ENVIRONMENTAL PRODUCT DECLARATION

CEMENT GROUT FOR TILE INSTALLATION

INDUSTRY-WIDE REPORT
PRODUCTS MANUFACTURED IN NORTH AMERICA

Grout is used as a product for filling crevices such as the spaces and joints between wall or floor tiles and often serves as a design element during tile installation.

TCNA
TILE COUNCIL OF NORTH AMERICA, INC.

This Environmental Product Declaration, provided by Tile Council of North America (TCNA) and its members, contains a comprehensive environmental analysis of 127,927,215.84 kg of grout produced in North America.

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

- Ardex
- Bostik
- Crest
- Custom Building Products
- HB Fuller
- Interceramic
- Laticrete
- Mapei
- Parex

Established in 1945 as Tile Council of America (TCA), TCNA is recognized for its leadership role in promoting the use of ceramic tile, conducting independent research and product testing, and developing industry standards.

For more information, please visit: www.TCNAtile.com 100 Clemson Research Blvd. Anderson, SC 29625

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
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ENVIRONMENTAL PRODUCT DECLARATION

TCNA
TILE COUNCIL OF NORTH AMERICA, INC.

NORTH AMERICAN CEMENT GROUT FOR TILE INSTALLATION
AS DEFINED BY ANSI A118.6 AND ANSI A118.7

According to ISO 14025, ISO 14040, AND ISO 14044

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL ENVIRONMENT 333 PFINGSTEN RD, NORTHBROOK, IL 60062 WWW.UL.COM WWW.SPOT.UL.COM
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	Program Operator Rules v 2.7 2022
MANUFACTURER NAME AND ADDRESS	Tile Council of North America (TCNA)
DECLARATION NUMBER	4789883337.102.1
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	Amount of grout required to install 1 m^2 of 450mm x 450mm tile with a 3mm joint width
REFERENCE PCR AND VERSION NUMBER	Part A: Life Cycle Assessment Calculation Rules and Report Requirements (UL Environment, V4.0, 2022) Part B: Cement-based Grout, Adhesive Mortar and Self-Leveling Underlayment EPD Requirements (UL Environment V1.0, 2022)
DESCRIPTION OF PRODUCT APPLICATION/USE	Grout is used as a product for filling crevices such as the spaces and joints between wall or floor tiles and often serves as a design element during tile installation.
PRODUCT RSL DESCRIPTION (IF APPL.)	75 years
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	January 1, 2023
PERIOD OF VALIDITY	5 Years
EPD TYPE	Industry-average
RANGE OF DATASET VARIABILITY	[Industry-average only; mean, median, standard deviation]
EPD SCOPE	Cradle to grave
YEAR(S) OF REPORTED PRIMARY DATA	2019, 2020
LCA SOFTWARE & VERSION NUMBER	GaBi 10.6.1.35
LCI DATABASE(S) & VERSION NUMBER	GaBi Database Service Pack 2021.2
LCIA METHODOLOGY & VERSION NUMBER	TRACI 2.1, IPCC AR5

The PCR review was conducted by:	UL Environment Review Panel epd@ul.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Cooper McCollum, UL Environment
This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	WAP Sustainability Consulting
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	James Mellentine, Thrive ESG

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.

1. Product Definition and Information

1.1. 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. Through its Green Initiative, TCNA and its members are industry leaders in distinguishing and communicating the sustainability and environmental attributes of ceramic tile and related installation materials by conducting research, developing educational programs, and providing a forum through which TCNA members can be active in the green building community.

Information in this document has been submitted by leading North American grout manufacturers. The life cycle data and product information presented herein are representative of a range of grout products from the following manufacturers:

1.2. Product Description

Product Identification

Grout is used as a product for filling crevices such as the spaces and joints between wall or floor tiles and often serves as a design element during tile installation. Grouting materials for tile installation are available in different forms, with cement-based grouts being most common.

Typically, cement grout for tile installation is a factory-prepared mixture of cement, aggregate, and other ingredients to produce a water-resistant, dense, uniformly-colored material. Cement grout for tile installation may be unsanded or sanded. Unsanded products utilize fine aggregates, are meant for joints 1/8" in width or less and/or are sometimes required for use with glass tile. Sanded products utilize graded sand as a coarser aggregate and are meant for joints 1/8" in width or greater.

Cement grouts for tile installation are characterized as standard or high performance. High performance products typically contain latex or other polymers to achieve improved characteristics such as increased bond strength, flexural strength, and lower water absorption for frost resistance.

Performance criteria for cement grout for tile installation are defined by ANSI A118.6 (standard) and A118.7 (high performance) and include linear shrinkage, water absorption, compressive strength, tensile strength and flexural strength.

Additionally, a variety of cement grouts for tile installation may be classified by ISO 13007 – Terms, Definitions and Specifications for Ceramic Tile Grouts and Adhesives.

As is the case with tile, cement grout is capable of withstanding a wide range of environmental stresses. Once cured, it is durable, fire- and heat-resistant, non-combustible, and non-sensitive to moisture.

Results in this EPD are based on the total materials purchased during 2019 and/ or 2020 based on data availability and weighted by annual production data at each of the facilities for the various manufacturers covering about 80%-90% of overall North American produced grout. Results are intended to represent grout manufacturing in North America.

1.3. Application

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

1.4. Declaration of Methodological Framework

This LCA follows an attributional approach and is a cradle to grave study.

1.5. Technical Requirements

Table 1 shows the technical specifications of the products, including any testing data as appropriate.

Table 1: Technical Data

	GROUT
Mass (wet)	Varies**
Density (wet)	Varies**
Compressive Strength	See ANSI A118.6, ANSI A118.7 and ISO 13007-3**
Shear Strength	N/A
Pot Life	Varies**
Open Time	Varies**
Mixture Proportion	Varies**
Microorganism Resistance (if applicable)	Varies**

**This industry-wide EPD represents a broad range of cement grout products. Shear strength, flexural strength, and tensile bond strength can vary depending on the type of tile, substrate the mortar itself, and its intended application. Consult with manufacturers and/or reference product-specific EPDs for additional information. For industry-wide construction data on these properties, reference product standards.

1.6. Properties of Declared Product as Delivered

Grouts are traditionally packaged in paper bags or pails, which in turn are packaged into carboard boxes. These cardboard boxes and skrink wrapped and loaded onto wooden pallets which are then delivered to the customer or job site.

1.7. Material Composition

The raw materials and composition for grout are shown in Table 2.

Table 2: Material Composition

MATERIAL	PERCENTAGE
Calcium Hydroxide	1%
Portland Cement	33.6%
Fly Ash	0.2%
Gypsum	1.1%
Iron Oxide	1.4%
Calcium Carbonate	23.8%
Quartz	36.1%
Silica	0.04%
Vinyl Acetate Ethylene Polymer	0.6%
Proprietary Additives	2.1%

1.8. Manufacturing

Raw materials, including quartz, silica, calcium carbonate, portland cement and other additives are stored until required for production. To manufacture grout, these materials are batch mixed based on formulation and packaged in bags and then palletized. After this, they are transported to customer locations or job sites. All manufacturers of products represented by this EPD are governed by federal and local requirements for dust control. Where applicable, dust collection systems are incorporated in processes to optimize material usage and mitigate airborne dust and particulate matter within the factory.

1.9. Packaging

Primary packaging is either a paper/plastic composite, plastic, or paper bag, with secondary/tertiary packaging of shrink film and pallets. The packagaing material required per functional unit for this analysis are shown in Table 3.

Table 3: Packaging Material per Functional Unit

INPUT	AMOUNT (KG)
Cardboard	5.00E-04
Pal	5.00E-04
Paper	2.00E-04
Polyethylene Bag	9.00E-04
Shrink Wrap	1.00E-04
Wood Pallet	2.20E-03

1.10. Transportation

The average transport distance of materials and packaging to the manufacturing location is 2935km by heavy-duty diesel truck. Additionally, the transportation from manufacturing gate to the construction site was included in this study, with an average distance of 500km by heavy-duty diesel truck, based on the defaults provided in Part B of the PCR.

1.11. Product Installation

Cement grout for tile installation is primarily installed by hand, with potential limited use of machines to mix the grout prior to application. Due to its material composition, grout is typically quite alkaline and, as such, eye and skin contact should be avoided, especially for prolonged periods and within small spaces. Additionally, precautions should be taken to reduce dust emissions and inhalation during the installation process. The installation safety instructions of a given grout product should be followed during application. During installation, grout is applied at approximately 0.212 kg/m^2 with around 4.5% of the total material lost as waste. Although some of this waste could be recycled, this scrap is modeled as being disposed of in a landfill.

1.12. Use

As required in the PCR, the results are based on the estimated service life (ESL) of the building of 75 years. Since grout usually last as long as the building itself, the reference service life (RSL) of the product is assumed to be 75 years. Hence, no replacements are necessary during the service life of the building. There are some impacts during the maintenance (B2) stage as grout uses water for cleaning purposes. The floors are regularly cleaned with tap water. It has been assumed that the floors are cleaned using a dust mop every day and using a damp mop 4 times a year for residential and 36 times a year for commercial applications as recommended by the Tile Council of North America (TCNA). The scenario for commercial applications has been adopted as a conservative estimate. Use phase inputs for grout are provided below.

Table 4: Use Phase Parameters for Grout

USE	CLEANING PROCESS	CLEANING FREQUENCY	CONSUMPTION OF ENERGY AND
Commercial	Dust mop	365 times/year	-
	Damp mop	36 times/year (Commercial)	Tap water

Table 5: Use Phase Inputs for Grout

	AMOUNT	UNIT
Tap Water	0.67	L/m2/year

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 grout are expected to last as long as the building itself, the Reference Service Life (RSL) of grout is taken to be 75 years.

1.14. Reuse, Recycling, and Energy Recovery

Grout is typically not reused, recovered, and recycled.

1.15. Disposal

As grout is bound to the tile during application, it is typically disposed with the tile and as such, can be used in multiple applications—for example, clean fill material in land reclamation/contouring projects, base or substrate material for roadways and/or parking lots, replacement for raw materials used in cement or brick kilns, etc.

However, for purposes of this EPD, the analysis adopts the most conservative approach and assumes that 100% of all grout waste is disposed of in a landfill.

2. Life Cycle Assessment Background Information

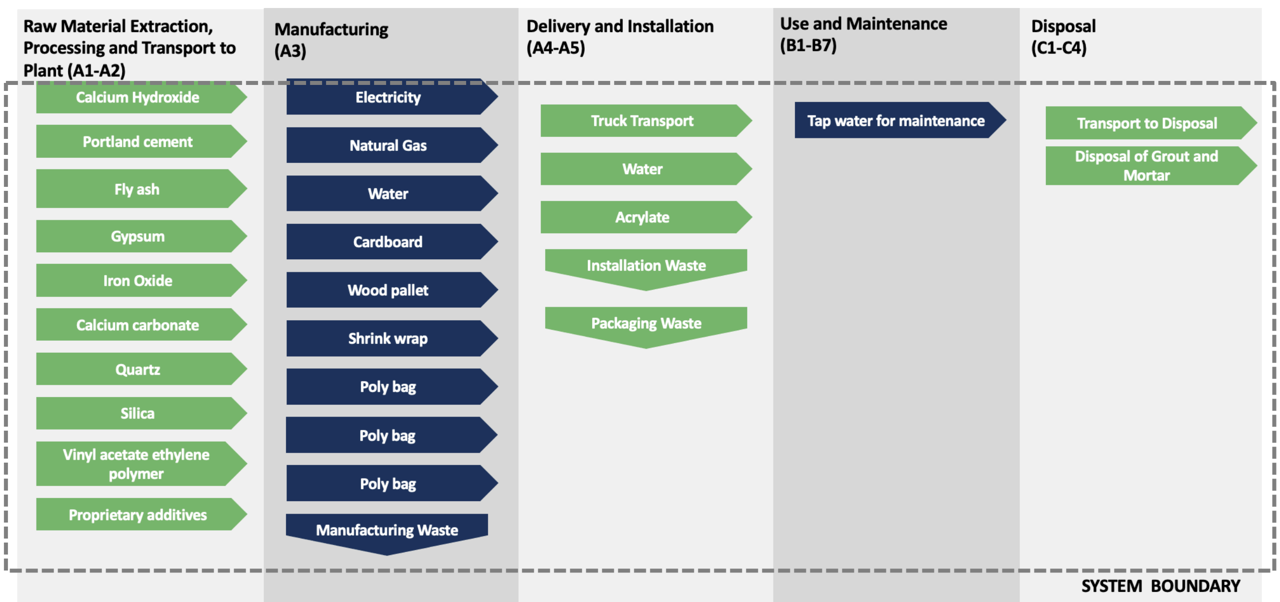
2.1. Functional Unit

The functional unit for grout according to the UL PCR is the amount of grout required to install 1 m^2 of 450mm x 450mm tile with a 3mm joint width, which is 0.212 kg.

2.2. System Boundary

This LCA is a Cradle-to-Grave study. An overview of the system boundary is shown in Figure 1.

Figure 1. System Boundary Diagram



2.3. Estimates and Assumptions

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

1. 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 kilogram and then converted to the reference flow. As there are different manufacturers surveyed for this study, scenarios were created for each facility for the various manufacturers to account for different production processes and raw materials.
2. Another assumption is that the installation tools are used enough times that the per square meter impacts are negligible.
3. 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.
4. 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.
5. For the minor additives that didn't have appropriate secondary datasets in GaBi, the volume of other raw materials was scaled up to meet reference flows per the functional unit. However, these fall well below the cut-off criteria. This method was applied as the most conservative approach rather than excluding unavailable materials.
6. 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

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.

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. When primary data did not exist, secondary data for raw material production was utilized from GaBi Database Version 10.6.1.35, Service Pack 2021.2.

2.6. Data Quality

A variety of tests and checks were performed throughout the project to ensure high quality of the completed LCA. Checks included an extensive review of project specific LCA models, as well as the background data used.

Temporal Coverage

Primary data were provided by the manufacturer and represent all information for calendar years 2019 and/ or 2020, based on data availability. Data necessary to model cradle-to-gate unit processes were sourced from Sphera's GaBi LCI datasets. Time coverage of the GaBi datasets varies from approximately 2010 to present. All datasets rely on at least one 1-year average data.

Technological Coverage

Primary data provided by the manufacturer is specific to the technology the companies use in manufacturing their products. 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 were sourced from GaBi LCI datasets. Technological coverage of the datasets is considered good relative to the actual supply chain of the manufacturer. 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.

Geographic Coverage

The geographical scope of the manufacturing portion of the life cycle is North America. All primary data were collected from the manufacturer. The geographical scope of the raw material acquisition is the US, Mexico, China, Sweden, France, Germany, Korea, Brazil, The Netherlands, Italy, and Spain. Customer distribution, site installation, and use portions of the life cycle is within North America.

In selecting secondary data (i.e. GaBi Datasets), priority was given to the accuracy and representativeness of the data. When available and deemed of significant quality, country-specific data was used. For manufacturing facilities in various locations, appropriate electricity sources as per eGRID regions were considered. Throughout data collection, priority was given to technological relevance and accuracy in selecting secondary data, which often led to the substitution of regional and/or global data for country-specific data.

2.7. Period under Review

Primary data were provided by the manufacturers and represent all information for calendar years 2019 and/ or 2020, based on data availability.

2.8. Allocation

General principles of allocation were based on ISO 14040/44. There are no products other than the product under study in the manufacturing process, and thus no allocation based on co-products were required. To derive a per-unit value for manufacturing inputs such as electricity, thermal energy, and water, allocation based on total production by mass was adopted. Recycled materials were accounted for via the cut-off method. Under this method, impacts and benefits associated with the previous life of a raw material from recycled stock are excluded from the system boundary.

2.9. Comparability

This study was not completed with the intent that comparative assertions with external objects or public disclosures (i.e., comparative marketing claims) would be made. However, the results from the report will be used as the basis of product optimization documentation and will be used to develop EPDs. The EPDs will be disclosed to the public.

3. Life Cycle Assessment Scenarios

Table 6: Transport to the building site (A4)

NAME	VALUE	UNIT
Fuel type	Diesel	-
Fuel efficiency	44.7	L/100km
Vehicle type	US: Truck - Heavy Heavy-duty Diesel Truck / 53,333 lb payload	-
Transport distance	500	km
Capacity utilization (including empty runs, mass based	67	%
Weight of products transported (if gross density not reported)	0.22	kg
Capacity utilization volume factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaging products)	1	1

Table 7: Installation into the building (A5)

NAME	VALUE	UNIT
Polymer modifier	5.50E-03	kg
Net freshwater consumption sourced from tap water and cured	5.00E-05	m^3
Product loss per functional unit	4.50E+00	%
Plastic waste	7.00E-03	kg
Metal waste	-	kg
Pulp waste	1.36E-02	kg
Waste materials at the construction site before waste processing, generated by product installation	1.40E-02	kg

Table 8: Reference Service Life and Maintenance (B2)

NAME	VALUE	UNIT
Reference Service Life (RSL)	75	years
Maintenance process information	Use phase parameters as recommended by TCNA guidelines	
Dust mop	27,375	Cycles/RSL and Cycles/ESL
Damp mop (Commercial)	2,700	Cycles/RSL and Cycles/ESL
Damp mop (Residential)	300	Cycles/RSL and Cycles/ESL
Net freshwater consumption specified by water source and fate	0.05 m3 tap water, evaporated	m3
Further assumptions for scenario development	Floor cleaned with dust mop daily and with damp mop 36 times/year for commercial applications and 4 times/year for residential applications	

Table 9: End of life (C1-C4)

NAME		VALUE	UNIT
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)		-	-
Collection process (specified by type)	Collected separately	-	kg
	Collected with mixed construction waste	0.264	kg
Recovery (specified by type)	Reuse	-	kg
	Recycling	-	kg
	Landfill	0.264	kg
	Incineration	-	kg
	Incineration with energy recovery	-	kg
	Energy conversion efficiency rate	-	-
Disposal (specified by type)	Product or material for final deposition	0.264	kg
Removals of biogenic carbon (excluding packaging)		-	kg CO_2

Note that repair (B3), replacement (B4), refurbishment (B5), Operational energy use (B6), Operational water use (B7), and reuse, recovery, and/or recycling potentials (D) has been removed from this section as they are not material to this investigation.

4. Life Cycle Assessment Results

Table 10: Description of the system boundary modules

	PRODUCT STAGE			CONSTRUCT-ION 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 Use	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	X	X	MND

X = declared module; MND = module not declared

4.1. Life Cycle Impact Assessment Results

Table 11: North American Impact Assessment Results

TRACI v2.1	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
AP [kg SO_2 eq]	3.54E-04	4.04E-05	9.13E-05	0.00E+00	3.32E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.03E-06	0.00E+00	4.97E-05
EP [kg N eq]	2.54E-05	3.85E-06	3.76E-06	0.00E+00	1.77E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.95E-07	0.00E+00	2.77E-06
GWP [kg CO_2 eq]	1.53E-01	8.67E-03	2.33E-02	0.00E+00	1.39E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E-03	0.00E+00	1.12E-02
ODP [kg CFC-11 eq]	7.24E-12	1.73E-18	3.26E-13	0.00E+00	1.04E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.23E-19	0.00E+00	3.90E-17
Resources [MJ]	1.60E-01	1.62E-02	6.02E-02	0.00E+00	2.17E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.97E-03	0.00E+00	2.27E-02
SFP [kg O_3 eq]	6.50E-03	9.34E-04	8.30E-04	0.00E+00	4.94E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-04	0.00E+00	8.83E-04
IPCC AR5 GWP 100 [kg CO2 eq]	1.53E-01	8.67E-03	2.33E-02	0.00E+00	1.39E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.12E-03	0.00E+00	1.12E-02
ADPfossil [MJ, LHV] - CML 2001-Jan 2016	1.22E+00	1.02E-01	4.34E-01	0.00E+00	1.89E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E-02	0.00E+00	1.35E-01

Comparisons cannot be made between product-specific or industry average EPDs at the design stage of a project, before a building has been specified. Comparisons may be made between product-specific or industry average EPDs at the time of product purchase when product performance and specifications have been established and serve as a functional unit for comparison. Environmental impact results shall be converted to a functional unit basis before any comparison is attempted.

Any comparison of EPDs shall be subject to the requirements of ISO 21930. EPDs are not comparative assertions and are either not comparable or have limited comparability when they have different system boundaries, are based on different product category rules or are missing relevant environmental impacts. Such comparison can be inaccurate, and could lead to erroneous selection of materials or products which are higher-impact, at least in some impact categories.

4.2. Life Cycle Inventory Results

Table 12: Resource Use

PARAMETER	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
RPR_E [MJ, LHV]	2.11E-01	5.04E-03	3.20E-02	0.00E+00	2.52E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-03	0.00E+00	1.48E-02
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
RPR_T [MJ, LHV]	2.11E-01	5.04E-03	3.20E-02	0.00E+00	2.52E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-03	0.00E+00	1.48E-02
$NRPR_E$ [MJ, LHV]	1.76E+00	1.22E-01	4.80E-01	0.00E+00	2.27E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	0.00E+00	1.78E-01
$NRPR_M$ [MJ, LHV]	9.24E-02	0.00E+00	4.16E-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
$NRPR_T$ [MJ, LHV]	1.85E+00	1.22E-01	4.84E-01	0.00E+00	2.27E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	0.00E+00	1.78E-01
SM [kg]	2.64E-04	0.00E+00	1.19E-05	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
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
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
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
FW [m^3]	6.82E-04	2.15E-05	1.55E-04	0.00E+00	8.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.28E-06	0.00E+00	2.45E-05

Table 13: Output Flows and Waste Categories

PARAMETER	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
HWD [kg]	5.40E-10	1.02E-11	5.61E-11	0.00E+00	2.98E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E-12	0.00E+00	1.69E-11
NHWD [kg]	1.19E-02	1.12E-05	1.43E-02	0.00E+00	2.55E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.75E-06	0.00E+00	2.66E-01
HLRW [kg]	7.07E-08	4.12E-10	8.52E-09	0.00E+00	7.19E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-10	0.00E+00	1.72E-09
ILLRW [kg]	5.98E-05	3.47E-07	9.34E-06	0.00E+00	6.25E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.50E-08	0.00E+00	1.49E-06
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
MR [kg]	5.30E-04	0.00E+00	2.62E-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
MER [kg]	1.33E-06	0.00E+00	4.27E-04	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
EEE [MJ]	1.87E-06	0.00E+00	8.41E-08	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
EET [MJ]	3.51E-06	0.00E+00	1.58E-07	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

Table 14: Carbon Emissions and Uptake

PARAMETER	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
BCRP [kg CO_2]	2.70E-04	0.00E+00	1.21E-05	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
BCEP [kg CO_2]	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
BCRK [kg CO_2]	5.91E-03	0.00E+00	2.66E-04	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
BCEK [kg CO_2]	0.00E+00	0.00E+00	1.88E-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
BCEW [kg CO_2]	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
CCE [kg CO_2]	6.13E-02	0.00E+00	2.76E-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
CCR [kg CO_2]	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
CWNR [kg CO_2]	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

5. LCA Interpretation

Overall, for TCNA member's grout products, Global Warming (GWP) and Resource depletion are the impact categories of most significance. Within these impact categories, many impacts are aggregated within raw material sourcing, transportation and manufacturing (A1-A3). The second largest life cycle stage in terms of global warming impacts is installation at customer site (A5).

For grout, in the sourcing and extraction stage, the largest contributors to the impacts in terms of raw materials are portland cement (51%), colorants (8.3%), sand (3.7%) and VAE copolymer (2.3%). Within manufacturing, electricity contributes to 20.2% of overall GWP impacts while thermal energy from natural gas contributes to 5.1%. Shipping to customer contributes around 4% of total GWP impacts, while installation contributes around 6.3% of GWP impacts. Finally, disposal of the product to landfill contributes 6.7% to total GWP impacts.

To reduce the environmental impacts of grout, the industry may consider increasing use of recycled content and other less carbon intensive raw materials. Additionally, seeking opportunities and partnerships to increase renewable energy use, efficiency gains, and purchase of offsets may reduce industry footprint.

Statistical Distribution of TRACI 2.1 Results

Table 15: Statistical Distribution

Statistical Parameter	TRACI 2.1, Acidification [kg SO2 eq.]	TRACI 2.1, Eutrophication [kg N eq.]	TRACI 2.1, Global Warming Air, incl. biogenic carbon [kg CO2 eq.]	TRACI 2.1, Ozone Depletion Air [kg CFC 11 eq.]	TRACI 2.1, Resources, Fossil fuels [MJ surplus energy]	TRACI 2.1, Smog Air [kg O3 eq.]
Mean	5.92E-04	4.69E-05	1.97E-01	1.39E-11	3.24E-01	9.87E-03
Median	4.96E-04	3.84E-05	1.68E-01	2.21E-14	2.73E-01	8.87E-03
Minimum	2.89E-04	2.13E-05	8.81E-02	1.75E-15	1.47E-01	5.12E-03
Maximum	1.77E-03	1.76E-04	7.96E-01	5.06E-10	1.08E+00	2.17E-02

6. Additional Environmental Information

6.1. Environment and Health During Manufacturing

All manufacturers of products represented by this EPD are governed by federal and local requirements for dust control. Where applicable, dust collection systems are incorporated in processes to optimize material usage and mitigate airborne dust and particulate matter within the factory.

6.2. Environment and Health During Installation

Refer to SDS for any PPE requirements. Contact manufacturer for OSHA Respirable Silica compliance information.

6.3. Extraordinary Effects

Fire

Once cured, grout is fire resistant.

Water

Once cured, grout is non-sensitive to moisture.

Mechanical Destruction

Tile should not be installed until any and all structural damage to the building has been adequately repaired and determined to be code compliant. Surfaces must be structurally sound, stable and rigid enough to support the grout, mortar, and tile, in addition to any other ancillary tile installation products.

6.4. Delayed Emissions

Inherently, cement grouts do not emit VOCs. For polymer-modified cement grouts, the South Coast Air Quality Management District (SCAQMD) Rule #1168 details VOC thresholds that are most commonly specified. Cement grouts for tile installation represented by this industry-wide EPD are typically in compliance. Additionally, some products covered by this EPD have been engineered to minimize airborne dust or other job-site particulates. Some cement grout for tile installation also has built-in mold and mildew protection to complement tile's inherent resistance to mold and mildew growth.

6.5. Environmental Activities and Certifications

Contact manufacturer or visit their website for other certifications or documentation, such as low VOC emission certifications, Health Product Declaration, VOC content data, and other information.

7. Supporting Documentation

The full text of the acronyms are found in Table 16.

Table 16. 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		
Biogenic Carbon Indicators			
BCRP	Biogenic Carbon Removal from Product	BCEW	Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes
BCEP	Biogenic Carbon Emission from Product	CCE	Calcination Carbon Emissions
BCRK	Biogenic Carbon Removal from Packaging	CCR	Carbonation Carbon Removals
BCEK	Biogenic Carbon Emission from Packaging	CWNR	Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes

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