NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Ethanol via Lignocellulosic Combustion of Switchgrass, Acquisition, Transport, and Conversion

Reference Flow: 1 kg of Ethanol (E95)

Brief Description: This process includes all inputs for the raw material acquisition, raw material transportation, and energy conversion for 1 kg of ethanol, based on lignocellulosic combustion of switchgrass.

Section I: Meta Data

Geographical Coverage: US **Region:** Midwest

Year Data Best Represents: 2009

Process Type: Energy Conversion (EC)

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

Allocation Applied: Yes

Completeness: Individual 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:

Acres_yr	*The area of land needed to produce the quantity of biomass*
Biomass_yield	*The amount of biomass produced each acre of farming each year*
BTL_bio_day	*The amount of biomass used for the ECF*
CF	*Capacity factor of ECF*
Load_Trailer	*Maximum weight of switchgrass transported by one trailer load*

S2_TRK_DIST	*Distance from the origin to the destination*
ETHANOL_PROD	*Ethanol production from refinery per 30-year study period*

Tracked Input Flows:

None

Tracked Output Flows:

Ethanol (E95) [Valuable substance]	*Ethanol fuel (E95) produced by the energy conversion facility and ready for transport*

Section II: Process Description

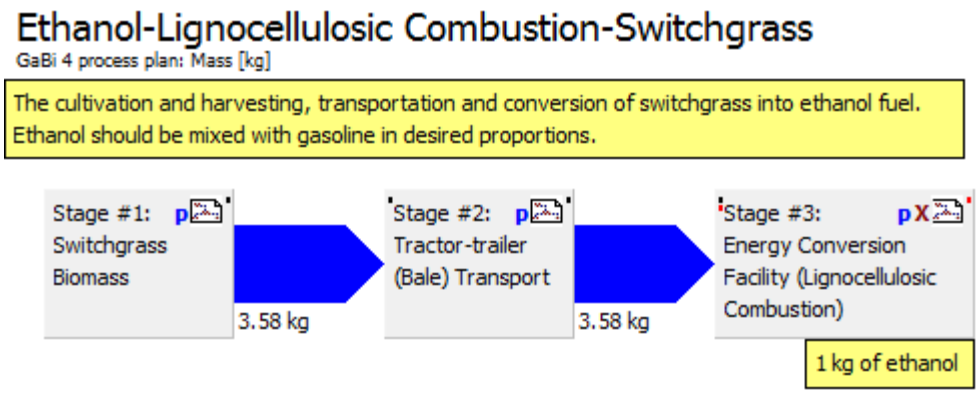
Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_CTG_Ethanol_LignocellulosicCombustion_Switchgrass_2011.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process covers all aspects of raw material acquisition (RMA), raw material transportation (RMT), and the energy conversion facility (ECF) for the production of ethanol (E95) via lignocellulosic combustion of switchgrass, as shown in **Figure 1**. At the downstream boundary of this unit process, one kilogram finished ethanol (E95) is delivered to the upstream boundary of finished fuels transport (LC Stage #4). The RMA, RMT, and ECF are discussed separately below.

Figure 1: Plan for RMA, RMT, and ECF for Lignocellulosic Combustion



Boundary and Description

LC Stage #1, raw material acquisition of switchgrass, includes land preparation for switchgrass production, cultivation of the switchgrass, and the harvesting and storing of the switchgrass. Most of the data used in the formation of the operation processes are from states in the U.S. Midwest.

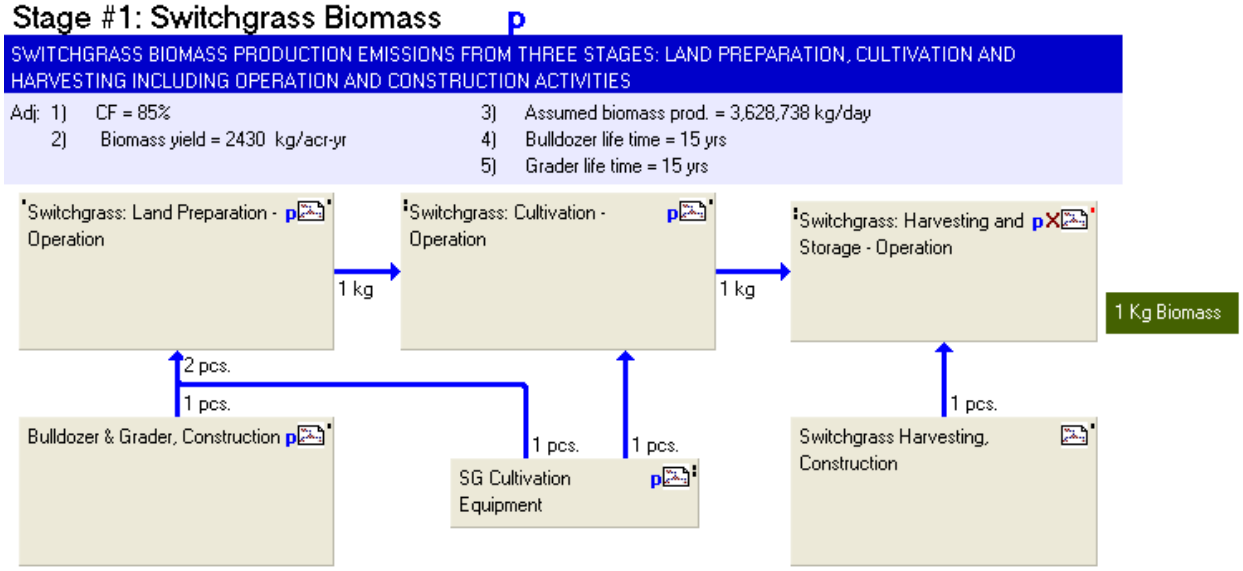
The RMA of switchgrass includes the construction of machinery needed for RMA operation processes. Within the machinery construction, upstream processes (for example, steel or rubber) are included. The plan for RMA of switchgrass is provided in **Figure 2**.

The biomass processes are set up slightly differently than some of the other feedstocks. Unlike other RMA pathways, biomass has a set order of operations for its production. The product from one process is the input to another process, which then lends itself to assembly of the model in series. Each of the operations uses a distinct set of machinery, and each piece is constructed as many times as needed during the study period. For the operation processes, each requires diesel fuel and calculates the emissions based on the diesel consumed. The cultivation process also includes the production and application of different fertilizers (potassium, nitrogen, and phosphorus).

The construction processes for machinery contain all of the machinery needed for the initial clearing of the site, cultivation, and harvesting of the switchgrass. The machinery includes:

- Bulldozer, 410 Horsepower
  (DS/DF_Stage1_C_Diesel_Track_Bulldozer_410_HP_2010.01.doc)
- Diesel Motor Grader
  (DS/DF_Stage1_C_Diesel_Motor_Grader_213_HP_2010.01.doc)
- Tiller
  (DS/DF_Stage1_C_Tiller_5015_lbs_TractorPropelled_2009.01.doc)
- Tractor
  (DS/DF_Stage1_C_Diesel_Tractor_165_HP_2009.01.doc)
- Seeder
  (DS/ DF_Stage1_C_Seeder_21900_lbs_TractorPropelled_2009.01.doc)
- Harvester
  (DS/ DF_Stage1_C_Diesel_Forage_Harvester_615_HP_2010.01.doc)
- Baler
  (DS/ DF_Stage1_C_Baler_3110_lbs_TractorPropelled_2009.01.doc)

Figure 2: Plan for RMA of Switchgrass, Including Land Preparation, Cultivation and Harvesting and Storage



Each piece of equipment is scaled to the production of one kilogram of switchgrass, accounting for the lifetime of each piece of equipment, as relevant. The profiles and processes included in RMA are provided in **Table 1**. Those shown in bold face were developed by NETL.

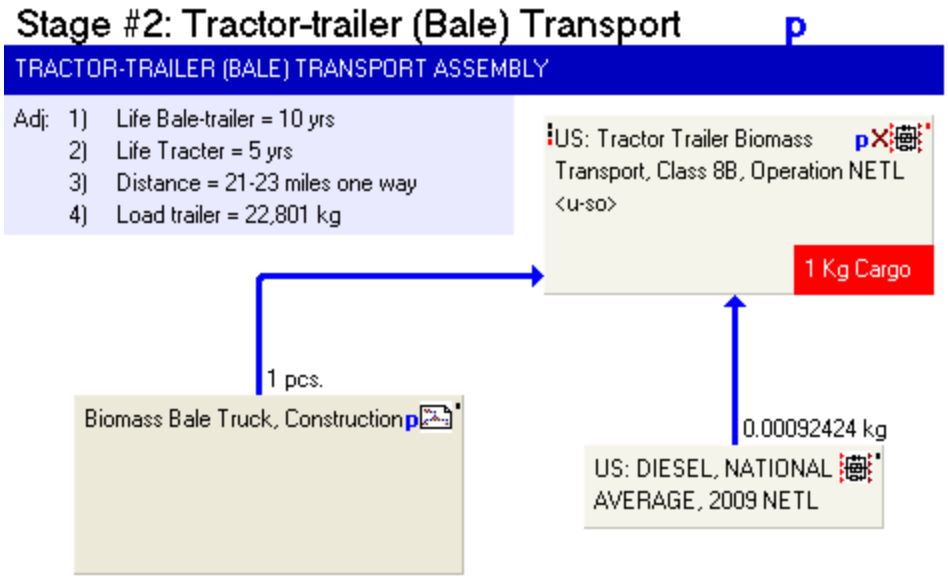
Table 1: Profiles and Processes Included in RMA of Switchgrass

Stage #1: Switchgrass Biomass
- Bulldozer & Grader, Construction
  - US: Diesel Motor Grader, 213 Horsepower, Construction NETL <u-so>
  - US: Diesel Track Bulldozer, 410 Horsepower, Construction NETL <u-so>
  - US: Switchgrass Land Preparation Assembly, Construction NETL <u-so>
  - WOR: Steel Plate, BF, Manufacture NETL <u-so>
- SG Cultivation Equipment
  - Seeder, Construction
    - US: Seeder, 21900 lbs, Tractor-Propelled, Construction NETL <u-so>
    - WOR: Steel Plate, BF, Manufacture NETL <u-so>
  - Tiller, Construction
    - US: Tiller, 5015 lbs, Tractor-Propelled, Construction NETL <u-so>
    - WOR: Steel Plate, BF, Manufacture NETL <u-so>
  - Tractor, Construction
    - US: Diesel Tractor, 165 Horsepower, Construction NETL <u-so>
    - WOR: Steel Plate, BF, Manufacture NETL <u-so>
  - US: Switchgrass Cultivation Assembly, Construction NETL <u-so>
- Switchgrass Harvesting, Construction
  - Switchgrass Baler, Construction
    - US: Baler, 3110 lbs, Tractor-Propelled, Construction NETL <u-so>

WOR: Steel Plate, BF, Manufacture NETL <u-so>
Switchgrass Harvester, Construction
US: Diesel Forage Harvester, 615 Horsepower, Construction NETL <u-so>
WOR: Steel Plate, BF, Manufacture NETL <u-so>
US: Switchgrass Harvesting Assembly, Construction NETL <u-so>
Switchgrass: Cultivation - Operation
Average K Fertilizer
EU-15: Average K Fertilizer NETL
US: North American Average Electricity Mix, 2007 080811 NETL
Average N Fertilizer
DE: Ammonia (NH3) PE
DE: Nitric acid (98%) PE
EU-15: Average N Fertilizer NETL
US: North American Average Electricity Mix, 2007 080811 NETL
Average P Fertilizer
DE: Sulphuric acid (96%) PE
EU-15: Average P Fertilizer NETL
US: North American Average Electricity Mix, 2007 080811 NETL
US: Phosphate NETL
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>
US: Switchgrass Cultivation, Operation NETL <u-so>
Switchgrass: Harvesting and Storage – Operation
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>
US: Switchgrass Harvesting & Storage, Operation NETL <u-so>
Switchgrass: Land Preparation – Operation
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>
US: Switchgrass: Land Preparation Operation NETL <u-so>

LC Stage #2 (RMT) includes the transport of the harvested switchgrass from the farm to the energy conversion facility (LC Stage #3). The construction of equipment used to transport switchgrass and the operation of that equipment are the two processes within RMT. Switchgrass transport takes place via tractor-trailer (i.e., semi truck) that is diesel-powered and suitable for the transport of switchgrass. The transport distance is an adjustable parameter for RMT. The plan for RMT of switchgrass is provided in **Figure 3.**

Figure 3: Plan for RMT of Switchgrass, Including Construction and Operation of Profiles for Transport



Construction of the truck for RMT includes the materials required to construct the piece of equipment, shown below, for transport. A bale truck is used as a proxy transport vehicle for switchgrass transport because it is presumed to represent a suitable transport vehicle for switchgrass.

- Bale Truck
  (DS/ DF_Stage2_C_Bale_Truck_Biomass_Transport_2010.01.doc)

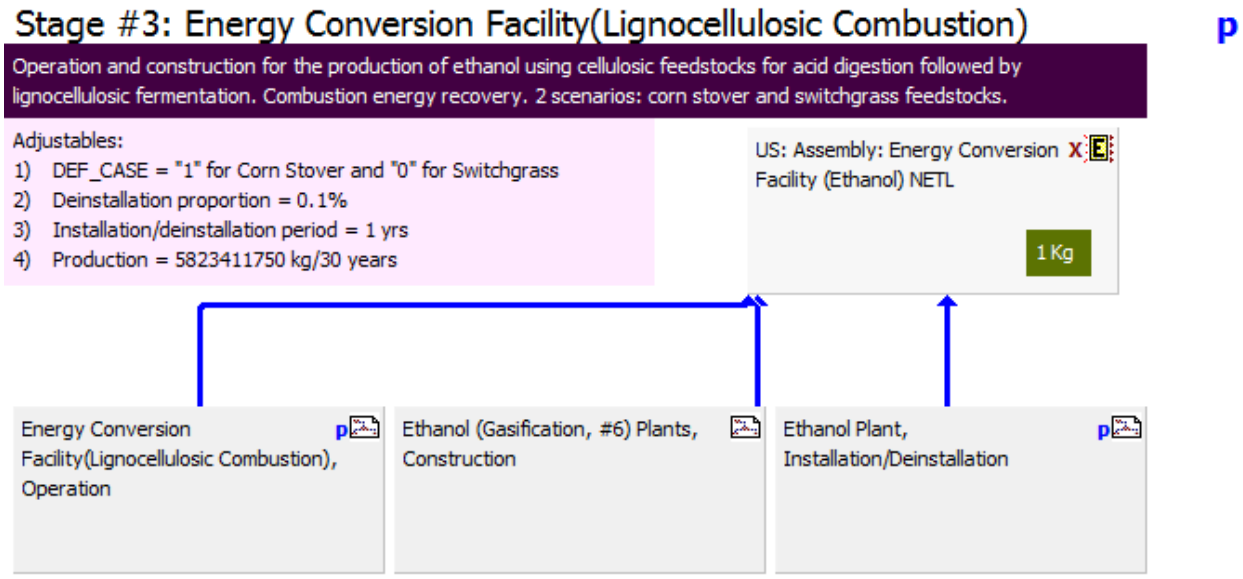
The profiles and processes included in RMT are provided in **Table 2**. Those shown in bold face were developed by NETL.

Table 2: Profiles and Processes Included in RMT for Switchgrass

Stage #2: Tractor-trailer (Bale) Transport
- Biomass Bale Truck, Construction
  - DE: Lead (99,995%) PE
  - DE: Styrene-butadiene rubber mix (SBR) PE
  - RER: Aluminum sheet mix PE
  - RER: Nylon 6.6 granulate (PA 6.6) ELCD/PlasticsEurope <p-agg>
  - RER: Polyurethane flexible foam (PU) PlasticsEurope
  - **US: Bale Truck, Biomass Transport, Construction NETL <u-so>**
  - **WOR: Steel Plate, BF, Manufacture NETL <u-so>**
- **US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>**
- **US: Tractor Trailer Biomass Transport, Class 8B, Operation NETL <u-so>**

LC Stage #3 (ECF) includes the conversion of switchgrass to fuel grade ethanol (E95) via a lignocellulosic combustion. This process can use either corn stover or switchgrass as the cellulosic feedstock in the production of ethanol. Finished ethanol from the ECF process is delivered to the upstream boundary of LC Stage #4, finished fuels transport. The plan for the switchgrass/ethanol ECF (lignocellulosic combustion) is provided in **Figure 4**.

Figure 4: Plan for ECF of Switchgrass to Ethanol (E95) Finished Fuel



The profiles and processes included in the ECF are provided in **Table 3**. Those shown in bold face were developed by NETL.

Table 3: Profiles and Processes Included in ECF for Switchgrass

Stage #3: Energy Conversion Facility (Lignocellulosic Combustion)
- Energy Conversion Facility(Lignocellulosic Combustion), Operation
  - US: MROW Grid Power Mix, 2005 (eGRID2007)
    - EU-15: Power from biomass - Energy Quality EDIP
    - GLO: Power from nuclear power plant PE
    - GLO: Power from wind power PE
    - **US: MROW Power grid mix, 2005 (eGRID2007) NETL**
    - US: Power from hard coal PE
    - US: Power from heavy fuel oil PE
    - US: Power from hydropower PE
    - US: Power from lignite PE
    - US: Power from natural gas PE
  - DE: Limestone flour (CaCO3; dried) PE
  - RER: Sulphuric acid (96%) PE
  - **US: Biochemical Ethanol Plant with Boiler Cogen NETL <u-so>**

US: Electricity, System Expansion NETL

Ethanol (Gasification, #6) Plants, Construction

US: MROW Grid Power Mix, 2005 (eGRID2007)

EU-15: Power from biomass - Energy Quality EDIP

GLO: Power from nuclear power plant PE

GLO: Power from wind power PE

US: MROW Power grid mix, 2005 (eGRID2007) NETL

US: Power from hard coal PE

US: Power from heavy fuel oil PE

US: Power from hydropower PE

US: Power from lignite PE

US: Power from natural gas PE

US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>

US: Ethanol Plant, Thermochemical, Construction NETL <u-so>

WOR: Steel Plate, BF, Manufacture NETL <u-so>

WOR: Steel, Stainless, 316 2B, 80% Recycled NETL <u-so>

Ethanol Plant, Installation/Deinstallation

US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>

US: Fischer-Tropsch Diesel (FTD) Energy Conversion Facility Commissioning/Decommissioning NETL <u-so>

US: Assembly: Energy Conversion Facility (Ethanol) NETL

Parameters and Balances

The parameters for the highest level modeling plans for RMA, RMT, and ECF for switchgrass to ethanol production are shown in **Table 4**. These parameters may or may not include the adjustable parameters shown previously, depending on how the model was created. **Table 5** presents the input and output balances for resources and emissions of interest for the cradle-to-gate plan as well as each of the RMA, RMT, and ECF plans.

Table 4: Adjustable Parameters for RMA, RMT, and ECF for Switchgrass Ethanol

Plan	Parameter	Value	Comment
LC Stage #1			
Stage #1: Switchgrass Biomass Production	acres_yr	5.00E+02	[acre/yr] Assumed size of farm is 500 acres (just to cal. individual stage results).
Stage #1: Switchgrass Biomass Production	Biomass_yield	2.43E+03	[kg/acre-year] Adjustable parameter. Default value is shown in 'Biomass Yield!C8' All other paramet
Stage #1: Switchgrass Biomass Production	BTL_bio_day	3.63E+06	[kg biomass/day] Tons of biomass used per day for the Plant; default value
Stage #1: Switchgrass Biomass Production	CF	0.85	[unitless proportion] Adjustable parameter. Capacity factor of CBTL plant, weighs into the required
LC Stage #2			
Stage #2: Tractor-trailer (Bale) Transport	Load_Trailer	2.28E+04	[kg] Maximum weight of switchgrass transported by 1 trailer load.
Stage #2: Tractor-trailer (Bale) Transport	S2_TRK_DIST	2.20E+01	[miles] adjustable parameter for distance from Origin to Destination. Calculated in "Biomass distance
LC Stage #3			
Stage #3: Energy Conversion Facility (Lignocellulosic Combustion)	ETHANOL_PROD	5.82E+09	[kg/Study Period] Ethanol production from refinery, per 30-year study period; see 'Calcs_FD' for ref

Table 5: Inputs and Output Balances for Cradle-to-Gate, RMA, RMT, and ECF for Ethanol Production via Lignocellulosic Combustion of Switchgrass (kg/kg produced)

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Inputs				
Flows	4.069E+03	4.079E+03	3.514E-02	-5.156E+00
Resources	4.069E+03	4.079E+03	3.514E-02	-5.156E+00
Energy resources	1.420E+00	1.607E+00	2.264E-03	-1.886E-01
Non renewable energy resources	1.420E+00	1.607E+00	2.262E-03	-1.886E-01
Crude oil (resource)	2.296E-01	1.893E-01	1.369E-03	3.890E-02
Hard coal (resource)	8.839E-01	1.108E+00	3.964E-04	-2.246E-01
Lignite (resource)	1.845E-02	1.796E-02	7.061E-05	4.198E-04
Natural gas (resource)	2.885E-01	2.913E-01	4.265E-04	-3.236E-03
Uranium (resource)	-2.209E-06	4.812E-07	3.687E-09	-2.694E-06
Renewable energy resources	-8.582E-07	6.532E-07	1.524E-06	-3.036E-06
Biomass	1.508E-06	8.941E-09	1.506E-06	-7.087E-09
Renewable fuels	1.096E-09	8.743E-10	8.482E-13	2.205E-10
Wood	-2.367E-06	6.434E-07	1.829E-08	-3.029E-06
Unspecified	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Land use	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Material resources	4.067E+03	4.077E+03	3.288E-02	-4.967E+00
Non renewable elements	1.047E-05	6.751E-06	5.663E-07	3.149E-06
Aluminum	-2.275E-09	1.619E-10	1.122E-12	-2.438E-09
Chromium	9.765E-11	5.960E-13	9.628E-11	7.712E-13
Copper	2.319E-11	2.062E-13	2.292E-11	6.030E-14
Iron	1.014E-05	6.713E-06	2.948E-07	3.134E-06
Lead	9.357E-11	3.598E-13	9.274E-11	4.755E-13
Magnesium	1.153E-13	6.984E-16	1.137E-13	9.108E-16
Mercury	2.931E-11	1.785E-13	2.891E-11	2.268E-13
Nickel	3.621E-13	2.261E-15	3.569E-13	2.855E-15
Phosphorus	1.152E-08	6.980E-11	1.136E-08	9.102E-11
Sulphur	2.595E-07	6.446E-10	2.580E-07	8.519E-10
Zinc	5.657E-08	3.727E-08	1.869E-09	1.744E-08
Non renewable resources	7.249E-01	1.724E+00	2.128E-03	-1.002E+00
Barium sulphate	3.814E-16	1.070E-16	9.650E-17	1.779E-16
Basalt	8.810E-06	1.252E-06	1.421E-06	6.136E-06
Bauxite	1.009E-04	1.037E-05	8.154E-05	8.965E-06
Bentonite	2.353E-04	2.191E-04	5.520E-06	1.074E-05
Calcium carbonate (CaCO3)	5.014E-02	5.015E-02	7.299E-09	-1.587E-05
Calcium chloride	3.905E-14	1.095E-14	9.880E-15	1.822E-14
Chalk (Calciumcarbonate)	1.997E-37	1.094E-39	1.978E-37	8.453E-40
Chromium ore (39%)	2.432E-04	2.657E-07	1.557E-09	2.429E-04
Clay	2.613E-05	3.510E-05	4.990E-07	-9.465E-06
Colemanite ore	-3.577E-07	5.120E-08	6.019E-10	-4.095E-07
Copper - Gold - Silver - ore (1,0% Cu; 0,4 g/t Au; 66 g/t Ag)	-8.415E-07	6.595E-07	7.494E-09	-1.509E-06
Copper - Gold - Silver - ore (1,1% Cu; 0,01 g/t Au; 2,86 g/t Ag)	-5.127E-07	4.018E-07	4.565E-09	-9.190E-07
Copper - Gold - Silver - ore (1,16% Cu; 0,002 g/t Au; 1,06 g/t Ag)	-2.894E-07	2.268E-07	2.577E-09	-5.187E-07
Copper - Molybdenum - Gold - Silver - ore (1,13% Cu; 0,02% Mo; 0,01 g/t Au; 2,86 g/t Ag)	-1.054E-06	2.032E-07	6.278E-09	-1.264E-06
Copper ore (0.14%)	-6.646E-05	1.001E-05	4.581E-08	-7.651E-05
Copper ore (1.2%)	-8.727E-08	6.839E-08	7.771E-10	-1.564E-07
Copper ore (4%)	-4.388E-17	9.895E-17	2.677E-18	-1.455E-16
Copper ore (sulphidic, 1.1%)	-1.016E-06	7.226E-08	5.006E-10	-1.088E-06
Dolomite	1.372E-02	1.355E-02	3.731E-06	1.580E-04
Feldspar (aluminum silicates)	8.128E-09	4.922E-11	8.014E-09	6.419E-11
Ferro manganese	2.355E-11	1.084E-13	2.330E-11	1.403E-13
Fluorspar (calcium fluoride; fluorite)	7.551E-07	7.547E-08	6.125E-07	6.712E-08
Granite	2.540E-18	1.359E-20	2.509E-18	1.739E-20
Gravel	5.513E-06	5.513E-06	0.000E+00	0.000E+00

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Gypsum (natural gypsum)	-1.333E-06	9.201E-06	2.184E-07	-1.075E-05
Heavy spar (BaSO4)	5.702E-04	5.299E-04	1.330E-05	2.703E-05
Ilmenite (titanium ore)	8.272E-11	1.022E-11	1.379E-16	7.250E-11
Inert rock	-8.561E-01	2.468E-01	1.496E-03	-1.104E+00
Iron ore (56,86%)	1.156E+00	1.154E+00	3.206E-04	9.198E-04
Iron ore (65%)	3.770E-08	6.147E-08	2.283E-09	-2.606E-08
Kaolin ore	-6.422E-07	9.186E-08	1.079E-09	-7.351E-07
Lead - zinc ore (4.6%-0.6%)	1.087E-04	4.352E-05	6.274E-05	2.401E-06
Limestone (calcium carbonate)	3.570E-01	2.612E-01	9.998E-05	9.569E-02
Magnesit (Magnesium carbonate)	7.725E-08	1.847E-10	4.715E-12	7.706E-08
Magnesium chloride leach (40%)	6.851E-05	6.025E-05	3.486E-07	7.903E-06
Manganese ore	5.822E-05	5.130E-08	3.154E-10	5.817E-05
Manganese ore (R.O.M.)	1.858E-06	1.709E-06	5.151E-08	9.723E-08
Molybdenite (Mo 0,24%)	-6.435E-07	1.241E-07	3.871E-09	-7.715E-07
Molybdenum ore (0.1%)	8.397E-05	7.185E-10	0.000E+00	8.397E-05
Natural Aggregate	-1.845E-03	3.365E-04	4.981E-06	-2.187E-03
Nickel ore (1,5%)	5.955E-05	1.342E-09	4.104E-13	5.955E-05
Nickel ore (1.6%)	6.152E-06	6.069E-06	1.581E-07	-7.447E-08
Olivine	2.449E-10	1.130E-12	2.423E-10	1.463E-12
Peat	5.513E-05	3.307E-07	8.872E-08	5.471E-05
Phosphate ore	5.020E-03	5.018E-03	1.467E-11	1.953E-06
Phosphorus minerals	5.550E-05	5.446E-05	1.034E-06	7.924E-09
Phosphorus ore (29% P2O5)	1.385E-08	5.268E-14	1.065E-11	1.384E-08
Potassium chloride	1.759E-07	9.771E-10	1.446E-07	3.038E-08
Precious metal ore (R.O.M)	-2.161E-08	7.485E-09	2.010E-10	-2.929E-08
Quartz sand (silica sand; silicon dioxide)	7.569E-05	7.275E-05	3.651E-07	2.571E-06
Raw pumice	-6.248E-08	8.913E-09	2.566E-11	-7.142E-08
Rutile (titanium ore)	1.242E-08	1.884E-11	1.238E-08	2.796E-11
sand	2.936E-08	1.662E-10	2.898E-08	2.163E-10
Slate	5.813E-10	2.409E-12	5.757E-10	3.193E-12
Sodium chloride (rock salt)	5.374E-04	4.337E-04	2.474E-05	7.897E-05
Sodium nitrate	6.174E-18	6.128E-20	6.065E-18	4.849E-20
Sodium sulphate	4.991E-09	4.138E-09	7.099E-11	7.820E-10
Soil	7.731E-03	1.087E-04	1.738E-06	7.620E-03
Sulphur (bonded)	3.140E-12	1.155E-11	4.092E-13	-8.816E-12
Talc	-1.073E-08	1.605E-09	6.317E-12	-1.234E-08
Tin ore	3.308E-17	9.276E-18	8.368E-18	1.543E-17
Titanium ore	-3.676E-07	6.849E-07	1.561E-08	-1.068E-06

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Zinc - copper ore (4.07%-2.59%)	5.150E-06	7.989E-06	1.618E-06	-4.457E-06
Zinc - lead - copper ore (12%-3%-2%)	9.454E-06	3.488E-06	8.604E-06	-2.638E-06
Zinc - lead ore (4.21%-4.96%)	-1.498E-17	3.379E-17	9.141E-19	-4.968E-17
Zinc ore (4%)	-8.694E-03	-8.689E-03	-2.380E-06	-2.820E-06
Zinc ore (sulphidic, 4%)	-3.916E-16	7.929E-16	3.383E-17	-1.218E-15
Renewable resources	4.067E+03	4.075E+03	3.075E-02	-3.966E+00
Water	4.068E+03	4.074E+03	2.486E-02	-9.343E-01
Water	1.326E-01	4.313E-02	9.166E-03	8.027E-02
Water (feed water)	3.253E+03	3.253E+03	8.281E-04	1.771E-04
Water (ground water)	4.180E+02	4.181E+02	5.404E-03	-1.196E-01
Water (lake water)	5.041E-06	5.041E-06	0.000E+00	2.193E-18
Water (municipal)	4.492E-06	4.492E-06	0.000E+00	0.000E+00
Water (river water)	0.000E+00	0.000E+00	5.609E-03	4.804E+00
Water (sea water)	2.497E-03	1.114E-04	3.360E-04	2.049E-03
Water (surface water)	3.964E+02	4.021E+02	3.434E-03	-5.702E+00
Water (well water)	8.187E-05	4.944E-07	8.074E-05	6.430E-07
Water (well-produced water)	2.229E-03	2.229E-03	0.000E+00	0.000E+00
Water (with river silt)	5.540E-12	3.534E-14	3.685E-16	5.504E-12
Air	-1.351E+00	1.674E+00	5.878E-03	-3.031E+00
Carbon dioxide	-1.156E-04	1.090E-04	6.025E-06	-2.307E-04
Nitrogen	4.495E-06	1.587E-08	4.458E-06	2.115E-08
Oxygen	0.000E+00	0.000E+00	6.711E-08	0.000E+00
Unspecified	-6.529E-07	4.646E-08	3.218E-10	-6.997E-07
Unspecified minerals	-1.485E-07	1.057E-08	7.322E-11	-1.592E-07
Unspecified resources	-5.044E-07	3.589E-08	2.486E-10	-5.405E-07
Area of Production Land	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Output				
Flows	1.008E+02	1.061E+02	1.337E-02	-4.936E-01
Resources	9.979E+01	1.046E+02	3.835E-05	5.172E-04
Energy resources	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Land use	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Material resources	9.979E+01	1.046E+02	3.835E-05	5.172E-04
Renewable resources	9.979E+01	1.046E+02	3.835E-05	5.172E-04
Water	9.979E+01	1.046E+02	3.835E-05	4.045E-04
Water (rain water)	1.035E+02	1.035E+02	0.000E+00	0.000E+00
Water (river water)	-3.697E+00	1.113E+00	0.000E+00	0.000E+00

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Water (wastewater)	2.940E-03	2.497E-03	3.835E-05	4.045E-04
Water (wastewater)	9.894E-03	9.894E-03	0.000E+00	0.000E+00
Nitrogen	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Oxygen	1.684E-04	5.583E-05	0.000E+00	1.126E-04
Ecoinvent	1.181E-05	1.181E-05	1.330E-14	-2.891E-11
Long-term emission	1.181E-05	1.181E-05	1.330E-14	-2.891E-11
Fresh water	1.181E-05	1.181E-05	1.330E-14	-2.891E-11
Chloride	1.181E-05	1.181E-05	0.000E+00	0.000E+00
Dissolved organic carbon, DOC (Ecoinvent)	-2.698E-11	1.920E-12	1.330E-14	-2.891E-11
Production residues in life cycle	1.958E+00	1.514E+00	9.320E-04	4.438E-01
Hazardous waste for disposal	3.033E-05	2.771E-06	2.409E-05	3.470E-06
Chromium containing slag	3.007E-10	7.142E-11	0.000E+00	2.293E-10
Dross (Fines)	1.982E-07	1.838E-08	1.564E-07	2.340E-08
Natrium oxide	3.370E-07	3.124E-08	2.659E-07	3.979E-08
Red mud (dry)	2.928E-05	2.715E-06	2.310E-05	3.457E-06
Soil and sand containing heavy metals	-5.121E-08	3.644E-09	2.524E-11	-5.488E-08
Toxic chemicals (unspecified)	5.727E-07	3.210E-09	5.652E-07	4.194E-09
Hazardous waste for recovery	5.866E-04	4.923E-04	4.981E-07	9.371E-05
Used oil	5.421E-08	5.819E-09	4.207E-08	6.327E-09
Waste water processing residue	5.865E-04	4.923E-04	4.561E-07	9.370E-05
Waste for disposal	1.957E+00	1.513E+00	4.152E-04	4.437E-01
Incineration good	2.898E-07	1.762E-09	2.857E-07	2.288E-09
Sludge from water works (6% dry matter-content)	1.388E-09	9.329E-11	1.272E-11	1.282E-09
Waste (solid)	4.427E-01	3.789E-06	5.025E-07	4.427E-01
Waste for disposal (unspecified)	2.928E-09	7.000E-10	0.000E+00	2.228E-09
Waste from steel works	1.515E+00	1.513E+00	4.144E-04	9.706E-04
Waste for recovery	4.995E-04	2.730E-06	4.922E-04	4.567E-06
Aluminum scrap	3.053E-11	3.585E-14	6.561E-12	2.393E-11
Chemicals (unspecified)	2.170E-07	9.550E-10	2.148E-07	1.257E-09
Cooling water	4.934E-04	2.636E-06	4.864E-04	4.311E-06
Cryolite	9.242E-08	8.569E-09	7.294E-08	1.091E-08
Dross	9.937E-07	5.358E-09	9.805E-07	7.857E-09
Filter dust	5.700E-11	1.134E-11	0.000E+00	4.567E-11
Furnace clinker	3.341E-08	2.834E-12	0.000E+00	3.340E-08
Gypsum	2.132E-08	0.000E+00	0.000E+00	2.132E-08
Gypsum (contaminated)	7.747E-14	4.521E-16	0.000E+00	7.701E-14
Gypsum (FDI)	7.204E-11	9.030E-12	1.173E-16	6.301E-11
Plastic (unspecified)	3.012E-07	1.834E-09	2.969E-07	2.497E-09

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Production residues (unspecified)	2.207E-09	1.447E-11	2.175E-09	1.742E-11
Rolling gravel	8.960E-09	7.496E-10	0.000E+00	8.210E-09
Rolling tinder	7.980E-12	1.587E-12	2.062E-23	6.393E-12
Slag	4.412E-06	4.076E-08	4.219E-06	1.528E-07
Slag (containing precious metal)	2.248E-11	1.048E-12	0.000E+00	2.143E-11
Slag (Iron plate production)	2.394E-08	2.375E-08	0.000E+00	1.827E-10
Slag (Mn 6,5%)	2.891E-08	1.234E-08	0.000E+00	1.658E-08
Waste paper	0.000E+00	1.846E-12	4.332E-11	0.000E+00
Wood	2.880E-10	2.559E-12	2.841E-10	1.318E-12
Wooden pallet (EURO)	1.233E-15	5.362E-18	1.220E-15	7.014E-18
Mixed Waste (Hazardous or Radioactive)	5.667E-08	5.667E-08	0.000E+00	0.000E+00
Neutralized residues	1.647E-12	1.646E-12	2.222E-17	2.302E-16
Emissions to air	-1.040E+00	-1.162E-01	1.230E-02	-9.358E-01
Heavy metals to air	4.964E-05	4.950E-05	1.607E-08	1.297E-07
Antimony	-6.143E-09	2.381E-10	3.754E-12	-6.385E-09
Arsenic (+V)	-6.995E-08	1.513E-09	5.006E-11	-7.152E-08
Arsenic trioxide	3.123E-14	2.942E-14	7.722E-16	1.032E-15
Cadmium (+II)	1.471E-07	1.507E-07	5.155E-11	-3.665E-09
Chromium (+III)	-9.677E-13	7.147E-12	1.696E-13	-8.284E-12
Chromium (+VI)	1.884E-10	1.612E-15	0.000E+00	1.884E-10
Chromium (unspecified)	2.544E-06	2.219E-06	6.454E-10	3.241E-07
Cobalt	-5.610E-10	4.350E-10	9.305E-12	-1.005E-09
Copper (+II)	-3.745E-09	1.240E-09	4.267E-11	-5.028E-09
Heavy metals to air (unspecified)	-1.411E-10	2.041E-11	6.438E-14	-1.616E-10
Hydrogen arsenic (arsine)	2.592E-12	2.442E-12	6.410E-14	8.576E-14
Iron	1.227E-08	1.750E-09	3.805E-11	1.048E-08
Lanthanides	-6.720E-14	8.491E-14	1.692E-15	-1.538E-13
Lead (+II)	6.241E-06	6.259E-06	2.119E-09	-2.046E-08
Manganese (+II)	-1.005E-08	4.001E-09	3.395E-11	-1.408E-08
Mercury (+II)	3.877E-07	3.939E-07	1.183E-10	-6.318E-09
Molybdenum	4.243E-08	1.275E-10	2.794E-12	4.230E-08
Nickel (+II)	1.073E-07	2.979E-09	2.516E-10	1.040E-07
Palladium	1.081E-18	3.031E-19	2.735E-19	5.043E-19
Rhodium	1.043E-18	2.926E-19	2.640E-19	4.868E-19
Selenium	-1.806E-07	4.807E-09	7.822E-11	-1.855E-07
Silver	1.206E-16	2.182E-18	1.241E-16	-5.670E-18
Tellurium	-1.291E-13	9.529E-13	2.262E-14	-1.105E-12
Thallium	1.091E-13	7.250E-12	4.738E-13	-7.615E-12

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Tin (+IV)	-6.966E-08	1.478E-09	3.690E-11	-7.117E-08
Titanium	-1.194E-11	5.581E-12	1.086E-13	-1.763E-11
Vanadium (+III)	1.196E-07	2.208E-08	1.075E-09	9.645E-08
Zinc (+II)	4.038E-05	4.044E-05	1.151E-08	-6.254E-08
Inorganic emissions to air	3.025E-01	-1.346E+00	7.434E-03	1.641E+00
Ammonia	6.078E-04	6.106E-04	3.668E-08	-2.862E-06
Ammonium	-8.460E-12	1.282E-12	3.621E-15	-9.745E-12
Ammonium nitrate	1.652E-14	6.785E-14	5.253E-16	-5.186E-14
Argon	3.036E-12	3.036E-12	0.000E+00	2.760E-21
Barium	2.535E-07	3.418E-07	8.464E-09	-9.676E-08
Beryllium	-7.521E-10	3.125E-11	8.372E-13	-7.842E-10
Boron compounds (unspecified)	-1.161E-06	9.261E-08	8.171E-10	-1.254E-06
Bromine	-5.249E-07	2.203E-08	2.781E-10	-5.473E-07
Carbon dioxide	3.153E+00	3.709E+00	5.775E-03	-5.625E-01
Carbon dioxide (biotic)	2.146E-10	2.146E-10	0.000E+00	0.000E+00
Carbon dioxide (biotic)	-2.039E+00	-5.509E+00	8.584E-07	3.470E+00
Carbon disulphide	1.922E-11	6.243E-13	1.972E-11	-1.131E-12
Carbon monoxide	2.697E-02	2.714E-02	1.564E-05	-1.877E-04
Carbon monoxide (biotic)	2.256E-04	1.308E-12	0.000E+00	2.256E-04
Chloride (unspecified)	2.320E-07	1.707E-08	6.055E-10	2.143E-07
Chlorine	5.303E-09	5.980E-10	4.564E-09	1.410E-10
Cyanide (unspecified)	4.697E-09	4.279E-10	1.161E-11	4.257E-09
Fluoride	7.378E-08	2.201E-08	1.181E-08	3.996E-08
Fluorides	1.125E-10	3.766E-11	5.392E-12	6.949E-11
Fluorine	-1.068E-11	2.918E-12	6.436E-13	-1.424E-11
Helium	-1.348E-10	4.479E-10	9.201E-12	-5.919E-10
Hydrogen	4.119E-07	3.418E-07	3.602E-08	3.402E-08
Hydrogen bromine (hydrobromic acid)	2.033E-10	1.795E-10	1.972E-12	2.181E-11
Hydrogen chloride	1.608E-04	1.640E-04	6.598E-08	-3.275E-06
Hydrogen cyanide (prussic acid)	2.295E-12	1.321E-11	9.470E-12	-2.039E-11
Hydrogen fluoride	-3.184E-07	9.397E-08	1.258E-08	-4.249E-07
Hydrogen iodide	2.178E-13	1.917E-13	2.020E-15	2.415E-14
Hydrogen phosphorous	4.194E-13	5.854E-14	3.834E-13	-2.259E-14
Hydrogen sulphide	9.261E-05	9.239E-05	4.686E-08	1.767E-07
Lead dioxide	-3.311E-11	2.363E-12	1.663E-14	-3.549E-11
Nitrogen (atmospheric nitrogen)	-1.282E-04	1.635E-05	5.153E-06	-1.497E-04
Nitrogen (N-compounds)	5.938E-13	5.938E-13	0.000E+00	0.000E+00
Nitrogen dioxide	2.614E-04	3.387E-05	4.580E-07	2.270E-04

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Nitrogen monoxide	6.880E-09	3.395E-11	5.976E-09	8.701E-10
Nitrogen oxides	5.619E-03	6.737E-03	4.913E-06	-1.124E-03
Nitrous oxide (laughing gas)	3.845E-03	3.788E-03	1.596E-07	5.728E-05
Oxygen	-3.386E-05	2.443E-05	7.911E-07	-5.908E-05
Scandium	-8.948E-16	3.985E-14	8.457E-16	-4.159E-14
Steam	-8.549E-01	4.075E-01	1.623E-03	-1.264E+00
Strontium	-7.033E-13	1.594E-12	3.203E-14	-2.329E-12
Sulphur dioxide	6.012E-03	7.886E-03	7.741E-06	-1.881E-03
Sulphur hexafluoride	3.798E-09	3.802E-09	2.354E-14	-4.252E-12
sulphur oxide	8.594E-11	8.594E-11	0.000E+00	0.000E+00
Sulphuric acid	1.630E-10	1.722E-10	1.398E-11	-2.326E-11
Tin oxide	-4.459E-15	9.596E-16	2.935E-17	-5.448E-15
Unspecified Particles	-1.216E-06	8.652E-08	5.993E-10	-1.303E-06
Zinc oxide	-8.918E-15	1.919E-15	5.871E-17	-1.090E-14
Zinc sulphate	6.574E-11	6.152E-11	1.614E-12	2.603E-12
Organic emissions to air (group VOC)	3.170E-03	3.617E-03	1.444E-05	-4.613E-04
Group NMVOC to air	9.747E-05	6.802E-05	2.973E-06	2.647E-05
Group PAH to air	8.026E-08	6.237E-08	1.546E-09	1.635E-08
Anthracene	7.589E-12	6.663E-12	1.852E-13	7.408E-13
Benzo{a}anthracene	3.818E-12	3.352E-12	9.317E-14	3.729E-13
Benzo{a}pyrene	-3.271E-09	2.466E-10	1.885E-11	-3.536E-09
Benzo{ghi}perylene	3.406E-12	2.991E-12	8.312E-14	3.327E-13
Benzofluoranthene	6.813E-12	5.981E-12	1.663E-13	6.655E-13
Chrysene	9.380E-12	8.235E-12	2.289E-13	9.161E-13
Dibenz(a)anthracene	2.123E-12	1.864E-12	5.179E-14	2.071E-13
Indeno[1,2,3-cd]pyrene	2.535E-12	2.225E-12	6.184E-14	2.474E-13
Naphthalene	7.970E-10	6.997E-10	1.945E-11	7.787E-11
Phenanthrene	2.503E-10	2.198E-10	6.109E-12	2.446E-11
Polycyclic aromatic hydrocarbons (PAH)	8.245E-08	6.117E-08	1.501E-09	1.978E-08
Halogenated organic emissions to air	-3.800E-08	1.013E-08	3.071E-09	-5.120E-08
Dichloroethane (ethylene dichloride)	1.165E-13	8.238E-14	3.392E-14	2.466E-16
Dichloromethane (methylene chloride)	1.253E-12	8.100E-15	1.235E-12	9.872E-15
Dioxins (unspec.)	-1.228E-11	-1.224E-11	-3.334E-15	-3.635E-14
Halogenated hydrocarbons (unspecified)	1.494E-10	9.295E-13	1.473E-10	1.179E-12
Halon (1301)	2.006E-19	0.000E+00	0.000E+00	2.006E-19
Polychlorinated biphenyls (PCB unspecified)	5.721E-12	5.367E-12	1.346E-13	2.200E-13
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	-2.999E-14	3.183E-15	2.223E-16	-3.340E-14
R 11 (trichlorofluoromethane)	-1.624E-08	3.514E-09	2.694E-11	-1.978E-08

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
R 114 (dichlorotetrafluoroethane)	-1.663E-08	3.599E-09	2.759E-11	-2.026E-08
R 116 (hexafluoroethane)	3.607E-10	3.344E-11	2.846E-10	4.258E-11
R 12 (dichlorodifluoromethane)	-3.492E-09	7.556E-10	5.792E-12	-4.254E-09
R 13 (chlorotrifluoromethane)	-2.193E-09	4.744E-10	3.637E-12	-2.671E-09
R 22 (chlorodifluoromethane)	-3.817E-09	8.259E-10	6.331E-12	-4.649E-09
Tetrafluoromethane	3.117E-09	3.236E-10	2.562E-09	2.320E-10
Vinyl chloride (VCM; chloroethene)	7.582E-10	6.066E-10	5.198E-12	1.463E-10
Acetaldehyde (Ethanal)	5.010E-09	9.220E-09	4.863E-10	-4.697E-09
Acetic acid	3.739E-09	3.849E-08	2.005E-09	-3.675E-08
Acetone (dimethylcetone)	3.761E-09	8.152E-09	4.770E-10	-4.868E-09
Acrolein	5.355E-11	4.701E-11	1.307E-12	5.230E-12
Aldehyde (unspecified)	-1.348E-09	6.595E-10	1.947E-11	-2.027E-09
Alkane (unspecified)	-2.900E-06	9.721E-08	2.837E-09	-3.000E-06
Alkene (unspecified)	-2.884E-06	8.999E-08	1.225E-09	-2.975E-06
Aromatic hydrocarbons (unspecified)	-2.473E-10	7.654E-10	1.617E-09	-2.629E-09
Benzene	2.006E-07	1.029E-07	1.562E-09	9.620E-08
Butadiene	-8.557E-12	1.221E-12	3.514E-15	-9.781E-12
Butane	8.699E-06	6.115E-06	1.207E-07	2.463E-06
Butane (n-butane)	-1.025E-07	2.451E-07	2.457E-09	-3.500E-07
Caprolactam	1.191E-12	4.534E-13	6.491E-14	6.728E-13
Cumene (isopropylbenzene)	5.059E-19	1.006E-19	0.000E+00	4.053E-19
Cyclohexane (hexahydro benzene)	-1.674E-11	1.154E-11	1.246E-12	-2.953E-11
Diethylamine	-2.165E-16	3.104E-17	9.054E-20	-2.477E-16
Ethane	2.798E-05	2.187E-05	3.419E-07	5.776E-06
Ethanol	-1.911E-08	6.093E-09	8.662E-10	-2.607E-08
Ethene (ethylene)	2.057E-09	2.064E-09	8.917E-11	-9.628E-11
Ethyl benzene	-2.882E-06	9.077E-08	1.157E-09	-2.974E-06
Fluoranthene	2.472E-11	2.170E-11	6.031E-13	2.414E-12
Fluorene	7.843E-11	6.886E-11	1.914E-12	7.664E-12
Formaldehyde (methanal)	-2.163E-07	6.833E-07	3.747E-09	-9.034E-07
Heptane (isomers)	1.322E-07	3.161E-08	3.664E-09	9.690E-08
Hexamethylene diamine (HMDA)	-5.033E-13	7.181E-14	2.067E-16	-5.753E-13
Hexane (isomers)	2.543E-07	4.815E-08	6.529E-08	1.409E-07
Mercaptan (unspecified)	1.031E-08	8.023E-09	6.796E-11	2.224E-09
Methanethiol	-3.091E-08	2.200E-09	1.524E-11	-3.313E-08
Methanol	-8.557E-09	3.800E-09	8.488E-10	-1.321E-08
NMVOC (unspecified)	5.303E-05	1.987E-05	1.800E-06	3.136E-05
Octane	7.271E-08	1.739E-08	2.016E-09	5.330E-08

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Pentane (n-pentane)	1.905E-06	3.076E-06	4.662E-08	-1.218E-06
Phenol (hydroxy benzene)	-1.094E-13	8.267E-14	3.158E-14	-2.236E-13
Propane	2.779E-05	1.511E-05	5.636E-07	1.212E-05
Propene (propylene)	-2.620E-07	8.147E-09	1.557E-10	-2.704E-07
Propionic acid (propane acid)	1.604E-13	4.948E-13	6.878E-14	-4.031E-13
Styrene	1.136E-12	1.470E-14	1.151E-12	-2.989E-14
Toluene (methyl benzene)	-1.307E-06	4.391E-08	6.009E-10	-1.351E-06
Trimethylbenzene	-4.324E-14	9.348E-15	2.859E-16	-5.287E-14
Xylene (dimethyl benzene)	-1.205E-05	3.773E-07	4.826E-09	-1.244E-05
Hydrocarbons (unspecified)	-6.820E-09	8.630E-09	1.082E-07	-1.237E-07
Methane	2.569E-03	3.051E-03	9.897E-06	-4.916E-04
Methane (biotic)	5.651E-09	8.507E-11	0.000E+00	5.565E-09
Organic chlorine compounds	1.860E-10	1.177E-12	1.833E-10	1.442E-12
Unspecified Organic Compounds	-8.450E-13	6.013E-14	4.165E-16	-9.056E-13
VOC (unspecified)	5.038E-04	4.983E-04	1.460E-06	3.944E-06
Other emissions to air	-1.347E+00	1.225E+00	4.855E-03	-2.576E+00
Aldehydes, unspecified	-4.225E-13	3.007E-14	2.083E-16	-4.528E-13
Exhaust	-2.192E+00	3.862E-01	4.102E-03	-2.582E+00
Particulate Matter, unspecified	8.307E-07	2.679E-07	3.812E-08	5.247E-07
Sand (Silica) (SiO2)	-8.055E-09	5.732E-10	3.970E-12	-8.632E-09
Used air	8.448E-01	8.385E-01	7.528E-04	5.520E-03
Particles to air	1.315E-03	1.363E-03	8.242E-07	-4.817E-05
Dust (PM10)	-1.604E-06	5.291E-07	1.409E-07	-2.274E-06
Dust (PM2,5 - PM10)	1.517E-12	1.517E-12	0.000E+00	0.000E+00
Dust (PM2.5)	-3.137E-05	1.944E-06	5.574E-08	-3.337E-05
Dust (Portland cement kiln)	3.503E-06	5.274E-08	0.000E+00	3.451E-06
Dust (unspecified)	1.345E-03	1.360E-03	6.273E-07	-1.598E-05
Metals (unspecified)	2.453E-10	2.677E-12	2.703E-10	-2.763E-11
Unspecified Organic Chlorine Compounds	-5.575E-12	3.967E-13	2.748E-15	-5.975E-12
Wood (dust)	-1.638E-12	3.542E-13	1.083E-14	-2.003E-12
Radioactive emissions to air	-1.905E-08	4.085E-09	3.160E-11	-2.316E-08
Uranium (total)	-1.905E-08	4.085E-09	3.160E-11	-2.316E-08
Unspecified Heavy Metals	-4.354E-16	3.098E-17	2.146E-19	-4.666E-16
Emissions to fresh water	4.849E-02	5.191E-02	6.882E-05	-3.481E-03
Analytical measures to fresh water	1.499E-04	3.794E-04	1.077E-06	-2.305E-04
Adsorbable organic halogen compounds (AOX)	9.247E-08	6.430E-08	9.729E-10	2.721E-08
Biological oxygen demand (BOD)	2.343E-06	2.113E-06	8.297E-08	1.470E-07
Chemical oxygen demand (COD)	-9.126E-05	1.375E-04	6.330E-07	-2.294E-04

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Nitrogenous Matter (unspecified, as N)	1.573E-04	1.566E-04	4.291E-08	6.315E-07
Solids (dissolved)	6.416E-05	6.735E-05	1.891E-07	-3.379E-06
Total Biochemical Oxygen Demand	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total dissolved organic bounded carbon	2.285E-07	1.597E-07	6.864E-08	2.007E-10
Total Dissolved Solids	1.478E-05	1.478E-05	0.000E+00	0.000E+00
Total organic bounded carbon	2.256E-06	7.412E-07	5.925E-08	1.455E-06
Total Suspended Solids	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Heavy metals to fresh water	2.773E-04	2.019E-04	8.643E-06	6.678E-05
Aluminium	3.284E-05	1.077E-05	1.542E-06	2.053E-05
Antimony	2.902E-07	9.540E-08	1.366E-08	1.811E-07
Arsenic (+V)	1.008E-06	4.021E-07	4.384E-08	5.619E-07
Cadmium (+II)	1.755E-07	1.267E-07	4.349E-09	4.437E-08
Chromium (+III)	-5.179E-09	1.050E-09	1.034E-11	-6.239E-09
Chromium (+VI)	3.231E-08	2.985E-13	1.867E-12	3.231E-08
Chromium (unspecified)	2.267E-06	1.153E-06	7.589E-08	1.038E-06
Cobalt	3.261E-11	1.938E-11	1.198E-12	1.203E-11
Copper (+II)	1.718E-06	8.264E-07	6.394E-08	8.281E-07
Heavy metals to water (unspecified)	5.372E-10	9.762E-10	1.005E-12	-4.400E-10
Iron	1.597E-04	1.556E-04	3.527E-06	5.177E-07
Lead (+II)	4.683E-06	2.622E-06	1.484E-07	1.912E-06
Manganese (+II)	-3.207E-07	8.473E-08	3.699E-10	-4.058E-07
Mercury (+II)	6.183E-07	6.089E-07	7.462E-10	8.593E-09
Molybdenum	-3.518E-08	1.037E-08	8.135E-11	-4.563E-08
Nickel (+II)	2.656E-05	9.890E-06	1.172E-06	1.550E-05
Selenium	-7.559E-09	2.010E-09	1.692E-11	-9.586E-09
Silver	2.833E-07	9.317E-08	1.334E-08	1.768E-07
Strontium	-8.680E-07	1.159E-07	4.718E-09	-9.885E-07
Thallium	1.108E-12	1.047E-12	2.774E-14	3.293E-14
Tin (+IV)	1.022E-09	2.920E-11	4.005E-12	9.885E-10
Titanium	-4.878E-09	1.081E-09	8.902E-12	-5.968E-09
Unspecified Substance	-3.766E-12	2.680E-13	1.856E-15	-4.036E-12
Uranium	3.793E-06	3.793E-06	0.000E+00	0.000E+00
Vanadium (+III)	-1.267E-08	3.289E-09	2.967E-11	-1.599E-08
Zinc (+II)	4.466E-05	1.570E-05	2.033E-06	2.692E-05
Inorganic emissions to fresh water	4.721E-02	5.038E-02	4.933E-05	-3.222E-03
Acid (calculated as H+)	2.458E-07	5.509E-09	1.654E-08	2.238E-07
Aluminum (+III)	-1.661E-06	3.289E-07	2.522E-09	-1.992E-06
Ammonia	9.952E-05	9.916E-05	2.756E-08	3.317E-07

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Ammonia, as N	6.951E-13	6.951E-13	0.000E+00	0.000E+00
Ammonium (total N)	3.545E-04	1.165E-04	1.669E-05	2.213E-04
Ammonium / ammonia	1.746E-04	1.765E-04	4.573E-08	-1.966E-06
Barium	6.623E-07	6.320E-07	1.133E-09	2.918E-08
Beryllium	-5.688E-11	1.239E-11	9.487E-14	-6.936E-11
Boron	-1.278E-06	1.135E-07	8.886E-10	-1.392E-06
Bromate	1.673E-12	1.075E-14	1.649E-12	1.310E-14
Bromine	2.578E-11	1.976E-11	1.865E-13	5.833E-12
Calcium (+II)	1.888E-02	1.909E-02	1.895E-06	-2.110E-04
Carbonate	2.859E-02	2.859E-02	9.991E-08	2.074E-06
Chlorate	1.673E-09	1.000E-11	1.650E-09	1.254E-11
Chloride	-1.410E-03	4.957E-04	2.004E-05	-1.926E-03
Chlorine (dissolved)	-1.963E-06	5.109E-07	3.464E-09	-2.477E-06
Copper ion (+II/+III)	7.585E-10	3.355E-14	1.874E-16	7.585E-10
Cyanide	2.638E-06	8.667E-07	1.244E-07	1.647E-06
Fluoride	4.775E-04	1.111E-03	3.080E-07	-6.341E-04
Fluorine	-3.057E-10	4.238E-10	9.363E-12	-7.389E-10
Hydrogen chloride	-4.165E-12	7.746E-12	1.725E-13	-1.208E-11
Hydrogen fluoride (hydrofluoric acid)	3.130E-11	2.479E-11	2.108E-13	6.302E-12
Hydrogen Ions (H+)	-8.408E-10	5.983E-11	4.145E-13	-9.011E-10
Hydroxide	6.304E-08	6.092E-09	4.991E-08	7.037E-09
Inorganic salts and acids (unspecified)	7.689E-16	5.445E-17	5.114E-20	7.144E-16
Iron ion (+II/+III)	3.466E-07	4.205E-12	0.000E+00	3.466E-07
Magnesium (+III)	-3.887E-05	3.619E-06	3.063E-08	-4.252E-05
Magnesium chloride	2.925E-13	8.246E-14	7.439E-14	1.356E-13
Metal ions (unspecific)	7.517E-08	4.019E-10	7.417E-08	5.941E-10
Neutral salts	1.225E-10	9.808E-11	1.616E-13	2.427E-11
Nickel ion (+III)	2.191E-08	1.875E-13	0.000E+00	2.191E-08
Nitrate	-1.104E-05	1.763E-06	6.882E-07	-1.349E-05
Nitrate (as total N)	-1.350E-11	9.610E-13	6.657E-15	-1.447E-11
Nitrogen	7.450E-05	7.445E-05	3.236E-08	2.446E-08
Nitrogen (as total N)	1.168E-08	1.168E-08	0.000E+00	0.000E+00
Nitrogen organic bounded	1.492E-06	9.281E-08	5.654E-09	1.394E-06
Phosphate	3.720E-07	2.766E-07	9.289E-10	9.442E-08
Phosphorus	3.282E-04	3.072E-04	1.497E-06	1.954E-05
Potassium	3.154E-08	9.734E-09	6.110E-09	1.570E-08
Silicate particles	7.128E-10	7.140E-10	4.007E-14	-1.241E-12
Sodium (+I)	1.144E-04	1.487E-04	6.797E-06	-4.115E-05

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Sodium chloride (rock salt)	1.231E-05	1.231E-05	1.504E-13	-3.018E-11
Sodium hypochlorite	2.706E-10	2.286E-10	7.418E-13	4.127E-11
Sulfates	9.238E-07	9.238E-07	0.000E+00	0.000E+00
Sulphate	-4.426E-04	1.497E-04	8.829E-07	-5.932E-04
Sulphide	6.052E-07	1.456E-07	1.311E-08	4.465E-07
Sulphite	-3.887E-07	3.358E-08	2.408E-10	-4.225E-07
Sulphur	1.832E-09	8.188E-10	1.136E-10	8.999E-10
Sulphuric acid	-5.368E-10	9.986E-10	2.224E-11	-1.558E-09
Unspecified Iron Oxides	-9.644E-12	6.863E-13	4.754E-15	-1.034E-11
Unspecified Oil	-3.417E-11	2.431E-12	1.684E-14	-3.662E-11
Unspecified Organic Chlorine compounds	-7.743E-14	5.510E-15	3.817E-17	-8.298E-14
Unspecified Salt	-3.098E-10	2.205E-11	1.527E-13	-3.320E-10
Unspecified Solids (Suspended)	-1.203E-09	8.559E-11	5.928E-13	-1.289E-09
Organic emissions to fresh water	1.674E-04	1.675E-04	6.649E-08	-1.961E-07
Halogenated organic emissions to fresh water	1.046E-11	2.876E-11	4.456E-13	-1.875E-11
1,2-Dibromoethane	-3.932E-15	2.711E-15	2.927E-16	-6.936E-15
Chlorinated hydrocarbons (unspecified)	3.182E-13	3.182E-13	2.046E-19	4.984E-18
Chloromethane (methyl chloride)	1.016E-11	2.841E-11	4.433E-13	-1.870E-11
Dichloroethane (ethylene dichloride)	3.581E-15	3.444E-15	1.365E-16	6.614E-19
Dichloropropane	-4.040E-16	5.763E-17	1.659E-19	-4.618E-16
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	1.685E-17	1.123E-17	5.590E-18	3.120E-20
Vinyl chloride (VCM; chloroethene)	-1.977E-14	2.355E-14	1.885E-15	-4.521E-14
Hydrocarbons to fresh water	1.666E-04	1.669E-04	1.092E-08	-2.634E-07
Acenaphthene	8.827E-12	2.440E-12	2.182E-13	6.169E-12
Acenaphthylene	3.667E-12	9.825E-13	9.060E-14	2.594E-12
Acetic acid	2.107E-08	8.105E-09	3.800E-10	1.258E-08
Acrylonitrile	-2.954E-11	4.215E-12	1.213E-14	-3.377E-11
Anthracene	1.391E-11	3.481E-12	3.137E-13	1.012E-11
Aromatic hydrocarbons (unspecified)	1.140E-08	6.414E-09	1.232E-10	4.864E-09
Benzene	2.124E-08	8.183E-09	4.338E-10	1.263E-08
Benzo{a}anthracene	1.169E-12	3.404E-13	3.130E-14	7.976E-13
Benzofluoranthene	5.098E-13	1.978E-13	1.688E-14	2.951E-13
Chrysene	5.010E-12	1.553E-12	1.409E-13	3.316E-12
Cresol (methyl phenol)	4.746E-11	2.121E-11	2.942E-12	2.331E-11
Ethyl benzene	9.461E-10	2.567E-10	2.220E-11	6.672E-10
Fluoranthene	1.517E-12	5.130E-13	3.724E-14	9.663E-13
Hexane (isomers)	5.178E-12	2.316E-12	3.212E-13	2.541E-12
Hydrocarbons (unspecified)	2.378E-07	2.018E-08	5.057E-09	2.126E-07

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Methanol	1.617E-04	1.623E-04	8.869E-10	-5.908E-07
Oil (unspecified)	4.554E-06	4.489E-06	2.913E-09	6.148E-08
Phenol (hydroxy benzene)	3.491E-08	4.410E-09	6.262E-10	2.988E-08
Polycyclic aromatic hydrocarbons (PAH, unspec.)	-1.379E-08	3.154E-09	9.443E-11	-1.704E-08
Toluene (methyl benzene)	1.191E-08	3.998E-09	2.705E-10	7.644E-09
Xylene (isomers; dimethyl benzene)	4.801E-09	2.577E-09	1.109E-10	2.112E-09
Carbon, organically bound	7.730E-07	6.678E-07	1.672E-08	8.844E-08
Naphthalene	5.670E-10	1.541E-10	1.349E-11	3.994E-10
N-unspecified (N)	-2.674E-11	1.903E-12	1.318E-14	-2.866E-11
Organic chlorine compounds (unspecified)	3.299E-11	2.021E-13	3.259E-11	1.939E-13
Organic compounds (dissolved)	3.564E-08	6.578E-11	3.548E-08	9.444E-11
Organic compounds (unspecified)	3.356E-09	2.059E-11	3.309E-09	2.650E-11
Unspecified wastewater	-2.022E-08	1.439E-09	9.967E-12	-2.167E-08
Other emissions to fresh water	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Particles to fresh water	6.900E-04	7.750E-04	9.694E-06	-9.477E-05
Metals (unspecified)	1.189E-09	1.835E-11	1.313E-09	-1.425E-10
Silicon dioxide (silica)	1.161E-06	9.937E-12	4.290E-15	1.161E-06
Soil loss by erosion into water	3.121E-07	4.729E-10	3.955E-12	3.116E-07
Solids (suspended)	4.129E-04	4.996E-04	9.618E-06	-9.634E-05
Suspended solids, unspecified	2.756E-04	2.755E-04	7.545E-08	8.940E-08
Unspecified Oxides	-8.018E-12	5.705E-13	3.952E-15	-8.592E-12
Radioactive emissions to fresh water	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Bromide	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Radionuclide	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sulfite	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Unspecified Solids (Dissolved)	-2.318E-09	1.650E-10	1.143E-12	-2.484E-09
Uranium (total)	3.524E-13	3.524E-13	0.000E+00	0.000E+00
Emissions to sea water	1.756E-03	2.809E-04	2.521E-05	1.450E-03
Analytical measures to sea water	3.073E-06	1.006E-06	8.724E-08	1.979E-06
Adsorbable organic halogen compounds (AOX)	1.134E-13	5.953E-14	5.137E-15	4.874E-14
Biological oxygen demand (BOD)	1.251E-07	6.567E-08	5.667E-09	5.376E-08
Chemical oxygen demand (COD)	2.823E-06	8.750E-07	7.590E-08	1.872E-06
Total organic bounded carbon	1.251E-07	6.567E-08	5.667E-09	5.376E-08
Heavy metals to sea water	6.086E-07	1.500E-07	1.830E-08	4.403E-07
Arsenic (+V)	8.375E-09	1.553E-09	1.950E-10	6.627E-09
Cadmium (+II)	2.171E-09	9.705E-10	9.772E-11	1.103E-09
Chromium (unspecified)	1.341E-08	2.342E-09	3.129E-10	1.076E-08
Cobalt	7.400E-09	9.034E-10	5.948E-11	6.437E-09

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Copper (+II)	1.889E-08	5.760E-09	5.912E-10	1.254E-08
Iron	1.055E-07	1.630E-08	1.472E-09	8.774E-08
Lead (+II)	4.529E-09	1.448E-09	1.565E-10	2.925E-09
Manganese (+II)	1.095E-08	1.673E-09	1.493E-10	9.127E-09
Mercury (+II)	9.387E-11	2.715E-11	2.366E-12	6.435E-11
Molybdenum	3.512E-10	2.781E-10	5.765E-12	6.734E-11
Nickel (+II)	9.217E-09	2.096E-09	2.097E-10	6.912E-09
Silver	3.369E-10	1.200E-10	1.710E-11	1.998E-10
Strontium	2.742E-07	9.763E-08	1.381E-08	1.628E-07
Tin (+IV)	4.036E-10	1.438E-10	2.049E-11	2.393E-10
Titanium	4.111E-11	1.465E-11	2.087E-12	2.438E-11
Vanadium (+III)	5.126E-09	6.378E-10	4.340E-11	4.444E-09
Zinc (+II)	1.475E-07	1.813E-08	1.159E-09	1.283E-07
Inorganic emissions to sea water	1.652E-03	2.273E-04	2.058E-05	1.404E-03
Aluminum (+III)	1.323E-09	4.715E-10	6.717E-11	7.847E-10
Ammonia	3.933E-08	1.401E-08	1.996E-09	2.332E-08
Barium	3.255E-07	4.522E-08	3.983E-09	2.763E-07
Beryllium	4.166E-10	4.939E-11	3.080E-12	3.641E-10
Boron	2.140E-08	7.624E-09	1.086E-09	1.269E-08
Calcium (+II)	2.337E-06	8.326E-07	1.186E-07	1.386E-06
Carbonate	2.042E-05	2.786E-06	2.504E-07	1.738E-05
Chloride	1.613E-03	2.202E-04	1.991E-05	1.373E-03
Magnesium	5.859E-07	2.124E-07	2.962E-08	3.439E-07
Nitrate	2.655E-08	3.691E-09	3.248E-10	2.253E-08
Sodium (+I)	2.498E-06	1.311E-06	1.132E-07	1.074E-06
Sulphate	8.826E-06	1.395E-06	1.061E-07	7.325E-06
Sulphide	3.672E-06	4.629E-07	4.550E-08	3.164E-06
Sulphur	1.145E-08	4.079E-09	5.812E-10	6.790E-09
Organic emissions to sea water	9.748E-07	1.689E-07	1.274E-08	7.931E-07
Hydrocarbons to sea water	9.642E-07	1.674E-07	1.263E-08	7.842E-07
Acenaphthene	3.173E-10	4.781E-11	3.308E-12	2.662E-10
Acenaphthylene	1.211E-10	1.826E-11	1.269E-12	1.015E-10
Acetic acid	9.554E-10	1.293E-10	7.601E-12	8.186E-10
Anthracene	8.836E-11	1.378E-11	1.162E-12	7.342E-11
Aromatic hydrocarbons (unspecified)	1.251E-09	6.567E-10	5.667E-11	5.377E-10
Benzene	8.069E-08	1.934E-08	1.209E-09	6.014E-08
Benzo{a}anthracene	7.079E-11	1.064E-11	7.215E-13	5.944E-11
Benzofluoranthene	7.823E-11	1.172E-11	7.804E-13	6.573E-11

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Chrysene	3.991E-10	5.990E-11	4.034E-12	3.352E-10
Cresol (methyl phenol)	2.966E-10	1.057E-10	1.505E-11	1.759E-10
Ethyl benzene	1.162E-08	4.917E-09	8.862E-11	6.612E-09
Fluoranthene	8.252E-11	1.240E-11	8.413E-13	6.928E-11
Hexane (isomers)	3.238E-11	1.154E-11	1.644E-12	1.920E-11
Oil (unspecified)	6.353E-07	1.002E-07	8.536E-09	5.266E-07
Phenol (hydroxy benzene)	1.421E-07	2.241E-08	1.549E-09	1.182E-07
Toluene (methyl benzene)	5.002E-08	1.504E-08	7.738E-10	3.421E-08
Xylene (isomers; dimethyl benzene)	4.075E-08	4.358E-09	3.767E-10	3.601E-08
Naphthalene	1.053E-08	1.548E-09	1.156E-10	8.866E-09
Particles to sea water	9.956E-05	5.226E-05	4.510E-06	4.279E-05
Solids (suspended)	9.956E-05	5.226E-05	4.510E-06	4.279E-05
Emissions to agricultural soil	6.185E-05	6.185E-05	0.000E+00	5.157E-12
Heavy metals to agricultural soil	6.185E-05	6.185E-05	0.000E+00	5.157E-12
Cadmium (+II)	8.642E-07	8.642E-07	0.000E+00	3.770E-12
Chromium (unspecified)	4.025E-05	4.025E-05	0.000E+00	0.000E+00
Copper (+II)	2.736E-06	2.736E-06	0.000E+00	1.978E-13
Lead (+II)	5.189E-07	5.189E-07	0.000E+00	2.967E-13
Mercury (+II)	4.918E-09	4.918E-09	0.000E+00	1.978E-15
Nickel (+II)	1.770E-06	1.770E-06	0.000E+00	9.892E-14
Zinc (+II)	1.570E-05	1.570E-05	0.000E+00	7.913E-13
Emissions to industrial soil	1.378E-04	1.339E-04	1.240E-07	3.811E-06
Heavy metals to industrial soil	1.242E-04	1.232E-04	3.170E-08	9.716E-07
Antimony	8.426E-19	1.388E-19	0.000E+00	7.038E-19
Arsenic (+V)	6.630E-08	6.630E-08	3.676E-14	1.097E-12
Cadmium (+II)	5.291E-11	3.926E-11	4.092E-12	9.557E-12
Chromium (+III)	8.684E-11	5.362E-13	8.572E-11	5.823E-13
Chromium (+VI)	2.530E-18	5.030E-19	0.000E+00	2.026E-18
Chromium (unspecified)	1.365E-08	1.068E-08	9.011E-11	2.879E-09
Cobalt	2.452E-10	1.904E-10	1.599E-12	5.318E-11
Copper (+II)	2.267E-10	1.091E-10	8.662E-11	3.097E-11
Iron	1.187E-04	1.187E-04	1.297E-10	4.307E-09
Lead (+II)	4.742E-07	4.741E-07	1.286E-10	1.644E-12
Manganese (+II)	2.746E-09	2.249E-09	1.945E-11	4.775E-10
Mercury (+II)	1.227E-09	1.226E-09	8.590E-13	6.622E-14
Nickel (+II)	3.578E-09	3.140E-09	7.091E-11	3.668E-10
Selenium	7.876E-09	7.876E-09	0.000E+00	5.772E-18
Strontium	4.517E-06	3.523E-06	3.073E-08	9.631E-07

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Thallium	5.732E-08	5.732E-08	0.000E+00	0.000E+00
Vanadium (+III)	3.619E-07	3.619E-07	0.000E+00	0.000E+00
Zinc (+II)	1.846E-09	1.185E-09	3.528E-10	3.083E-10
Inorganic emissions to industrial soil	1.365E-05	1.072E-05	9.211E-08	2.836E-06
Aluminum (+III)	1.520E-08	1.198E-08	1.005E-10	3.116E-09
Ammonia	7.140E-06	5.566E-06	4.822E-08	1.526E-06
Bromide	2.101E-09	1.632E-09	1.370E-11	4.558E-10
Calcium (+II)	-5.241E-08	1.138E-08	3.472E-10	-6.413E-08
Chloride	2.448E-06	1.904E-06	1.601E-08	5.280E-07
Chlorine	5.902E-16	1.174E-16	0.000E+00	4.728E-16
Fluoride	7.004E-08	5.439E-08	4.568E-10	1.519E-08
Magnesium (+III)	-7.219E-09	1.590E-09	4.813E-11	-8.856E-09
Phosphorus	7.345E-07	5.729E-07	4.998E-09	1.566E-07
Potassium (+I)	1.749E-06	1.371E-06	1.139E-08	3.669E-07
Sodium (+I)	-4.588E-09	9.921E-10	3.034E-11	-5.610E-09
Sulphate	2.221E-07	1.751E-07	1.500E-09	4.549E-08
Sulphide	1.333E-06	1.051E-06	9.002E-09	2.729E-07
Organic emissions to industrial soil	9.961E-09	6.253E-09	1.718E-10	3.536E-09
Oil (unspecified)	9.961E-09	6.253E-09	1.718E-10	3.536E-09
Radioactive emissions to industrial soil	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Calcium Fluoride	9.054E-09	9.054E-09	0.000E+00	0.000E+00
Radionuclide	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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