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# NETL Life Cycle Inventory Data

## Process Documentation File

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US *The percent of American mined uranium enriched in Europe and used in American reactors*

Transportation Distances By Truck, Train, and Ocean Freighter for each of the following:

Mine to Conversion Facility *The distances to transport from the port to the conversion facility by each mode of transportation*

Conversion Facility to Enrichment Facility *The distances to transport from the conversion facility to the enrichment facility by each mode of transportation*

Enrichment Facility to Fuel Assembly *The distances to transport from the enrichment facility to the fuel assembly facility by each mode of transportation*

### Tracked Input Flows:

Yellowcake ( $U_3O_8$ ) *The quantity of yellowcake that is produced at the mines and goes to the conversion facility*

Uranium Hexafluoride ( $UF_6$ ) *The output from the conversion facility that enters the enrichment facility*

Enriched Uranium Hexafluoride ( $UF_6$ ) *The output from the enrichment facility that enters the fuel assembly facility*

### Tracked Output Flows:

Fuel Assembly *Assembled enriched uranium for insertion into the nuclear reactor*

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## Section II: Process Description

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### Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS\_RMA\_Uranium\_EU\_Enrich\_2011.02.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) as seen in **Figure 1**. At the end, one kilogram of uranium fuel assembly is delivered to the life cycle (LC) Stage #2 boundary.

## Boundary and Description

LC Stage #1, RMA of uranium, includes extraction (open pit, in situ, and underground mining) and processing of yellowcake, conversion of yellowcake to uranium hexafluoride, enrichment of the concentration uranium hexafluoride, and the assembly of the enriched uranium hexafluoride into fuel assemblies. The enrichment occurs in Europe, using centrifugal enrichment technology exclusively.

Each of the steps of the RMA processing includes the construction and operations of the step. The transportation between the steps is considered part of RMA and the modes are discussed in detail below. With the machinery and facility construction, upstream processes (for example, steel or concrete) are included. The plans for U.S. and European RMA of Uranium use the same unit processes; however, include different parameters applicable to each scenario. The European plan is provided in **Figure 1**. The overall plans are the same for U.S. and European RMA, but the transportation distances and type of enrichment are specific to the supply chain.

There are transportation steps between each of the processing steps, but the product of each step undergoes more processing before it reaches the energy conversion facility, hence why it is still considered part of the RMA stage instead of RMT. The same transportation plan is repeated for each transportation location. The uranium is transported by three modes: truck, ocean freighter, or truck. Each mode has operating emissions. The plan for the transportation of uranium is provided in **Figure 2**.

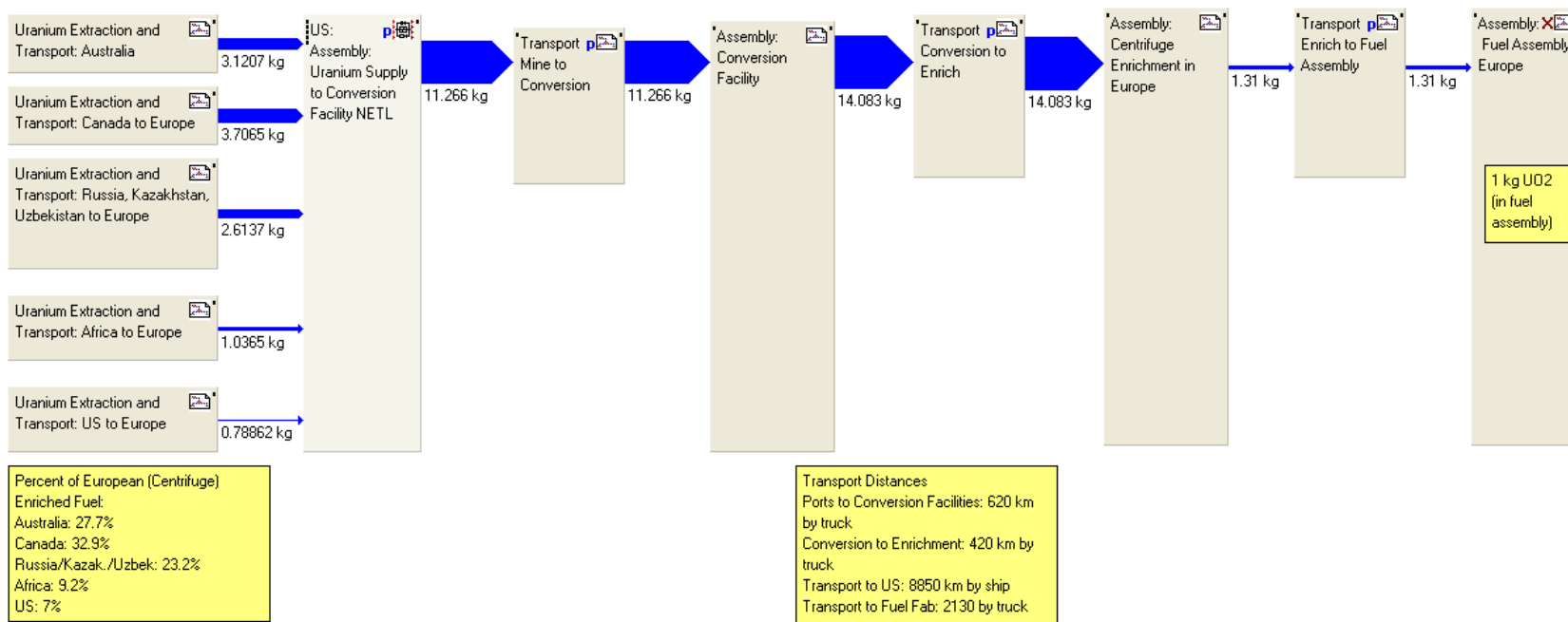
The construction processes for both machinery and facilities were created. The machinery includes:

- Underground Uranium Mine  
(DS/DF\_Stage1\_C\_Underground\_Uranium\_Mine\_2010.01.doc)
- Open Pit Uranium Mine, Construction  
(DS/DF\_DF\_Stage1\_C\_Open\_Pit\_Uranium\_Mine\_2010.01.doc)
- Uranium Milling, Construction  
(DS/DF\_DS\_Stage1\_C\_Milling\_Facility\_2010.01.xls)
- In Situ Uranium Mine, Construction  
(DS/DF\_DF\_Stage1\_C\_In\_Situ\_Uranium\_Extraction\_2010\_01.doc)
- Uranium Conversion Facility, Construction  
(DS/DF\_Stage1\_C\_Conversion\_Facility\_UF6\_2010.01.doc)
- US Enrichment Facility, Construction  
(DS/DF\_Stage1\_C\_Nuclear\_Enrichment\_Facility\_2010\_01.doc)

**Figure 1: Plan for RMA of Uranium, Including Extraction, Conversion, Enrichment, and Fuel Assembly**

**LC Stage #1: European Enrichment Chain**

GaBi 4 process plan: Mass [kg]

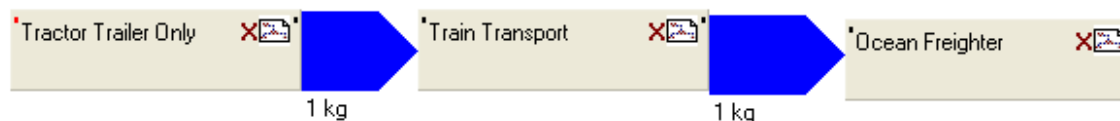


**Figure 2: Plan for Transportation of Uranium, including Construction and Operation of Profiles for Transport**

**Uranium Transport**

GaBi 4 process plan: Mass [kg]

Transportation modes are modeled in series. They can be turned on and off with the addition of a distance of transport.



- Enrichment, Decommissioning  
(DS/DF\_Stage1\_C\_GasDiffusion-Decommissioning\_2010.01.doc)
- Fuel Assembly, Construction  
(DS/DF\_Stage1\_C\_Fuel\_Fabrication\_Facility\_2010.01.doc)

Each piece of equipment or facility is scaled to the production of one kilogram of fuel assembly. 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 for Uranium, EU Enrichment**

LC Stage #1: European Enrichment Chain

Assembly: Centrifuge Enrichment in Europe

Centrifuge Enrichment in Europe, Operation

DE: Chlorine mix PE

EU-15: Diesel ELCD/PE-GaBi

EU-15: Lubricants PE

FR: Natural gas mix PE

FR: Power grid mix ELCD/PE-GaBi

**US: Gas Centrifuge Uranium Enrichment, Operation NETL**

**US: Industrial Boiler, Natural Gas Fired, Over 100 Million BTU/hr NETL**

Enrichment Facility, Construction

DE: Copper mix PE

EU-15: Bitumen at refinery PE

EU-15: Diesel ELCD/PE-GaBi

FR: Power grid mix ELCD/PE-GaBi

RER: Aluminum ingot mix PE

RER: Aluminum sheet PE <p-agg>

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

**US: Enrichment Facility, Construction NETL**

**WOR: Steel Pipe, Welded, BF, Manufacture NETL <u-so>**

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

DE: Diesel PE

**Enrichment, Decommissioning**

FR: Power grid mix ELCD/PE-GaBi

**US: Assembly: Enrichment Facility Centrifuge**

**US: UF<sub>6</sub> Storage Container, Construction NETL**

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

Assembly: Conversion Facility

Conversion, Construction

DE: Cast iron part PE <p-agg>

DE: Copper mix PE

DE: Steel cold rolled PE

**North American Average Electricity Mix, 2007 070111 NETL**

RER: Aluminum ingot mix PE

RER: Aluminum sheet PE <p-agg>

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

US: Thermal energy from heavy fuel oil PE

US: Uranium Conversion Facility, Construction NETL

Conversion, Operation

CA: Uranium Conversion Facility, Operation NETL

North American Average Electricity Mix, 2007 070111 NETL

US: Industrial Boiler, Natural Gas Fired, Over 100 Million BTU/hr NETL

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

US: Assembly: Conversion Facility NETL

Assembly: Fuel Assembly Europe

Fuel Assembly, Construction

DE: Cast iron part PE <p-agg>

DE: Copper mix PE

DE: Steel cold rolled PE

North American Average Electricity Mix, 2007 070111 NETL

RER: Aluminum ingot mix PE

RER: Aluminum sheet PE <p-agg>

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

US: Fuel Assembly, Construction NETL

US: Thermal energy from heavy fuel oil PE

Fuel Assembly, Operation

North American Average Electricity Mix, 2007 070111 NETL

US: Fuel Assembly, Operation NETL

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

US: Assembly: Fuel Assembly Europe NETL

Transport Conversion to Enrich

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

US: Ocean Freighter Transport, Operation NETL

US: Tractor-trailer Transport, Operation NETL

US: Train Transport, Operation NETL

Transport Enrich to Fuel Assembly

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

US: Ocean Freighter Transport, Operation NETL

US: Tractor-trailer Transport, Operation NETL

US: Train Transport, Operation NETL

Transport Mine to Conversion

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

US: Ocean Freighter Transport, Operation NETL

US: Tractor-trailer Transport, Operation NETL

US: Train Transport, Operation NETL

Uranium Extraction and Transport: Africa to Europe

Transport Africa to Europe

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

US: Ocean Freighter Transport, Operation NETL

US: Tractor-trailer Transport, Operation NETL

US: Train Transport, Operation NETL

Uranium Mining Mixer: Africa

ASSEMBLY: In Situ Uranium Mine

In Situ Mine, Construction

North American Average Electricity Mix, 2007 070111 NETL

North American Average Electricity Mix, 2007 070111 NETL

RER: Polyvinylchloride pipe (PVC) PlasticsEurope

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

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

US: In Situ Uranium Mine, Construction NETL

In Situ Mining, Operation

DE: Carbon dioxide PE

DE: Soda (Na<sub>2</sub>CO<sub>3</sub>) PE

DE: Sodium chloride (rock salt) PE

FR: Hydrogen peroxide PE

GB: Chlorine mix PE

GB: Oxygen PE

North American Average Electricity Mix, 2007 070111 NETL

US: In Situ Leach Mining Operation NETL

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

US: Assembly: In Situ Uranium Mine

ASSEMBLY: Open Pit Uranium Mine

Uranium Milling, Construction

DE: Copper mix PE

DE: Pine log with bark ELCD/PE-GaBi

DE: Steel cold rolled PE

North American Average Electricity Mix, 2007 070111 NETL

RER: Aluminum ingot mix PE

RER: Aluminum sheet PE <p-agg>

RER: Polyvinylchloride pipe (PVC) PlasticsEurope

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

US: Diesel Fired Construction Equipment, Variable Horsepower NETL

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

US: Uranium Milling, Construction NETL

Uranium Open Pit Mine, Construction

DE: Cast iron part PE <p-agg>

DE: Copper mix PE

DE: Steel cold rolled PE

DE: Styrene-butadiene rubber mix (SBR) PE

North American Average Electricity Mix, 2007 070111 NETL

RER: Aluminum ingot mix PE

RER: Aluminum sheet PE <p-agg>

RER: Polyvinylchloride pipe (PVC) PlasticsEurope

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

US: Thermal energy from heavy fuel oil PE

US: Uranium Open Pit Mine, Construction NETL

WOR: Rebar Wire Rod, BF Manufactures NETL

Uranium Open Pit Mining, Operation

DE: Fuel oil light at refinery PE

DE: Limestone hydrate (Ca(OH)<sub>2</sub>) PE

DE: Soda (Na<sub>2</sub>CO<sub>3</sub>) PE

DE: Sulphuric acid (96%) PE

GB: Ammonia (NH<sub>3</sub>) PE

North American Average Electricity Mix, 2007 070111 NETL

RER: Ammonium nitrate PE

US: Diesel Fired Construction Equipment, Variable Horsepower NETL

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

US: Industrial Boiler, Natural Gas Fired, Over 100 Million BTU/hr NETL

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

US: Uranium Open Pit Mining and Milling Operations NETL

US: Assembly: Open Pit Uranium Mine

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

US: Surface Mine Commissioning / Decommissioning NETL

STAGE #1: I6 RMA

Coal Mine Commissioning/Decommissioning

US: Commissioning and Decommissioning of Illinois No. 6 Coal Mine NETL <u-so>

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

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

COAL MINE CONSTRUCTION

GAB II, ASPHALT (Medium water content)

DK: GAB II, ASPHALT (Medium water content)

DK: Gravel round: at mine/CH S NETL

EU-15: Bitumen at refinery PE

North American Average Electricity Mix, 2007 070111 NETL

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

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

BF: Hot-dip Galvanized NETL

DE: Cast iron part PE <p-agg>

DE: Copper mix PE

DE: Stainless steel cold roll PE

DE: Steel cold rolled PE

DE: Styrene-butadiene rubber mix (SBR) PE



North American Average Electricity Mix, 2007 070111 NETL

RER: Polyvinylchloride pipe (PVC) PlasticsEurope

US: COAL MINE, CONSTRUCTION NETL

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

US: Thermal energy from heavy fuel oil PE

WOR: Rebar Wire Rod, BF Manufactures NETL

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

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

Coal Mine, Operation

North American Average Electricity Mix, 2007 070111 NETL

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

US: Underground Mine, Illinois No. 6 Bituminous Coal, Operation <u-so>

US: ASSEMBLY: COAL MINE CONSTRUCTION & OPERATION NETL

US: Uranium Mining Mixer: Africa NETL

Uranium Extraction and Transport: Australia

Transport Australia Mine to Port

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

US: Ocean Freighter Transport, Operation NETL

US: Tractor-trailer Transport, Operation NETL

US: Train Transport, Operation NETL

Uranium Mining Mixer: Australia

ASSEMBLY: In Situ Uranium Mine

In Situ Mine, Construction

North American Average Electricity Mix, 2007 070111 NETL

North American Average Electricity Mix, 2007 070111 NETL

RER: Polyvinylchloride pipe (PVC) PlasticsEurope

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

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

US: In Situ Uranium Mine, Construction NETL

In Situ Mining, Operation

DE: Carbon dioxide PE

DE: Soda (Na<sub>2</sub>CO<sub>3</sub>) PE

DE: Sodium chloride (rock salt) PE

FR: Hydrogen peroxide PE

GB: Chlorine mix PE

GB: Oxygen PE

North American Average Electricity Mix, 2007 070111 NETL

US: In Situ Leach Mining Operation NETL

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

US: Assembly: In Situ Uranium Mine

ASSEMBLY: Open Pit Uranium Mine

Uranium Milling, Construction

DE: Copper mix PE

DE: Pine log with bark ELCD/PE-GaBi  
DE: Steel cold rolled PE  
**North American Average Electricity Mix, 2007 070111 NETL**  
RER: Aluminum ingot mix PE  
RER: Aluminum sheet PE <p-agg>  
RER: Polyvinylchloride pipe (PVC) PlasticsEurope  
**US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>**  
**US: Diesel Fired Construction Equipment, Variable Horsepower NETL**  
**US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>**  
**US: Uranium Milling, Construction NETL**

Uranium Open Pit Mine, Construction

DE: Cast iron part PE <p-agg>  
DE: Copper mix PE  
DE: Steel cold rolled PE  
DE: Styrene-butadiene rubber mix (SBR) PE  
**North American Average Electricity Mix, 2007 070111 NETL**  
RER: Aluminum ingot mix PE  
RER: Aluminum sheet PE <p-agg>  
RER: Polyvinylchloride pipe (PVC) PlasticsEurope  
**US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>**  
US: Thermal energy from heavy fuel oil PE  
**US: Uranium Open Pit Mine, Construction NETL**  
**WOR: Rebar Wire Rod, BF Manufactures NETL**

Uranium Open Pit Mining, Operation

DE: Fuel oil light at refinery PE  
DE: Limestone hydrate (Ca(OH)<sub>2</sub>) PE  
DE: Soda (Na<sub>2</sub>CO<sub>3</sub>) PE  
DE: Sulphuric acid (96%) PE  
GB: Ammonia (NH<sub>3</sub>) PE  
**North American Average Electricity Mix, 2007 070111 NETL**  
RER: Ammonium nitrate PE  
**US: Diesel Fired Construction Equipment, Variable Horsepower NETL**  
**US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>**  
**US: Industrial Boiler, Natural Gas Fired, Over 100 Million BTU/hr NETL**  
**US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL**  
**US: Uranium Open Pit Mining and Milling Operations NETL**

US: Assembly: Open Pit Uranium Mine

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

**US: Surface Mine Commissioning / Decommissioning NETL**

STAGE #1: I6 RMA

Coal Mine Commissioning/Decommissioning

**US: Commissioning and Decommissioning of Illinois No. 6 Coal Mine NETL <u-so>**

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

US: GASOLINE, NATIONAL AVERAGE, 2009 NETL <u-so>  
COAL MINE CONSTRUCTION  
GAB II, ASPHALT (Medium water content)  
DK: GAB II, ASPHALT (Medium water content)  
DK: Gravel round: at mine/CH S NETL  
EU-15: Bitumen at refinery PE  
North American Average Electricity Mix, 2007 070111 NETL  
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>  
US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL  
BF: Hot-dip Galvanized NETL  
DE: Cast iron part PE <p-agg>  
DE: Copper mix PE  
DE: Stainless steel cold roll PE  
DE: Steel cold rolled PE  
DE: Styrene-butadiene rubber mix (SBR) PE  
North American Average Electricity Mix, 2007 070111 NETL  
RER: Polyvinylchloride pipe (PVC) PlasticsEurope  
US: COAL MINE, CONSTRUCTION NETL  
US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>  
US: Thermal energy from heavy fuel oil PE  
WOR: Rebar Wire Rod, BF Manufactures NETL  
WOR: Steel Plate, BF, Manufacture NETL <u-so>  
WOR: Steel, Stainless, 316 2B, 80% Recycled NETL <u-so>  
Coal Mine, Operation  
North American Average Electricity Mix, 2007 070111 NETL  
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>  
US: Underground Mine, Illinois No. 6 Bituminous Coal, Operation <u-so>  
US: ASSEMBLY: COAL MINE CONSTRUCTION & OPERATION NETL  
US: Uranium Mining Mixer: Australia NETL  
Uranium Extraction and Transport: Canada to Europe  
Transport Canada to Europe  
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>  
US: Ocean Freighter Transport, Operation NETL  
US: Tractor-trailer Transport, Operation NETL  
US: Train Transport, Operation NETL  
Uranium Mining Mixer: Canada  
ASSEMBLY: In Situ Uranium Mine  
In Situ Mine, Construction  
North American Average Electricity Mix, 2007 070111 NETL  
North American Average Electricity Mix, 2007 070111 NETL  
RER: Polyvinylchloride pipe (PVC) PlasticsEurope  
US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>  
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>

**US: In Situ Uranium Mine, Construction NETL**

## In Situ Mining, Operation

DE: Carbon dioxide PE

DE: Soda (Na<sub>2</sub>CO<sub>3</sub>) PE

DE: Sodium chloride (rock salt) PE

FR: Hydrogen peroxide PE

GB: Chlorine mix PE

GB: Oxygen PE

**North American Average Electricity Mix, 2007 070111 NETL****US: In Situ Leach Mining Operation NETL****US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL**

## US: Assembly: In Situ Uranium Mine

## ASSEMBLY: Open Pit Uranium Mine

## Uranium Milling, Construction

DE: Copper mix PE

DE: Pine log with bark ELCD/PE-GaBi

DE: Steel cold rolled PE

**North American Average Electricity Mix, 2007 070111 NETL**

RER: Aluminum ingot mix PE

RER: Aluminum sheet PE &lt;p-agg&gt;

RER: Polyvinylchloride pipe (PVC) PlasticsEurope

**US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>****US: Diesel Fired Construction Equipment, Variable Horsepower NETL****US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>****US: Uranium Milling, Construction NETL**

## Uranium Open Pit Mine, Construction

DE: Cast iron part PE &lt;p-agg&gt;

DE: Copper mix PE

DE: Steel cold rolled PE

DE: Styrene-butadiene rubber mix (SBR) PE

**North American Average Electricity Mix, 2007 070111 NETL**

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

US: Thermal energy from heavy fuel oil PE

**US: Uranium Open Pit Mine, Construction NETL****WOR: Rebar Wire Rod, BF Manufactures NETL**

## Uranium Open Pit Mining, Operation

DE: Fuel oil light at refinery PE

DE: Limestone hydrate (Ca(OH)<sub>2</sub>) PEDE: Soda (Na<sub>2</sub>CO<sub>3</sub>) PE

DE: Sulphuric acid (96%) PE

GB: Ammonia (NH3) PE  
North American Average Electricity Mix, 2007 070111 NETL  
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US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>  
US: Industrial Boiler, Natural Gas Fired, Over 100 Million BTU/hr NETL  
US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL  
US: Uranium Open Pit Mining and Milling Operations NETL

US: Assembly: Open Pit Uranium Mine  
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>  
US: Surface Mine Commissioning / Decommissioning NETL

STAGE #1: I6 RMA

Coal Mine Commissioning/Decommissioning  
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COAL MINE CONSTRUCTION

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

Coal Mine, Operation  
North American Average Electricity Mix, 2007 070111 NETL  
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>  
US: Underground Mine, Illinois No. 6 Bituminous Coal, Operation <u-so>  
US: ASSEMBLY: COAL MINE CONSTRUCTION & OPERATION NETL

US: Uranium Mining Mixer: Canada NETL

Uranium Extraction and Transport: Russia, Kazakhstan, Uzbekistan to Europe

Transport Russia to Europe

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

US: Ocean Freighter Transport, Operation NETL

US: Tractor-trailer Transport, Operation NETL

US: Train Transport, Operation NETL

Uranium Mining Mixer: Russia

ASSEMBLY: In Situ Uranium Mine

In Situ Mine, Construction

North American Average Electricity Mix, 2007 070111 NETL

North American Average Electricity Mix, 2007 070111 NETL

RER: Polyvinylchloride pipe (PVC) PlasticsEurope

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

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

US: In Situ Uranium Mine, Construction NETL

In Situ Mining, Operation

DE: Carbon dioxide PE

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**US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>**  
**US: Industrial Boiler, Natural Gas Fired, Over 100 Million BTU/hr NETL**  
**US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL**  
**US: Uranium Open Pit Mining and Milling Operations NETL**  
**US: Assembly: Open Pit Uranium Mine**  
**US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>**  
**US: Surface Mine Commissioning / Decommissioning NETL**

STAGE #1: I6 RMA

Coal Mine Commissioning/Decommissioning

**US: Commissioning and Decommissioning of Illinois No. 6 Coal Mine NETL <u-so>**  
**US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>**  
**US: GASOLINE, NATIONAL AVERAGE, 2009 NETL <u-so>**

COAL MINE CONSTRUCTION

GAB II, ASPHALT (Medium water content)  
DK: GAB II, ASPHALT (Medium water content)  
DK: Gravel round: at mine/CH S NETL  
EU-15: Bitumen at refinery PE  
**North American Average Electricity Mix, 2007 070111 NETL**  
**US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>**  
**US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL**  
**BF: Hot-dip Galvanized NETL**  
DE: Cast iron part PE <p-agg>  
DE: Copper mix PE  
DE: Stainless steel cold roll PE

DE: Steel cold rolled PE  
DE: Styrene-butadiene rubber mix (SBR) PE  
**North American Average Electricity Mix, 2007 070111 NETL**  
RER: Polyvinylchloride pipe (PVC) PlasticsEurope  
**US: COAL MINE, CONSTRUCTION NETL**  
US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>  
US: Thermal energy from heavy fuel oil PE  
WOR: Rebar Wire Rod, BF Manufactures NETL  
WOR: Steel Plate, BF, Manufacture NETL <u-so>  
WOR: Steel, Stainless, 316 2B, 80% Recycled NETL <u-so>

Coal Mine, Operation

**North American Average Electricity Mix, 2007 070111 NETL**  
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>  
US: Underground Mine, Illinois No. 6 Bituminous Coal, Operation <u-so>

US: ASSEMBLY: COAL MINE CONSTRUCTION & OPERATION NETL

**US: Uranium Mining Mixer: Russia NETL**

Uranium Extraction and Transport: US to Europe

Transport US to Europe

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

US: Ocean Freighter Transport, Operation NETL

US: Tractor-trailer Transport, Operation NETL

US: Train Transport, Operation NETL

Uranium Mining Mixer:US

ASSEMBLY: In Situ Uranium Mine

In Situ Mine, Construction

**North American Average Electricity Mix, 2007 070111 NETL**  
**North American Average Electricity Mix, 2007 070111 NETL**  
RER: Polyvinylchloride pipe (PVC) PlasticsEurope  
US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>  
US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>  
US: In Situ Uranium Mine, Construction NETL

In Situ Mining, Operation

DE: Carbon dioxide PE  
DE: Soda (Na<sub>2</sub>CO<sub>3</sub>) PE  
DE: Sodium chloride (rock salt) PE  
FR: Hydrogen peroxide PE  
GB: Chlorine mix PE  
GB: Oxygen PE  
**North American Average Electricity Mix, 2007 070111 NETL**  
US: In Situ Leach Mining Operation NETL  
US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL

US: Assembly: In Situ Uranium Mine

ASSEMBLY: Open Pit Uranium Mine



## Uranium Milling, Construction

DE: Copper mix PE  
DE: Pine log with bark ELCD/PE-GaBi  
DE: Steel cold rolled PE

**North American Average Electricity Mix, 2007 070111 NETL**

RER: Aluminum ingot mix PE  
RER: Aluminum sheet PE <p-agg>  
RER: Polyvinylchloride pipe (PVC) PlasticsEurope  
**US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>**  
**US: Diesel Fired Construction Equipment, Variable Horsepower NETL**  
**US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>**  
**US: Uranium Milling, Construction NETL**

## Uranium Open Pit Mine, Construction

DE: Cast iron part PE <p-agg>  
DE: Copper mix PE  
DE: Steel cold rolled PE  
DE: Styrene-butadiene rubber mix (SBR) PE

**North American Average Electricity Mix, 2007 070111 NETL**

RER: Aluminum ingot mix PE  
RER: Aluminum sheet PE <p-agg>  
RER: Polyvinylchloride pipe (PVC) PlasticsEurope  
**US: Concrete, ready mixed, R-5-0 (100% Portland Cement) NETL <u-so>**  
US: Thermal energy from heavy fuel oil PE  
**US: Uranium Open Pit Mine, Construction NETL**  
**WOR: Rebar Wire Rod, BF Manufactures NETL**

## Uranium Open Pit Mining, Operation

DE: Fuel oil light at refinery PE  
DE: Limestone hydrate (Ca(OH)<sub>2</sub>) PE  
DE: Soda (Na<sub>2</sub>CO<sub>3</sub>) PE  
DE: Sulphuric acid (96%) PE  
GB: Ammonia (NH<sub>3</sub>) PE

**North American Average Electricity Mix, 2007 070111 NETL**

RER: Ammonium nitrate PE  
**US: Diesel Fired Construction Equipment, Variable Horsepower NETL**  
**US: DIESEL, NATIONAL AVERAGE, 2009 NETL <u-so>**  
**US: Industrial Boiler, Natural Gas Fired, Over 100 Million BTU/hr NETL**  
**US: Natural Gas RMA/RMT, Mix Nominal, 060911 NETL**  
**US: Uranium Open Pit Mining and Milling Operations NETL**

**US: Assembly: Open Pit Uranium Mine**

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

**US: Surface Mine Commissioning / Decommissioning NETL**

STAGE #1: I6 RMA

Coal Mine Commissioning/Decommissioning

US: Commissioning and Decommissioning of Illinois No. 6 Coal Mine NETL <u-so>

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

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

#### COAL MINE CONSTRUCTION

GAB II, ASPHALT (Medium water content)

DK: GAB II, ASPHALT (Medium water content)

DK: Gravel round: at mine/CH S NETL

EU-15: Bitumen at refinery PE

North American Average Electricity Mix, 2007 070111 NETL

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

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

BF: Hot-dip Galvanized NETL

DE: Cast iron part PE <p-agg>

DE: Copper mix PE

DE: Stainless steel cold roll PE

DE: Steel cold rolled PE

DE: Styrene-butadiene rubber mix (SBR) PE

North American Average Electricity Mix, 2007 070111 NETL

RER: Polyvinylchloride pipe (PVC) PlasticsEurope

US: COAL MINE, CONSTRUCTION NETL

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

US: Thermal energy from heavy fuel oil PE

WOR: Rebar Wire Rod, BF Manufactures NETL

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

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

#### Coal Mine, Operation

North American Average Electricity Mix, 2007 070111 NETL

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

US: Underground Mine, Illinois No. 6 Bituminous Coal, Operation <u-so>

US: ASSEMBLY: COAL MINE CONSTRUCTION & OPERATION NETL

US: Uranium Mining Mixer: US NETL

US: Assembly: Uranium Supply to Conversion Facility NETL

## Parameters and Balances

The parameters for the highest level modeling plans for RMA of uranium are shown in **Table 2**. These parameters may or may not include the adjustable parameters shown previously, depending on how the model was created. **Table 3** presents the input and output balances for resources and emissions of interest for the RMA plan.

Table 2: Adjustable Parameters for RMA of Uranium

Plan	Parameter	Value	Comment
US: Assembly: Uranium Supply to Conversion Facility NETL	Africa	0.092	[unitless] Adjustable parameter; portion of uranium extracted in Africa.
US: Assembly: Uranium Supply to Conversion Facility NETL	Australia	0.277	[unitless] Adjustable parameter; portion of uranium extracted in Australia.
US: Assembly: Uranium Supply to Conversion Facility NETL	Canada	0.329	[unitless] Adjustable parameter; portion of uranium extracted in Canada.
US: Assembly: Uranium Supply to Conversion Facility NETL	Russia	0.232	[unitless] Adjustable parameter; portion of uranium extracted in Russia.
US: Assembly: Uranium Supply to Conversion Facility NETL	US	0.07	[unitless] Adjustable parameter; portion of uranium extracted in US.
Transport Mine/Port to Conversion	MC_truck_dist	620	[km] distance from the mine to conversion facility by truck.
Transport Mine/Port to Conversion	MC_train_dist	0	[km] distance from the mine to conversion facility by train.
Transport Mine/Port to Conversion	MC_ocean_dist	0	[km] distance from the mine to conversion facility by ocean freighter.
Transport Conversion to Enrich	CE_truck_dist	420	[km] distance from the conversion facility to enrichment facility by truck.
Transport Conversion to Enrich	CE_train_dist	0	[km] distance from the conversion facility to enrichment facility by train.
Transport Conversion to Enrich	CE_ocean_dist	0	[km] distance from the conversion facility to enrichment facility by ocean freighter.
Transport Enrich to Fuel Assembly	EF_truck_dist	2130	[km] distance from the enrichment facility to fuel assembly by truck.
Transport Enrich to Fuel Assembly	EF_train_dist	0	[km] distance from the enrichment facility to fuel assembly by train.
Transport Enrich to Fuel Assembly	EF_ocean_dist	8850	[km] distance from the enrichment facility to fuel assembly by ocean freighter.

Table 3: Inputs and Output Balances for RMA of Uranium, European Enrichment (kg/kg delivered)

Process or Category	Cradle to Gate (RMA)
<b>Inputs</b>	
Flows	1.856E+04
Resources	1.856E+04
Energy resources	3.973E+03
Non renewable energy resources	3.973E+03
Crude oil (resource)	7.530E+01
Crude oil	3.663E-01
Crude oil Algeria	2.380E+00

Process or Category	Cradle to Gate (RMA)
Crude oil Angola	1.736E+00
Crude oil Argentina	1.543E-02
Crude oil Australia	1.287E-01
Crude oil Austria	2.161E-02
Crude oil Bolivia	2.026E-06
Crude oil Brazil	1.254E-01
Crude oil Brunei	6.004E-08
Crude oil Bulgaria	1.101E-06
Crude oil Cameroon	1.169E-01
Crude oil Canada	5.977E+00
Crude oil Central Africa	0.000E+00
Crude oil Central America	0.000E+00
Crude oil Chile	2.079E-05
Crude oil China	9.443E-03
Crude oil CIS	1.185E+01
Crude oil Colombia	3.942E-02
Crude oil Czech Republic	2.045E-03
Crude oil Denmark	1.037E+00
Crude oil Ecuador	8.579E-01
Crude oil Egypt	8.403E-02
Crude oil France	3.599E-02
Crude oil Gabon	3.469E-02
Crude oil Germany	8.400E-01
Crude oil Greece	4.140E-03
Crude oil Hungary	1.482E-03
Crude oil India	3.047E-07
Crude oil Indonesia	5.049E-02
Crude oil Iran	6.348E-01
Crude oil Iraq	1.750E+00
Crude oil Ireland	2.433E-07
Crude oil Italy	1.617E-01
Crude oil Japan	8.819E-10
Crude oil Kuwait	1.042E+00
Crude oil Libya	2.889E+00
Crude oil Malaysia	3.354E-08
Crude oil Mexico	3.514E+00

Process or Category	Cradle to Gate (RMA)
Crude oil Middle East	0.000E+00
Crude oil Netherlands	1.986E-01
Crude oil New Zealand	7.611E-03
Crude oil Nigeria	3.798E+00
Crude oil North Africa	0.000E+00
Crude oil Norway	7.683E+00
Crude oil Oman	8.659E-03
Crude oil Poland	3.273E-02
Crude oil Qatar	1.054E-02
Crude oil Romania	8.732E-03
Crude oil Saudi Arabia	5.150E+00
Crude oil Slovakia	1.082E-05
Crude oil South Africa	1.489E-08
Crude oil Spain	6.741E-03
Crude oil Syria	3.913E-06
Crude oil Trinidad and Tobago	1.068E-02
Crude oil Tunisia	1.031E-01
Crude oil Turkey	2.107E-09
Crude oil United Arab Emirates	2.676E-02
Crude oil United Kingdom	6.210E+00
Crude oil USA	1.293E+01
Crude oil Venezuela	3.406E+00
Hard coal (resource)	7.313E+01
Hard coal	1.501E-02
Hard Coal (Illinois No 6)	4.029E+01
Hard coal Australia	5.100E+00
Hard coal Belgium	2.240E-04
Hard coal Bosnia and Herzegovina	2.630E-02
Hard coal Brazil	1.519E-03
Hard coal Canada	4.362E+00
Hard coal Chile	2.167E-03
Hard coal China	3.130E-01
Hard coal CIS	6.957E-01
Hard coal Colombia	1.531E+00
Hard coal Czech Republic	2.466E-01
Hard coal France	3.792E-01

Process or Category	Cradle to Gate (RMA)
Hard coal Germany	5.871E+00
Hard coal India	2.251E-05
Hard coal Indonesia	1.310E-01
Hard coal Italy	2.230E-04
Hard coal Japan	9.110E-09
Hard coal Malaysia	1.444E-09
Hard coal Mexico	6.798E-04
Hard coal New Zealand	1.777E-03
Hard coal Poland	2.072E+00
Hard coal Portugal	1.291E-07
Hard coal South Africa	3.170E+00
Hard coal Spain	2.259E-02
Hard coal Turkey	9.077E-06
Hard coal United Kingdom	2.655E-01
Hard coal USA	8.222E+00
Hard coal Venezuela	3.485E-01
Hard coal Vietnam	5.376E-02
Hard Coal, Pure, Fuel	4.279E-04
Hard Coal, Raw, Fuel	3.351E-03
Lignite (resource)	1.097E+01
Lignite	7.035E-05
Lignite Australia	1.410E-01
Lignite Austria	2.285E-03
Lignite Bosnia and Herzegovina	6.075E-02
Lignite Bulgaria	7.763E-03
Lignite Canada	6.303E-02
Lignite CIS	2.845E-02
Lignite Czech Republic	1.204E-01
Lignite France	1.408E-01
Lignite Germany	4.533E-03
Lignite Germany (Central Germany)	1.157E+00
Lignite Germany (Lausitz)	3.078E+00
Lignite Germany (Rheinisch)	5.582E+00
Lignite Greece	2.607E-01
Lignite Hungary	2.523E-03
Lignite India	4.503E-06

Process or Category	Cradle to Gate (RMA)
Lignite Macedonia	4.018E-03
Lignite Poland	8.182E-02
Lignite Romania	6.344E-05
Lignite Serbia and Montenegro	6.953E-04
Lignite Slovakia	1.013E-02
Lignite Slovenia	7.183E-02
Lignite Spain	4.753E-02
Lignite Turkey	2.612E-07
Lignite USA	1.070E-01
Natural gas (resource)	3.813E+03
Natural gas	2.982E-02
Natural gas Algeria	2.132E+00
Natural gas Angola	2.141E-01
Natural gas Argentina	1.291E-02
Natural gas Australia	2.381E-02
Natural gas Austria	3.761E-03
Natural gas Bolivia	4.073E-03
Natural gas Brazil	1.952E-02
Natural gas Brunei	5.296E-04
Natural gas Bulgaria	1.312E-06
Natural gas Cameroon	2.899E-02
Natural gas Canada	1.038E+00
Natural gas Chile	4.758E-03
Natural gas China	6.758E-04
Natural gas CIS	5.174E+00
Natural gas Colombia	3.636E-03
Natural gas Czech Republic	2.139E-04
Natural gas Denmark	2.159E-01
Natural gas Ecuador	5.285E-02
Natural gas Egypt	4.745E-03
Natural gas France	2.643E-01
Natural gas Gabon	5.066E-03
Natural gas Germany	1.846E+00
Natural gas Greece	2.772E-04
Natural gas Hungary	1.555E-03
Natural gas India	1.725E-06

Process or Category	Cradle to Gate (RMA)
Natural gas Indonesia	2.708E-03
Natural gas Iran	4.559E-02
Natural gas Iraq	7.853E-02
Natural gas Ireland	5.565E-04
Natural gas Italy	2.488E-02
Natural gas Japan	3.047E-06
Natural gas Kuwait	4.397E-02
Natural gas Libyan	9.776E-02
Natural gas Malaysia	4.987E-04
Natural gas Mexico	2.063E-01
Natural gas Netherlands	2.627E+00
Natural gas New Zealand	5.082E-04
Natural gas Nigeria	6.866E-01
Natural gas Norway	3.882E+00
Natural gas Oman	2.370E-03
Natural gas Poland	3.143E-03
Natural gas Qatar	9.304E-03
Natural gas Romania	3.317E-04
Natural gas Saudi Arabia	2.505E-01
Natural gas Slovakia	1.751E-04
Natural gas South Africa	5.092E-05
Natural gas Spain	8.300E-04
Natural gas Syria	4.205E-07
Natural gas Trinidad and Tobago	2.705E-02
Natural gas Tunisia	1.161E-02
Natural gas Turkey	2.131E-10
Natural gas United Arab Emirates	2.872E-03
Natural gas United Kingdom	1.468E+00
Natural gas USA	3.540E+03
Natural gas Venezuela	1.661E-01
Natural Gas, Fuel	1.336E-03
Natural gas, Raw Material	2.527E+02
Pit gas	6.649E-05
Pit Methane	2.598E-01
Uranium (resource)	4.621E-03
Nuclear energy	0.000E+00



Process or Category	Cradle to Gate (RMA)
Uranium natural	4.621E-03
Renewable energy resources	6.927E-03
Biomass	5.204E-04
Energy, gross calorific value, in biomass, primary forest	0.000E+00
Primary energy from geothermics	0.000E+00
Primary energy from hydro power	0.000E+00
Primary energy from solar energy	0.000E+00
Primary energy from waves	0.000E+00
Primary energy from wind power	0.000E+00
Renewable fuels	2.583E-06
Wood	6.404E-03
Unspecified	0.000E+00
Energy unspecified (APME)	0.000E+00
Thermal Energy from Diesel Fuel	0.000E+00
Land use	0.000E+00
Hemerobie ecoinvent	0.000E+00
Transformation, from unknown	0.000E+00
Transformation, to mineral extraction site	0.000E+00
Occupation	0.000E+00
Biotic Production	0.000E+00
Erosion Resistance	0.000E+00
Groundwater Replenishment	0.000E+00
Mechanical Filtration	0.000E+00
Physicochemical Filtration	0.000E+00
Transformation	0.000E+00
Biotic Production	0.000E+00
Erosion Resistance	0.000E+00
Groundwater Replenishment	0.000E+00
Mechanical Filtration	0.000E+00
Physicochemical Filtration	0.000E+00
Material resources	1.459E+04
Non renewable elements	1.804E+00
Aluminum	1.354E-06
Chromium	1.434E-07
Copper	5.035E-06
Iron	1.794E+00

Process or Category	Cradle to Gate (RMA)
Lead	1.482E-07
Magnesium	1.052E-12
Mercury	1.438E-07
Nickel	2.198E-09
Phosphorus	1.312E-07
Sulphur	-2.113E-05
Zinc	9.985E-03
Non renewable resources	6.356E+02
Barium sulphate	3.283E-12
Basalt	6.053E-02
Bauxite	2.260E+00
Bentonite	2.601E-01
Calcium carbonate (CaCO <sub>3</sub> )	8.812E-03
Calcium chloride	3.362E-10
Chalk (Calcium carbonate)	1.445E-32
Chromium ore (39%)	6.684E-04
Clay	4.001E-02
Colemanite ore	9.902E-05
Copper - Gold - Silver - ore (1,0% Cu; 0,4 g/t Au; 66 g/t Ag)	8.560E+00
Copper - Gold - Silver - ore (1,1% Cu; 0,01 g/t Au; 2,86 g/t Ag)	5.215E+00
Copper - Gold - Silver - ore (1,16% Cu; 0,002 g/t Au; 1,06 g/t Ag)	2.943E+00
Copper - Molybdenum - Gold - Silver - ore (1,13% Cu; 0,02% Mo; 0,01 g/t Au; 2,86 g/t Ag)	2.028E-03
Copper ore (0.14%)	1.749E-02
Copper ore (1.2%)	8.877E-01
Copper ore (4%)	2.341E-13
Copper ore (sulphidic, 1.1%)	6.043E-04
Dolomite	1.092E-01
Feldspar (aluminum silicates)	5.679E-08
Ferro manganese	7.645E-08
Fluorspar (calcium fluoride; fluorite)	1.668E-02
Granite	1.082E-14
Gravel	4.609E-02
Gypsum (natural gypsum)	1.592E-02
Heavy spar (BaSO <sub>4</sub> )	6.299E-01
Ilmenite (titanium ore)	1.222E-03
Inert rock	3.858E+02

Process or Category	Cradle to Gate (RMA)
Iron ore (56,86%)	9.847E+00
Iron ore (65%)	1.884E-04
Kaolin ore	1.776E-04
Lead - zinc ore (4.6%-0.6%)	5.187E-02
Limestone (calcium carbonate)	8.985E+01
Magnesit (Magnesium carbonate)	3.580E-07
Magnesium chloride leach (40%)	8.461E-02
Manganese ore	1.340E-04
Manganese ore (R.O.M.)	9.332E-02
Molybdenite (Mo 0,24%)	1.239E-03
Molybdenum ore (0.1%)	6.255E-06
Natural Aggregate	1.376E+00
Nickel ore (1,5%)	1.045E-05
Nickel ore (1.6%)	3.256E-01
Olivine	7.896E-07
Peat	8.522E-03
Phosphate ore	1.353E-06
Phosphorus minerals	1.362E-06
Phosphorus ore (29% P2O5)	1.127E-08
Potassium chloride	5.515E-05
Precious metal ore (R.O.M)	5.863E-05
Quartz sand (silica sand; silicon dioxide)	3.629E-01
Raw pumice	1.510E-05
Rutile (titanium ore)	2.194E-09
sand	2.920E-05
Slate	3.799E-07
Sodium chloride (rock salt)	1.198E+02
Sodium nitrate	7.377E-13
Sodium sulphate	1.459E-05
Soil	3.501E+00
Sulphur (bonded)	2.648E-08
Talc	2.738E-06
Tin ore	2.847E-13
Titanium ore	1.203E-03
Zinc - copper ore (4.07%-2.59%)	1.954E+00
Zinc - lead - copper ore (12%-3%-2%)	1.467E+00

Process or Category	Cradle to Gate (RMA)
Zinc - lead ore (4.21%-4.96%)	7.995E-14
Zinc ore (4%)	-7.988E-03
Zinc ore (sulphidic, 4%)	1.120E-12
Renewable resources	1.395E+04
Water	1.338E+04
Water	6.314E+01
Water (feed water)	5.207E-02
Water (ground water)	4.125E+03
Water (lake water)	4.246E+02
Water (municipal)	3.912E-02
Water (municipal)	3.783E+02
Water (river water)	0.000E+00
Water (sea water)	1.853E+00
Water (surface water)	8.385E+03
Water (well water)	4.455E-02
Water (well-produced water)	7.254E-01
Water (with river silt)	1.031E-10
Water,turbine use, unspecified natural origin	0.000E+00
Air	5.679E+02
Carbon dioxide	1.698E+00
Nitrogen	3.988E-03
Oxygen	0.000E+00
Unspecified	3.885E-04
Unspecified minerals	8.839E-05
Unspecified resources	3.001E-04
<b>Output</b>	
Flows	2.863E+04
Resources	1.148E+04
Energy resources	0.000E+00
Non renewable energy resources	0.000E+00
Hard coal (resource)	0.000E+00
Hard Coal (Illinois No 6)	0.000E+00
Natural gas (resource)	0.000E+00
Natural gas CIS	0.000E+00
Natural gas Denmark	0.000E+00
Natural gas Germany	0.000E+00

Process or Category	Cradle to Gate (RMA)
Natural gas Netherlands	0.000E+00
Natural gas Norway	0.000E+00
Non Renewable Energy	0.000E+00
Renewable energy resources	0.000E+00
Feedstock Energy	0.000E+00
Renewable Energy	0.000E+00
Thermal Energy from Diesel Fuel	0.000E+00
Total Primary Energy	0.000E+00
Land use	0.000E+00
Hemeroby	0.000E+00
Occup. as Forest land	0.000E+00
Material resources	1.148E+04
Renewable resources	1.148E+04
Water	1.148E+04
Water	0.000E+00
Water (Evaporated)	9.339E+00
Water (feed water)	0.000E+00
Water (ground water)	0.000E+00
Water (lake water)	0.000E+00
Water (river water)	5.768E+03
Water (sea water)	0.000E+00
Water (wastewater)	5.273E+03
Water (wastewater)	4.301E+02
Nitrogen	0.000E+00
Oxygen	8.049E-01
Ecoinvent	9.876E-02
Long-term emission	9.876E-02
Fresh water	9.876E-02
Chloride	9.876E-02
Dissolved organic carbon, DOC (Ecoinvent)	1.605E-08
Total organic carbon, TOC (Ecoinvent)	0.000E+00
Emissions to air	1.769E+03
Heavy metals to air	5.731E-04
Antimony	6.424E-07
Arsenic (+V)	4.869E-06
Arsenic trioxide	3.507E-11

Process or Category	Cradle to Gate (RMA)
Cadmium (+II)	9.778E-07
Chromium (+III)	1.255E-08
Chromium (+VI)	1.403E-11
Chromium (unspecified)	7.419E-06
Cobalt	2.189E-06
Copper (+II)	5.403E-05
Heavy metals to air (unspecified)	4.743E-08
Hydrogen arsenic (arsine)	2.911E-09
Iron	1.418E-05
Lanthanides	5.520E-10
Lead (+II)	7.467E-05
Manganese (+II)	1.367E-05
Mercury (+II)	6.779E-06
Molybdenum	8.864E-07
Nickel (+II)	3.577E-05
Palladium	9.305E-15
Rhodium	8.982E-15
Selenium	9.514E-06
Silver	2.754E-11
Tellurium	1.648E-09
Thallium	1.187E-07
Tin (+IV)	4.764E-06
Titanium	8.963E-08
Vanadium (+III)	1.699E-04
Zinc (+II)	1.725E-04
Inorganic emissions to air	1.324E+03
Ammonia	6.009E-01
Ammonium	2.442E-09
Ammonium nitrate	1.317E-10
Argon	5.550E-04
Barium	4.066E-04
Beryllium	9.208E-08
Boron compounds (unspecified)	1.030E-04
Bromine	3.062E-05
Carbon dioxide	8.134E+02
Carbon dioxide (biotic)	2.195E-05

Process or Category	Cradle to Gate (RMA)
Carbon dioxide (biotic)	5.320E-01
Carbon disulphide	8.517E-09
Carbon monoxide	2.417E+00
Carbon monoxide (biotic)	1.093E-08
Chloride (unspecified)	1.287E-04
Chlorine	8.363E-06
Cyanide (unspecified)	3.049E-06
Fluoride	4.928E-04
Fluorides	2.426E-07
Fluorine	1.152E-08
Helium	1.298E-04
Hydrogen	1.024E-03
Hydrogen bromine (hydrobromic acid)	2.641E-07
Hydrogen chloride	2.327E-03
Hydrogen cyanide (prussic acid)	4.091E-07
Hydrogen fluoride	4.794E-04
Hydrogen iodide	2.843E-10
Hydrogen phosphorous	1.052E-08
Hydrogen sulphide	1.329E-03
Lead dioxide	1.978E-08
Nitrogen (atmospheric nitrogen)	4.766E-02
Nitrogen (N-compounds)	1.085E-04
Nitrogen dioxide	1.076E-02
Nitrogen monoxide	8.338E-09
Nitrogen oxides	4.057E+00
Nitrous oxide (laughing gas)	3.351E-02
Oxygen	1.025E-01
Scandium	1.062E-10
Steam	5.011E+02
Strontium	8.287E-09
Sulphur dioxide	2.078E+00
Sulphur hexafluoride	3.331E-05
sulphur oxide	2.842E-02
Sulphuric acid	2.995E-06
Tin oxide	9.088E-12
Unspecified Particles	7.235E-04

Process or Category	Cradle to Gate (RMA)
Zinc oxide	1.818E-11
Zinc sulphate	7.312E-08
Organic emissions to air (group VOC)	1.265E+01
Group NMVOC to air	1.207E+00
Group PAH to air	2.249E-04
Anthracene	9.030E-09
Benzo(a)anthracene	4.544E-09
Benzo(a)pyrene	2.651E-06
Benzo(ghi)perylene	4.053E-09
Benzo(a)fluoranthene	8.107E-09
Chrysene	1.116E-08
Dibenz(a)anthracene	2.526E-09
Indeno[1,2,3-cd]pyrene	3.016E-09
Naphthalene	9.483E-07
Phenanthrene	2.979E-07
Polycyclic aromatic hydrocarbons (PAH)	2.210E-04
Halogenated organic emissions to air	1.738E-04
Dichloroethane (ethylene dichloride)	2.516E-06
Dichloromethane (methylene chloride)	1.627E-08
Dioxins (unspec.)	6.986E-12
Halogenated hydrocarbons (unspecified)	7.728E-07
Halon (1301)	0.000E+00
Polychlorinated biphenyls (PCB unspecified)	7.372E-09
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	1.890E-11
R 11 (trichlorofluoromethane)	3.386E-05
R 114 (dichlorotetrafluoroethane)	3.468E-05
R 116 (hexafluoroethane)	7.754E-06
R 12 (dichlorodifluoromethane)	7.280E-06
R 13 (chlorotrifluoromethane)	4.571E-06
R 22 (chlorodifluoromethane)	7.957E-06
Tetrafluoromethane	6.984E-05
Vinyl chloride (VCM; chloroethene)	4.548E-06
Acetaldehyde (Ethanal)	2.548E-05
Acetic acid	1.063E-04
Acetone (dimethylcetone)	2.463E-05
Acrolein	6.372E-08



Process or Category	Cradle to Gate (RMA)
Aldehyde (unspecified)	6.856E-06
Alkane (unspecified)	2.334E-04
Alkene (unspecified)	1.582E-04
Aromatic hydrocarbons (unspecified)	8.959E-06
Benzene	2.078E-04
Butadiene	2.068E-09
Butane	7.045E-03
Butane (n-butane)	2.207E-04
Caprolactam	5.079E-11
Cumene (isopropylbenzene)	8.410E-16
Cyclohexane (hexahydro benzene)	1.891E-07
Diethylamine	5.263E-14
Ethane	2.158E-02
Ethanol	6.164E-05
Ethene (ethylene)	2.429E-06
Ethyl benzene	1.552E-04
Fluoranthene	2.941E-08
Fluorene	9.332E-08
Formaldehyde (methanal)	2.909E-04
Heptane (isomers)	1.980E-04
Hexamethylene diamine (HMDA)	1.216E-10
Hexane (isomers)	3.029E-04
Mercaptan (unspecified)	6.198E-06
Methanethiol	1.840E-05
Methanol	6.095E-05
NM VOC (unspecified)	1.140E+00
Octane	1.089E-04
Pentane (n-pentane)	2.935E-03
Phenol (hydroxy benzene)	1.490E-09
Propane	3.289E-02
Propene (propylene)	1.407E-05
Propionic acid (propane acid)	1.514E-08
Styrene	2.099E-10
Toluene (methyl benzene)	7.397E-05
Trimethylbenzene	8.853E-11
Xylene (dimethyl benzene)	6.480E-04

Process or Category	Cradle to Gate (RMA)
Hydrocarbons (unspecified)	1.860E-04
Methane	1.144E+01
Methane (biotic)	5.416E-04
Organic chlorine compounds	5.382E-07
Unspecified Organic Compounds	5.028E-10
VOC (unspecified)	7.528E-03
Other emissions to air	4.312E+02
Aldehydes, unspecified	2.514E-10
Exhaust	3.605E+02
non used primary energy from wind power	0.000E+00
Particulate Matter, unspecified	2.049E-03
Sand (Silica) (SiO <sub>2</sub> )	4.793E-06
Unused primary energy from solar energy	0.000E+00
Used air	7.063E+01
Waste heat	0.000E+00
Particles to air	7.351E-01
Dust (PM10)	2.784E-01
Dust (PM2,5 - PM10)	1.921E-03
Dust (PM2.5)	1.219E-02
Dust (Portland cement kiln)	3.358E-01
Dust (unspecified)	1.068E-01
Metals (unspecified)	2.048E-07
Unspecified Organic Chlorine Compounds	3.318E-09
Wood (dust)	3.354E-09
Radioactive emissions to air	1.011E-04
Antimony (Sb124)	0.000E+00
Argon (Ar41)	0.000E+00
Carbon (C14)	0.000E+00
Cesium (Cs134)	0.000E+00
Cesium (Cs137)	0.000E+00
Cobalt (Co58)	0.000E+00
Cobalt (Co60)	0.000E+00
Hydrogen (H3)	0.000E+00
Iodine (I129)	0.000E+00
Iodine (I131)	0.000E+00
Krypton (Kr85)	0.000E+00

Process or Category	Cradle to Gate (RMA)
Krypton (Kr85m)	0.000E+00
Plutonium (Pu alpha)	0.000E+00
radionuclides	0.000E+00
Radon (Rn222)	0.000E+00
Uranium (total)	1.011E-04
Uranium (U234)	0.000E+00
Uranium (U235)	0.000E+00
Uranium (U238)	0.000E+00
Xenon (Xe131m)	0.000E+00
Xenon (Xe133)	0.000E+00
Xenon (Xe133m)	0.000E+00
Xenon (Xe135)	0.000E+00
Xenon (Xe135m)	0.000E+00
Xenon (Xe137)	0.000E+00
Xenon (Xe138)	0.000E+00
Unspecified Heavy Metals	2.591E-13
Emissions to fresh water	1.069E+03
Analytical measures to fresh water	2.464E+00
Adsorbable organic halogen compounds (AOX)	6.433E-05
Biological oxygen demand (BOD)	7.359E-02
Chemical oxygen demand (COD)	4.156E-02
Nitrogenous Matter (unspecified, as N)	1.995E-04
Solids (dissolved)	5.193E-01
Total Biochemical Oxygen Demand	0.000E+00
Total dissolved organic bounded carbon	1.907E-02
Total Dissolved Solids	1.785E+00
Total organic bounded carbon	2.525E-02
Total Suspended Solids	0.000E+00
Heavy metals to fresh water	6.054E+02
Aluminium	1.382E-03
Antimony	1.605E-04
Arsenic (+V)	1.123E-03
Cadmium (+II)	6.432E-05
Chromium (+III)	8.846E-06
Chromium (+VI)	1.519E-06
Chromium (unspecified)	1.081E-03

Process or Category	Cradle to Gate (RMA)
Cobalt	1.315E-08
Copper (+II)	1.078E-03
Heavy metals to water (unspecified)	1.055E-05
Iron	6.450E-02
Lead (+II)	1.849E-03
Manganese (+II)	5.251E-02
Mercury (+II)	9.002E-06
Molybdenum	9.009E-05
Nickel (+II)	1.515E+02
Selenium	2.210E-04
Silver	1.566E-04
Strontium	4.089E-04
Thallium	1.271E-09
Tin (+IV)	1.836E-08
Titanium	1.202E-05
Unspecified Substance	2.241E-09
Uranium	4.538E+02
Vanadium (+III)	3.108E-05
Zinc (+II)	2.691E-02
Inorganic emissions to fresh water	4.567E+02
Acid (calculated as H+)	4.516E-04
Acidity	0.000E+00
Aluminum (+III)	1.997E-02
Aluminum ion (+III)	4.957E-12
Ammonia	4.701E-01
Ammonia, as N	6.301E-09
Ammonium (total N)	1.497E-02
Ammonium / ammonia	3.495E+02
Barium	9.777E-01
Beryllium	1.188E-07
Bicarbonate	6.390E+00
Boron	5.721E-03
Bromate	2.162E-08
Bromine	1.571E-08
Calcium (+II)	1.558E+01
Carbonate	5.287E-01

Process or Category	Cradle to Gate (RMA)
Chlorate	1.254E-05
Chloride	3.844E+01
Chlorine (dissolved)	4.820E-03
Copper ion (+II/+III)	2.828E-10
Cyanide	1.457E-03
Fluoride	1.686E-01
Fluorine	1.440E-06
Hydrogen chloride	8.760E-07
Hydrogen fluoride (hydrofluoric acid)	2.620E-08
Hydrogen ions (H+)	5.003E-07
Hydroxide	1.384E-03
Inorganic salts and acids (unspecified)	1.581E-13
Iron ion (+II/+III)	3.666E-08
Magnesium (+III)	9.456E-03
Magnesium chloride	2.531E-09
Magnesium ion (+II)	5.722E-02
Metal ions (unspecific)	5.803E-08
Neutral salts	2.914E-07
Nickel ion (+III)	1.632E-09
Nitrate	6.953E-01
Nitrate (as total N)	8.036E-09
Nitrogen	4.258E-01
Nitrogen (as total N)	3.143E-03
Nitrogen organic bounded	6.957E-04
Phosphate	7.819E-04
Phosphorus	1.743E-02
Potassium	1.816E-05
Salinity (dissolved salts)	1.840E+00
Silicate particles	2.517E-04
Sodium (+I)	1.010E+01
Sodium chloride (rock salt)	1.472E+00
Sodium hypochlorite	6.697E-07
Sulfates	1.172E-01
Sulphate	4.877E+00
Sulphide	9.499E-04
Sulphite	3.010E-05

Process or Category	Cradle to Gate (RMA)
Sulphur	4.186E-07
Sulphur dioxide	0.000E+00
Sulphuric acid	1.129E-04
Total Dissolved Solids	2.496E+01
Unspecified Iron Oxides	5.739E-09
Unspecified Oil	2.033E-08
Unspecified Organic Chlorine compounds	4.608E-11
Unspecified Salt	1.843E-07
Unspecified Solids (Suspended)	7.157E-07
Organic emissions to fresh water	1.472E-01
Halogenated organic emissions to fresh water	6.693E-07
1,2-Dibromoethane	4.442E-11
Chlorinated hydrocarbons (unspecified)	2.772E-09
Chloromethane (methyl chloride)	6.335E-08
Dichloroethane (ethylene dichloride)	1.054E-07
Dichloropropane	9.763E-14
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD)	3.430E-10
Vinyl chloride (VCM; chloroethene)	4.974E-07
Hydrocarbons to fresh water	1.464E-01
Acenaphthene	1.472E-08
Acenaphthylene	6.096E-09
Acetic acid	5.374E-05
Acrylonitrile	7.139E-09
Anthracene	2.361E-08
Aromatic hydrocarbons (unspecified)	6.982E-06
Benzene	2.927E-05
Benzo{a}anthracene	1.910E-09
Benzo{fluoranthene	7.978E-10
Chrysene	8.107E-09
Cresol (methyl phenol)	1.071E-08
Ethyl benzene	1.641E-06
Fluoranthene	2.602E-09
Hexane (isomers)	1.176E-09
Hydrocarbons (unspecified)	7.880E-02
Methanol	2.851E-02
Oil (unspecified)	3.887E-02

Process or Category	Cradle to Gate (RMA)
Phenol (hydroxy benzene)	3.357E-05
Polycyclic aromatic hydrocarbons (PAH, unspec.)	2.907E-05
Toluene (methyl benzene)	1.743E-05
Xylene (isomers; dimethyl benzene)	9.655E-06
Carbon, organically bound	7.814E-04
Naphthalene	8.873E-07
N-unspecified (N)	1.591E-08
Organic chlorine compounds (unspecified)	3.278E-08
Organic compounds (dissolved)	1.032E-06
Organic compounds (unspecified)	8.215E-06
Unspecified wastewater	1.203E-05
Other emissions to fresh water	0.000E+00
Detergent (unspecified)	0.000E+00
non used primary energy from water power	0.000E+00
Unused primary energy from geothermal	0.000E+00
Waste heat	0.000E+00
Waste water	0.000E+00
Particles to fresh water	4.843E+00
Metals (unspecified)	2.200E-06
Silicon dioxide (silica)	8.651E-08
Soil loss by erosion into water	3.635E-07
Solids (suspended)	4.843E+00
Suspended solids, unspecified	2.534E-04
Unspecified Oxides	4.771E-09
Radioactive emissions to fresh water	0.000E+00
Americium (Am241)	0.000E+00
Antimony (Sb124)	0.000E+00
Antimony (Sb125)	0.000E+00
Carbon (C14)	0.000E+00
Cesium (Cs134)	0.000E+00
Cesium (Cs137)	0.000E+00
Cobalt (Co58)	0.000E+00
Cobalt (Co60)	0.000E+00
Curium (Cm alpha)	0.000E+00
Hydrogen (H3)	0.000E+00
Iodine (I129)	0.000E+00

Process or Category	Cradle to Gate (RMA)
Iodine (I131)	0.000E+00
Manganese (Mn54)	0.000E+00
Plutonium (Pu alpha)	0.000E+00
Radionuclides	0.000E+00
Radium (Ra226)	0.000E+00
Ruthenium (Ru106)	0.000E+00
Silver (Ag110m)	0.000E+00
Strontium (Sr90)	0.000E+00
Thorium (Th234)	0.000E+00
Uranium	0.000E+00
Bromide	0.000E+00
Radionuclide	0.000E+00
Sulfite	0.000E+00
Unspecified Solids (Dissolved)	1.379E-06
Uranium (total)	2.968E-05
Emissions to sea water	2.180E+00
Analytical measures to sea water	6.089E-03
Adsorbable organic halogen compounds (AOX)	3.270E-10
Biological oxygen demand (BOD)	3.607E-04
Chemical oxygen demand (COD)	5.367E-03
Total organic bounded carbon	3.607E-04
Heavy metals to sea water	1.342E-02
Arsenic (+V)	9.472E-06
Cadmium (+II)	5.521E-06
Chromium (unspecified)	1.499E-05
Cobalt	7.859E-06
Copper (+II)	3.352E-05
Iron	1.453E-04
Lead (+II)	9.194E-06
Manganese (+II)	1.490E-05
Mercury (+II)	1.663E-07
Molybdenum	1.209E-02
Nickel (+II)	1.338E-05
Silver	1.125E-06
Strontium	9.095E-04
Tin (+IV)	1.348E-06



Process or Category	Cradle to Gate (RMA)
Titanium	1.373E-07
Vanadium (+III)	5.561E-06
Zinc (+II)	1.550E-04
Inorganic emissions to sea water	1.872E+00
Aluminum (+III)	4.419E-06
Ammonia	1.313E-04
Barium	3.645E-04
Beryllium	4.281E-07
Boron	7.145E-05
Calcium (+II)	7.803E-03
Carbonate	2.292E-02
Chloride	1.818E+00
Magnesium	1.946E-03
Nitrate	2.972E-05
Sodium (+I)	7.204E-03
Sulphate	9.712E-03
Sulphide	4.162E-03
Sulphur	3.823E-05
Organic emissions to sea water	1.170E-03
Hydrocarbons to sea water	1.156E-03
Acenaphthene	4.192E-07
Acenaphthylene	1.598E-07
Acetic acid	1.105E-06
Anthracene	1.123E-07
Aromatic hydrocarbons (unspecified)	3.607E-06
Benzene	9.368E-05
Benzo(a)anthracene	9.383E-08
Benzo(a)fluoranthene	1.040E-07
Chrysene	5.296E-07
Cresol (methyl phenol)	9.903E-07
Ethyl benzene	8.636E-06
Fluoranthene	1.094E-07
Hexane (isomers)	1.081E-07
Oil (unspecified)	7.936E-04
Phenol (hydroxy benzene)	1.554E-04
Toluene (methyl benzene)	5.805E-05

Process or Category	Cradle to Gate (RMA)
Xylene (isomers; dimethyl benzene)	3.977E-05
Naphthalene	1.363E-05
Particles to sea water	2.871E-01
Solids (suspended)	2.871E-01
Emissions to industrial soil	1.431E+04
Heavy metals to industrial soil	1.431E+04
Antimony	1.161E-15
Arsenic (+V)	7.930E+00
Cadmium (+II)	8.341E-08
Chromium (+III)	2.357E-10
Chromium (+VI)	4.205E-15
Chromium (unspecified)	8.372E-06
Cobalt	1.464E-07
Copper (+II)	8.369E-08
Iron	1.419E+04
Lead (+II)	5.671E+01
Manganese (+II)	1.951E-06
Mercury (+II)	1.467E-01
Nickel (+II)	3.165E-06
Selenium	9.421E-01
Strontium	2.736E-03
Thallium	6.857E+00
Vanadium (+III)	4.329E+01
Zinc (+II)	9.473E-07
Inorganic emissions to industrial soil	8.475E-03
Aluminum (+III)	9.563E-06
Ammonia	4.318E-03
Bromide	1.255E-06
Calcium (+II)	1.074E-04
Chloride	1.470E-03
Chlorine	9.812E-13
Fluoride	4.184E-05
Magnesium (+III)	1.486E-05
Phosphorus	4.450E-04
Potassium (+I)	1.079E-03
Sodium (+I)	9.395E-06

Process or Category	Cradle to Gate (RMA)
Sulphate	1.397E-04
Sulphide	8.381E-04
Organic emissions to industrial soil	7.333E-05
Oil (unspecified)	7.333E-05
Radioactive emissions to industrial soil	0.000E+00
Uranium	0.000E+00
Calcium Fluoride	7.490E-01
Radionuclide	0.000E+00

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## References

None.

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**Section III: Document Control Information**

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