ENVIRONMENTAL PRODUCT DECLARATION

CERAMIC TILE

INDUSTRY-WIDE EPD
PRODUCTS MANUFACTURED IN NORTH AMERICA

TCNA
TILE COUNCIL OF NORTH AMERICA, INC.

Tile Council of North America (TCNA) is a trade association representing manufacturers of ceramic tile, tile installation materials, tile equipment, raw materials, and other tile-related products.

Established in 1945 as the Tile Council of America (TCA), it became the Tile Council of North America (TCNA) in 2003, reflecting its membership expansion to all of North America.

This is an industry-wide EPD initiated by TCNA with participation from the following companies:

- American Wonder Porcelain
- Arto Brick
- Crossville Inc.
- Dal-Tile Corporation
- Del Conca USA Inc.
- Florida Tile
- Interceramic USA
- Ironrock
- Porcelanite-Lamosa
- Portobello Tile Inc.
- Quarry Tile Co.
- StonePeak Ceramics Inc.
- Vitromex USA, Inc.

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ENVIRONMENTAL PRODUCT DECLARATION

North American Ceramic Tile: Mosaic, Quarry, Pressed Floor, Glazed Wall and Porcelain as defined by ANSI 137.1 American National Standard Specification for Ceramic Tile

According to ISO 14025, EN 15804, and ISO 21930:2017

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Environment 333 Pfingsten Road Northbrook, IL 60611 https://www.ul.com/ https://spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	General Program Instructions v.2.1 April 2017
MANUFACTURER NAME AND ADDRESS	Tile Council of North America, Inc; 100 Clemson Research Blvd, Anderson, SC, USA
DECLARATION NUMBER	4789101745.101.2 (EPD Extended)
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	North American Ceramic Tile: Mosaic Quarry, Pressed Floor, Glazed Wall and Porcelian, 1 m^2
REFERENCE PCR AND VERSION NUMBER	Part B: Flooring EPD Requirements, UL 10010-7, Version 2.0, September 2018
DESCRIPTION OF PRODUCT APPLICATION/USE	Ceramic tiles made in North America are primarily made up of clays, sand, feldspar, and other additives and then pressed or extruded into shape following by firing in a kiln. Uses include: commercial, light commercial, institutional, and residential interior and exterior applications.
PRODUCT RSL DESCRIPTION (IF APPL.)	75 years
MARKETS OF APPLICABILITY	North America, including United States, Canada and Mexico
DATE OF ISSUE	April 1, 2020
DATE OF EXPIRATION	October 1, 2025
EPD TYPE	Industry-Average
RANGE OF DATASET VARIABILITY	N/A
EPD SCOPE	Cradle-to-grave
YEAR(S) OF REPORTED PRIMARY DATA	2018
LCA SOFTWARE & VERSION NUMBER	GaBi Database Version 9.2.0.58, Service Pack 39
LCI DATABASE(S) & VERSION NUMBER	GaBi Database Version 9.2.0.58, Service Pack 39
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1 & CML 2001-2016

This PCR review was conducted by:	UL Environment PCR Review Panel epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Grant R. Martin Grant R. Martin, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	James Mellentine James Mellentine, Ramboll

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

ENVIRONMENTAL PRODUCT DECLARATION

North American Ceramic Tile: Mosaic, Quarry, Pressed Floor, Glazed Wall and Porcelain as defined by ANSI 137.1 American National Standard Specification for Ceramic Tile

According to ISO 14025, EN 15804 and ISO 21930:2017

Tile Council of North America (TCNA)

TCNA is a trade association representing manufacturers of ceramic tile, tile installation materials, tile equipment, raw materials, and other tile-related products.

The Tile Council is recognized for its leadership role in facilitating the development of North American and international industry quality standards to benefit tile consumers. Additionally, TCNA regularly conducts independent research and product testing, works with regulatory, trade, and other government agencies, offers professional training, and publishes installation guidelines, tile standards, economic reports, and promotional literature.

TCNA Participating Member Companies

Environment

1. Product Definition and Information

1.1. Product Description

Product Identification

Ceramic tiles made in North America are primarily made up of clays, sand, feldspar and other additives and then pressed or extruded into shape followed by firing in a kiln. Ceramic tiles can be glazed or unglazed. There are several advantages to ceramic tiles, including fire resistance, non-combustibility, durability, slip resistance, and ease of maintenance. The UNSPSC code for this flooring product is 301617 and the CSI code is 09 30 00.

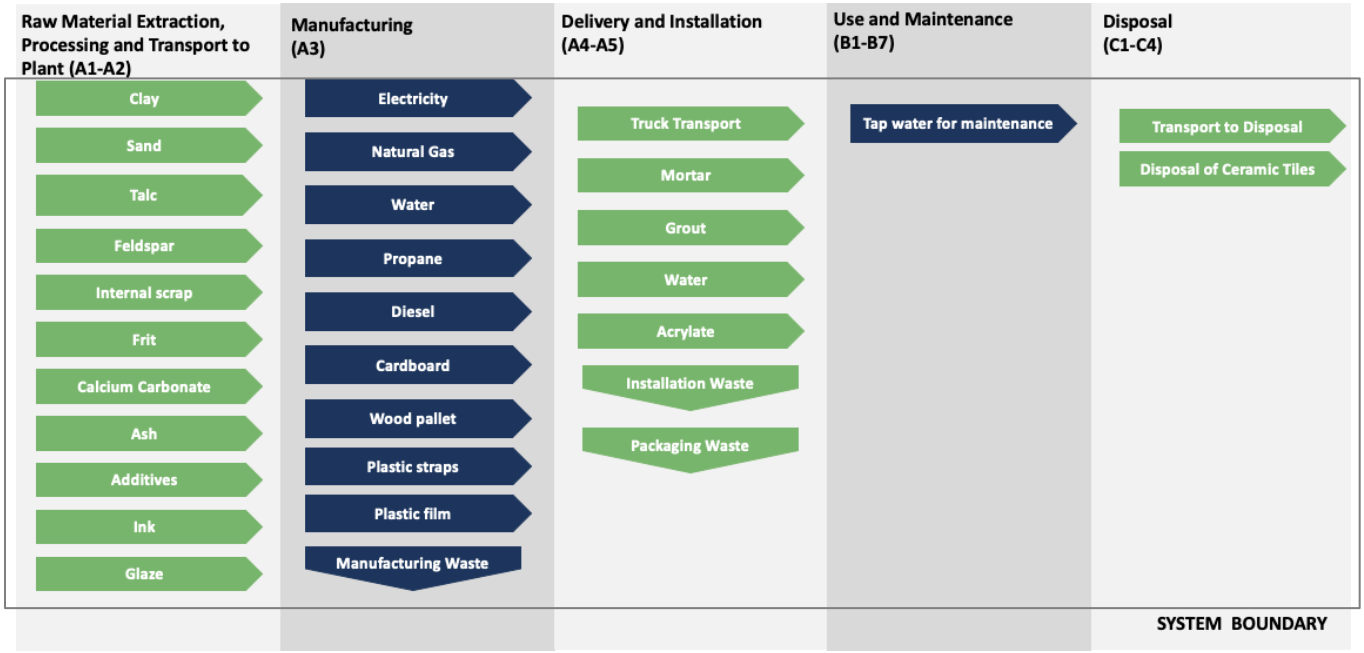
Most tile manufacturing in North America occurs in the US and Mexico. Of the total production in North America, about 85% of tile produced in 2018 is covered in this EPD. This can be considered to be representative of the average tile produced in North America.

Ceramic tiles are available in an asortment of types with varied characteristics, including glazed wall, mosaic, quarry, procelin and pressed floor.

Product Specification

The product is described using the specifications outlined in Table 1.

Flow Diagram



Product Average

Results in this EPD are based on the total materials purchased during 2018 and weighted by annual production data at each of the facilities for the various manufacturers.

1.2. Application

Ceramic tile products are commonly used in a variety of applications including commercial, light commercial, institutional, and residential interior and exterior applications.

1.3. Application Rules

The products considered in this EPD meet or exceed the following technical specification:

- ANSI A137.1 – American National Standard Specifications for Ceramic Tile
- ISO 13006 – International Organization for Standardization Specificications for Ceramic Tile

Additionally, many of the tiles considered in this EPD have been certified to ANSI 138.1. This is the standard for Green Squared Certification for Tiles and Installation Materials.

Some products also have fire testing, and results of these tests can be found at each of the manufacturers' websites.

1.4. Declaration of Methodological Framework

This EPD covers a cradle-to-grave LCA study. A summary of the life cycle modules can be found in Table 13.

According to Part A of the PCR, the Estimated Service Life (ESL) of the building is assumed to be 75 years. Since ceramic tiles are expected to last as long as the building itself, the Reference Service Life (RSL) of ceramic tiles is taken to be 75 years.

The cut-off criteria are described in Section 2.4 and allocation procedures are described in Section 2.8. Infrastructure flows have been excluded.

1.5. Technical Requirements

The following technical data describe the industry average product included in the EPD.

Table 1: Technical Data

PARAMETER	INDUSTRY AVERAGE	UNIT
Nominal Area	131,069.61 - 825,110.65	mm^2
Nominal Value Sizes	1x1 - 60x120	in
Average Fired Weight	18,800.00	g/m^2
Average Fired Weight	3.7	lb/ft^2
Thickness min value	6.83	mm
Thickness max value	12.19	mm
Class	P1, P2, P3, P4, E2	-
Tile Type	Porcelain, Ceramic, Quarry, Mosaic, Impervious, Vitreous, Semi-Vitreous, Non-Vitreous	-
Grade	Standard and Second	-
Dimensional Categories	Calibrated, Calibrated and Rectified	-

1.6. Properties of Declared Product as Delivered

Overall for many industry members cardboard boxes and plastic straps form primary packaging. Secondary packaging includes plastic film and wooden pallets. For the purposes of this study, packaging waste disposal have been modeled as per guidelines in section 2.8.5 of *Part A: Life Cycle Assessment Calculation Rules and Report Requirements* from UL Environment.

1.7. Material Composition

The general compositions of the products are presented in the table below. The composition is presented as a production-weighted average to protect the confidentiality of the composition of individual manufacturers' products.

Table 2: Material Composition

COMPONENT	MATERIAL	MASS %
Body	Clay	69.78%
	Sand	6.22%
	Talc	1.12%
	Feldspar	11.26%
	Internal Scrap	6.48%
	Frit	0.41%
	Calcium Carbonate	1.46%
	Ash	1.35%
	Additives	0.66%
Surface	Ink	0.15%
	Glaze	1.06%

The product does not contain hazardous substances per the applicable regional-specific legislation, as indicated in Section 2.8.6 of *Part A: Life Cycle Assessment Calculation Rules and Report Requirements* from UL Environment.

1.8. Manufacturing

The manufacturing process begins with mining of raw materials, which is a mixture composed mostly of clay, feldspar and minerals. These raw materials are listed in Table 2. The raw materials are batched and mixed to a powder according to the type of tile. Water is then added to form a wet slurry called slip. This slurry is then pumped into a large spray dryer. Next, the clay is formed into a tile shape. After that, the tiles are dried to remove some of their moisture.

Where applicable, the glaze is then applied onto the surface of the tile while being passed on a conveyer belt. Finally, the tiles are fired in a kiln at extremely high temperatures. After this, the tiles are sent for inspection and sorting. Any defective tiles are sent to the tile waste processing section and then re-used in the batching and mixing process.

Any unfired or fired scrap produced in the manufacturing process is returned to the clay mixing and slip production step in the manufacturing process thus minimizing waste production.

1.9. Packaging

Once the tiles are manufactured, they are packaged in cardboard and palletized using plastic straps and wrapped in plastic film.

Table 3: Packaging

Packaging Type	Material	Amount (kg)	Disposal Pathway
Cardboard Box	Corrugated Cardboard	0.14	Recycled (75%), Landfilled (20%), Incinerated (5%)
Plastic Film	Low Density Polyethylene	0.003	Recycled (15%), Landfilled (68%), Incinerated (17%)
Plastic Strap	Polypropylene	0.002	Recycled (15%), Landfilled (68%), Incinerated (17%)
Wood Pallet	Wood	0.02	Recycled (75%), Landfilled (20%), Incinerated (5%)

1.10. Transportation

It is assumed that all raw materials are distributed by truck, ship and/ or rail depending on the location of the supplier. Select materials are initially delivered by ship and/or barge up until the port of entry and then to the facility by truck. The location of suppliers was provided by associates from participating member companies. Transport of raw material from supplier to the manufacturing facility was calculated for each raw material.

The product is delivered to the customer via truck depending on the location of the end-user. Transport to the installation site is assumed to be 800 km as per recommendation by the PCR (Part B) for all floor applications. This was chosen due to the unavailability of granular sales data. The transportation distance for all waste flows is assumed to be 161 km (100 mi) based on best available data.

1.11. Product Installation

Tile Council of North America (TCNA) and American National Standards Institute (ANSI) have recommended installation instructions for guidance that are provided online. These guidelines have been used to model the installation scenario in this assessment. Installation equipment is required though not included in the study as these are multi-use tools and the impacts per functional unit is considered negligible.

Some additional materials are required to install tiles on the floor at the site, namely, grout and mortar. Cement mortar acts as the adhesive that binds the tile to the floor. It has been calculated that 4.07 kg of mortar on average is required to install 1 m^2 of tile. 4.5% of the total material is lost as waste which is then sent to the landfill. Cement grout acts as the filler for the spaces in between the tiles. It was determined that 0.212 kg of grout on average is required to fill an area of 1m^2 of ceramic tiles. Along with cement and mortar, installation solution made up of acrylate and water is also used in the installation process. All waste generated during installation, including packaging waste, is disposed of according to the tables found in Section 2.8.5 of *Part A: Life Cycle Assessment Calculation Rules and Report Requirements* from UL Environment.

1.12. Use

The floors are regularly cleaned with tap water. It has been determined that the floors are cleaned using a dust mop every day and using a damp mop 36 times a year for commercial applications as recommended by the Tile Council of North America (TCNA).

Table 4: Use Phase Assumptions

TYPE	VALUE	UNIT
Cleaning per Week (Dust mop)	7	#
Cleaning per Week (Damp mop) Commercial	0.69	#
Weeks per Year Where Cleaning Occurred	52	#

Table 5: Use Phase Inputs

INPUT	VALUE	UNIT
Tap water	0.783	$L/m^2/yr$

Ceramic tile products are traditionally not repaired or refurbished and are only replaced if the product fails or a new look is desired.

1.13. Reference Service Life and Estimated Building Service Life

According to Part A of the PCR, the Estimated Service Life (ESL) of the building is assumed to be 75 years. Since ceramic tiles are expected to last as long as the building itself, the Reference Service Life (RSL) of ceramic tiles is taken to be 75 years. The reference service life assumes the product was installed according to the manufacturer's recommendations.

1.14. Reuse, Recycling, and Energy Recovery

Although some manufacturers included in this EPD have tile take-back programs at the end of its useful life, for the puposes of this EPD, all waste has been classified according to regional-specific legislation as laid out in Section 2.8.6 in *Part A: Life Cycle Assessment Calculation rules and Report Requirements* from UL Environment.

1.15. Disposal

Disposal pathways in the EPD are modeled in accordance with disposal routes and waste classification referenced in Sections 2.8.5 and 2.8.6 of *Part A: Life Cycle Assessment Calculation Rules and Report Requirements* from UL Environment.

2. Life Cycle Assessment Background Information

2.1. Functional Unit

The functional unit of the flooring product is one (1) m^2 of floor covering, as indicated in Table 6.

Table 6: Functional Unit

NAME	VALUE	UNIT
Functional Unit	1 m^2	
Mass	18.8	kg

2.2. System Boundary

The type of EPD is cradle-to-grave. All LCA modules are included and are summarized in Table 7

Table 7: System Boundary

MODULE NAME	DESCRIPTION	ANALYSIS PERIOD	SUMMARY OF INCLUDED ELEMENTS
A1	Product Stage: Raw Material Supply	2018	Raw Material sourcing and processing as defined by secondary data.
A2	Product Stage: Transport	2018	Shipping from supplier to manufacturing site. Fuel use requirements estimated based on product weights and estimated distance.
A3	Product Stage: Manufacturing	2018	Energy, water and material inputs required for manufacturing products from raw materials. Packaging materials and manufacturing waste are included as well.
A4	Construction Process Stage: Transport	2019	Shipping from manufacturing site to project site. Fuel use requirements estimated based on product weights and mapped distance.
A5	Construction Process Stage: Installation	2019	Installation adhesives, installation waste and packaging material waste.
B1	Use Stage: Use	2019	Use of the product.
B2	Use Stage: Maintenance	2019	Cleaning energy, water, and materials, including refinishing the product.
B3	Use Stage: Repair	2019	Ceramic tile is typically replaced and not repaired.
B4	Use Stage: Replacement	2019	Total materials and energy required to manufacture a replacement.
B5	Use Stage: Refurbishment	2019	Ceramic tile is typically not refurbished.
B6	Operational Energy Use	2019	Operational Energy Use of Building Integrated System During Product Use
B7	Operational Water Use	2019	Operational Water Use of Building Integrated System During Product Use
C1	EOL: Deconstruction	2019	No inputs required for deconstruction.
C2	EOL: Transport	2019	Shipping from project site to landfill. Fuel use requirements estimated based on product weight and mapped distance.
C3	EOL: Waste Processing	2019	Waste processing not required. All waste can be processed as is.
C4	EOL: Disposal	2019	Assumes all products are sent to landfill. Landfill impacts modeled based on secondary data.
D	Benefits beyond system	MND	Credits from energy or material capture.

2.3. Estimates and Assumptions

All estimates and assumptions are within the requirements of ISO 14040/44. The majority of the estimations are within the primary data. Assumptions made thoughout the study are listed below:

- The primary data was collected as annual totals including all utility usage and production information. For the LCA, the usage information was divided by the production to create an energy and water use per square meter. As there are different products produced at this facility, it is assumed all products are using the same amount of energy.
- Another assumption is that the installation tools are used enough times that the per square meter impacts are negligible.
- Materials required for installation were assumed to be as recommended by Tile Council of North America (TCNA). In reality, these material quantities and application rates may not be used thus changing the overall impact of installation.
- Use-phase scenarios are also taken as per TCNA guidelines. However, use phase scenarios have a high degree of variability based on user preferences which might affect overall results.
- The disposal pathways and the corresponding transportation distances of unused product waste, packaging waste, and post-consumer product waste are assumed in accordance with the PCR (Part A).
- The inclusion of overhead energy, water, and waste data was determined appropriate due to the inability to sub-meter and isolate manufacturing energy from overhead energy.

2.4. Cut-off Criteria

All inputs in which data was available were included. Material inputs greater than 1% (based on total mass of the final product) were included within the scope of analysis. Material inputs less than 1% were included if sufficient data was available to warrant inclusion and/or the material input was thought to have significant environmental impact. Cumulative excluded material inputs and environmental impacts are less than 5% based on total weight of the functional unit.

The list of excluded materials and energy inputs include:

- Proprietary Additives (0.05% of final product)

This was due to lack of available, adequate representative secondary data. However, the excluded materials were below the cut off criteria and include minor additives.

2.5. Data Sources

Primary data were collected by facility personnel and from utility bills and was used for all manufacturing processes for all participating members. Whenever available, supplier data was used for raw materials used in the production process. When primary data did not exist, secondary data for raw material production was utilized from GaBi Database Version 9.2.0.58, Service Pack 39.

2.6. Data Quality

Geographical Coverage

The geographical scope of the manufacturing portion of the life cycle is North America. The geographical scope of the raw material acquisition is USA, Mexico, Africa, Italy, Spain, Turkey, Portugal, Canada and China. Customer distribution, site installation and use portions of the life cycle is mostly North America. This LCA uses country-specific energy datasets

that take into account US eGrid specific energy and transportation mixes. Since an electricity dataset specific to Mexico was not available, the SRTV eGRID dataset was used as a substitute. This substitution was based on CO_2 emissions per unit of electricity by the Mexican grid and its proximity to the STRV emission value (values taken from The Climate Registry, 2018). Overall, the geographic coverage of primary data is considered good.

Time Coverage

Primary data were provided by associates from different manufacturers and represent calendar year 2018. Using 2018 data meets the PCR requirement that manufacturer specific data be within the last 5 years. Time coverage of this data is considered good. Data necessary to model cradle-to-gate unit processes was sourced from thinkstep LCI datasets. Time coverage of the GaBi datasets varies from approximately 2009 to present. All datasets rely on at least one 1-year average data. Overall time coverage of the datasets is considered good and meets the requirement of the PCR that all data be updated within a 10-year period. The specific time coverage of secondary datasets can be referenced in the dataset references table in each supplemental LCA report.

Technological Coverage

Primary data provided by participating members are specific to the technology that the company uses in manufacturing their product. It is site specific and considered of good quality. It is worth noting that the energy and water used in manufacturing the product includes overhead energy such as lighting, heating and sanitary use of water. Sub-metering was not available to extract process only energy and water use from the total energy use. Sub-metering would improve the technological coverage of data quality. Data necessary to model cradle-to-gate unit processes was sourced from thinkstep LCI datasets. Technological coverage of the datasets is considered good relative to the actual supply chain of Republic. While improved life cycle data from suppliers would improve technological coverage, the use of lower quality generic datasets does meet the goal of this LCA.

2.7. Period under Review

The period under review is calendar year 2018.

2.8. Allocation

General principles of allocation were based on ISO 14040/44. There are no products other than ceramic tiles that are produced as part of the manufacturing processes studied in the LCA. Since there are no co-products, no allocation based on co-products is required. To derive a per unit value for manufacturing inputs such as electricity, thermal energy and water, allocation based on total production in square meters was adopted. Allocation was most prevalent in the secondary GaBi datasets used to represent upstream processes. As a default, GaBi datasets use a physical mass basis for allocation. Throughout the study recycled materials were accounted for via the cut-off method. Additionally, impacts and benefits associated with secondary functions of materials at end of life are also excluded (i.e. production into a third life or energy generation from the incineration plant). The study does include the impacts associated with reprocessing and preparation of recycled materials that are part of the bill of materials of the products under study.

3. Life Cycle Assessment Scenarios

Table 8. Transport to the building site (A4)

NAME	TRUCK	UNIT
Fuel type	Diesel	
Liters of fuel	39.0625	L/100km
Vehicle type	Heavy Duty Truck	-
Transport distance	800	km
Capacity utilization	65	%
Weight of total products transported	22,679.619	kg
Capacity utilization volume factor	1	-

Table 9. Installation into the building (A5)

NAME	VALUE	UNIT
Mortar	4.07	kg
Grout	0.212	kg
Acrylate	0.043	kg
Net freshwater consumption specified by water source and fate	0.0004 m3 tap water, installation solution	m3
Product loss per functional unit	0.94	kg
Waste materials at the construction site before waste processing, generated by product installation	1.105	kg
Packaging waste, cardboard	0.14	kg
Packaging waste, plastic film	0.003	kg
Packaging waste, wood pallet	0.02	kg
Packaging waste, plastic strap	0.002	kg
Biogenic carbon contained in packaging	0.98	kg CO_2
VOC content of flooring	N/A	$\mu g/m^3$

Table 10. Reference Service Life

NAME	VALUE	UNIT
RSL	75	years
Declared product properties (at the gate) and finishes, etc.	See Table 1	-
Design application	Installation per recommendation by manufacturer	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	Accepted industry standard	-
Indoor environment (if relevant for indoor applications)	Normal building operating conditions	-

NAME	VALUE	UNIT
Use conditions, e.g. frequency of use, mechanical exposure	Normal building operating conditions	-

Table 11. Maintenance (B2)

NAME	VALUE	UNIT
Maintenance process information	Use phase parameters as recommended by TCNA guidelines	
Dust mop	27,375	Cycles/ RSL and Cycles/ ESL
Damp mop	2,700	Cycles/ RSL and Cycles/ ESL
Net freshwater consumption specified by water source and fate	0.05 m3 tap water, evaporated	m^3
Energy input, specified by activity, type and amount	0	kWh/m^2 floor/yr
Direct emissions to ambient air, soil and water	-	kg
Further assumptions for scenario development	Floor cleaned with dust mop daily and with damp mop 36 times/year for commercial applications	

Table 12. End of life (C1-C4)

NAME		VALUE	UNIT
Assumptions for scenario development		Product is either disposed of with the underlying floor or manually removed via scraping	
Collection process	Collected separately	23.69	kg
	Collected with mixed construction waste	0	kg
Recovery	Reuse	0	kg
	Recycling	0	kg
	Landfill	23.69	kg
	Incineration	0	kg
	Incineration with energy recovery	0	kg
	Energy conversion efficiency rate	84-94	%
Disposal	Product or material for final deposition	23.69	kg
Removals of biogenic carbon (excluding packaging)		0.14	kg

Note: Since the tiles are not repaired or refurbished during its RSL, there are no impacts in stages (B1, B3, B4, B5, B6, and B7). Scenario tables related to these phases is omitted above.

4. Life Cycle Assessment Results

Table 13. Description of the system boundary modules

	PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/ Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
Cradle to Grave	X			X	X	X	X	X	X	X	X	X	X	X	X	X	MND

4.1. Life Cycle Impact Assessment Results

Table 14. North American Impact Assessment Results (TRACI 2.1)

TRACI v2.1	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
AP [kg SO_2 eq]	2.07E-02	5.56E-03	5.35E-03	0.00E+00	2.86E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.94E-04	0.00E+00	4.57E-03	MND
EP [kg N eq]	1.42E-03	4.65E-04	4.65E-04	0.00E+00	1.22E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.25E-05	0.00E+00	2.33E-04	MND
GWP [kg CO_2 eq]	1.41E+01	1.23E+00	2.96E+00	0.00E+00	2.46E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.81E-01	0.00E+00	9.96E-01	MND
ODP [kg CFC 11 eq]	3.15E-10	-6.02E-15	3.52E-10	0.00E+00	1.92E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.40E-15	0.00E+00	-4.99E-14	MND
Resources [MJ]	2.43E+01	2.28E+00	2.55E+00	0.00E+00	1.47E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.32E-01	0.00E+00	2.00E+00	MND
POCP [kg O_3 eq]	4.21E-01	1.31E-01	9.24E-02	0.00E+00	5.52E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.02E-02	0.00E+00	9.16E-02	MND

Table 15. EU Impact Assessment Results (CML 2001-Jan 2016)

CML 2001- Jan 2016	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
$ADP_{element}$ [kg Sb-eq]	7.27E-06	2.31E-07	5.44E-06	0.00E+00	2.96E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.37E-08	0.00E+00	4.12E-07	MND
ADP_{fossil} [MJ, LHV]	1.83E+02	1.71E+01	2.23E+01	0.00E+00	1.32E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.98E+00	0.00E+00	1.55E+01	MND
AP [kg SO_2 eq]	1.85E-02	4.10E-03	4.84E-03	0.00E+00	2.29E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.68E-04	0.00E+00	4.20E-03	MND
EP [kg PO_4^{-3} eq]	2.76E-03	1.16E-03	6.86E-04	0.00E+00	8.42E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.90E-04	0.00E+00	5.52E-04	MND
GWP 100 [kg CO_2 eq]	1.42E+01	1.23E+00	2.98E+00	0.00E+00	2.47E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.82E-01	0.00E+00	1.00E+00	MND
ODP [kg CFC-11 eq]	2.93E-10	5.33E-16	2.77E-10	0.00E+00	1.92E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-16	0.00E+00	5.50E-15	MND
POCP [kg ethene eq]	1.47E-03	-5.76E-04	7.36E-04	0.00E+00	1.93E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.23E-04	0.00E+00	3.56E-04	MND

4.2. Life Cycle Inventory Results

Table 16. Resource Use

PARAMETER	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
RPR_E [MJ, LHV]	9.15E+00	5.30E-01	2.67E+00	0.00E+00	7.68E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-01	0.00E+00	1.21E+00	MND
RPR_M [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
$NRPR_E$ [MJ, LHV]	1.93E+02	1.72E+01	2.35E+01	0.00E+00	1.38E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E+00	0.00E+00	1.59E+01	MND
$NRPR_M$ [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
SM [kg]	1.36E+00	0.00E+00	4.17E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
NRSF [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
RE [MJ, LHV]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
FW [m^3]	2.75E-02	2.06E-03	7.49E-03	0.00E+00	5.76E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.80E-04	0.00E+00	1.89E-03	MND

Table 17. Output Flows and Waste Categories

PARAMETER	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD [kg]	1.93E-07	1.39E-07	8.12E-08	0.00E+00	9.48E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.24E-08	0.00E+00	5.57E-08	MND
NHWD [kg]	3.13E-01	6.47E-04	1.09E+00	0.00E+00	7.59E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E-04	0.00E+00	2.27E+01	MND
HLRW [kg] or [m^3]	4.88E-06	4.59E-08	6.16E-07	0.00E+00	3.42E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-08	0.00E+00	1.94E-07	MND
ILLRW [kg] or [m^3]	3.93E-03	3.80E-05	4.84E-04	0.00E+00	2.31E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.85E-06	0.00E+00	1.54E-04	MND
CRU [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
MR [kg]	0.00E+00	0.00E+00	5.48E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
MER [kg]	0.00E+00	0.00E+00	3.66E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND
EE [MJ, LHV]	0.00E+00	0.00E+00	1.39E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	MND

Table 18. Carbon Emissions and Removals

PARAMETER	PARAMETER	INDUSTRY AVERAGE	UNIT
BCRP	Biogenic Carbon Removal from Product	0.14	kg CO_2
BCEP	Biogenic Carbon Emission from Product	0.12	kg CO_2
BCRK	Biogenic Carbon Removal from Packaging	0.98	kg CO_2
BCEK	Biogenic Carbon Emission from Packaging	0.42	kg CO_2

Note: All acronyms can be found in Section 6.

5. LCA Interpretation

For TCNA member's ceramic tile products, Global Warming (GWP) and Abiotic Depletion of fossil fuels are the impact categories of most significance. Within these impact categories, the vast majority of impacts are aggregated in the A1-A3 phase of the life cycle of the product. A1-A3 includes raw material sourcing, transportation, and manufacturing. The second largest life cycle stage is A5 in terms of global warming impacts which is transport of product to customer.

For ceramic tiles, in the sourcing and extraction stage, the largest contributors to the impacts in terms of raw materials are clay (20.2%), feldspar (2.1%), sand (5.7%) and glaze (0.5%). Within manufacturing, electricity contributes to 10.7% of overall GWP impacts while thermal energy from natural gas contributes to 36.5%.

Shipping to customer contributes around 6% of total GWP impacts, while materials used during installation contributes around 11% of GWP impacts. Finally, disposal of the product to landfill contributes 7% to total GWP impacts.

6. Supporting Documentation

The full text of the acronyms found in Section 0 are found in Table 19.

Table 19. Acronym Key

Acronym	Text	Acronym	Text
LCA Indicators			
ADP-elements	Abiotic depletion potential for non-fossil resources	GWP	Global warming potential
ADP-fossil	Abiotic depletion potential for fossil resources	OPD	Depletion of stratospheric ozone layer
AP	Acidification potential of soil and water	POCP	Photochemical ozone creation potential
EP	Eutrophication potential	Resources	Depletion of non-renewable fossil fuels
LCI Indicators			
RPR_E	Use of renewable primary energy excluding renewable primary energy resources used as raw materials	RPR_M	Use of renewable primary energy resources used as raw materials
$NRPR_E$	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	$NRPR_M$	Use of non-renewable primary energy resources used as raw materials
SM	Use of secondary materials	FW	Net use of fresh water
RSF	Use of renewable secondary fuels	NRSF	Use of non-renewable secondary fuels
HWD	Disposed-of-hazardous waste	MR	Materials for recycling
NHWD	Disposed-of non-hazardous waste	MER	Materials for energy recovery
HLRW	High-level radioactive waste, conditioned, to final repository	ILLRW	Intermediate- and low-level radioactive waste, conditioned, to final repository
CRU	Components for reuse	EE	Exported energy
RE	Recovered Energy		

7. References

1. Life Cycle Assessment, LCA Report for Tile Council of North America. WAP Sustainability Consulting. December 2019.
2. UL Environment General Program Instructions April 2017, version 2.1
3. Product Category Rule (PCR) for Building-Related Products and Services, Part A: Life Cycle Assessment Calculation Rules and Report Requirements UL 10010. Version 3.2, December 12, 2018.
4. Part B: Flooring EPD Requirements. UL Environment. V2.0. 2018.
5. ISO 14044: 2006 Environmental Management – Life cycle assessment – Requirements and Guidelines.
6. ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and Procedures.
7. ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.
8. European Standard DIN EN 15804: 2012.04+A1 2013. Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products (includes Amendment A1:2013)
9. ANSI A137.1 American National Standard Specifications for Ceramic Tile. 2017.