NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Ethanol Dry Milling Process Acquisition, Transport, and Conversion

Reference Flow: 1 kg of Ethanol (E100)

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 a dry milling process using corn grain.

Section I: Meta Data

Geographical Coverage: US **Region:** N/A

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	*Acreage used for corn grain production; annualized*
CORN_YIELD_YR	*Annual yield of corn grain per acre*
Fertilizer_K	*Mass of potassium fertilizer applied annually, per acre*
Fertilizer_N	*Mass of nitrogen fertilizer applied annually, per acre*

Fertilizer_P	*Mass of phosphorous fertilizer applied annually, per acre*
Distance	*Distance the corn grain feedstock travels from the farm to the energy conversion facility*
Load_SRWC	*Maximum mass of SRWC transported by one trailer load*
ETHANOL_PROD	*Ethanol produced by the energy conversion facility, total mass per 30-year study period*
S3_DISPL_FEED	*Mass of corn displaced by dried distillers grains with solubles (DDGS)*

Tracked Input Flows:

None

Tracked Output Flows:

Ethanol (E100) [Valuable substance]	*Ethanol fuel (E100) produced by the energy conversion facility and ready for transport*

Section II: Process Description

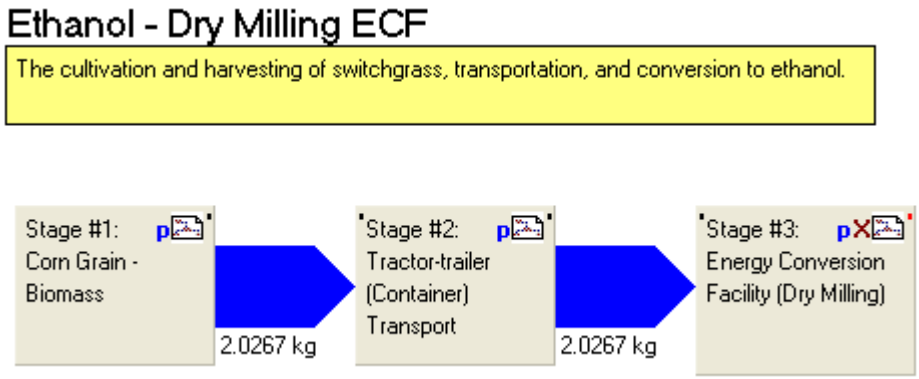
Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_CTG_Ethanol_DryMill _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 (E100) via dry mill process, as shown in **Figure 1**. At the downstream boundary of this unit process, one kilogram finished ethanol (E100) 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 Dry Milling



Boundary and Description

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

The RMA of corn grain 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 corn grain is provided in **Figure 2**.

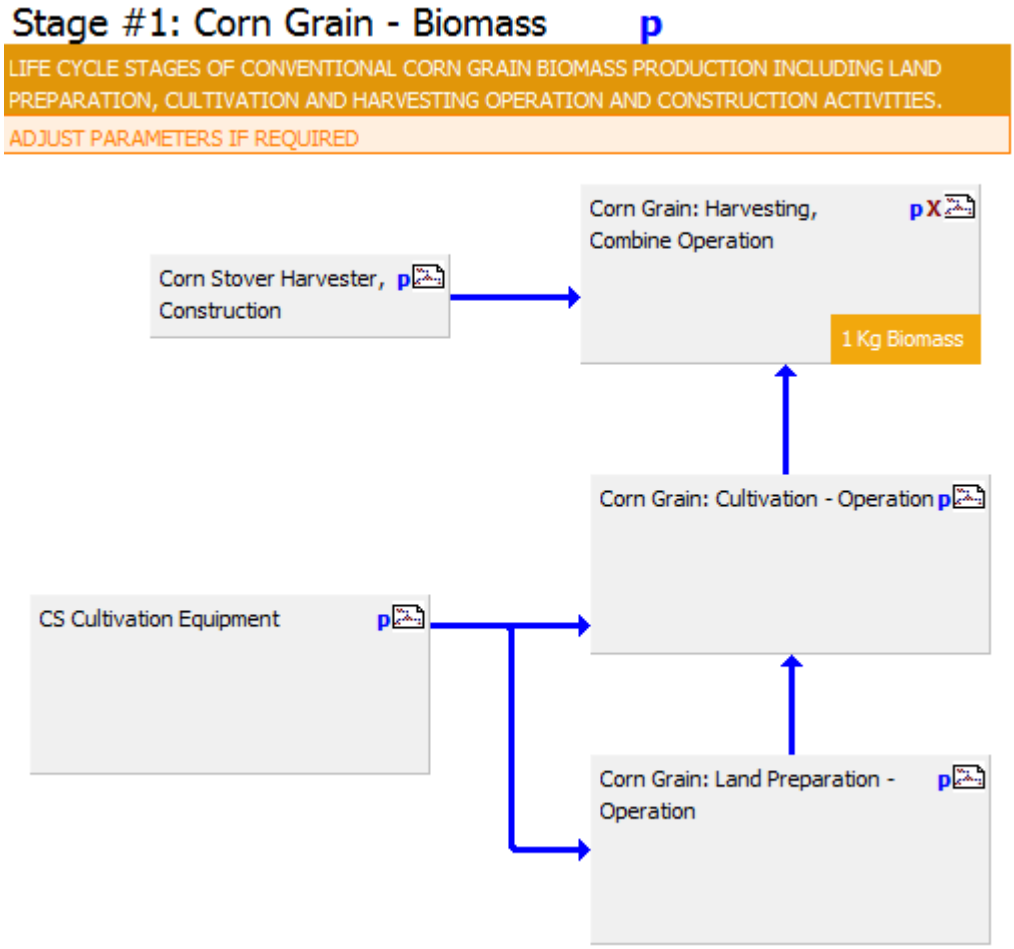
The biomass processes discussed here are set up slightly differently than some of the other feedstocks. Unlike other RMA pathways, biomass has a set order of operations for its production. The product from one process is the input to another process, which then lends itself to assembly of the model in 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). Agricultural production of corn grain is considered concurrently to corn stover, as shown in **Figure 2**.

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

- 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_Diesel_Forage_Harvester_615_HP_2010.01.doc)

- Harvester
  (DS/ DF_Stage1_C_Harvester_300_ Bushel_Capacity_2009.01.doc)
- Baler
  (DS/ DF_Stage1_C_Baler_3110_lbs_TractorPropelled_2009.01.doc)

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



Each piece of equipment is scaled to the production of one kilogram of corn product, 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 Corn Grain

Ethanol - Dry Milling ECF

Stage #1: Corn Grain - Biomass

Corn Grain: Cultivation - Operation

- Average K Fertilizer
  - EU-15: Average K Fertilizer NETL
  - North American Average Electricity Mix, 2007 NETL
- Average N Fertilizer
  - DE: Ammonia (NH3) PE
  - DE: Nitric acid (98%) PE
  - EU-15: Average N Fertilizer NETL
  - North American Average Electricity Mix, 2007 NETL
- Average P Fertilizer
  - DE: Sulphuric acid (96%) PE
  - EU-15: Average P Fertilizer NETL
  - North American Average Electricity Mix, 2007 NETL
  - US: Phosphate NETL
- US: Corn Grain Cultivation, Operation NETL <u-so>
- US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>

Corn Grain: Harvesting, Combine Operation

- US: Corn Grain Harvesting & Storage, Operation NETL <u-so>
- US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>

Corn Grain: Land Preparation - Operation

- US: Corn Grain Land Preparation, Operation NETL <u-so>
- US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>

Corn Stover Harvester, Construction

- US: Harvester, 300-Bushel Capacity, 6 Cylinder, Construction NETL <u-so>
- WOR: Steel Plate, BF, Manufacture NETL <u-so>

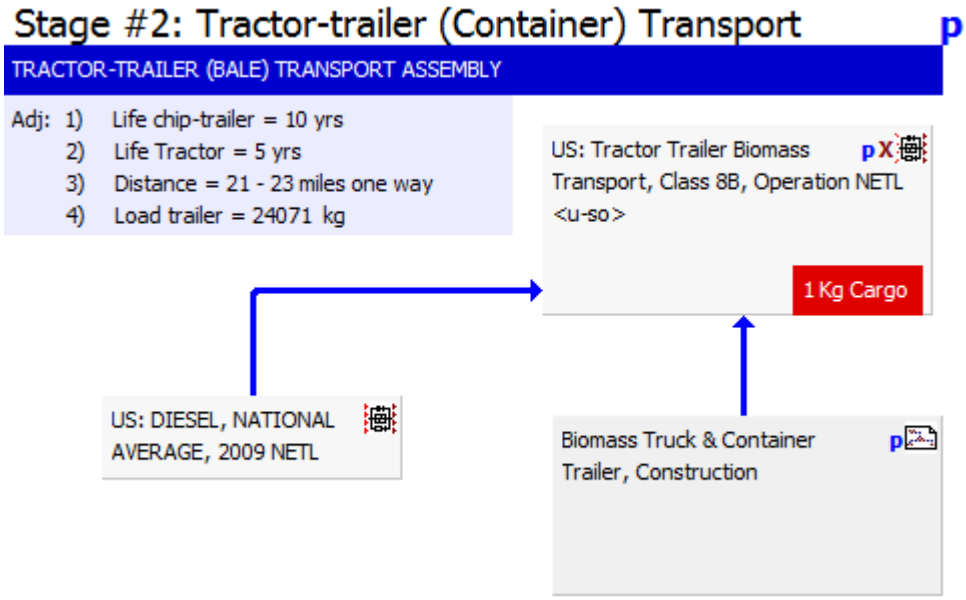
CS Cultivation Equipment

- 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: Corn Stover Cultivation Assembly, Construction NETL <u-so>

LC Stage #2 (RMT) includes the transport of the harvested corn grain from the farm to the energy conversion facility (LC Stage #3). The construction of equipment used to

transport corn grain and the operation of that equipment are the two processes within RMT. Corn grain transport takes place via tractor-trailer (i.e., semi truck) that is diesel-powered and suitable for the transport of corn grain. The transport distance is an adjustable parameter for RMT. The plan for RMT of corn grain is provided in **Figure 3.**

Figure 3: Plan for RMT of Corn Grain, 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 chip truck is used as a proxy transport vehicle for corn grain transport because it is presumed to represent a suitable transport vehicle for harvested corn grain.

- Chip Truck
  (DS/ DF_Stage2_C_Chip_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 Corn Stover

Stage #2: Tractor-trailer (Container) Transport

Biomass Truck & Container Trailer, 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: Chip Truck, Biomass Transport, Construction NETL <u-so>

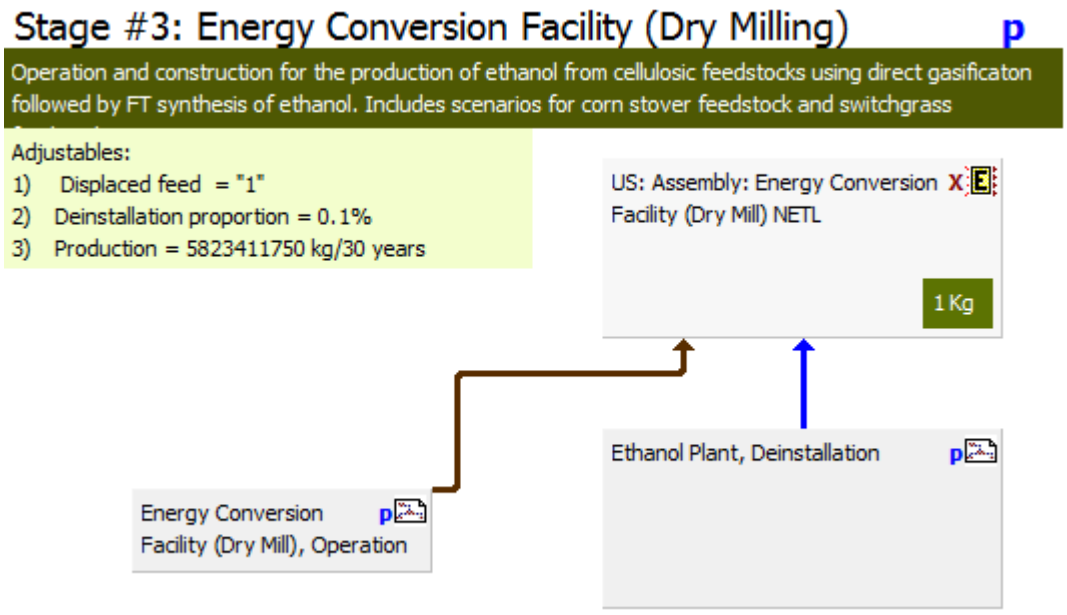
WOR: Steel Plate, BF, Manufacture NETL <u-so>

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 raw corn grain to fuel grade ethanol (E95), via a dry milling process. Consistent with a dry milling process, operation of the facility is presumed to result in the production of dry distillers grains with solubles (DDGS). DDGS are assumed to displace corn feed at a ratio indicated by the adjustable parameter, S3_DISPL_FEED, as noted previously (default value of 1.0). Finished ethanol from the ECF process is delivered to the upstream boundary of LC Stage #4, finished fuels transport. The plan for the corn grain/ethanol ECF (dry mill) is provided in **Figure 4**.

Figure 4: Plan for ECF of Corn Grain to Ethanol (E100) Finished Fuel



Construction of conventional dry mill ethanol plant is not included in the model for the ECF. Therefore, no construction processes are considered for the ECF.

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 RMT for Corn Stover

Stage #3: Energy Conversion Facility (Dry Milling)

Energy Conversion Facility (Dry Mill), 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

US: Dry Mill Ethanol Plant Operation NETL <u-so>

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

US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL

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 (Dry Mill) NETL

US: Power from hydropower PE

US: Power from lignite PE

US: Power from natural gas PE

US: Dry Mill Ethanol Plant Operation NETL <u-so>

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

US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL

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 (Dry Mill) NETL

Parameters and Balances

The parameters for the highest level modeling plans for RMA, RMT, and ECF for corn grain 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 Corn Grain Ethanol

Plan	Parameter	Value	Comment
LC Stage #1			
Stage #1: Corn Grain - Biomass	ACRES_YR	652070	[acre/yr] Assumed size of farm in acres, annualized.
Stage #1: Corn Grain - Biomass	CORN_YIELD_YR	2979.6	[kg/acre-yr] Annual yield per acre. Value is from the operations sheet for corn and stover.
Stage #1: Corn Grain - Biomass	Fertilizer_K	20.1764	[kg/acre] Amount of potassium applied via fertilizer annually, per acre.
Stage #1: Corn Grain - Biomass	Fertilizer_N	58.4623	[kg/acre] amount of nitrogen applied via fertilizer annually, per acre.
Stage #1: Corn Grain - Biomass	Fertilizer_P	9.030	[kg/acre] amount of phosphorus applied via fertilizer annually, per acre.
LC Stage #2			
Stage #2: Tractor-trailer (Container) Transport	Distance	21	[miles] Distance from biomass origin (LC Stage #1) to the ECF (LC Stage #3).
Stage #2: Tractor-trailer (Container) Transport	Load_SRWC	24071	[kg] Maximum weight of SRWC transported by 1 trailer load.
LC Stage #3			
Stage #3: Energy Conversion Facility (Dry Milling)	ETHANOL_PROD	5.82E+09	[kg/Study Period] Ethanol production from refinery, per 30-year study period.
Stage #3: Energy Conversion Facility (Dry Milling)	S3_DISPL_FEED	1	[kg] Mass of corn feed displaced by DDGS. Default = 1.

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

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Inputs				
Flows	9.040E+01	8.544E+01	2.473E-02	4.937E+00
Resources	9.040E+01	8.544E+01	2.473E-02	4.937E+00
Energy resources	1.487E+00	1.118E+00	1.418E-03	3.672E-01
Non renewable energy resources	1.487E+00	1.118E+00	1.417E-03	3.672E-01
Crude oil (resource)	1.525E-01	1.326E-01	7.624E-04	1.913E-02

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Hard coal (resource)	8.888E-01	8.019E-01	2.618E-04	8.670E-02
Lignite (resource)	9.214E-03	8.120E-03	1.299E-04	9.643E-04
Natural gas (resource)	4.364E-01	1.756E-01	2.626E-04	2.604E-01
Uranium (resource)	1.329E-06	2.180E-07	6.562E-09	1.104E-06
Renewable energy resources	2.365E-06	3.014E-07	8.371E-07	1.227E-06
Biomass	8.328E-07	4.673E-09	8.085E-07	1.966E-08
Renewable fuels	3.917E-10	3.911E-10	6.112E-13	1.285E-14
Wood	1.532E-06	2.964E-07	2.856E-08	1.207E-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
Material resources	8.891E+01	8.432E+01	2.332E-02	4.570E+00
Non renewable elements	5.926E-04	4.068E-06	2.974E-07	5.883E-04
Aluminum	1.047E-09	1.037E-10	5.747E-13	9.424E-10
Chromium	5.297E-11	3.023E-13	5.169E-11	9.780E-13
Copper	1.251E-11	1.272E-13	1.230E-11	7.647E-14
Iron	5.892E-04	4.045E-06	1.517E-07	5.850E-04
Lead	5.057E-11	1.814E-13	4.978E-11	6.031E-13
Magnesium	6.255E-14	3.535E-16	6.104E-14	1.155E-15
Mercury	1.590E-11	9.097E-14	1.552E-11	2.876E-13
Nickel	1.964E-13	1.155E-15	1.916E-13	3.621E-15
Phosphorus	6.251E-09	3.533E-11	6.100E-09	1.154E-10
Sulphur	1.399E-07	3.190E-10	1.385E-07	1.111E-09
Zinc	3.280E-06	2.247E-08	9.666E-10	3.257E-06
Non renewable resources	1.792E+00	1.346E+00	2.957E-03	4.432E-01
Barium sulphate	9.207E-16	5.103E-17	3.586E-16	5.111E-16
Basalt	8.719E-06	5.998E-07	5.183E-06	2.936E-06
Bauxite	3.454E-04	5.250E-06	3.234E-04	1.683E-05
Bentonite	2.074E-04	1.001E-04	3.012E-06	1.043E-04
Calcium carbonate (CaCO3)	2.188E-02	2.187E-02	3.740E-09	6.133E-06
Calcium chloride	9.426E-14	5.225E-15	3.671E-14	5.233E-14
Chalk (Calciumcarbonate)	1.079E-37	6.169E-40	1.062E-37	1.072E-39
Chromium ore (39%)	9.043E-07	1.280E-07	4.073E-09	7.722E-07
Clay	2.979E-05	1.625E-05	3.573E-07	1.319E-05
Colemanite ore	1.818E-07	2.430E-08	2.074E-09	1.554E-07
Copper - Gold - Silver - ore (1,0% Cu; 0,4 g/t Au; 66 g/t Ag)	1.028E-06	3.981E-07	2.739E-08	6.021E-07
Copper - Gold - Silver - ore (1,1% Cu; 0,01 g/t Au; 2,86 g/t Ag)	6.260E-07	2.425E-07	1.669E-08	3.668E-07
Copper - Gold - Silver - ore (1,16% Cu; 0,002 g/t Au; 1,06 g/t Ag)	3.533E-07	1.369E-07	9.418E-09	2.070E-07

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Copper - Molybdenum - Gold - Silver - ore (1,13% Cu; 0,02% Mo; 0,01 g/t Au; 2,86 g/t Ag)	6.344E-07	1.071E-07	2.295E-08	5.044E-07
Copper ore (0.14%)	3.395E-05	4.741E-06	6.320E-08	2.914E-05
Copper ore (1.2%)	1.066E-07	4.129E-08	2.840E-09	6.244E-08
Copper ore (4%)	1.455E-16	4.589E-17	3.508E-18	9.609E-17
Copper ore (sulphidic, 1.1%)	4.671E-07	4.630E-08	2.565E-10	4.206E-07
Dolomite	9.885E-03	9.852E-03	1.558E-06	3.157E-05
Feldspar (aluminum silicates)	4.408E-09	2.491E-11	4.302E-09	8.140E-11
Ferro manganese	1.274E-11	5.500E-14	1.251E-11	1.780E-13
Fluorspar (calcium fluoride; fluorite)	2.594E-06	3.834E-08	2.429E-06	1.258E-07
Granite	1.376E-18	6.914E-21	1.347E-18	2.205E-20
Gravel	3.575E-06	3.575E-06	0.000E+00	0.000E+00
Gypsum (natural gypsum)	1.249E-05	4.228E-06	1.651E-07	8.100E-06
Heavy spar (BaSO4)	5.012E-04	2.421E-04	7.256E-06	2.519E-04
Ilmenite (titanium ore)	6.636E-12	6.629E-12	7.068E-17	7.666E-15
Inert rock	5.521E-01	1.117E-01	2.339E-03	4.380E-01
Iron ore (56,86%)	8.393E-01	8.391E-01	1.353E-04	1.101E-04
Iron ore (65%)	6.140E-08	2.827E-08	7.667E-09	2.547E-08
Kaolin ore	3.264E-07	4.361E-08	3.722E-09	2.791E-07
Lead - zinc ore (4.6%-0.6%)	7.459E-05	1.988E-05	3.369E-05	2.101E-05
Limestone (calcium carbonate)	1.931E-01	1.895E-01	6.400E-05	3.524E-03
Magnesit (Magnesium carbonate)	2.549E-10	8.512E-11	4.460E-12	1.653E-10
Magnesium chloride leach (40%)	3.102E-05	2.728E-05	4.659E-07	3.279E-06
Manganese ore	1.746E-07	2.473E-08	8.431E-10	1.490E-07
Manganese ore (R.O.M.)	1.648E-06	7.862E-07	6.000E-08	8.020E-07
Molybdenite (Mo 0,24%)	3.877E-07	6.539E-08	1.415E-08	3.082E-07
Molybdenum ore (0.1%)	4.659E-10	4.659E-10	0.000E+00	0.000E+00
Natural Aggregate	1.043E-03	1.589E-04	1.194E-05	8.723E-04
Nickel ore (1,5%)	1.276E-09	8.455E-10	7.575E-13	4.301E-10
Nickel ore (1.6%)	5.885E-06	2.784E-06	1.154E-07	2.986E-06
Olivine	1.325E-10	5.732E-13	1.301E-10	1.855E-12
Peat	5.679E-07	1.513E-07	2.385E-07	1.781E-07
Phosphate ore	4.853E-03	4.853E-03	9.497E-12	1.062E-10
Phosphorus minerals	5.322E-05	5.265E-05	5.549E-07	1.072E-08
Phosphorus ore (29% P2O5)	6.535E-12	2.656E-14	5.813E-12	6.954E-13
Potassium chloride	1.743E-01	1.743E-01	7.760E-08	1.548E-09
Precious metal ore (R.O.M)	1.725E-08	3.769E-09	7.026E-10	1.278E-08
Quartz sand (silica sand; silicon dioxide)	4.180E-05	3.329E-05	2.737E-07	8.241E-06
Raw pumice	3.137E-08	4.231E-09	4.746E-11	2.709E-08

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Rutile (titanium ore)	6.688E-09	9.167E-12	6.644E-09	3.545E-11
sand	1.592E-08	8.419E-11	1.556E-08	2.743E-10
Slate	3.143E-10	1.214E-12	3.090E-10	4.049E-12
Sodium chloride (rock salt)	2.163E-04	1.945E-04	1.984E-05	1.998E-06
Sodium nitrate	3.351E-18	3.445E-20	3.255E-18	6.149E-20
Sodium sulphate	2.120E-09	1.852E-09	2.501E-10	1.808E-11
Soil	2.179E-04	5.050E-05	3.943E-06	1.635E-04
Sulphur (bonded)	1.014E-11	5.389E-12	3.122E-13	4.440E-12
Talc	5.485E-09	7.608E-10	1.005E-11	4.715E-09
Tin ore	7.984E-17	4.425E-18	3.109E-17	4.432E-17
Titanium ore	1.013E-06	3.152E-07	1.296E-08	6.848E-07
Zinc - copper ore (4.07%-2.59%)	9.815E-06	3.679E-06	8.777E-07	5.259E-06
Zinc - lead - copper ore (12%-3%-2%)	8.824E-06	1.617E-06	4.624E-06	2.582E-06
Zinc - lead ore (4.21%-4.96%)	4.968E-17	1.567E-17	1.198E-18	3.281E-17
Zinc ore (4%)	-6.316E-03	-6.315E-03	-9.923E-07	-1.518E-08
Zinc ore (sulphidic, 4%)	1.045E-15	3.710E-16	2.246E-17	6.519E-16
Renewable resources	8.712E+01	8.297E+01	2.036E-02	4.126E+00
Water	8.517E+01	8.223E+01	1.434E-02	2.918E+00
Water	1.297E-01	2.097E-02	4.858E-03	1.039E-01
Water (feed water)	3.844E-04	0.000E+00	4.464E-04	0.000E+00
Water (ground water)	4.720E+01	4.697E+01	3.090E-03	2.260E-01
Water (lake water)	3.269E-06	3.269E-06	0.000E+00	0.000E+00
Water (municipal)	2.913E-06	2.913E-06	0.000E+00	0.000E+00
Water (sea water)	2.483E-04	1.046E-04	1.819E-04	0.000E+00
Water (surface water)	3.756E+01	3.524E+01	5.723E-03	2.319E+00
Water (well water)	4.441E-05	2.504E-07	4.334E-05	8.155E-07
Water (well-produced water)	2.704E-01	1.446E-03	0.000E+00	2.690E-01
Water (with river silt)	1.620E-14	1.581E-14	3.659E-16	2.204E-17
Air	1.953E+00	7.385E-01	6.005E-03	1.208E+00
Carbon dioxide	2.435E-04	4.958E-05	8.925E-06	1.850E-04
Nitrogen	2.427E-06	7.971E-09	2.392E-06	2.683E-08
Oxygen	0.000E+00	0.000E+00	0.000E+00	2.718E-06
Unspecified	3.004E-07	2.977E-08	1.649E-10	2.704E-07
Unspecified minerals	6.833E-08	6.772E-09	3.752E-11	6.152E-08
Unspecified resources	2.320E-07	2.300E-08	1.274E-10	2.089E-07
Area of Production Land	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Output				

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Flows	7.676E+00	2.158E+00	1.183E-02	5.507E+00
Resources	2.750E+00	6.232E-01	5.615E-04	2.127E+00
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	2.750E+00	6.232E-01	5.615E-04	2.127E+00
Renewable resources	2.750E+00	6.232E-01	5.615E-04	2.127E+00
Water	2.750E+00	6.232E-01	5.575E-04	2.127E+00
Water (feed water)	0.000E+00	4.641E-06	0.000E+00	5.735E-05
Water (river water)	2.473E+00	6.152E-01	5.379E-04	1.857E+00
Water (sea water)	0.000E+00	0.000E+00	0.000E+00	3.827E-05
Water (wastewater)	2.711E-01	1.576E-03	1.965E-05	2.695E-01
Water (wastewater)	6.416E-03	6.416E-03	0.000E+00	0.000E+00
Nitrogen	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Oxygen	2.634E-05	2.506E-05	3.999E-06	0.000E+00
Ecoinvent	7.661E-06	7.661E-06	6.814E-15	1.117E-11
Long-term emission	7.661E-06	7.661E-06	6.814E-15	1.117E-11
Fresh water	7.661E-06	7.661E-06	6.814E-15	1.117E-11
Chloride	7.661E-06	7.661E-06	0.000E+00	0.000E+00
Dissolved organic carbon, DOC (Ecoinvent)	1.241E-11	1.230E-12	6.814E-15	1.117E-11
Production residues in life cycle	1.101E+00	1.100E+00	5.319E-04	2.098E-05
Hazardous waste for disposal	9.958E-05	1.412E-06	9.368E-05	4.490E-06
Chromium containing slag	4.631E-11	4.631E-11	0.000E+00	0.000E+00
Dross (Fines)	6.600E-07	9.365E-09	6.210E-07	2.968E-08
Natrium oxide	1.122E-06	1.592E-08	1.055E-06	5.045E-08
Red mud (dry)	9.747E-05	1.383E-06	9.170E-05	4.383E-06
Soil and sand containing heavy metals	2.356E-08	2.335E-09	1.294E-11	2.121E-08
Toxic chemicals (unspecified)	3.104E-07	1.624E-09	3.034E-07	5.318E-09
Hazardous waste for recovery	2.208E-04	2.202E-04	4.887E-07	3.464E-08
Used oil	1.778E-07	2.902E-09	1.670E-07	7.980E-09
Waste water processing residue	2.206E-04	2.202E-04	3.218E-07	2.666E-08
Waste for disposal	1.100E+00	1.100E+00	1.732E-04	1.144E-05
Incineration good	1.572E-07	8.928E-10	1.534E-07	2.902E-09
Sludge from water works (6% dry matter-content)	7.593E-10	4.611E-11	6.516E-12	7.067E-10
Waste (solid)	1.094E-05	1.888E-06	2.575E-07	8.797E-06
Waste for disposal (unspecified)	4.539E-10	4.539E-10	0.000E+00	0.000E+00
Waste from steel works	1.100E+00	1.100E+00	1.728E-04	2.644E-06
Waste for recovery	2.708E-04	1.339E-06	2.645E-04	5.012E-06

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Aluminum scrap	3.606E-12	1.751E-14	3.522E-12	6.664E-14
Chemicals (unspecified)	1.174E-07	4.820E-10	1.153E-07	1.594E-09
Cooling water	2.673E-04	1.284E-06	2.611E-04	4.941E-06
Cryolite	3.077E-07	4.366E-09	2.895E-07	1.384E-08
Dross	5.389E-07	2.617E-09	5.263E-07	9.959E-09
Filter dust	7.351E-12	7.351E-12	0.000E+00	0.000E+00
Furnace clinker	1.838E-12	1.838E-12	0.000E+00	0.000E+00
Gypsum (contaminated)	2.932E-16	2.932E-16	0.000E+00	0.000E+00
Gypsum (FDI)	5.862E-12	5.856E-12	6.010E-17	6.519E-15
Plastic (unspecified)	1.633E-07	9.363E-10	1.594E-07	2.995E-09
Production residues (unspecified)	1.197E-09	7.485E-12	1.167E-09	2.209E-11
Rolling gravel	4.861E-10	4.861E-10	0.000E+00	0.000E+00
Rolling tinder	1.029E-12	1.029E-12	1.057E-23	5.574E-21
Slag	2.330E-06	2.274E-08	2.265E-06	4.285E-08
Slag (containing precious metal)	6.798E-13	6.798E-13	0.000E+00	0.000E+00
Slag (Iron plate production)	1.540E-08	1.540E-08	0.000E+00	0.000E+00
Slag (Mn 6,5%)	7.999E-09	7.999E-09	0.000E+00	0.000E+00
Waste paper	2.486E-11	1.159E-12	2.326E-11	4.400E-13
Wood	1.557E-10	1.516E-12	1.525E-10	1.671E-12
Wooden pallet (EURO)	6.667E-16	2.712E-18	6.551E-16	8.895E-18
Mixed Waste (Hazardous or Radioactive)	3.675E-08	3.675E-08	0.000E+00	0.000E+00
Neutralized residues	1.069E-12	1.068E-12	1.138E-17	1.235E-15
Emissions to air	3.766E+00	3.849E-01	1.068E-02	3.370E+00
Heavy metals to air	3.622E-05	3.597E-05	9.736E-09	2.347E-07
Antimony	2.564E-09	1.084E-10	7.391E-12	2.448E-09
Arsenic (+V)	2.846E-08	7.201E-10	1.014E-10	2.764E-08
Arsenic trioxide	2.803E-14	1.344E-14	4.215E-16	1.416E-14
Cadmium (+II)	1.112E-07	1.095E-07	2.636E-11	1.673E-09
Chromium (+III)	9.681E-12	3.284E-12	1.280E-13	6.269E-12
Chromium (+VI)	1.045E-15	1.045E-15	0.000E+00	0.000E+00
Chromium (unspecified)	1.616E-06	1.613E-06	2.967E-10	3.030E-09
Cobalt	1.401E-09	3.154E-10	1.584E-11	1.070E-09
Copper (+II)	3.671E-09	6.484E-10	4.060E-11	2.982E-09
Heavy metals to air (unspecified)	7.122E-11	9.687E-12	1.118E-13	6.142E-11
Hydrogen arsenic (arsine)	2.326E-12	1.116E-12	3.499E-14	1.176E-12
Iron	2.036E-09	1.577E-09	3.319E-11	4.251E-10
Lanthanides	1.133E-13	3.975E-14	4.748E-15	6.885E-14
Lead (+II)	4.565E-06	4.548E-06	1.042E-09	1.568E-08

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Manganese (+II)	7.808E-09	1.814E-09	7.813E-11	5.916E-09
Mercury (+II)	2.889E-07	2.861E-07	5.950E-11	2.761E-09
Molybdenum	1.378E-10	1.189E-10	2.110E-12	1.674E-11
Nickel (+II)	6.566E-09	2.214E-09	5.757E-10	3.776E-09
Palladium	2.609E-18	1.446E-19	1.016E-18	1.448E-18
Rhodium	2.519E-18	1.396E-19	9.809E-19	1.398E-18
Selenium	7.349E-08	2.253E-09	1.386E-10	7.109E-08
Silver	7.084E-17	1.248E-18	6.669E-17	2.903E-18
Tellurium	1.291E-12	4.378E-13	1.706E-14	8.359E-13
Thallium	9.595E-12	3.320E-12	2.993E-13	5.975E-12
Tin (+IV)	2.792E-08	6.790E-10	8.597E-11	2.716E-08
Titanium	1.019E-11	2.595E-12	3.010E-13	7.296E-12
Vanadium (+III)	3.670E-08	1.832E-08	2.221E-09	1.616E-08
Zinc (+II)	2.945E-05	2.939E-05	5.010E-09	5.277E-08
Inorganic emissions to air	2.124E+00	-2.400E-01	5.666E-03	2.358E+00
Ammonia	2.678E-04	2.663E-04	2.203E-08	1.450E-06
Ammonium	4.381E-12	6.154E-13	6.744E-15	3.759E-12
Ammonium nitrate	5.854E-14	3.167E-14	8.096E-16	2.606E-14
Argon	1.969E-12	1.969E-12	0.000E+00	0.000E+00
Barium	3.635E-07	1.561E-07	4.772E-09	2.026E-07
Beryllium	3.222E-10	1.455E-11	2.187E-12	3.055E-10
Boron compounds (unspecified)	5.258E-07	4.201E-08	1.581E-09	4.822E-07
Bromine	2.196E-07	1.002E-08	5.296E-10	2.091E-07
Carbon dioxide	3.508E+00	2.556E+00	3.587E-03	9.486E-01
Carbon dioxide (biotic)	1.392E-10	1.392E-10	0.000E+00	0.000E+00
Carbon dioxide (biotic)	-2.113E+00	-3.010E+00	7.067E-07	8.965E-01
Carbon disulphide	1.184E-11	2.887E-13	1.076E-11	7.880E-13
Carbon monoxide	2.043E-02	1.960E-02	1.329E-05	8.077E-04
Carbon monoxide (biotic)	8.482E-13	8.482E-13	0.000E+00	0.000E+00
Chloride (unspecified)	1.924E-08	1.576E-08	9.743E-10	2.499E-09
Chlorine	2.782E-09	2.692E-10	2.464E-09	4.888E-11
Cyanide (unspecified)	5.080E-10	3.921E-10	9.208E-12	1.067E-10
Fluoride	9.131E-08	1.406E-08	4.598E-08	3.127E-08
Fluorides	1.094E-10	1.832E-11	2.763E-12	8.828E-11
Fluorine	7.396E-12	1.342E-12	3.636E-13	5.691E-12
Helium	5.409E-10	2.073E-10	1.049E-11	3.231E-10
Hydrogen	1.940E-07	1.524E-07	2.730E-08	1.431E-08
Hydrogen bromine (hydrobromic acid)	9.197E-11	8.112E-11	2.228E-12	8.622E-12

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Hydrogen chloride	1.204E-04	1.187E-04	6.248E-08	1.617E-06
Hydrogen cyanide (prussic acid)	2.747E-11	5.960E-12	1.135E-11	1.016E-11
Hydrogen fluoride	2.825E-07	4.360E-08	4.626E-08	1.927E-07
Hydrogen iodide	9.545E-14	8.666E-14	2.374E-15	6.420E-15
Hydrogen phosphorous	1.657E-12	2.975E-14	1.522E-12	1.054E-13
Hydrogen sulphide	6.737E-05	6.707E-05	6.729E-08	2.296E-07
Lead dioxide	1.524E-11	1.513E-12	9.527E-15	1.372E-11
Nitrogen (atmospheric nitrogen)	9.155E-05	7.364E-06	2.827E-06	8.136E-05
Nitrogen (N-compounds)	3.851E-13	3.851E-13	0.000E+00	0.000E+00
Nitrogen dioxide	1.876E-03	1.184E-04	2.428E-07	1.757E-03
Nitrogen monoxide	3.286E-09	1.650E-11	3.208E-09	6.206E-11
Nitrogen oxides	5.985E-03	4.501E-03	3.610E-06	1.480E-03
Nitrous oxide (laughing gas)	1.712E-03	1.700E-03	9.005E-08	1.127E-05
Oxygen	6.427E-05	1.141E-05	6.528E-07	5.221E-05
Scandium	4.215E-14	1.869E-14	2.430E-15	2.103E-14
Steam	6.885E-01	1.814E-01	2.050E-03	5.051E-01
Strontium	1.924E-12	7.473E-13	9.027E-14	1.086E-12
Sulphur dioxide	9.508E-03	5.625E-03	7.637E-06	3.876E-03
Sulphur hexafluoride	2.467E-09	2.465E-09	8.223E-14	1.775E-12
sulphur oxide	4.445E-09	5.573E-11	0.000E+00	4.389E-09
Sulphuric acid	1.831E-10	7.862E-11	1.639E-11	8.815E-11
Tin oxide	2.868E-15	5.035E-16	1.024E-16	2.262E-15
Unspecified Particles	5.593E-07	5.543E-08	3.071E-10	5.035E-07
Zinc oxide	5.735E-15	1.007E-15	2.048E-16	4.523E-15
Zinc sulphate	5.841E-11	2.811E-11	8.807E-13	2.943E-11
Organic emissions to air (group VOC)	8.976E-02	8.342E-02	8.731E-06	6.340E-03
Group NMVOC to air	8.165E-02	8.101E-02	1.677E-06	6.431E-04
Group PAH to air	5.243E-08	4.262E-08	4.260E-09	5.552E-09
Anthracene	6.693E-12	3.020E-12	9.833E-14	3.575E-12
Benzo{a}anthracene	3.368E-12	1.519E-12	4.948E-14	1.799E-12
Benzo{a}pyrene	1.596E-09	1.553E-10	6.862E-11	1.372E-09
Benzo{ghi}perylene	3.005E-12	1.356E-12	4.414E-14	1.605E-12
Benzofluoranthene	6.009E-12	2.711E-12	8.829E-14	3.210E-12
Chrysene	8.273E-12	3.732E-12	1.216E-13	4.419E-12
Dibenz(a)anthracene	1.872E-12	8.448E-13	2.750E-14	1.000E-12
Indeno[1,2,3-cd]pyrene	2.236E-12	1.009E-12	3.284E-14	1.194E-12
Naphthalene	7.030E-10	3.171E-10	1.033E-11	3.755E-10
Phenanthrene	2.208E-10	9.962E-11	3.244E-12	1.180E-10

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Polycyclic aromatic hydrocarbons (PAH)	4.988E-08	4.203E-08	4.177E-09	3.670E-09
Halogenated organic emissions to air	3.792E-08	4.609E-09	1.151E-08	2.181E-08
Dichloroethane (ethylene dichloride)	7.191E-14	5.339E-14	1.821E-14	3.128E-16
Dichloromethane (methylene chloride)	6.795E-13	4.175E-15	6.628E-13	1.253E-14
Dioxins (unspec.)	-8.891E-12	-8.897E-12	-1.388E-15	8.154E-15
Halogenated hydrocarbons (unspecified)	8.104E-11	4.740E-13	7.907E-11	1.495E-12
Polychlorinated biphenyls (PCB unspecified)	5.095E-12	2.452E-12	7.363E-14	2.569E-12
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	1.528E-14	1.465E-15	8.053E-16	1.301E-14
R 11 (trichlorofluoromethane)	9.747E-09	1.591E-09	4.797E-11	8.108E-09
R 114 (dichlorotetrafluoroethane)	9.982E-09	1.630E-09	4.912E-11	8.303E-09
R 116 (hexafluoroethane)	1.201E-09	1.704E-11	1.130E-09	5.400E-11
R 12 (dichlorodifluoromethane)	2.096E-09	3.421E-10	1.031E-11	1.743E-09
R 13 (chlorotrifluoromethane)	1.316E-09	2.148E-10	6.475E-12	1.095E-09
R 22 (chlorodifluoromethane)	2.291E-09	3.739E-10	1.127E-11	1.905E-09
Tetrafluoromethane	1.088E-08	1.641E-10	1.017E-08	5.454E-10
Vinyl chloride (VCM; chloroethene)	3.351E-10	2.822E-10	3.328E-12	4.958E-11
Acetaldehyde (Ethanal)	9.370E-09	4.399E-09	5.587E-10	4.413E-09
Acetic acid	4.187E-08	1.756E-08	2.363E-09	2.195E-08
Acetone (dimethylcetone)	8.770E-09	3.908E-09	5.521E-10	4.311E-09
Acrolein	4.723E-11	2.131E-11	6.940E-13	2.523E-11
Aldehyde (unspecified)	1.397E-09	2.991E-10	2.851E-11	1.069E-09
Alkane (unspecified)	1.196E-06	4.476E-08	4.062E-09	1.147E-06
Alkene (unspecified)	1.176E-06	4.096E-08	2.093E-09	1.132E-06
Aromatic hydrocarbons (unspecified)	2.949E-09	4.029E-10	9.842E-10	1.562E-09
Benzene	7.786E-08	5.229E-08	1.447E-09	2.412E-08
Butadiene	4.296E-12	5.795E-13	6.500E-15	3.710E-12
Butane	4.778E-06	2.838E-06	6.890E-08	1.871E-06
Butane (n-butane)	2.623E-07	1.077E-07	2.394E-09	1.522E-07
Caprolactam	1.107E-12	2.206E-13	3.326E-14	8.532E-13
Cumene (isopropylbenzene)	6.524E-20	6.524E-20	0.000E+00	0.000E+00
Cyclohexane (hexahydro benzene)	2.339E-11	5.217E-12	4.688E-12	1.348E-11
Diethylamine	1.089E-16	1.473E-17	1.686E-19	9.397E-17
Ethane	1.567E-05	9.997E-06	1.986E-07	5.476E-06
Ethanol	1.714E-08	3.039E-09	1.068E-09	1.303E-08
Ethene (ethylene)	1.393E-09	9.604E-10	4.993E-11	3.830E-10
Ethyl benzene	1.175E-06	4.130E-08	2.000E-09	1.132E-06
Fluoranthene	2.180E-11	9.835E-12	3.203E-13	1.164E-11
Fluorene	6.918E-11	3.121E-11	1.016E-12	3.695E-11

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Formaldehyde (methanal)	8.097E-02	8.097E-02	4.127E-09	3.655E-07
Heptane (isomers)	7.840E-08	1.960E-08	2.041E-09	5.676E-08
Hexamethylene diamine (HMDA)	2.527E-13	3.409E-14	3.824E-16	2.182E-13
Hexane (isomers)	1.518E-07	2.966E-08	3.517E-08	8.695E-08
Mercaptan (unspecified)	4.327E-09	3.731E-09	4.336E-11	5.524E-10
Methanethiol	1.422E-08	1.409E-09	7.808E-12	1.280E-08
Methanol	1.080E-08	2.001E-09	1.037E-09	7.766E-09
NMVOC (unspecified)	6.277E-04	1.096E-05	9.735E-07	6.157E-04
Octane	4.313E-08	1.078E-08	1.123E-09	3.123E-08
Pentane (n-pentane)	2.880E-06	1.401E-06	2.894E-08	1.449E-06
Phenol (hydroxy benzene)	4.343E-13	4.179E-14	1.170E-13	2.755E-13
Propane	1.671E-05	7.410E-06	3.202E-07	8.977E-06
Propene (propylene)	1.068E-07	3.706E-09	2.088E-10	1.029E-07
Propionic acid (propane acid)	1.737E-12	2.317E-13	8.362E-14	1.421E-12
Styrene	6.474E-13	6.714E-15	6.222E-13	1.849E-14
Toluene (methyl benzene)	5.364E-07	1.999E-08	9.556E-10	5.155E-07
Trimethylbenzene	2.793E-14	4.904E-15	9.976E-16	2.203E-14
Xylene (dimethyl benzene)	4.913E-06	1.716E-07	8.353E-09	4.733E-06
Hydrocarbons (unspecified)	1.122E-07	5.476E-09	5.808E-08	4.864E-08
Methane	6.476E-03	2.054E-03	6.232E-06	4.416E-03
Methane (biotic)	7.610E-09	5.517E-11	0.000E+00	7.555E-09
Organic chlorine compounds	1.009E-10	5.970E-13	9.841E-11	1.875E-12
Unspecified Organic Compounds	3.887E-13	3.852E-14	2.134E-16	3.500E-13
VOC (unspecified)	1.639E-03	3.567E-04	7.637E-07	1.281E-03
Other emissions to air	1.548E+00	5.381E-01	5.005E-03	1.005E+00
Aldehydes, unspecified	1.944E-13	1.926E-14	1.067E-16	1.750E-13
Exhaust	1.181E+00	1.720E-01	4.599E-03	1.004E+00
Particulate Matter, unspecified	1.008E-06	1.306E-07	1.953E-08	8.576E-07
Sand (Silica) (SiO2)	3.705E-09	3.672E-10	2.035E-12	3.336E-09
Used air	3.674E-01	3.661E-01	4.064E-04	8.996E-04
Particles to air	4.116E-03	3.357E-03	1.689E-06	7.569E-04
Dust (PM10)	5.668E-06	3.072E-07	9.309E-08	5.267E-06
Dust (PM2,5 - PM10)	9.840E-13	9.840E-13	0.000E+00	0.000E+00
Dust (PM2.5)	1.436E-05	8.917E-07	1.210E-07	1.335E-05
Dust (Portland cement kiln)	4.718E-06	3.420E-08	0.000E+00	4.684E-06
Dust (unspecified)	4.091E-03	3.356E-03	1.475E-06	7.336E-04
Metals (unspecified)	1.591E-10	1.605E-12	1.451E-10	1.239E-11
Unspecified Organic Chlorine Compounds	2.565E-12	2.542E-13	1.408E-15	2.309E-12

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Wood (dust)	1.058E-12	1.858E-13	3.780E-14	8.347E-13
Radioactive emissions to air	1.140E-08	1.851E-09	5.634E-11	9.491E-09
Uranium (total)	1.140E-08	1.851E-09	5.634E-11	9.491E-09
Unspecified Heavy Metals	2.003E-16	1.985E-17	1.100E-19	1.803E-16
Emissions to fresh water	5.864E-02	4.909E-02	4.110E-05	9.509E-03
Analytical measures to fresh water	2.900E-03	2.620E-04	7.377E-07	2.638E-03
Adsorbable organic halogen compounds (AOX)	4.218E-08	3.071E-08	6.465E-10	1.082E-08
Biological oxygen demand (BOD)	3.257E-05	9.992E-07	4.510E-08	3.152E-05
Chemical oxygen demand (COD)	1.880E-04	9.351E-05	4.965E-07	9.398E-05
Nitrogenous Matter (unspecified, as N)	1.139E-04	1.139E-04	1.789E-08	1.835E-08
Solids (dissolved)	7.529E-04	4.356E-05	1.073E-07	7.092E-04
Total dissolved organic bounded carbon	1.938E-05	1.035E-07	3.685E-08	1.924E-05
Total Dissolved Solids	1.793E-03	9.586E-06	0.000E+00	1.783E-03
Total organic bounded carbon	6.926E-07	3.855E-07	3.342E-08	2.737E-07
Heavy metals to fresh water	2.977E-04	1.244E-04	4.584E-06	1.687E-04
Aluminium	3.199E-05	5.239E-06	7.900E-07	2.596E-05
Antimony	2.834E-07	4.641E-08	6.998E-09	2.300E-07
Arsenic (+V)	1.032E-06	2.309E-07	2.249E-08	7.791E-07
Cadmium (+II)	1.802E-07	9.956E-08	2.247E-09	7.842E-08
Chromium (+III)	3.024E-09	4.822E-10	1.818E-11	2.524E-09
Chromium (+VI)	1.338E-12	1.922E-13	1.019E-12	1.269E-13
Chromium (unspecified)	2.106E-06	7.853E-07	3.892E-08	1.281E-06
Cobalt	2.762E-11	9.223E-12	6.264E-13	1.777E-11
Copper (+II)	1.686E-06	5.592E-07	3.282E-08	1.094E-06
Heavy metals to water (unspecified)	7.948E-10	6.217E-10	2.586E-12	1.706E-10
Iron	1.790E-04	9.930E-05	1.961E-06	7.779E-05
Lead (+II)	4.307E-06	1.719E-06	7.612E-08	2.512E-06
Manganese (+II)	4.089E-06	4.646E-08	6.158E-10	4.042E-06
Mercury (+II)	5.996E-07	5.862E-07	3.832E-10	1.303E-08
Molybdenum	3.083E-08	4.786E-09	1.374E-10	2.591E-08
Nickel (+II)	2.553E-05	5.181E-06	6.006E-07	1.975E-05
Selenium	1.007E-08	1.019E-09	2.582E-11	9.028E-09
Silver	2.768E-07	4.533E-08	6.834E-09	2.246E-07
Strontium	5.533E-07	6.798E-08	3.030E-09	4.823E-07
Thallium	9.912E-13	4.780E-13	1.514E-14	4.980E-13
Tin (+IV)	7.874E-11	1.434E-11	2.058E-12	6.235E-11
Titanium	2.964E-09	4.899E-10	1.495E-11	2.460E-09
Unspecified Substance	1.732E-12	1.717E-13	9.513E-16	1.560E-12

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Uranium	2.460E-06	2.460E-06	0.000E+00	0.000E+00
Vanadium (+III)	8.769E-09	1.582E-09	4.608E-11	7.141E-09
Zinc (+II)	4.350E-05	8.064E-06	1.042E-06	3.439E-05
Inorganic emissions to fresh water	5.427E-02	4.820E-02	3.024E-05	6.038E-03
Acid (calculated as H+)	7.948E-08	2.657E-09	6.443E-08	1.240E-08
Aluminum (+III)	9.648E-07	1.507E-07	4.420E-09	8.097E-07
Ammonia	7.210E-05	7.208E-05	1.153E-08	1.543E-08
Ammonia, as N	4.508E-13	4.508E-13	0.000E+00	0.000E+00
Ammonium (total N)	3.462E-04	5.670E-05	8.550E-06	2.810E-04
Ammonium / ammonia	7.848E-05	7.762E-05	2.706E-08	8.391E-07
Barium	7.517E-05	4.101E-07	6.752E-10	7.476E-05
Beryllium	3.421E-11	5.611E-12	1.688E-13	2.843E-11
Boron	7.254E-07	5.146E-08	1.094E-09	6.729E-07
Bromate	9.075E-13	5.540E-15	8.853E-13	1.661E-14
Bromine	1.104E-11	9.195E-12	1.161E-13	1.733E-12
Calcium (+II)	1.856E-02	1.844E-02	1.324E-06	1.186E-04
Carbonate	2.817E-02	2.764E-02	5.747E-08	5.292E-04
Chlorate	9.069E-10	5.118E-12	8.859E-10	1.591E-11
Chloride	1.902E-03	2.395E-04	1.288E-05	1.649E-03
Chlorine (dissolved)	1.267E-06	2.443E-07	6.068E-09	1.017E-06
Copper ion (+II/+III)	1.791E-13	2.155E-14	9.604E-17	1.575E-13
Cyanide	2.575E-06	4.217E-07	6.373E-08	2.090E-06
Fluoride	1.291E-03	1.049E-03	4.486E-07	2.419E-04
Fluorine	6.425E-10	1.949E-10	6.713E-12	4.409E-10
Hydrogen chloride	1.144E-11	3.566E-12	1.324E-13	7.737E-12
Hydrogen fluoride (hydrofluoric acid)	1.361E-11	1.153E-11	1.364E-13	1.949E-12
Hydrogen Ions (H+)	3.868E-10	3.833E-11	2.124E-13	3.482E-10
Hydroxide	2.109E-07	3.095E-09	1.981E-07	9.719E-09
Inorganic salts and acids (unspecified)	2.440E-17	2.436E-17	3.673E-20	7.213E-22
Iron ion (+II/+III)	2.727E-12	2.727E-12	0.000E+00	0.000E+00
Magnesium (+III)	2.522E-05	1.646E-06	3.573E-08	2.353E-05
Magnesium chloride	7.097E-13	3.934E-14	2.764E-13	3.940E-13
Metal ions (unspecific)	4.076E-08	1.958E-10	3.982E-08	7.534E-10
Neutral salts	4.419E-11	4.387E-11	3.085E-13	1.314E-14
Nickel ion (+III)	1.216E-13	1.216E-13	0.000E+00	0.000E+00
Nitrate	9.550E-06	7.982E-07	3.797E-07	8.372E-06
Nitrate (as total N)	6.212E-12	6.157E-13	3.411E-15	5.593E-12
Nitrogen	1.800E-04	1.752E-04	1.745E-08	4.835E-06

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Nitrogen (as total N)	1.417E-06	7.576E-09	0.000E+00	1.409E-06
Nitrogen organic bounded	1.072E-07	8.532E-08	3.913E-09	1.798E-08
Phosphate	1.373E-07	1.255E-07	6.393E-10	1.123E-08
Phosphorus	3.182E-04	2.898E-04	7.672E-07	2.762E-05
Potassium	1.089E-08	4.517E-09	3.301E-09	3.068E-09
Silicate particles	8.642E-08	4.628E-10	4.344E-14	8.596E-08
Sodium (+I)	3.508E-04	6.722E-05	4.168E-06	2.794E-04
Sodium chloride (rock salt)	1.493E-03	7.984E-06	5.498E-13	1.485E-03
Sodium hypochlorite	1.054E-10	1.023E-10	2.102E-12	1.032E-12
Sulfates	1.120E-04	5.990E-07	0.000E+00	1.114E-04
Sulphate	1.272E-03	7.603E-05	1.183E-06	1.195E-03
Sulphide	2.751E-07	1.008E-07	7.746E-09	1.666E-07
Sulphite	1.765E-07	1.515E-08	3.179E-10	1.611E-07
Sulphur	2.208E-09	4.023E-10	5.827E-11	1.747E-09
Sulphuric acid	1.474E-09	4.598E-10	1.707E-11	9.975E-10
Unspecified Iron Oxides	4.436E-12	4.397E-13	2.436E-15	3.994E-12
Unspecified Oil	1.572E-11	1.558E-12	8.630E-15	1.415E-11
Unspecified Organic Chlorine compounds	3.562E-14	3.530E-15	1.956E-17	3.207E-14
Unspecified Salt	1.425E-10	1.412E-11	7.825E-14	1.283E-10
Unspecified Solids (Suspended)	5.532E-10	5.483E-11	3.038E-13	4.981E-10
Organic emissions to fresh water	7.663E-05	7.404E-05	3.679E-08	2.556E-06
Halogenated organic emissions to fresh water	2.576E-11	1.329E-11	6.029E-13	1.187E-11
1,2-Dibromoethane	5.494E-15	1.226E-15	1.101E-15	3.168E-15
Chlorinated hydrocarbons (unspecified)	2.064E-13	2.064E-13	2.563E-19	6.512E-18
Chloromethane (methyl chloride)	2.551E-11	1.307E-11	6.001E-13	1.185E-11
Dichloroethane (ethylene dichloride)	2.307E-15	2.233E-15	7.330E-17	8.388E-19
Dichloropropane	2.028E-16	2.736E-17	3.069E-19	1.752E-16
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	1.032E-17	7.280E-18	3.001E-18	3.959E-20
Vinyl chloride (VCM; chloroethene)	3.422E-14	1.438E-14	1.714E-15	1.812E-14
Hydrocarbons to fresh water	7.598E-05	7.373E-05	6.844E-09	2.239E-06
Acenaphthene	4.495E-12	1.636E-12	1.278E-13	2.731E-12
Acenaphthylene	1.860E-12	6.659E-13	5.301E-14	1.141E-12
Acetic acid	7.732E-09	7.028E-09	2.282E-10	4.758E-10
Acrylonitrile	1.483E-11	2.001E-12	2.244E-14	1.281E-11
Anthracene	6.533E-12	2.310E-12	1.886E-13	4.034E-12
Aromatic hydrocarbons (unspecified)	5.461E-09	3.080E-09	7.151E-11	2.310E-09
Benzene	1.048E-08	4.614E-09	2.561E-10	5.608E-09
Benzo{a}anthracene	6.366E-13	2.329E-13	1.793E-14	3.858E-13

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Benzofluoranthene	3.387E-13	1.348E-13	9.214E-15	1.947E-13
Chrysene	2.854E-12	1.064E-12	7.973E-14	1.710E-12
Cresol (methyl phenol)	5.718E-11	1.042E-11	1.509E-12	4.525E-11
Ethyl benzene	4.751E-10	1.716E-10	1.337E-11	2.901E-10
Fluoranthene	7.886E-13	3.213E-13	2.205E-14	4.453E-13
Hexane (isomers)	6.245E-12	1.138E-12	1.648E-13	4.942E-12
Hydrocarbons (unspecified)	1.958E-06	1.229E-08	2.760E-09	1.943E-06
Methanol	7.102E-05	7.079E-05	8.952E-10	2.333E-07
Oil (unspecified)	2.945E-06	2.907E-06	1.688E-09	3.653E-08
Phenol (hydroxy benzene)	8.757E-09	3.056E-09	3.720E-10	5.329E-09
Polycyclic aromatic hydrocarbons (PAH, unspec.)	9.139E-09	1.650E-09	3.239E-10	7.166E-09
Toluene (methyl benzene)	6.110E-09	2.362E-09	1.592E-10	3.589E-09
Xylene (isomers; dimethyl benzene)	3.165E-09	1.472E-09	7.407E-11	1.619E-09
Carbon, organically bound	6.227E-07	3.050E-07	9.098E-09	3.086E-07
Naphthalene	2.841E-10	9.946E-11	7.907E-12	1.767E-10
N-unspecified (N)	1.230E-11	1.219E-12	6.754E-15	1.107E-11
Organic chlorine compounds (unspecified)	1.789E-11	1.009E-13	1.750E-11	2.920E-13
Organic compounds (dissolved)	1.920E-08	3.231E-11	1.905E-08	1.202E-10
Organic compounds (unspecified)	1.820E-09	1.046E-11	1.776E-09	3.361E-11
Unspecified wastewater	9.301E-09	9.218E-10	5.107E-12	8.374E-09
Other emissions to fresh water	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Particles to fresh water	1.097E-03	4.291E-04	5.497E-06	6.624E-04
Metals (unspecified)	7.832E-10	1.045E-11	7.051E-10	6.767E-11
Silicon dioxide (silica)	6.447E-12	6.444E-12	2.303E-15	4.357E-17
Soil loss by erosion into water	2.511E-10	2.199E-10	2.560E-12	2.864E-11
Solids (suspended)	8.968E-04	2.289E-04	5.464E-06	6.624E-04
Suspended solids, unspecified	2.003E-04	2.002E-04	3.146E-08	4.813E-10
Unspecified Oxides	3.688E-12	3.655E-13	2.025E-15	3.320E-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)	1.066E-09	1.057E-10	5.855E-13	9.601E-10
Uranium (total)	2.285E-13	2.285E-13	0.000E+00	0.000E+00
Emissions to sea water	5.229E-04	1.823E-04	1.535E-05	3.252E-04
Analytical measures to sea water	1.969E-06	5.230E-07	4.784E-08	1.398E-06
Adsorbable organic halogen compounds (AOX)	1.193E-13	2.817E-14	2.699E-15	8.840E-14
Biological oxygen demand (BOD)	1.316E-07	3.107E-08	2.977E-09	9.751E-08

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Chemical oxygen demand (COD)	1.705E-06	4.608E-07	4.188E-08	1.203E-06
Total organic bounded carbon	1.316E-07	3.107E-08	2.977E-09	9.751E-08
Heavy metals to sea water	3.627E-07	8.243E-08	9.844E-09	2.704E-07
Arsenic (+V)	4.258E-09	8.470E-10	1.142E-10	3.297E-09
Cadmium (+II)	2.977E-09	5.064E-10	5.788E-11	2.413E-09
Chromium (unspecified)	6.771E-09	1.288E-09	1.936E-10	5.289E-09
Cobalt	1.143E-09	6.873E-10	4.074E-11	4.150E-10
Copper (+II)	1.328E-08	2.891E-09	3.274E-10	1.006E-08
Iron	2.854E-08	1.098E-08	8.804E-10	1.668E-08
Lead (+II)	3.428E-09	7.203E-10	8.526E-11	2.623E-09
Manganese (+II)	2.894E-09	1.133E-09	8.972E-11	1.672E-09
Mercury (+II)	5.315E-11	1.449E-11	1.320E-12	3.735E-11
Molybdenum	2.668E-10	1.738E-10	2.954E-12	9.004E-11
Nickel (+II)	4.604E-09	1.156E-09	1.202E-10	3.328E-09
Silver	3.344E-10	5.849E-11	8.765E-12	2.672E-10
Strontium	2.704E-07	4.765E-08	7.081E-09	2.157E-07
Tin (+IV)	4.005E-10	7.006E-11	1.050E-11	3.200E-10
Titanium	4.080E-11	7.136E-12	1.069E-12	3.259E-11
Vanadium (+III)	8.348E-10	4.802E-10	2.927E-11	3.253E-10
Zinc (+II)	2.248E-08	1.377E-08	7.998E-10	7.915E-09
Inorganic emissions to sea water	4.156E-04	1.569E-04	1.291E-05	2.458E-04
Aluminum (+III)	1.313E-09	2.297E-10	3.443E-11	1.049E-09
Ammonia	3.903E-08	6.827E-09	1.023E-09	3.118E-08
Barium	8.074E-08	3.108E-08	2.508E-09	4.715E-08
Beryllium	5.909E-11	3.819E-11	2.165E-12	1.874E-11
Boron	2.124E-08	3.715E-09	5.567E-10	1.697E-08
Calcium (+II)	2.319E-06	4.057E-07	6.079E-08	1.853E-06
Carbonate	5.053E-06	1.930E-06	1.577E-07	2.966E-06
Chloride	4.017E-04	1.525E-04	1.252E-05	2.367E-04
Magnesium	5.828E-07	1.033E-07	1.519E-08	4.643E-07
Nitrate	6.585E-09	2.537E-09	2.045E-10	3.844E-09
Sodium (+I)	2.627E-06	6.205E-07	5.946E-08	1.947E-06
Sulphate	2.229E-06	9.097E-07	6.681E-08	1.252E-06
Sulphide	9.005E-07	3.320E-07	2.864E-08	5.399E-07
Sulphur	1.136E-08	1.988E-09	2.979E-10	9.079E-09
Organic emissions to sea water	2.676E-07	1.129E-07	7.930E-09	1.468E-07
Hydrocarbons to sea water	2.654E-07	1.116E-07	7.855E-09	1.459E-07
Acenaphthene	6.336E-11	3.964E-11	2.193E-12	2.152E-11

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Acenaphthylene	2.434E-11	1.511E-11	8.401E-13	8.397E-12
Acetic acid	1.396E-10	1.058E-10	5.115E-12	2.866E-11
Anthracene	2.338E-11	1.049E-11	7.395E-13	1.215E-11
Aromatic hydrocarbons (unspecified)	1.316E-09	3.107E-10	2.977E-11	9.751E-10
Benzene	2.780E-08	1.103E-08	7.328E-10	1.604E-08
Benzo{a}anthracene	1.374E-11	8.882E-12	4.803E-13	4.381E-12
Benzofluoranthene	1.478E-11	9.855E-12	5.218E-13	4.407E-12
Chrysene	7.668E-11	5.015E-11	2.690E-12	2.383E-11
Cresol (methyl phenol)	2.944E-10	5.148E-11	7.715E-12	2.352E-10
Ethyl benzene	3.358E-09	2.388E-09	5.858E-11	9.116E-10
Fluoranthene	1.602E-11	1.036E-11	5.608E-13	5.107E-12
Hexane (isomers)	3.214E-11	5.621E-12	8.423E-13	2.567E-11
Oil (unspecified)	1.734E-07	7.097E-08	5.293E-09	9.709E-08
Phenol (hydroxy benzene)	3.255E-08	1.543E-08	1.000E-09	1.612E-08
Toluene (methyl benzene)	1.897E-08	8.045E-09	4.611E-10	1.047E-08
Xylene (isomers; dimethyl benzene)	7.361E-09	3.159E-09	2.576E-10	3.945E-09
Naphthalene	2.233E-09	1.258E-09	7.512E-11	9.004E-10
Particles to sea water	1.047E-04	2.473E-05	2.369E-06	7.760E-05
Solids (suspended)	1.047E-04	2.473E-05	2.369E-06	7.760E-05
Emissions to agricultural soil	5.341E-05	5.341E-05	0.000E+00	0.000E+00
Heavy metals to agricultural soil	5.341E-05	5.341E-05	0.000E+00	0.000E+00
Cadmium (+II)	8.036E-07	8.036E-07	0.000E+00	0.000E+00
Chromium (unspecified)	3.847E-05	3.847E-05	0.000E+00	0.000E+00
Copper (+II)	1.998E-06	1.998E-06	0.000E+00	0.000E+00
Lead (+II)	3.459E-07	3.459E-07	0.000E+00	0.000E+00
Mercury (+II)	4.672E-09	4.672E-09	0.000E+00	0.000E+00
Nickel (+II)	1.176E-06	1.176E-06	0.000E+00	0.000E+00
Zinc (+II)	1.061E-05	1.061E-05	0.000E+00	0.000E+00
Emissions to industrial soil	8.538E-05	8.421E-05	8.061E-08	1.092E-06
Heavy metals to industrial soil	7.951E-05	7.922E-05	1.994E-08	2.707E-07
Antimony	9.003E-20	9.003E-20	0.000E+00	0.000E+00
Arsenic (+V)	4.300E-08	4.300E-08	2.469E-14	3.366E-13
Cadmium (+II)	2.406E-11	1.826E-11	2.251E-12	3.548E-12
Chromium (+III)	4.722E-11	2.595E-13	4.602E-11	9.402E-13
Chromium (+VI)	3.262E-19	3.262E-19	0.000E+00	0.000E+00
Chromium (unspecified)	5.791E-09	4.969E-09	5.883E-11	7.632E-10
Cobalt	1.024E-10	8.853E-11	1.016E-12	1.288E-11
Copper (+II)	1.053E-10	5.075E-11	4.659E-11	7.988E-12

Process or Category	Cradle to Gate	Cradle to Gate (RMA)	Gate to Gate (RMT)	Gate to Gate (ECF)
Iron	7.694E-05	7.694E-05	8.343E-11	1.044E-09
Lead (+II)	3.075E-07	3.074E-07	6.904E-11	1.601E-12
Manganese (+II)	1.272E-09	1.047E-09	1.458E-11	2.103E-10
Mercury (+II)	7.958E-10	7.953E-10	4.613E-13	2.315E-14
Nickel (+II)	1.919E-09	1.466E-09	4.845E-11	4.052E-10
Selenium	5.107E-09	5.107E-09	0.000E+00	0.000E+00
Strontium	1.925E-06	1.637E-06	1.938E-08	2.681E-07
Thallium	3.717E-08	3.717E-08	0.000E+00	0.000E+00
Vanadium (+III)	2.347E-07	2.347E-07	0.000E+00	0.000E+00
Zinc (+II)	8.334E-10	5.515E-10	1.908E-10	9.111E-11
Inorganic emissions to industrial soil	5.863E-06	4.986E-06	6.025E-08	8.168E-07
Aluminum (+III)	6.524E-09	5.577E-09	6.775E-11	8.799E-10
Ammonia	3.033E-06	2.587E-06	3.048E-08	4.155E-07
Bromide	8.778E-10	7.587E-10	8.711E-12	1.104E-10
Calcium (+II)	3.391E-08	5.966E-09	1.210E-09	2.673E-08
Chloride	1.026E-06	8.855E-07	1.023E-08	1.303E-07
Chlorine	7.611E-17	7.611E-17	0.000E+00	0.000E+00
Fluoride	2.926E-08	2.529E-08	2.904E-10	3.680E-09
Magnesium (+III)	4.695E-09	8.328E-10	1.674E-10	3.695E-09
Phosphorus	3.130E-07	2.662E-07	3.152E-09	4.363E-08
Potassium (+I)	7.408E-07	6.380E-07	7.561E-09	9.526E-08
Sodium (+I)	2.964E-09	5.205E-10	1.059E-10	2.338E-09
Sulphate	9.597E-08	8.146E-08	9.971E-10	1.351E-08
Sulphide	5.758E-07	4.887E-07	5.982E-09	8.108E-08
Organic emissions to industrial soil	7.316E-09	2.841E-09	4.191E-10	4.056E-09
Oil (unspecified)	7.316E-09	2.841E-09	4.191E-10	4.056E-09
Radioactive emissions to industrial soil	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Calcium Fluoride	5.871E-09	5.871E-09	0.000E+00	0.000E+00
Radionuclide	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Embedded Unit Processes

NETL (2010). *NETL Life Cycle Inventory Data – Process Data Sheet File: Corn Grain Harvesting and Storage, Operation*. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: Febrary 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

NETL (2010). *NETL Life Cycle Inventory Data – Unit Process: Chip Truck, Biomass Transport, Construction.* U.S. Department of Energy, National Energy Technology

Laboratory. Last Updated: October 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

NETL (2010). *NETL Life Cycle Inventory Data – Unit Process: Dry Mill Ethanol Plant Operation.* U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: February 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

NETL (2010). *NETL Life Cycle Inventory Data – Unit Process: Tractor Trailer Biomass Transport – Class 8B, Operations*. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: January 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

NETL (2011). *NETL Life Cycle Inventory Data – Process Data Sheet File: Corn Grain Land Preparation, Operation*. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: June 2011 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

NETL (2011). *NETL Life Cycle Inventory Data – Process Data Sheet File: Corn Grain, Cultivation, Operation.* U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: June 2011 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

References

None.

Section III: Document Control Information

Date Created:	September 12, 2011
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 (2011). *NETL Life Cycle Inventory Data – Unit Process: Ethanol Dry Milling Process, Acquisition, Transport, and Conversion.* U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: September 2011 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

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.