NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Concrete production

Reference Flow: 1 kg of concrete product

Brief Description: Input and output flows for producing 1 kg concrete product, ready mix, precast or concrete masonry unit from plant

Section I: Meta Data

Geographical Coverage: United States **Region:**

Year Data Best Represents: 2007

Process Type: Manufacturing Process (MP)

Process Scope: Cradle-to-Gate Process (CG)

Allocation Applied: No

Completeness: All Relevant Flows Captured

Flows Aggregated in Data Set:

☒ Process ☒ Energy Use ☐ Energy P&D ☒ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☒ Greenhouse Gases	☒ Criteria Air Pollutants	☒ Other
Releases to Water:	☒ Inorganic Emissions	☒ Organic Emissions	☒ Other
Water Usage:	☐ Water Consumption	☒ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

None.

Tracked Input Flows:

Coal	*[technosphere] coal*
gasoline	*[technosphere] gasoline*
Liquefied petroleum gas	*[technosphere] Liquefied petroleum gas*
middle distillates	*[technosphere] middle distillates*
natural gas	*[technosphere] natural gas*

petroleum coke	*[technosphere] petroleum coke*
residual oil	*[technosphere] residual oil*
electricity	*[technosphere] electricity*

Tracked Output Flows:

concrete product	**Reference flow**

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage123_M_Concrete_Production_2016.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

This unit process provides a summary of relevant input and output flows associated with the production of precast concrete, ready mix concrete, or concrete masonry units. The PS tab allows the user to switch between scenarios so that the unit process can represent any of 11 preset scenarios or a concrete mix provided by the user. The reference flow of this unit process is 1 kg of concrete product.

Boundary and Description

This unit process is largely based on data from Marceau et al. (2007), which was taken from confidential industry surveys. Marceau et al. (2007) used surveys from precast, ready mix, and CMU plants to perform a life cycle inventory on the cradle-to-gate process. This data was then broken down by input to allow the user to choose different concrete mixes and find the associated emissions with the production of that concrete mix.

The PS tab of the associated *DS_Stage123_Concrete_Production.xlsx* provides 11 concrete mixes: 7 ready mix variations, 3 precast mix variations, and 1 CMU mix. It also provides space for the user to input other concrete mixes if needed. The PS tab then calculates the burden for all of the upstream inputs (Portland cement (PC), PC substitutes, water, coarse aggregate and fine aggregate), transport of inputs to the plant, and operation of the plant. When choosing the concrete type to use, strength is usually the most important factor. Most concrete used is around 20 MPa with some in the 25- to 30-MPa range. Only 1 to 2% of the concrete market is rated for higher strengths (Marceau et al. 2007). The ready mix concretes represent lower strengths, while precast can be used to create higher strengths due to the plant's ability to better regulate mixing and curing conditions. **Table 1**

shows the strengths along with the primary material differences between the mixes. Note that there are a number of ways to get to 20 MPa concrete, with the fly ash and slag variants offsetting the use of virgin Portland Cement.

Additionally, results from Habert et al. were used to add impacts associated with concrete admixtures. Because admixtures represent a small weight percentage of the total concrete mix and they have very small global warming impacts, many life cycle analyses do not include them. However, admixtures can have larger affects in other impact categories (Habert et al. 2011).

Habert et al. (2011) provide information on the abiotic depletion, global warming potential (GWP), ozone layer depletion, human toxicity, ecotoxicity, photochemical oxidation, acidification and eutrophication impacts of admixture production. The impact categories are presented in terms of equivalents (e.g. CO_2 equivalents for GWP and SO_2 equivalents for acidification) rather than material flows. Thus, the actual emissions are not provided, only aggregates of emissions converted into equivalents. For the purposes of the unit process, these have been entered as simple chemical emissions which are not exactly representative of the actual emissions and can change the impacts in a later impact analysis. For example, the SO_2 equivalents are meant to only affect acidification, but entering SO_2 as an output in an impact analysis software may also affect human health. These affects, although incalculable, are considered negligible due to the likelihood that they are small per mass admixture, and because they will be small per mass concrete.

The resulting emissions for each of the pre-set concrete mixes are shown in **Table 2**.

Table 1: Unit Process Input and Output Flows

Concrete Type	Compressive Strength (MPa)	Density (kg/m^3)	Cement (kg/m^3)	Silica Fume (kg/m^3)	Fly Ash (kg/m^3)	Slag Cement (kg/m^3)	Course Aggregate (kg/m^3)	Fine Aggregate (kg/m^3)
Precast Mix 1	50	2,290	504	0	0	0	1,050	555
Precast Mix 2	70	2,380	445	56	0	0	1,112	611
Precast Mix 3	Unspecified	2,320	386	0	0	0	1,068	742
Ready Mix 1	35	2,370	335	0	0	0	1,187	712
Ready Mix 2	25	2,380	279	0	0	0	1,187	771
Ready Mix 3	20	2,320	223	0	0	0	1,127	831
Ready Mix 4	20	2,320	179	0	44	0	1,127	831
Ready Mix 5	20	2,320	167	0	56	0	1,127	831
Ready Mix 6	20	2,320	145	0	0	78	1,127	831
Ready Mix 7	20	2,320	112	0	0	112	1,127	831
Concrete Masonry Unit	Unspecified	1,822	159	0	0	0	1,081	473

Figure 1: Unit Process Scope and Boundary

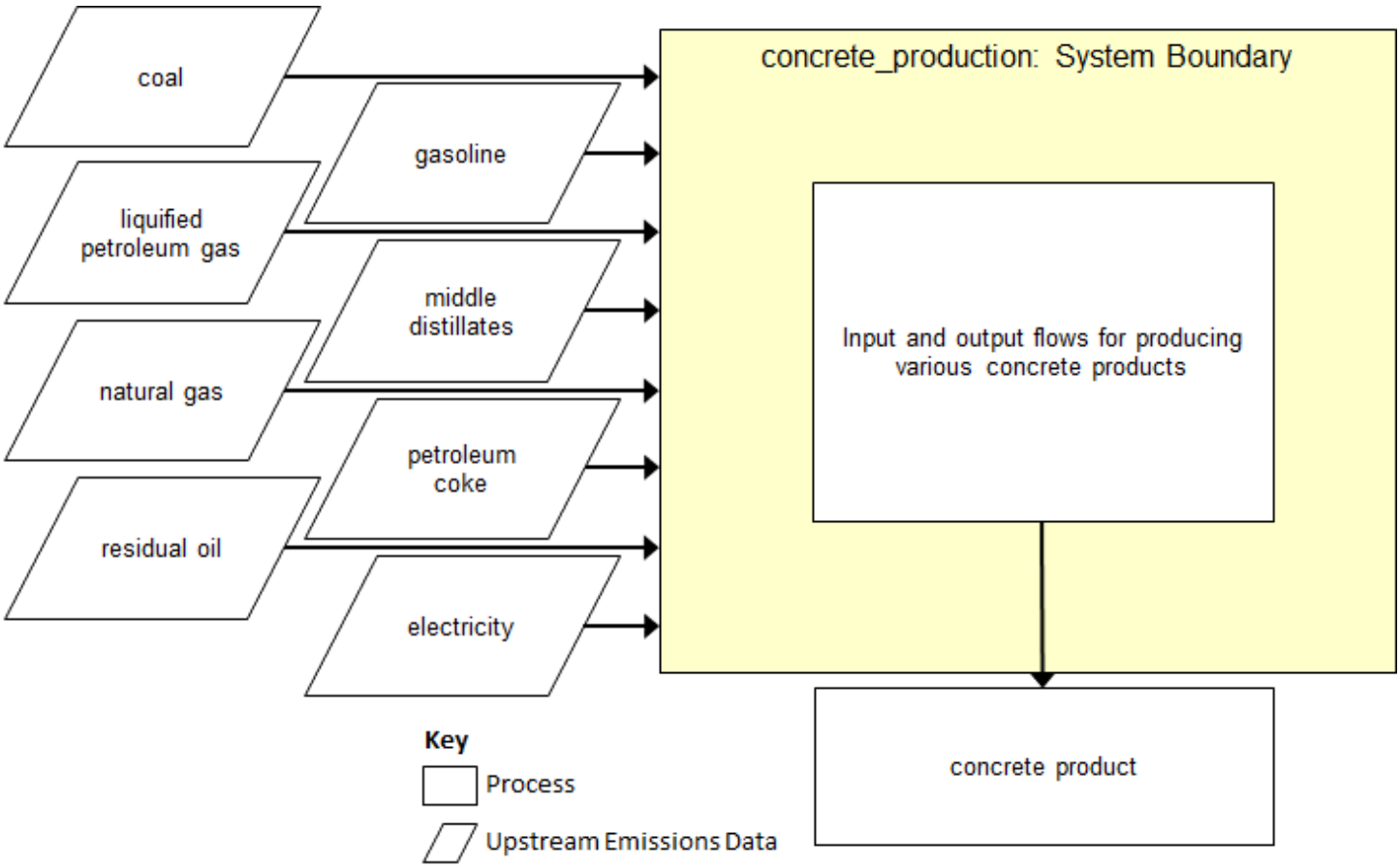

Table 1: Unit Process Input and Output Flows

Flow Name	Value, Precast 1	Value, Precast 2	Value, Precast 3	Value, Ready Mix 1	Value, Ready Mix 2	Value, Ready Mix 3	Value, Ready Mix 4	Value, Ready Mix 5	Value, Ready Mix 6	Value, Ready Mix 7	Value, CMU	Units (Per Reference Flow)	DQI
Inputs													
limestone	3.00E-01	2.55E-01	2.27E-01	1.93E-01	1.60E-01	1.31E-01	1.05E-01	9.81E-02	8.51E-02	6.58E-02	1.19E-01	kg	1,1,3,1,1
shale	1.11E-02	9.39E-03	8.36E-03	7.10E-03	5.89E-03	4.83E-03	3.88E-03	3.62E-03	3.14E-03	2.43E-03	4.38E-03	kg	1,1,3,1,1
clay	1.35E-02	1.15E-02	1.02E-02	8.67E-03	7.19E-03	5.90E-03	4.74E-03	4.42E-03	3.84E-03	2.96E-03	5.36E-03	kg	1,1,3,1,1
foundary sand	8.75E-04	7.44E-04	6.62E-04	5.62E-04	4.66E-04	3.82E-04	3.07E-04	2.86E-04	2.49E-04	1.92E-04	3.47E-04	kg	1,1,3,1,1
sand	8.82E-03	7.50E-03	6.67E-03	5.67E-03	4.70E-03	3.85E-03	3.09E-03	2.89E-03	2.51E-03	1.94E-03	3.50E-03	kg	1,1,3,1,1
iron	3.01E-03	2.56E-03	2.28E-03	1.94E-03	1.61E-03	1.32E-03	1.06E-03	9.86E-04	8.56E-04	6.61E-04	1.20E-03	kg	1,1,3,1,1
fly ash	5.09E-03	4.32E-03	3.85E-03	3.27E-03	2.71E-03	2.22E-03	2.07E-02	2.58E-02	1.45E-03	1.12E-03	2.02E-03	kg	1,1,3,1,1
slag	4.53E-03	3.85E-03	3.43E-03	2.91E-03	2.41E-03	1.98E-03	1.59E-03	1.48E-03	3.49E-02	4.93E-02	1.80E-03	kg	1,1,3,1,1
slate	2.25E-04	1.91E-04	1.70E-04	1.44E-04	1.20E-04	9.82E-05	7.88E-05	7.35E-05	6.38E-05	4.93E-05	8.91E-05	kg	1,1,3,1,1
gypsum	1.07E-02	9.06E-03	8.06E-03	6.85E-03	5.68E-03	4.66E-03	3.74E-03	3.49E-03	3.03E-03	2.34E-03	4.23E-03	kg	1,1,3,1,1
water input	3.09E-01	2.60E-01	2.52E-01	1.84E-01	1.63E-01	1.46E-01	1.30E-01	1.26E-01	1.18E-01	1.05E-01	1.40E-01	kg	1,1,3,1,1
coal	**2.22E-02**	**1.88E-02**	**1.68E-02**	**1.42E-02**	**1.18E-02**	**9.68E-03**	**7.77E-03**	**7.25E-03**	**6.30E-03**	**4.86E-03**	**8.79E-03**	**kg**	**1,1,3,1,1**
gasoline	**4.39E-04**	**4.39E-04**	**4.41E-04**	**1.74E-04**	**1.74E-04**	**1.75E-04**	**1.75E-04**	**1.75E-04**	**1.75E-04**	**1.75E-04**	**1.93E-04**	**kg**	**1,1,3,1,1**
Liquified petroleum gas	**1.68E-06**	**1.68E-06**	**1.68E-06**	**6.74E-09**	**5.59E-09**	**4.59E-09**	**3.68E-09**	**3.43E-09**	**2.98E-09**	**2.30E-09**	**1.47E-06**	**kg**	**1,1,3,1,1**
middle distillates	**3.29E-03**	**3.27E-03**	**3.27E-03**	**8.94E-04**	**8.79E-04**	**8.67E-04**	**8.51E-04**	**8.47E-04**	**8.40E-04**	**8.28E-04**	**6.60E-04**	**kg**	**1,1,3,1,1**
natural gas	**3.86E-03**	**3.75E-03**	**3.69E-03**	**5.75E-04**	**5.01E-04**	**4.36E-04**	**3.76E-04**	**3.60E-04**	**3.31E-04**	**2.86E-04**	**2.07E-03**	**kg**	**1,1,3,1,1**
petroleum coke	**4.94E-03**	**4.20E-03**	**3.73E-03**	**3.17E-03**	**2.63E-03**	**2.16E-03**	**1.73E-03**	**1.62E-03**	**1.40E-03**	**1.08E-03**	**1.96E-03**	**kg**	**1,1,3,1,1**
residual oil	**8.05E-05**	**7.88E-05**	**7.97E-05**	**8.03E-05**	**7.93E-05**	**7.85E-05**	**7.69E-05**	**7.65E-05**	**7.57E-05**	**7.45E-05**	**8.03E-05**	**kg**	**1,1,3,1,1**
waste energy	8.89E-05	7.55E-05	6.72E-05	5.71E-05	4.74E-05	3.88E-05	3.12E-05	2.91E-05	2.52E-05	1.95E-05	3.53E-05	GJ	1,1,3,1,1
electricity	**4.92E-02**	**4.46E-02**	**4.19E-02**	**2.38E-02**	**2.05E-02**	**1.76E-02**	**1.49E-02**	**1.42E-02**	**1.29E-02**	**1.09E-02**	**1.96E-02**	**kWh**	**1,1,3,1,1**
Outputs													
concrete product	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00		
carbon dioxide [emission to air]	2.13E-01	1.83E-01	1.64E-01	1.31E-01	1.09E-01	9.03E-02	7.31E-02	6.84E-02	5.99E-02	4.70E-02	8.58E-02	kg	1,1,3,1,1

Flow Name	Value, Precast 1	Value, Precast 2	Value, Precast 3	Value, Ready Mix 1	Value, Ready Mix 2	Value, Ready Mix 3	Value, Ready Mix 4	Value, Ready Mix 5	Value, Ready Mix 6	Value, Ready Mix 7	Value, CMU	Units (Per Reference Flow)	DQI
R 11 (trichlorofluoromethane) [Halogenated organic emissions to air]	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	kg	4,3,2,4,1
Dichlorobenzene (p-DCB; 1,4-dichlorobenzene) [Halogenated organic emissions to fresh water]	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	kg	4,3,2,4,1
Ethene (ethylene) [Group NMVOC to air]	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	kg	4,3,2,4,1
Sulphur dioxide [Inorganic emissions to fresh water]	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	kg	4,3,2,4,1
Phosphate [Inorganic emissions to fresh water]	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	kg	4,3,2,4,1
Aluminum (+III) [Inorganic emissions to fresh water]	1.89E-07	1.61E-07	1.43E-07	1.22E-07	1.01E-07	8.27E-08	6.63E-08	6.19E-08	5.37E-08	4.15E-08	7.50E-08	kg	1,1,3,1,1
Ammonium / ammonia [Inorganic emissions to fresh water]	2.08E-07	1.77E-07	1.58E-07	1.34E-07	1.11E-07	9.11E-08	7.31E-08	6.82E-08	5.92E-08	4.57E-08	8.27E-08	kg	1,1,3,1,1
Chloride [Inorganic emissions to fresh water]	1.60E-04	1.36E-04	1.21E-04	1.03E-04	8.52E-05	6.98E-05	5.61E-05	5.23E-05	4.54E-05	3.51E-05	6.34E-05	kg	1,1,3,1,1
Organic compounds (dissolved) [organic emissions to fresh water]	3.03E-06	2.57E-06	2.29E-06	1.95E-06	1.61E-06	1.32E-06	1.06E-06	9.91E-07	8.60E-07	6.65E-07	1.20E-06	kg	1,1,3,1,1
Nitrite [Inorganic emissions to fresh water]	1.30E-06	1.10E-06	9.80E-07	8.32E-07	6.90E-07	5.66E-07	4.54E-07	4.24E-07	3.68E-07	2.84E-07	5.14E-07	kg	1,1,3,1,1
Grease [Waste for recovery]	1.65E-06	1.41E-06	1.25E-06	1.06E-06	8.81E-07	7.22E-07	5.80E-07	5.41E-07	4.70E-07	3.63E-07	6.56E-07	kg	1,1,3,1,1
Phenol [unspecified]	4.85E-09	4.12E-09	3.67E-09	3.11E-09	2.58E-09	2.12E-09	1.70E-09	1.59E-09	1.38E-09	1.06E-09	1.92E-09	kg	1,1,3,1,1
Phosphorus [Inorganic emissions to fresh water]	1.21E-09	1.03E-09	9.16E-10	7.78E-10	6.46E-10	5.29E-10	4.25E-10	3.96E-10	3.44E-10	2.66E-10	4.81E-10	kg	1,1,3,1,1
Sulphate [Inorganic emissions to fresh water]	1.35E-04	1.15E-04	1.02E-04	8.69E-05	7.21E-05	5.91E-05	4.74E-05	4.43E-05	3.84E-05	2.97E-05	5.37E-05	kg	1,1,3,1,1
Sulphide [Inorganic emissions to fresh water]	1.45E-08	1.24E-08	1.10E-08	9.34E-09	7.75E-09	6.35E-09	5.10E-09	4.76E-09	4.13E-09	3.19E-09	5.77E-09	kg	1,1,3,1,1

Flow Name	Value, Precast 1	Value, Precast 2	Value, Precast 3	Value, Ready Mix 1	Value, Ready Mix 2	Value, Ready Mix 3	Value, Ready Mix 4	Value, Ready Mix 5	Value, Ready Mix 6	Value, Ready Mix 7	Value, CMU	Units (Per Reference Flow)	DQI
Suspended solids, unspecified [Particles to fresh water]	5.15E-05	4.38E-05	3.89E-05	3.31E-05	2.74E-05	2.25E-05	1.81E-05	1.68E-05	1.46E-05	1.13E-05	2.04E-05	kg	1,1,3,1,1
Water (wastewater) [Water]	1.02E+00	8.99E-01	8.24E-01	5.33E-01	4.44E-01	3.67E-01	2.98E-01	2.79E-01	2.44E-01	1.92E-01	3.22E-01	kg	1,1,3,1,1
Zinc [Heavy metals to fresh water]	7.28E-09	6.18E-09	5.50E-09	4.67E-09	3.88E-09	3.18E-09	2.55E-09	2.38E-09	2.07E-09	1.60E-09	2.89E-09	kg	1,1,3,1,1
Ammonia [Inorganic emissions to air]	1.20E-06	1.04E-06	9.40E-07	6.72E-07	5.57E-07	4.57E-07	3.67E-07	3.42E-07	2.97E-07	2.29E-07	4.15E-07	kg	1,1,3,1,1
Carbon monoxide [Inorganic emissions to air]	2.84E-04	2.49E-04	2.27E-04	1.62E-04	1.36E-04	1.14E-04	9.33E-05	8.78E-05	7.77E-05	6.25E-05	1.07E-04	kg	1,1,3,1,1
Hydrogen chloride [Inorganic emissions to air]	1.61E-05	1.37E-05	1.22E-05	1.04E-05	8.59E-06	7.05E-06	5.66E-06	5.28E-06	4.59E-06	3.55E-06	6.38E-06	kg	1,1,3,1,1
Mercury (+II) [Heavy metals to air]	1.34E-08	1.14E-08	1.02E-08	8.61E-09	7.15E-09	5.86E-09	4.71E-09	4.39E-09	3.82E-09	2.95E-09	5.32E-09	kg	1,1,3,1,1
Methane [Organic emissions to air (group VOC)]	8.57E-06	7.33E-06	6.57E-06	5.42E-06	4.52E-06	3.73E-06	3.03E-06	2.83E-06	2.48E-06	1.95E-06	3.48E-06	kg	1,1,3,1,1
Nitrogen oxides [Inorganic emissions to air]	5.28E-04	4.54E-04	4.09E-04	3.39E-04	2.86E-04	2.38E-04	1.96E-04	1.85E-04	1.63E-04	1.31E-04	2.21E-04	kg	1,1,3,1,1
Dust (unspecified) [Particles to air]	7.05E-04	6.16E-04	5.65E-04	4.98E-04	4.34E-04	3.78E-04	3.25E-04	3.11E-04	2.84E-04	2.45E-04	3.55E-04	kg	1,1,3,1,1
Sulphur dioxide [Inorganic emissions to air]	2.84E-04	2.41E-04	2.15E-04	1.82E-04	1.51E-04	1.24E-04	9.96E-05	9.29E-05	8.07E-05	6.23E-05	1.13E-04	kg	1,1,3,1,1
NMVOC (unspecified) [Group NMVOC to air]	6.66E-06	6.35E-06	6.17E-06	2.92E-06	2.69E-06	2.49E-06	2.30E-06	2.25E-06	2.16E-06	2.02E-06	2.54E-06	kg	1,1,3,1,1
Waste (solid) [Waste for disposal]	4.11E-02	3.99E-02	3.91E-02	1.60E-02	1.50E-02	1.42E-02	1.35E-02	1.33E-02	1.29E-02	1.24E-02	3.14E-02	kg	1,1,3,1,1
Copper [Heavy metals to fresh water]	5.14E-12	5.20E-12	5.33E-12	8.49E-12	8.54E-12	8.59E-12	8.59E-12	8.59E-12	8.59E-12	8.59E-12	1.95E-12	kg	1,1,3,1,1
Iron [Heavy metals to fresh water]	5.14E-12	5.20E-12	5.33E-12	8.49E-12	8.54E-12	8.59E-12	8.59E-12	8.59E-12	8.59E-12	8.59E-12	1.95E-12	kg	1,1,3,1,1
Arsenic [Heavy metals to air]	1.72E-10	1.72E-10	1.73E-10	1.72E-10	1.72E-10	1.72E-10	1.72E-10	1.72E-10	1.72E-10	1.72E-10	1.58E-10	kg	1,1,3,1,1
Beryllium [Inorganic emissions to air]	1.88E-11	1.88E-11	1.88E-11	2.25E-11	2.25E-11	2.25E-11	2.25E-11	2.25E-11	2.25E-11	2.25E-11	1.28E-11	kg	1,1,3,1,1

Flow Name	Value, Precast 1	Value, Precast 2	Value, Precast 3	Value, Ready Mix 1	Value, Ready Mix 2	Value, Ready Mix 3	Value, Ready Mix 4	Value, Ready Mix 5	Value, Ready Mix 6	Value, Ready Mix 7	Value, CMU	Units (Per Reference Flow)	DQI
Cadmium [Heavy metals to air]	8.58E-11	8.58E-11	8.60E-11	3.24E-11	3.25E-11	3.25E-11	3.25E-11	3.25E-11	3.25E-11	3.25E-11	4.25E-11	kg	1,1,3,1,1
Chromium (unspecified) [Heavy metals to fresh water]	6.28E-10	6.28E-10	6.28E-10	5.55E-10	5.56E-10	5.56E-10	5.56E-10	5.56E-10	5.56E-10	5.56E-10	5.81E-10	kg	1,1,3,1,1
Cobalt [Heavy metals to air]	3.25E-11	3.34E-11	3.56E-11	3.13E-11	3.21E-11	3.29E-11	3.29E-11	3.29E-11	3.29E-11	3.29E-11	3.57E-11	kg	1,1,3,1,1
Copper [Heavy metals to air]	1.07E-11	1.07E-11	1.07E-11	1.86E-11	1.86E-11	1.86E-11	1.86E-11	1.86E-11	1.86E-11	1.86E-11	0.00E+00	kg	1,1,3,1,1
Lead [Heavy metals to air]	2.49E-10	2.49E-10	2.50E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.35E-10	2.19E-10	kg	1,1,3,1,1
Manganese [Heavy metals to air]	3.81E-09	3.81E-09	3.81E-09	3.82E-09	3.82E-09	3.82E-09	3.82E-09	3.82E-09	3.82E-09	3.82E-09	3.81E-09	kg	1,1,3,1,1
Nickel [Heavy metals to air]	1.18E-09	1.19E-09	1.22E-09	1.12E-09	1.13E-09	1.14E-09	1.14E-09	1.14E-09	1.14E-09	1.14E-09	1.18E-09	kg	1,1,3,1,1
Tetrachloroethene (perchloroethylene) [Halogenated organic emissions to air]	1.30E-12	1.31E-12	1.34E-12	2.07E-12	2.08E-12	2.09E-12	2.09E-12	2.09E-12	2.09E-12	2.09E-12	3.81E-13	kg	1,1,3,1,1
Phosphorus [Inorganic emissions to air]	1.87E-09	1.87E-09	1.87E-09	1.90E-09	1.90E-09	1.90E-09	1.90E-09	1.90E-09	1.90E-09	1.90E-09	1.87E-09	kg	1,1,3,1,1
radionuclides [Radioactive emissions to air]	1.31E-05	1.31E-05	1.33E-05	1.13E-05	1.13E-05	1.14E-05	1.14E-05	1.14E-05	1.14E-05	1.14E-05	5.49E-06	kBq	1,1,3,1,1
Selenium [Heavy metals to air]	4.49E-11	4.50E-11	4.52E-11	6.38E-11	6.39E-11	6.40E-11	6.40E-11	6.40E-11	6.40E-11	6.40E-11	1.78E-11	kg	1,1,3,1,1
Sulphur oxides [Inorganic emissions to air]	1.19E-06	1.20E-06	1.23E-06	1.16E-06	1.17E-06	1.18E-06	1.18E-06	1.18E-06	1.18E-06	1.18E-06	1.10E-06	kg	1,1,3,1,1
Zinc [Heavy metals to air]	7.12E-12	7.12E-12	7.12E-12	1.24E-11	1.24E-11	1.24E-11	1.24E-11	1.24E-11	1.24E-11	1.24E-11	0.00E+00	kg	1,1,3,1,1

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Note: Inventory items not included are assumed to be zero based on best engineering judgment or assumed to be zero because no data was available to categorize them for this unit process at the time of its creation.

Embedded Unit Processes

None.

References

Marceau et al. 2007

Marceau, Medgar L, Michael A. Nisbet and Martha G. VanGeem. 2007. Life Cycle Inventory of Portland Cement Concrete. Portland Cement Association. *Portland Cement Association*

Habert et al. 2011

Habert, G., J.B. d'Espinose de Lacaillerie and N. Roussel. 2011. An environmental evaluation of geopolymer based concrete production: reviewing current research trends. Journal of Cleaner Production, 19 (11).

Section III: Document Control Information

Date Created: March 2, 2016

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

Revision History:

Original/no revisions

How to Cite This Document: This document should be cited as:

NETL (2016). NETL Life Cycle Inventory Data – Unit Process: Concrete Production – Version 01. U.S. Department of Energy, National Energy Technology Laboratory. Retrieved [DATE] from www.netl.doe.gov/LCA

Section IV: Disclaimer

Neither the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) nor any person acting on behalf of these organizations:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this document, or that the use of any information, apparatus, method, or process disclosed in this document may not infringe on privately owned rights; or

B. Assumes any liability with this report as to its use, or damages resulting from the use of any information, apparatus, method, or process disclosed in this document.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by NETL. The views and opinions of the authors expressed herein do not necessarily state or reflect those of NETL.