declared unit is defined for EPDs covering only the cradle-to-gate or cradle-to-gate plus end-of-life stages (see Section 6.2). If the intended use of the EPD is for comparison purposes between different building products, the entire life cycle shall be included, including the use and end-of-life stages. In such situations the functional unit shall be used as the reference unit, not the declared unit.

Since these PCR for precast concrete products only cover the cradle-to-gate stages, a declared unit shall be used. The declared unit shall be one metric tonne. Data may additionally be presented per U.S. (short) ton.

6.2 | SYSTEM BOUNDARIES

Figure 1 shows the life-cycle stages and individual modules that shall be included within the LCA system boundary, depending on whether the EPD is BtoB or Business to Consumer (BtoC).

FIGURE 1 Life-Cycle Stages and Modules

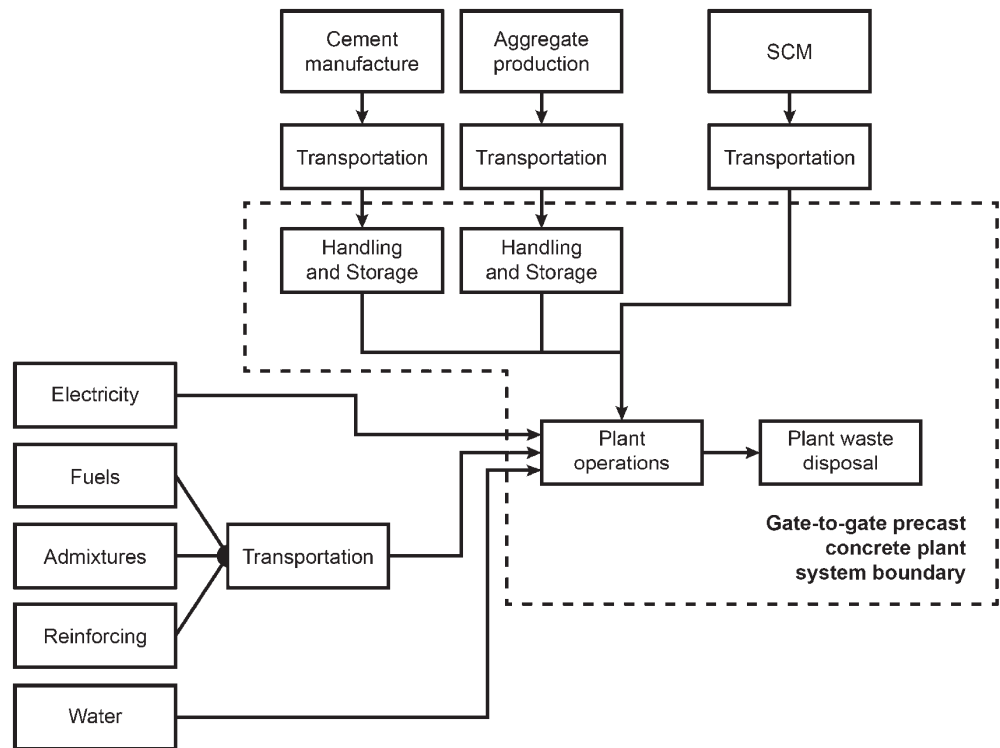
PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE			
Raw material supply	Transport	Manufacturing	Transport	Construction-installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4

Cradle-to-Gate or “Information Module” (BtoB EPDs) | The life-cycle activities and related processes shall include modules A1, A2, and A3—the product stage—as defined below, with scenarios for other life-cycle stages as appropriate.

Cradle-to-Grave (mandatory for BtoC EPDs) | A complete cradle-to-grave LCA shall be developed for the product, including all life-cycle stages and modules, for a specified defined function and service life, inclusive of maintenance and replacement and end-of-life effects.

Any site-generated energy and purchased electricity shall be included in the system boundary. The extraction, processing, and delivery of purchased primary fuels, for example natural gas and primary fuels used to generate purchased electricity, shall also be included within the boundaries of the system. Regionally specific inventory data on electricity shall be based on subnational U.S. and Canadian consumption mixes that account for power trade between the regions. If such regional data are not available, production mixes of the three continental interconnections (East, West, Texas) as well as those of Hawaii and Alaska may be used. A comparable approach shall be taken for electricity consumption in the case of materials or input products imported from outside the U.S. and Canada. The sources for electricity (calculation procedure) shall be documented.

As shown in Figure 2, precast concrete components are made by placing concrete and reinforcement into formwork at the plant and curing. Production procedures vary between the different categories of precast concrete products. Architectural and structural precast concrete are made with conventional reinforcement in custom-made individual forms or standardized forms. These forms can be made of wood, fiberglass, concrete, steel and other materials. Wood or fiberglass forms can generally be used 40 to 50 times without major maintenance while concrete and steel forms have practically unlimited service lives. Because of the frequent reuse of formwork, it may be excluded in the primary product stages (see A3 requirements below). Form-release agents are applied to forms prior to placing the concrete to prevent the concrete from sticking to the forms when they are removed. The steps in the precast production process include: (1) Formwork preparation; (2) placement of reinforcement, strand, and hardware as required; (3) concrete mixing; (4) conveying to the form in ready-mix trucks, specially designed transporters with a dumping mechanism that places the concrete in the form, or concrete buckets carried by overhead cranes; (5) placing the concrete in the form; (6) consolidation by vibration, leveling, and surface finishing; (7) curing; and (8) form stripping and storage in the yard prior to shipment.

FIGURE 2 Cradle-to-Gate Precast Plant System Boundary**Cradle-to-gate precast concrete plant system boundary***Notes for Figure 2:*

1. There may be instances where concrete is supplied to the precast concrete plant from outside the precast concrete plant system boundary. In those cases, the manufacture and transportation of cement, aggregate, supplementary cementitious materials, and admixtures may be combined into one flow named 'concrete manufacture,' which will include all upstream energy and material flows related to the manufacturing of the product 'concrete.'
2. SCM is Supplementary Cementitious Materials and consists of materials such as fly ash, slag cement (ground, granulated blast-furnace slag), and silica fume.

In the case of precast concrete EPDs based on these PCR, modules A1 to A3 (highlighted in Figure 1) apply. The following are factors to be taken into account for the relevant modules.

Modules A1-A3, the Product Stage:

- A1—Extraction and processing of raw materials, including fuels used in product production and transport within the manufacturing process (A3);
- A2—Average or specific transportation of raw materials (including recycled materials) from extraction site, manufacturing source or distribution terminal (as appropriate for each material) to manufacturing site (including any recovered materials from source to be recycled in the process) and including empty backhauls and transportation to interim distribution centers or terminals;
- A3—Manufacturing of the product including all energy and materials required and all emissions and wastes produced. This includes, but is not limited to:

- Energy use throughout the production process, including energy used to cure the products, for heating/cooling and lighting of the manufacturing facility, for on-site transportation, and operation of equipment;
- Use of all types of cement, including normal portland cement, white cement, alternative low carbon cements, portland limestone cement, blended cements, and fine and coarse supplementary cementitious materials (fly ash, ground granulated blast furnace slag, silica fume, limestone, and the like);
- Use of all types of aggregate (manufactured and natural, lightweight, and normal weight);
- Use of reinforcement including mild-steel reinforcement, stainless-steel reinforcement, fibers (synthetic and steel), prestressing strand, FRP composite reinforcement and the like;
- Average or specific transportation shall be included for all inputs;
- Fresh water – batch and process water (process water would include washout water as well as curing water);
- Use of admixtures;
- Packaging, including transportation and waste disposal, to make product ready for shipment;
- If packaging is purchased from multiple suppliers, then a weighted average of the transportation distances by mode from all suppliers shall be included in the LCA modeling;
- Average or specific transportation from manufacturing site to recycling/reuse/landfill for pre-consumer wastes and unutilized by-products from manufacturing, including empty backhauls; and
- Recycling/reuse/energy recovery of pre-consumer wastes and by-products from production.

All assumptions from LCA shall be described in detail. Module A1, A2, and A3 may be declared as one aggregated module A1-A3.

Any transportation data other than identified above shall be indicated. If transportation information is included in other stages than indicated, or if no transportation information exists and assumptions are made, this should be noted.

Excluded from System Boundary | A summary of items that may be excluded in the primary product stages include:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure;
- Formwork shall be excluded;
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment;
- Personnel-related activities (travel, furniture, and office supplies); and
- Energy and water use related to company management and sales activities that may be located either within the factory site or at another location.

7.0 Life-Cycle Inventory Analysis

7.1 | DATA COLLECTION AND DESCRIPTION OF DATA

The data shall be representative according to temporal, geographical, and technological requirements.

Temporal | The obtained information from the manufacturing process should be annual values, preferably from the previous twelve-month period or calendar year. Average background or secondary data shall not be older than ten years unless accompanied by a statement attesting to the validity of older data.

Geographical | The geographic region of the relevant life-cycle stages included in the calculation of representative data shall be documented.

Technological | Data shall represent technology in use.

The use of specific or generic background data shall be documented. As a rule, the following distribution will be applied:

- Extraction and/or production of raw materials (specific or average background);
- Manufacturing of the product (specific);
- Data sources and any calculation procedures for the fuel mix for electricity generation shall be documented;
- Hazardous waste shall be reported according to applicable U.S. and/or Canadian federal or state/provincial regulations (or appropriate regulations for materials imported from outside North America);
- If EPDs for upstream products are not available, data from the best available published literature shall be permitted to be used; and
- If multiple suppliers are used for one material, then a weighted average, based on volume or mass, shall be used to assign transport distance and mode.

For generic data, national databases shall be used to the extent that they are applicable (for example, U.S. Life Cycle Inventory Database, www.nrel.gov/lci). If appropriate national data are not available, sources for similar technology adjusted for national boundary conditions (for example, energy mix) may be used. Data from other regions are acceptable if it is determined and justified that those data are the best available.

All data sources shall be specified, including database and year of publication (reference). Sources of data for transport models (including transport mode, distances, and quantities to be transported) and thermal energy production shall be documented. Where proxy data is used in the absence of specific data for chemicals or other inputs, the source and justification for selection of the proxies shall be documented in the LCA report.

When preparing an average EPD for an identical product manufactured at multiple facilities, the LCI data for each site shall be weighted to determine the average. Weighting shall be by annual product production. Data reported in the declarations shall be as production-weighted averages of multiple facilities.

The product content will be described in the declaration. Product specific data that is confidential because of the competitive business environment, intellectual property rights, or similar legal restrictions

need not be declared. In such cases, a notation that the information is confidential will be made along with a description of the function of the component.

7.2 | CUTOFF RULES

Criteria for the exclusion of inputs and outputs (cutoff rules) in the LCA and information modules and any additional information are intended to support an efficient calculation procedure. They shall not be applied in order to hide data and all inputs and outputs of a unit process for which data are available shall be included in the calculation. Any application of the criteria for the exclusion of inputs and outputs shall be documented. Data gaps may be filled by conservative assumptions with average or generic data. Any assumptions for such choices shall be documented.

The cutoff criteria for flows to be considered within the system boundary are as follows:

Mass | If a flow is less than 1% of the cumulative mass of the unit process, it may be excluded, provided its environmental relevance is minor.

Energy | If a flow is less than 1% of the cumulative energy of the unit process, it may be excluded, provided its environmental relevance is minor.

Environmental relevance | Material and energy flows known or expected to have the potential to cause environmentally relevant emissions into air, water or soil related to the environmental indicators of these PCR shall be included using proxy data.

At least 95% of the energy usage and mass flow shall be included and the life-cycle impact data shall contain at least 95% of all elementary flows that contribute to each of the declared category indicators.

All hazardous and toxic materials and substances shall be included in the inventory and the cutoff rules do not apply to such substances.

7.3 | DATA QUALITY REQUIREMENTS

The quality of data used to generate the EPD shall be addressed in the project report in compliance with ISO 14044, Section 4.2.3.6. Any secondary data source used in the underlying life-cycle inventory shall be complete and representative of the applicable North American region in terms of its geographic and technological coverage and of a recent vintage, which is typically less than ten years old. Any deviations from these requirements for secondary data shall be documented, and the following apply.

- All data shall be accurate, consistent, reproducible, and representative of the production process, current technology, and current measurement capability with any known uncertainty levels stated.
- The information obtained from the manufacturing process shall be annual average values.
- Average background data shall not be older than ten years for industry average data or five years for producer specific data, unless justification is provided.
- When the owner of the EPD is not the owner of all upstream processes, the owner shall contact its suppliers within the system boundary. If the suppliers do not supply data, the owner shall use the best-available data in the literature based on data quality requirements of this PCR.
- Data shall be identified as direct (for example, measurements or purchasing records), indirect (based on calculations), estimated, or other.

Precast manufacturers may be able to provide the necessary data through the North American Precast Concrete Sustainable Plant Program (see Section 12.0).

7.4 | UNITS

SI units shall be used with conversions as shown in the table below as necessary. Preferred power and energy units are as follows:

- kWh or MJ for electric energy
- kW or MW for power

TABLE 2: Conversion Factors to be Used if Reporting in IP Units (Imperial)

CONVERT FROM	TO	MULTIPLY BY
Square meter (m ²)	Square foot (ft ²)	1.076391E+01
Kilogram (kg)	Pound (lb)	2.204622
Mega joule (MJ)	British Thermal Unit (Btu)	9.478170E+02
Degree Celsius (°C)	Degree Fahrenheit (°F)	(°C * 9/5) +32
Cubic meter (m ³)	Cubic foot (ft ³)	3.531466E+01
Meter (m)	Foot (ft)	3.281
m ² K/W	ft ² Fhr/Btu	5.6783
Metric tonne	Ton	1.102

Source: NIST: <http://physics.nist.gov/Pubs/SP811/appenB9.html>; <http://www.nist.gov/pml/wmd/metric/temp.cfm>; and <http://www.nist.gov/pml/wmd/metric/common-conversion-b.cfm>

7.5 | ALLOCATION RULES

In a production process in which more than one type of product is generated, it is necessary to allocate the environmental flows (inputs and outputs) from the process to the different products to get product-based inventory data. Allocation, if required, shall follow the requirements and guidance of ISO 14044, Section 4.3.4.

Where relevant, recycled and recovered materials shall be considered raw materials. Only the materials, water, energy, emissions, and other elemental flows associated with reprocessing, handling, sorting, and transportation from the generating industrial process to their use in the production process need to be considered. Any allocations before reprocessing shall be allocated to the original product. Fly ash, blast furnace slag (as an aggregate or a cement), and silica fume shall be considered recovered materials and not co-products. Note that EPA states in their Waste Reduction Model (WARM) document: “Because fly ash is a byproduct (waste) of the process of combusting coal for electricity, WARM considers that there are no manufacturing or combustion emissions associated with fly ash itself.” Recycled and recovered materials with fuel content and used as fuels, such as used tires, shall be considered alternative energy. Blast furnace slag is considered a waste product and not a co-product. The referenced PCR UN CPC 3744 notes that in countries where slag is not considered a waste, economic allocation should be applied. However, the PCR UN CPC 3744 states that in Europe, it has been shown that the contribution of slag to the overall revenue of the producing system is in the order of 1% or less and that allocation burdens can therefore be neglected.

When a product's original function is no longer needed or possible, the product can be processed further in a waste management system. For example, it can be recycled, reused, or energy recovered. Emissions from downstream recycling, or combustion after the end-of-waste state, will be allocated to the new downstream products, such as heat and electricity. In the case of incineration of wastes for energy production at the primary production site, the combustion emissions shall be allocated to the product unless the energy is exported.

Concrete recycling processes may be treated as closed-loop recycling when the recycled concrete is crushed and used as a substitute for aggregate for the production of manufactured concrete and concrete masonry products. In this case only, the flows and impacts associated with recovery and crushing of the recycled concrete shall be taken into account and the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials.

If different allocation options are relevant and a deviation of greater than 20% is a foreseen outcome, a sensitivity analysis shall be initiated. These different allocation approaches and data sets shall be documented and declared.

In cases where several similar products (such as multiple mix designs with similar strength, reinforcing, insulation, and curing) are produced by a site or company, these PCR offer the possibility for similar products to be grouped as an average product in the same EPD provided that the difference between their environmental impacts is less than 5% for each environmental impact category. In cases where the difference is greater than 5%, it is still possible to include average products in the same EPD (for example, in separate columns in a table). If a single value is chosen for each impact category for all products, the value reported should be the worst performance within the range of variation. It is also permissible to show arithmetically weighted averaged data in an EPD as supplementary information.

8.0 Impact Categories and Characterization Factors

Environmental impact category indicators shall be taken from Table 3 for declaring environmental aspects in accordance with ISO 21930, Section 8.2 and ISO 14044.

TABLE 3: Declaration of Environmental Category Indicator Results, Use of Resources, and Generation of Waste

CATEGORY INDICATOR	UNIT
Global warming potential (GWP)	kg CO ₂ equiv
Acidification potential	kg SO ₂ equiv
Eutrophication potential	kg N equiv
Smog creation potential	kg O ₃ equiv
Ozone depletion potential	kg CFC-11 equiv
Total primary energy consumption	
Nonrenewable energy resources	MJ (HHV)
Renewable energy resources	MJ (HHV)
Material resources consumption	
Nonrenewable material resources	kg
Renewable material resources	kg
Net fresh water (inputs minus outputs)	L
Non-hazardous waste generated	kg
Hazardous waste generated	kg

Notes for Table 3:

1. Fresh water is naturally occurring water on the earth's surface and underground as groundwater in aquifers and underground streams. The term specifically excludes seawater and brackish water, but does include fresh water that has been treated to make it potable. Energy use and other impacts associated with fresh water treatment are not included.
2. Recovered or recycled materials are neither nonrenewable nor renewable resources under ISO definitions. The use of such materials can be reported as additional environmental information as per Section 9.
3. Primary energy is an energy form found in nature that has not been subjected to any conversion or transformation process. Examples of primary fuels are coal, natural gas, biomass, etc.
4. Recycled and recovered materials with fuel content and used as fuels shall be considered alternative energy. Examples of secondary fuels recovered from previous use or as waste are solvents, wood, tires, and animal fat. Emissions from secondary fuels shall be included in the calculation of the relevant environmental impacts.
5. Energy consumption shall be reported in Higher Heating Values (HHV) mega joules.
6. Where applicable, feedstock energy shall be declared and shown separately.

The impact categories of life-cycle impact assessment (LCIA) shall be calculated using characterization factors specified in version 2.1 of TRACI (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts). <http://www.epa.gov/nrmrl/std/traci/traci.html>

9.0 Additional Environmental Information

An EPD shall include, where relevant, additional information, such as given in the points below, related to environmental issues, other than the environmental information derived from LCA, LCI, or information modules. This information shall be separated from the information described in ISO 21930, Sections 7.2.2 and 7.2.3. Identification of the significant environmental aspects should, as a minimum, take into consideration the following:

- Information on environmental issues, such as:
 - Impact(s) and potential impact(s) on biodiversity,
 - Toxicity related to human health or the environment or both, and
 - Geographical aspects relating to any stages of the life cycle (for example, a discussion on the relation between the potential environmental impact(s) and the location of the product system);
- Data on product performance, if environmentally significant;
- Organization's adherence to any environmental management system, with a statement on where an interested party may find details of the system;
- Any other environmental certification program, such as the North American Sustainable Plant Program, applied to the product and a statement on where an interested party may find details of the certification program;
- Other environmental activities of the organization, such as participation in recycling or recovery programs or renewable energy credits (REC), provided details of these programs are readily available to the purchaser or user and contact information is provided;
- Information that is derived from LCA but not communicated in the typical LCI- or LCIA-based formats;
- Instructions and limits for efficient use;
- Hazard and risk assessment on human health and the environment;
- Information on absence or level of presence of a material in the product that is considered of environmental significance in certain areas (see ISO 14021, Sections 5.4 and 5.7);
- Preferred waste management option for used products; and
- Potential for incidents that can have impact(s) on the environment, such as recycled content or recycling rates.

Additional information shall only be related to environmental issues. Information and instructions on product safety unrelated to the environmental performance of the product shall not be part of a Type III environmental declaration.

10.0 EPD Supporting Data

A project report shall be prepared in accordance with the requirements and guidance of ISO 14044, Section 6, for third-party reports. This information shall document the LCA study and additional environmental information in a systematic, comprehensive way, and shall be made available to the verifier in order to demonstrate that the requirements of this PCR document and ISO 21930 have been met. The project report shall include, where relevant:

- The commissioner of the report, the contact information of the report author, and the date of the report;
- The input and output environmental data of the unit processes that are used for the LCA calculations;
- The documentation (measurements, calculations, estimates, sources, correspondence, traceable references to origin, and so forth) that provides the basis from which the process data for the LCA is formulated;
- The specification used to create the manufacturer's products;
- Energy consumption figures;
- Emission data to air, water, and soil;
- Waste production;
- Data that demonstrates that the information is complete— in specific cases, reference can be made to, for instance, standards or quality regulations;
- Referenced literature and databases from which data have been extracted;
- Data used to carry out sensitivity analyses;
- Documentation that demonstrates that the products can fulfill the desired function(s) and performance;
- Documentation that demonstrates that the chosen processes and scenarios in the flow chart satisfy the requirements set in ISO 21930;
- Documentation and substantiation of the percentages and figures (number of cycles, prices, and so forth) used for the calculations in the allocation procedure;
- Information showing how averages of different reporting locations have been calculated to obtain generic data;
- Documentation used to substantiate any qualitative information in the additional environmental information;
- Procedures used to carry out the data collection (questionnaires, instructions, informative material, confidentiality agreements, and so forth);
- The characterization factors used;
- The criteria and substantiation used to determine the system limits and the selection of input and output flows;
- Documentation that demonstrates consistency when using information modules; and
- Documentation used to substantiate the other choices and assumptions.

11.0 Content of the EPD

The following demonstration of verification shall be completed and included with the EPD. Note that third-party verification is optional for BtoB EPDs, but mandatory for BtoC EPDs.

Demonstration of Verification

PCR review, was conducted by:

< name and organization of the chair, and information on how to contact the chair through the programme operator >

Independent verification of the declaration and data, according to ISO 14025:

internal external

(Where appropriate¹) Third party verifier:

<name of third party verifier>

All Type III environmental declarations in a product category shall follow the format and include the parameters as identified in this PCR. The following general information shall be declared in the EPD:

- Name and address of the manufacturer(s);
- Product identification by name (including, for example, production code) and a simple visual representation of the product;
- Description of the product's use and the declared unit of the product to which the data relates;
- Product sub-category, as listed below. The following descriptive information, per respective product sub-category, shall be included in the EPD, keeping in mind that products may be grouped according to the allocation rules in Section 7.5:
 - Structural precast products
 - Compressive strength
 - Reinforcement area, per grade and type of reinforcement
 - Amount of additional hardware
 - Architectural precast products
 - Compressive strength
 - Reinforcement area, per grade and type of reinforcement
 - Amount of additional hardware
 - Insulated architectural precast products
 - Compressive strength
 - Reinforcement area, per grade and type of reinforcement
 - Amount of additional hardware

¹ Optional for business to business communication, mandatory for business to consumer communication.

- Insulation area, per insulation type
- Underground precast products
 - Compressive strength
 - Reinforcement area, per grade and type of reinforcement
 - Amount of additional hardware
- Description of the application (installation) of the product where relevant;
- Detailed list of the substances, by weight, that make up the product, taking into account cutoff rules and confidentiality;
- Data from LCA or LCI or information modules, as per ISO 14025, Section 7.2.2;
- Additional environmental information (see Section 9);
- Statement that the EPD is cradle to gate;
- Statement that EPDs from different programs (using different PCR) may not be comparable;
- Statement that the EPD represents an average performance, where an EPD declares an average performance for a number of products; in addition, with the range of the products' performance with respect to the average stated;
- Site(s), manufacturer or group of manufacturers, or those representing them, for whom the results of the LCA are representative;
- Information on where explanatory material may be obtained;
- Description or diagram of the life-cycle stages included in the LCA and system boundaries;
- Name of the program and the program operator's address and, if relevant, the logo and website URL;
- Identification of the PCR document on which the EPD is based;
- Date the EPD was issued and period of validity;
- Name of PCR review panel chair;
- Whether the independent review of the EPD and data was conducted by an internal or external verifier (third-party verification is mandatory for BtoC EPDs); and
- Name, address, phone number, fax number, and e-mail of the third-party verifier and logo of the verification body, if applicable.

12.0 References

ASTM Standards:²

ASTM A36 / A36M Standard Specification for Carbon Structural Steel

ASTM A108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

ASTM A123 / A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A153 / A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A184 Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement

ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

ASTM A416 / A416M Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete

ASTM A555 / A555M Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods

ASTM A615/ A615M Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

ASTM A706 / A706M Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

ASTM A767 / A767M Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

ASTM A775 / A775M Standard Specification for Epoxy-Coated Steel Reinforcing Bars

ASTM A820 / A820M Standard Specification for Steel Fibers for Fiber-Reinforced Concrete

ASTM A884 / A884M Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement

ASTM A934 / A934M Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars

ASTM A1064 / A1064M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

ASTM C33 / C33M Standard Specification for Concrete Aggregates

ASTM C150 / C150M Standard Specification for Portland Cement

ASTM C260 / C260M Standard Specification for Air-Entraining Admixtures for Concrete

² Available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, <http://www.astm.org>.

ASTM C330 / C330M Standard Specification for Lightweight Aggregates for Structural Concrete

ASTM C494 / C494M Standard Specification for Chemical Admixtures for Concrete

ASTM C595 Standard Specification for Blended Hydraulic Cements

ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C979 / C979M Standard Specification for Pigments for Integrally Colored Concrete

ASTM C989 / C989M Standard Specification for Slag Cement for Use in Concrete and Mortars

ASTM C1017 / C1017M Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

ASTM C1116 / C1116M Standard Specification for Fiber-Reinforced Concrete

ASTM C1157 / C1157M Standard Performance Specification for Hydraulic Cement

ASTM C1240 Standard Specification for Silica Fume Used in Cementitious Mixtures

ASTM C1602 / C1602M Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

ASTM G109 Standard Test Method for Determining Effects of Chemical Admixtures on Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments

CSA Standards:³

CAN/CGSB-1.40 Anticorrosive Structural Steel Alkyd Primer

CAN/CSA A23.1/A23.2 Concrete Materials and Methods of Concrete Construction/Test methods and Standard Practices for Concrete

CAN/CSA A23.4 Precast concrete — Materials and construction

CAN/CSA A3000 Cementitious Materials Compendium

CAN/CSA G30.18 Carbon steel bars for concrete reinforcement

CAN/CSA G40.20/G40.21 General requirements for rolled or welded structural quality steel / Structural quality steel

CSA S806 Design and construction of building structures with fibre-reinforced polymers

ISO Standards:⁴

ISO 6707-1: 014 Buildings and Civil Engineering Works — Vocabulary — Part 1: General Terms

ISO 14021:1999 Environmental Labels and Declarations — Self-declared Environmental Claims (Type II Environmental Labeling)

ISO 14025:2006 Environmental Labels and Declarations — Type III Environmental

³ Available from CSA Group, 178 Rexdale Boulevard, Toronto, ON Canada M9W 1R3, <http://www.csagroup.org>

⁴ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.

Declarations — Principles and Procedures

ISO 14040:2006 Environmental Management — Life Cycle Assessment — Principles and Framework

ISO 14044:2006 Environmental Management — Life Cycle Assessment — Requirements and Guidelines

ISO 14050:2009 Environmental Management — Vocabulary

ISO 21930:2007 Sustainability in Building Construction — Environmental Declaration of Building Products

Other References:

BS EN 15804 Sustainability of construction works — *Environmental product declarations — Core rules for the product category of construction products*⁵

Carbon Leadership Forum (CLF), *Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPDs) of Concrete*, Revised Version 1.1 December 2013⁶

Life Cycle Assessment of Precast Concrete Commercial Buildings: Cradle-to-Grave, prepared for The Precast/Prestressed Concrete Institute, January 11, 2013. The report was prepared by Morrison Hershfield and the Athena Sustainable Materials Institute

North American Precast Concrete Sustainable Plant Program, Sustainable Precast Concrete Benchmark Calculator (v2.01 or later), Canadian Precast/Prestressed Concrete Institute, www.cpci.ca⁷

Life Cycle Assessment of Precast Concrete Commercial Buildings: Cradle-to-Grave, prepared for The Canadian Precast Prestressed Concrete Institute, May 11, 2012. The report was prepared by Morrison Hershfield and the Athena Sustainable Materials Institute

The Norwegian EPD Foundation, NPCR 20, Product-Category Rules (PCR) for preparing an environmental declaration (EPD) for Product Group Precast Concrete Products, March 2012⁸

Product Category Rules for Cement, developed by the Centre for the Development of Product Sustainability in co-operation with AITEC and Buzzi Unicem, September 15, 2010⁹

Product Category Rules for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, ASTM International, September 2014. http://www.astm.org/CERTIFICATION/filtrexx40.cgi?-P+PROG+7+cert_detail.frm¹⁰

UN CPC 3744 *Cement Product Category Rules*, version 2.0, dated May 16, 2013, Centre for the Development of Product Sustainability in co-operation with AITEC¹¹

5 European Committee for Standardization (CEN), Avenue Marnix 17, B-1000 Brussels, Belgium, www.cen.eu

6 Carbon Leadership Forum (CLF), www.carbonleadershipforum.org;
<http://www.carbonleadershipforum.org/clf-pcr-v11-2013-12-04.pdf>

7 Available from the Canadian Precast / Prestressed Concrete Institute; www.cpci.ca

8 Available from EPD-Norge; <http://www.epd-norge.no/getfile.php/PDF/PCR/NPCR%2020%20Concrete%20products%281%29.pdf>

9 Available from International EPD System; <http://www.environdec.com/PCR/Detail/?Pcr=5942#.Uu-g1NGYab8>

10 Available from ASTM International; <http://www.astm.org/CERTIFICATION/EpdAndPCRs.html>

11 Available from International EPD System; www.environdec.com

UN CPC 375 *Concrete Product Category Rules*, version 1.0, dated February 12, 2013, developed for the World Business Council for Sustainable Development (WBCSD) Cement Sustainability Initiative—global scope¹²

US EPA *Waste Reduction Model (WARM) – Fly Ash Chapter*: <http://epa.gov/climatechange/wycd/waste/downloads/fly-ash-chapter10-28-10.pdf>¹³

¹² Available from World Business Council for Sustainable Development (WBCSD), Maison de la Paix, Chemin Eugène- Rigot 2, CH-1211 Geneva, Switzerland. www.wbcscement.org; http://www.wbcscement.org/pdf/pcr1302_CPC_375_Concrete_1_0.pdf

¹³ Available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20004, <http://www.epa.gov>.

Appendix A Product Definitions:

STRUCTURAL PRECAST PRODUCTS:

- **Piles, piers and columns** provide support for infrastructure projects. Piles come in many different shapes and sizes, ranging from 250 mm square piles to 900 mm diameter cylindrical piles. Columns can be cast in virtually any shape.
- **Pier caps** are precast elements and mounted on the infrastructure substructure.
- **Girders and beams** can be manufactured in a variety of shapes. These include I-girders, Bulb-T girders, NU girders, NEXT girders, hollow slabs and long span box girders.
- **Deck slabs** consist of precast concrete panels (partial depth or full depth) that are used to create or form a road surface.
- **Hollow core slabs** are prefabricated floor slabs produced using dry cast extrusion systems where very low slump concrete is forced through a machine and compacted around cores formed with augers or tubes. High strength stressing strands are pretensioned prior to placing the concrete.
- **Double tee slabs** are prefabricated wet cast floor slabs produced on long line casting beds. Bulkheads are placed in the casting bed to form the required double tee lengths for individual projects. High strength stressing strands are pretensioned prior to placing the concrete.
- **Precast Concrete Foundation Panels** are manufactured for residential and commercial buildings. Designs vary from thin-shell precast concrete with a partially embedded metal frame to panels with insulation and concrete headers, footers, and studs. Panels are available in standard and custom sizes and designs
- **Precast Concrete Short Span Bridges** include single-piece arches, two-piece arches and conventionally reinforced rigid frame bridges, parapets, wingwalls, headwalls and endwalls. Each system has its own specification for span length, height and load capacity.
- **Precast Concrete Sound Walls** are manufactured to provide a noise barrier between roadways and highways and neighborhoods and commercial developments. They are typically reflective or absorptive sound walls.
- **Precast Concrete Traffic Barriers** serve as barricades on roadways and also serve as safety and security devices.
- **Precast Concrete Retaining Walls** are wall systems that provide permanent erosion control and retain earth. There are numerous proprietary systems available which include precast concrete mechanically stabilized earth (MSE) face panels and large precast modular blocks (PMB). They can be manufactured with an architectural finish.
- **Precast Concrete Storm Shelters** are built to protect individuals and they come in a variety of sizes to accommodate a small family to an entire community. They can be built to be installed underground or above ground.

ARCHITECTURAL PRECAST PRODUCTS:

- **Insulated precast wall panels** consist of two, conventionally reinforced or prestressed concrete wythes with a continuous layer of rigid insulation placed between. They can be mass-produced in standard widths on long line casting beds or individually when special finishes and shapes are required.

- **Architectural precast panels** are concrete panels used as exterior cladding in commercial and residential buildings.
- **Precast Concrete Veneers** are manufactured as cladding to be placed on various substrates. The precast units can be made into almost any shape (flat panels, column covers, curved sections, angled or more detailed shapes). They can be manufactured to replicate granite, limestone, brick or any other material.

UNDERGROUND PRECAST PRODUCTS:

- **Precast Concrete Septic Tanks** constitute the first step in any decentralized wastewater treatment system. Precast concrete tanks can also house aerobic treatment units and pumps. Tanks are available in a range of sizes and configurations to match the needs of any project. Sizes typically range from 500 gallon to 20,000 gallons (1900 to 75,700 liters) but can be made in smaller and larger sizes as well.
- **Precast Concrete Grease Interceptors** remove grease from the waste stream and bring the water to acceptable effluent standards before discharging it into a sanitary sewer system. They range in size and configuration to meet the needs of the food establishment. Sizes typically range from 500 gallon to 20,000 gallons (1900 to 75,700 liters) but can be made in smaller and larger sizes as well.
- **Reinforced Concrete Pipe** can be manufactured in round, elliptical and arch shapes. They are made in standard diameters of 250 mm to 3000 mm with a full range of accessories and fittings available for all pipe sizes, including bends, tees, end sections, headwalls and anchor blocks.
- **Precast Concrete Catch Basins (CBs)** are inlet devices that collect storm water, and convey this flow to the storm system.
- **Precast Box Culverts** have a large number of applications including storm sewers, service tunnels, or small bridges and pedestrian crossings.
- **Precast Concrete Tunnel Liners** are manufactured to a specific design radius in a series of components that are installed in the field to form a complete ring or arch that can support the remaining unexcavated soils.
- **Detention/Retention Precast Concrete Products** capture and store runoff in large pipes or subsurface structures. Stormwater may enter into a series of underground chambers or compartments for storage through a riser pipe connected to a catch basin or other stormwater collection structure.
- **Precast Concrete Water Quality Units (WQUs)**, also commonly called trapping catch basins, oil/grit separators or oil/water separators, consist of one or more chambers that promote sedimentation of coarse materials and separation of free oil (as opposed to emulsified or dissolved oil) from stormwater.
- **Precast Concrete Manholes** are most commonly located where pipe size changes, where the pipe changes direction, and where the pipe elevation needs to change substantially. They typically range in size from 1220 to 3650 mm in diameter but can be made in other diameters as well.
- **Precast Concrete Utility Structures** are manufactured to house vital service equipment and provide connections for communications, electrical, alternative energy, gas, and steam systems. Structures include vaults, trenches, equipment pads or bases, and buildings.
- **Precast Concrete Storm Shelters** are built to protect individuals and come in a variety of sizes to accommodate a small family to an entire community. They can be built to be installed underground or above ground.

- **Precast Concrete Pavement Slabs** are long-term pavement repair treatments best suited to heavily trafficked areas that have a high cost for lane closures during construction. There are jointed and unjointed slabs along with prestressed and non-prestressed systems. Typical sizes are 3.7 m (12 ft) wide and 2.4 m (8 ft) to 3.7 m (12 ft) long. Panels can be made up to 6.1 m (20 ft) long or longer when required.
- **Precast Concrete Cemetery Products** are manufactured in different applications such as burial vaults, cemetery slabs, cremation products, mausoleums and a variety of cemetery structures and site amenities.