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# NETL Life Cycle Inventory Data

## Process Documentation File

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|               |  |
|---------------|--|
| Ecuador       | <i>The portion of crude oil entering refineries from Ecuador</i>   |
| Iraq          | <i>The portion of crude oil entering refineries from Iraq</i>  |
| Kuwait        | <i>The portion of crude oil entering refineries from Kuwait</i>  |
| Mexico        | <i>The portion of crude oil entering refineries from Mexico</i>  |
| Nigeria       | <i>The portion of crude oil entering refineries from Nigeria</i>   |
| Other         | <i>The portion of crude oil entering refineries from all other countries besides those listed explicitly</i> |
| Saudia_Arabia | <i>The portion of crude oil entering refineries from Saudi Arabia</i>  |
| Venezuela     | <i>The portion of crude oil entering refineries from Venezuela</i>   |

### Tracked Input Flows:

### Tracked Output Flows:

|                                |                          |
|--------------------------------|--------------------------|
| Crude Oil [Valuable Substance] | <i>Crude oil mixture</i> |
|--------------------------------|--------------------------|

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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\_US\_Crude\_Oil\_Mix\_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 crude oil is extracted internationally and has been prepared for entry into life cycle (LC) Stage #2.

### Boundary and Description

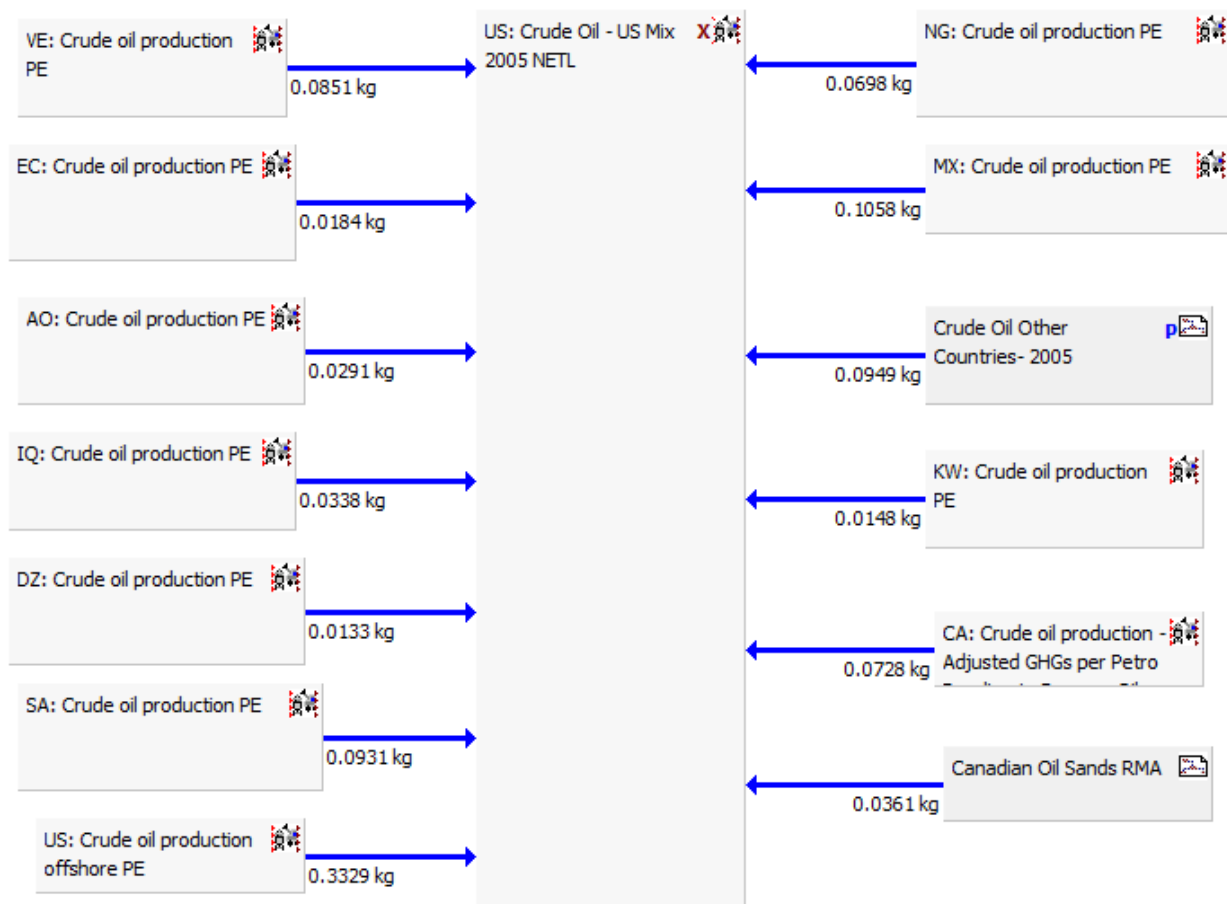
LC stage #1, RMA of crude oil, includes the U.S. imports from primary countries (Algeria, Angola, Canada, Ecuador, Iraq, Kuwait, Mexico, Nigeria, Saudi Arabia, and Venezuela) along with the summation of all other imported crude oil and U.S. extraction in combination with any initial processing of the oil.

The RMA of imported crude oil includes the operations of the different extraction wells. No construction data is included for this RMA.

**Figure 1: Plan for RMA of U.S. Crude Oil Mix**

#### Conventional Crude Oil - US Mix, 2005

GaBi 4 process plan:Reference quantities  
The names of the basic processes are shown.



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 U.S. Crude Oil Mix**

Crude Oil - National Average, 2005  
Crude oil - Canada NETL, 2005  
CA: Crude oil Canadian (Conventional) NETL  
CA: Crude sand oil production, NETL NETL  
CA: Natural gas mix PE  
Crude Oil - Domestic, 2005-Updated  
US: Crude oil production offshore PE  
US: Crude oil production onshore PE  
AO: Crude oil production PE  
DZ: Crude oil production PE  
EC: Crude oil production PE  
IQ: Crude oil production PE  
KW: Crude oil production PE  
MX: Crude oil production PE  
NG: Crude oil production PE  
SA: Crude oil production PE  
US: Crude oil mix PE  
US: National Average, 2005 NETL  
VE: Crude oil production PE

### Parameters and Balances

The parameters for the highest level modeling plan for the U.S. crude oil import mix 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 U.S. Crude Oil Mix**

| Plan                            | Parameter    | Value | Comment   |
|---------------------------------|--------------|-------|---|
| <b>LC Stage #1</b>              |              |       |   |
| US: National Average, 2005 NETL | Algeria      | 1.33  | [%] Percentage imported from Algeria (DZ)       |
| US: National Average, 2005 NETL | Angola       | 2.91  | [%] Percentage imported from Angola (AO)        |
| US: National Average, 2005 NETL | Canada       | 7.28  | [%] Percentage imported from Canada             |
| US: National Average, 2005 NETL | CA_Oil Sands | 3.61  | [%] Percentage imported from Canadian Oil Sands |
| US: National Average, 2005 NETL | Ecuador      | 1.84  | [%] Percentage imported from Ecuador (EC)       |
| US: National Average, 2005 NETL | Iraq         | 3.38  | [%] Percentage imported from Iraq (IQ)          |
| US: National Average, 2005 NETL | Kuwait       | 1.48  | [%] Percentage imported from Kuwait (KW)        |
| US: National Average, 2005 NETL | Mexico       | 10.58 | [%] Percentage imported from Mexico (MX)        |
| US: National Average, 2005 NETL | Nigeria      | 6.98  | [%] Percentage imported from Nigeria (NG)       |
| US: National Average, 2005 NETL | other        | 9.49  | [%] Percentage imported from other countries    |
| US: National Average, 2005 NETL | Saudi Arabia | 9.31  | [%] Percentage imported from Saudi Arabia (SA)  |
| US: National Average, 2005 NETL | USA          | 33.29 | [%] Percentage extracted in the U.S.            |
| US: National Average, 2005 NETL | Venezuela    | 8.51  | [%] Percentage imported from Venezuela          |

**Table 3: Input and Output Balances for RMA of U.S. Crude Oil Mix (kg/kg extracted)**

| Process or Category            | Cradle to Gate (RMA) |
|--------------------------------|----------------------|
| <b>Inputs</b>                  |                      |
| Flows                          | 1.657E+00            |
| Resources                      | 1.657E+00            |
| Energy resources               | 1.078E+00            |
| Non renewable energy resources | 1.078E+00            |
| Crude oil (resource)           | 1.008E+00            |
| Crude oil Algeria              | 2.295E-02            |
| Crude oil Angola               | 3.876E-02            |
| Crude oil Argentina            | 1.810E-05            |
| Crude oil Australia            | 1.632E-05            |
| Crude oil Austria              | 7.882E-06            |
| Crude oil Bolivia              | 9.540E-11            |

| Process or Category      | Cradle to Gate (RMA) |
|--------------------------|----------------------|
| Crude oil Brazil         | 2.878E-05            |
| Crude oil Brunei         | 6.761E-11            |
| Crude oil Bulgaria       | 7.821E-12            |
| Crude oil Cameroon       | 3.411E-05            |
| Crude oil Canada         | 1.175E-01            |
| Crude oil Chile          | 6.360E-09            |
| Crude oil China          | 4.187E-06            |
| Crude oil CIS            | 1.108E-03            |
| Crude oil Colombia       | 5.705E-05            |
| Crude oil Czech Republic | 5.275E-07            |
| Crude oil Denmark        | 2.388E-04            |
| Crude oil Ecuador        | 2.795E-02            |
| Crude oil Egypt          | 3.207E-05            |
| Crude oil France         | 1.133E-05            |
| Crude oil Gabon          | 4.218E-05            |
| Crude oil Germany        | 3.653E-05            |
| Crude oil Greece         | 1.572E-06            |
| Crude oil Hungary        | 2.984E-09            |
| Crude oil India          | 1.501E-12            |
| Crude oil Indonesia      | 1.280E-05            |
| Crude oil Iran           | 2.202E-04            |
| Crude oil Iraq           | 4.353E-02            |
| Crude oil Ireland        | 4.346E-11            |
| Crude oil Italy          | 5.017E-05            |
| Crude oil Kuwait         | 2.442E-02            |
| Crude oil Libya          | 3.421E-04            |
| Crude oil Malaysia       | 3.347E-11            |
| Crude oil Mexico         | 1.157E-01            |
| Crude oil Netherlands    | 3.041E-05            |
| Crude oil New Zealand    | 4.093E-07            |
| Crude oil Nigeria        | 7.961E-02            |
| Crude oil Norway         | 9.715E-04            |
| Crude oil Oman           | 5.088E-06            |
| Crude oil Poland         | 1.751E-06            |
| Crude oil Qatar          | 2.158E-06            |
| Crude oil Romania        | 3.153E-06            |

| Process or Category              | Cradle to Gate (RMA) |
|----------------------------------|----------------------|
| Crude oil Saudi Arabia           | 1.034E-01            |
| Crude oil Slovakia               | 6.810E-12            |
| Crude oil South Africa           | 6.302E-11            |
| Crude oil Spain                  | 2.620E-06            |
| Crude oil Syria                  | 4.353E-11            |
| Crude oil Trinidad and Tobago    | 1.543E-05            |
| Crude oil Tunisia                | 1.409E-05            |
| Crude oil Turkey                 | 6.747E-16            |
| Crude oil United Arab Emirates   | 2.756E-06            |
| Crude oil United Kingdom         | 1.376E-03            |
| Crude oil USA                    | 3.344E-01            |
| Crude oil Venezuela              | 9.505E-02            |
| Hard coal (resource)             | 1.892E-03            |
| Hard coal Australia              | 5.598E-05            |
| Hard coal Belgium                | 8.339E-09            |
| Hard coal Bosnia and Herzegovina | 6.472E-10            |
| Hard coal Brazil                 | 2.197E-07            |
| Hard coal Canada                 | 6.027E-04            |
| Hard coal Chile                  | 6.630E-07            |
| Hard coal China                  | 9.155E-06            |
| Hard coal CIS                    | 1.265E-05            |
| Hard coal Colombia               | 9.343E-05            |
| Hard coal Czech Republic         | 5.220E-06            |
| Hard coal France                 | 1.615E-07            |
| Hard coal Germany                | 1.120E-04            |
| Hard coal India                  | 3.345E-17            |
| Hard coal Indonesia              | 5.786E-06            |
| Hard coal Italy                  | 1.979E-10            |
| Hard coal Japan                  | 3.068E-12            |
| Hard coal Malaysia               | 1.178E-12            |
| Hard coal Mexico                 | 1.264E-05            |
| Hard coal New Zealand            | 5.424E-07            |
| Hard coal Poland                 | 3.301E-05            |
| Hard coal Portugal               | 7.652E-10            |
| Hard coal South Africa           | 5.612E-05            |
| Hard coal Spain                  | 4.655E-06            |

| Process or Category               | Cradle to Gate (RMA) |
|-----------------------------------|----------------------|
| Hard coal Turkey                  | 3.117E-12            |
| Hard coal United Kingdom          | 4.448E-06            |
| Hard coal USA                     | 8.560E-04            |
| Hard coal Venezuela               | 2.619E-05            |
| Hard coal Vietnam                 | 5.174E-07            |
| Lignite (resource)                | 9.056E-04            |
| Lignite Australia                 | 2.344E-05            |
| Lignite Austria                   | 7.750E-07            |
| Lignite Bosnia and Herzegovina    | 1.439E-09            |
| Lignite Bulgaria                  | 4.462E-09            |
| Lignite Canada                    | 1.286E-04            |
| Lignite CIS                       | 5.512E-07            |
| Lignite Czech Republic            | 2.948E-06            |
| Lignite France                    | 2.691E-08            |
| Lignite Germany (Central Germany) | 5.081E-04            |
| Lignite Germany (Lausitz)         | 6.601E-05            |
| Lignite Germany (Rheinisch)       | 1.193E-04            |
| Lignite Greece                    | 1.059E-06            |
| Lignite Hungary                   | 1.227E-08            |
| Lignite India                     | 6.691E-18            |
| Lignite Macedonia                 | 2.944E-09            |
| Lignite Poland                    | 1.047E-06            |
| Lignite Romania                   | 2.810E-10            |
| Lignite Serbia and Montenegro     | 1.147E-08            |
| Lignite Slovakia                  | 1.084E-09            |
| Lignite Slovenia                  | 9.540E-09            |
| Lignite Spain                     | 9.776E-06            |
| Lignite Turkey                    | 8.363E-14            |
| Lignite USA                       | 4.390E-05            |
| Natural gas (resource)            | 6.713E-02            |
| Natural gas Algeria               | 1.789E-03            |
| Natural gas Angola                | 4.743E-03            |
| Natural gas Argentina             | 5.307E-06            |
| Natural gas Australia             | 3.622E-06            |
| Natural gas Austria               | 9.468E-07            |
| Natural gas Bolivia               | 1.918E-07            |



| Process or Category        | Cradle to Gate (RMA) |
|----------------------------|----------------------|
| Natural gas Brazil         | 3.679E-06            |
| Natural gas Brunei         | 5.879E-07            |
| Natural gas Bulgaria       | 1.231E-12            |
| Natural gas Cameroon       | 8.496E-06            |
| Natural gas Canada         | 9.540E-03            |
| Natural gas Chile          | 1.513E-06            |
| Natural gas China          | 4.768E-07            |
| Natural gas CIS            | 1.337E-04            |
| Natural gas Colombia       | 6.218E-06            |
| Natural gas Czech Republic | 3.916E-08            |
| Natural gas Denmark        | 1.929E-05            |
| Natural gas Ecuador        | 1.703E-03            |
| Natural gas Egypt          | 3.240E-06            |
| Natural gas France         | 1.020E-06            |
| Natural gas Gabon          | 6.228E-06            |
| Natural gas Germany        | 5.392E-05            |
| Natural gas Greece         | 1.040E-07            |
| Natural gas Hungary        | 1.480E-09            |
| Natural gas India          | 1.500E-13            |
| Natural gas Indonesia      | 6.419E-07            |
| Natural gas Iran           | 2.528E-05            |
| Natural gas Iraq           | 1.756E-03            |
| Natural gas Ireland        | 9.692E-08            |
| Natural gas Italy          | 5.052E-06            |
| Natural gas Japan          | 5.931E-13            |
| Natural gas Kuwait         | 8.805E-04            |
| Natural gas Libyan         | 9.071E-06            |
| Natural gas Malaysia       | 5.759E-07            |
| Natural gas Mexico         | 6.417E-03            |
| Natural gas Netherlands    | 6.437E-05            |
| Natural gas New Zealand    | 2.715E-08            |
| Natural gas Nigeria        | 1.408E-02            |
| Natural gas Norway         | 6.460E-05            |
| Natural gas Oman           | 1.456E-06            |
| Natural gas Poland         | 1.154E-07            |
| Natural gas Qatar          | 9.259E-06            |

| Process or Category              | Cradle to Gate (RMA) |
|----------------------------------|----------------------|
| Natural gas Romania              | 2.014E-07            |
| Natural gas Saudi Arabia         | 3.447E-03            |
| Natural gas Slovakia             | 6.439E-11            |
| Natural gas South Africa         | 1.826E-09            |
| Natural gas Spain                | 3.246E-07            |
| Natural gas Syria                | 4.677E-12            |
| Natural gas Trinidad and Tobago  | 3.814E-05            |
| Natural gas Tunisia              | 1.845E-06            |
| Natural gas Turkey               | 6.825E-17            |
| Natural gas United Arab Emirates | 4.858E-07            |
| Natural gas United Kingdom       | 9.931E-05            |
| Natural gas USA                  | 1.815E-02            |
| Natural gas Venezuela            | 4.042E-03            |
| Pit Methane                      | 8.499E-06            |
| Uranium (resource)               | 2.702E-08            |
| Uranium natural                  | 2.702E-08            |
| Renewable energy resources       | 1.001E-06            |
| 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 wind power   | 0.000E+00            |
| Wood                             | 1.001E-06            |
| Material resources               | 5.789E-01            |
| Non renewable elements           | 1.880E-11            |
| Iron                             | 4.223E-13            |
| Lead                             | 6.530E-18            |
| Sulphur                          | 1.838E-11            |
| Non renewable resources          | 2.204E-01            |
| Barium sulphate                  | 6.694E-16            |
| Basalt                           | 3.515E-05            |
| Bauxite                          | 5.136E-06            |
| Bentonite                        | 3.932E-03            |
| Calcium chloride                 | 6.853E-14            |
| Chromium ore (39%)               | 2.699E-08            |
| Clay                             | 2.631E-04            |
| Colemanite ore                   | 1.404E-09            |

| Process or Category                        | Cradle to Gate (RMA) |
|--|----------------------|
| Copper ore (0.14%)                         | 5.488E-07            |
| Copper ore (4%)                            | 1.425E-15            |
| Copper ore (sulphidic, 1.1%)               | 1.691E-12            |
| Dolomite                                   | 4.453E-09            |
| Ferro manganese                            | 3.265E-18            |
| Fluorspar (calcium fluoride; fluorite)     | 6.238E-09            |
| Gypsum (natural gypsum)                    | 1.406E-04            |
| Heavy spar (BaSO4)                         | 9.510E-03            |
| Inert rock                                 | 1.951E-01            |
| Iron ore (56,86%)                          | 2.885E-03            |
| Iron ore (65%)                             | 1.115E-07            |
| Kaolin ore                                 | 1.534E-09            |
| Lead - zinc ore (4.6%-0.6%)                | 7.667E-04            |
| Limestone (calcium carbonate)              | 6.761E-03            |
| Magnesit (Magnesium carbonate)             | 2.774E-09            |
| Magnesium chloride leach (40%)             | 5.839E-05            |
| Manganese ore                              | 5.173E-09            |
| Manganese ore (R.O.M.)                     | 3.006E-05            |
| Molybdenite (Mo 0,24%)                     | 2.631E-10            |
| Natural Aggregate                          | 3.310E-04            |
| Nickel ore (1,5%)                          | 4.058E-12            |
| Nickel ore (1.6%)                          | 1.060E-04            |
| Olivine                                    | 3.592E-17            |
| Peat                                       | 5.105E-06            |
| Phosphate ore                              | 4.750E-09            |
| Phosphorus minerals                        | 2.610E-09            |
| Potassium chloride                         | 1.271E-09            |
| Precious metal ore (R.O.M)                 | 1.566E-09            |
| Quartz sand (silica sand; silicon dioxide) | 1.172E-04            |
| Raw pumice                                 | 1.490E-10            |
| Slate                                      | 6.041E-17            |
| Sodium chloride (rock salt)                | 2.037E-06            |
| Sodium sulphate                            | 4.691E-12            |
| Soil                                       | 1.879E-04            |
| Sulphur (bonded)                           | 8.916E-12            |
| Talc                                       | 1.167E-09            |

| Process or Category                  | Cradle to Gate (RMA) |
|--------------------------------------|----------------------|
| Tin ore                              | 5.805E-17            |
| Titanium ore                         | 9.758E-06            |
| Zinc - copper ore (4.07%-2.59%)      | 1.274E-04            |
| Zinc - lead - copper ore (12%-3%-2%) | 5.306E-05            |
| Zinc - lead ore (4.21%-4.96%)        | 4.867E-16            |
| Zinc ore (sulphidic, 4%)             | 2.279E-15            |
| Renewable resources                  | 3.584E-01            |
| Water                                | 2.439E-01            |
| Water (ground water)                 | 8.527E-02            |
| Water (sea water)                    | 1.020E-02            |
| Water (surface water)                | 1.484E-01            |
| Air                                  | 1.144E-01            |
| Carbon dioxide                       | 1.313E-04            |
| Nitrogen                             | 4.540E-11            |
| Oxygen                               | 3.769E-16            |
| <b>Output</b>                        |                      |
| Flows                                | 3.964E-01            |
| Resources                            | 1.207E-01            |
| Energy resources                     | 0.000E+00            |
| Non renewable energy resources       | 0.000E+00            |
| Crude oil (resource)                 | 0.000E+00            |
| Crude oil Ecuador                    | 0.000E+00            |
| Crude oil Iraq                       | 0.000E+00            |
| Material resources                   | 1.207E-01            |
| Renewable resources                  | 1.207E-01            |
| Water                                | 1.207E-01            |
| Water (ground water)                 | 0.000E+00            |
| Water (river water)                  | 1.201E-01            |
| Water (sea water)                    | 0.000E+00            |
| Water (wastewater)                   | 5.897E-04            |
| Emissions to air                     | 2.498E-01            |
| Heavy metals to air                  | 1.150E-07            |
| Antimony                             | 7.939E-11            |
| Arsenic (+V)                         | 8.527E-10            |
| Arsenic trioxide                     | 5.275E-13            |
| Cadmium (+II)                        | 1.729E-10            |

| Process or Category               | Cradle to Gate (RMA) |
|-----------------------------------|----------------------|
| Chromium (+III)                   | 1.094E-10            |
| Chromium (unspecified)            | 4.932E-10            |
| Cobalt                            | 2.917E-10            |
| Copper (+II)                      | 1.811E-09            |
| Heavy metals to air (unspecified) | 4.662E-12            |
| Hydrogen arsenic (arsine)         | 4.378E-11            |
| Iron                              | 1.127E-09            |
| Lanthanides                       | 1.401E-13            |
| Lead (+II)                        | 8.345E-09            |
| Manganese (+II)                   | 3.150E-09            |
| Mercury (+II)                     | 2.984E-10            |
| Molybdenum                        | 7.554E-11            |
| Nickel (+II)                      | 1.409E-08            |
| Palladium                         | 1.897E-18            |
| Rhodium                           | 1.831E-18            |
| Selenium                          | 8.859E-10            |
| Silver                            | 3.048E-19            |
| Tellurium                         | 1.458E-11            |
| Thallium                          | 1.073E-10            |
| Tin (+IV)                         | 3.793E-10            |
| Titanium                          | 8.235E-12            |
| Vanadium (+III)                   | 7.716E-08            |
| Zinc (+II)                        | 5.457E-09            |
| Inorganic emissions to air        | 2.055E-01            |
| Ammonia                           | 2.411E-06            |
| Ammonium                          | 2.743E-14            |
| Ammonium nitrate                  | 5.228E-14            |
| Barium                            | 5.989E-06            |
| Beryllium                         | 4.769E-11            |
| Boron compounds (unspecified)     | 7.386E-09            |
| Bromine                           | 3.075E-09            |
| Carbon dioxide                    | 1.919E-01            |
| Carbon dioxide (biotic)           | 7.897E-06            |
| Carbon disulphide                 | 4.737E-13            |
| Carbon monoxide                   | 4.409E-04            |
| Chloride (unspecified)            | 1.463E-08            |

| Process or Category                  | Cradle to Gate (RMA) |
|--------------------------------------|----------------------|
| Chlorine                             | 2.449E-12            |
| Cyanide (unspecified)                | 4.340E-10            |
| Fluoride                             | 7.361E-10            |
| Fluorides                            | 6.552E-09            |
| Fluorine                             | 4.646E-12            |
| Helium                               | 1.966E-09            |
| Hydrogen                             | 5.125E-07            |
| Hydrogen bromine (hydrobromic acid)  | 1.122E-10            |
| Hydrogen chloride                    | 2.564E-07            |
| Hydrogen cyanide (prussic acid)      | 4.414E-11            |
| Hydrogen fluoride                    | 4.062E-08            |
| Hydrogen iodide                      | 5.609E-15            |
| Hydrogen phosphorous                 | 2.077E-14            |
| Hydrogen sulphide                    | 4.779E-06            |
| Lead dioxide                         | 3.184E-15            |
| Nitrogen (atmospheric nitrogen)      | 5.764E-05            |
| Nitrogen dioxide                     | 5.615E-16            |
| Nitrogen monoxide                    | 1.868E-11            |
| Nitrogen oxides                      | 6.142E-04            |
| Nitrous oxide (laughing gas)         | 5.220E-06            |
| Oxygen                               | 9.807E-05            |
| Scandium                             | 7.062E-14            |
| Steam                                | 1.138E-02            |
| Strontium                            | 2.683E-12            |
| Sulphur dioxide                      | 9.902E-04            |
| Sulphur hexafluoride                 | 2.219E-13            |
| Sulphuric acid                       | 2.817E-09            |
| Tin oxide                            | 2.769E-16            |
| Zinc oxide                           | 5.540E-16            |
| Zinc sulphate                        | 1.103E-09            |
| Organic emissions to air (group VOC) | 4.663E-03            |
| Group NMVOC to air                   | 8.494E-04            |
| Group PAH to air                     | 3.122E-08            |
| Anthracene                           | 1.525E-10            |
| Benzo(a)anthracene                   | 7.674E-11            |
| Benzo(a)pyrene                       | 3.325E-11            |

| Process or Category                                | Cradle to Gate (RMA) |
|--|----------------------|
| Benzo(ghi)perylene                                 | 6.846E-11            |
| Benzofluoranthene                                  | 1.369E-10            |
| Chrysene   | 1.885E-10            |
| Dibenz(a)anthracene                                | 4.266E-11            |
| Indeno[1,2,3-cd]pyrene                             | 5.094E-11            |
| Naphthalene  | 1.602E-08            |
| Phenanthrene                                       | 5.032E-09            |
| Polycyclic aromatic hydrocarbons (PAH)             | 9.417E-09            |
| Halogenated organic emissions to air               | 2.289E-09            |
| Dichloromethane (methylene chloride)               | 2.650E-17            |
| Dioxins (unspec.)                                  | 4.319E-15            |
| Halogenated hydrocarbons (unspecified)             | 1.316E-17            |
| Polychlorinated biphenyls (PCB unspecified)        | 9.623E-11            |
| Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD) | 3.595E-15            |
| R 11 (trichlorofluoromethane)                      | 1.772E-10            |
| R 114 (dichlorotetrafluoroethane)                  | 1.815E-10            |
| R 12 (dichlorodifluoromethane)                     | 3.809E-11            |
| R 13 (chlorotrifluoromethane)                      | 2.392E-11            |
| R 22 (chlorodifluoromethane)                       | 4.165E-11            |
| Tetrafluoromethane                                 | 5.869E-11            |
| Vinyl chloride (VCM; chloroethene)                 | 1.672E-09            |
| Acetaldehyde (Ethanal)                             | 2.241E-08            |
| Acetic acid  | 1.212E-08            |
| Acetone (dimethylcetone)                           | 2.001E-08            |
| Acrolein   | 1.076E-09            |
| Aldehyde (unspecified)                             | 3.587E-10            |
| Alkane (unspecified)                               | 2.181E-08            |
| Alkene (unspecified)                               | 1.157E-08            |
| Aromatic hydrocarbons (unspecified)                | 1.077E-09            |
| Benzene  | 1.315E-07            |
| Butadiene  | 2.041E-14            |
| Butane   | 8.228E-05            |
| Butane (n-butane)                                  | 1.111E-08            |
| Cyclohexane (hexahydro benzene)                    | 1.086E-11            |
| Diethylamine                                       | 6.859E-19            |
| Ethane   | 2.187E-04            |

| Process or Category                     | Cradle to Gate (RMA) |
|---|----------------------|
| Ethanol                                 | 5.523E-09            |
| Ethene (ethylene)                       | 5.486E-09            |
| Ethyl benzene                           | 1.423E-08            |
| Fluoranthene                            | 4.967E-10            |
| Fluorene                                | 1.576E-09            |
| Formaldehyde (methanal)                 | 3.112E-08            |
| Heptane (isomers)                       | 2.909E-06            |
| Hexamethylene diamine (HMDA)            | 1.200E-15            |
| Hexane (isomers)                        | 4.315E-06            |
| Mercaptan (unspecified)                 | 2.221E-08            |
| Methanol                                | 5.403E-09            |
| NMVOC (unspecified)                     | 9.190E-05            |
| Octane                                  | 1.600E-06            |
| Pentane (n-pentane)                     | 2.748E-05            |
| Phenol (hydroxy benzene)                | 2.228E-13            |
| Propane                                 | 4.197E-04            |
| Propene (propylene)                     | 1.003E-09            |
| Propionic acid (propane acid)           | 1.885E-12            |
| Styrene                                 | 1.203E-14            |
| Toluene (methyl benzene)                | 4.739E-08            |
| Trimethylbenzene                        | 2.699E-15            |
| Xylene (dimethyl benzene)               | 7.635E-08            |
| Methane                                 | 3.749E-03            |
| Organic chlorine compounds              | 2.617E-14            |
| VOC (unspecified)                       | 6.403E-05            |
| Other emissions to air                  | 3.961E-02            |
| Exhaust                                 | 3.890E-02            |
| non used primary energy from wind power | 0.000E+00            |
| Particulate Matter, unspecified         | 1.080E-05            |
| Unused primary energy from solar energy | 0.000E+00            |
| Used air                                | 6.947E-04            |
| Waste heat                              | 0.000E+00            |
| Particles to air                        | 2.201E-05            |
| Dust (PM10)                             | 4.787E-06            |
| Dust (PM2.5)                            | 1.040E-05            |
| Dust (unspecified)                      | 6.824E-06            |



| Process or Category                        | Cradle to Gate (RMA) |
|--|----------------------|
| Metals (unspecified)                       | 9.249E-14            |
| Wood (dust)                                | 1.022E-13            |
| Radioactive emissions to air               | 2.325E-10            |
| 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            |
| Krypton (Kr85m)                            | 0.000E+00            |
| Plutonium (Pu alpha)                       | 0.000E+00            |
| Radon (Rn222)                              | 0.000E+00            |
| Uranium (total)                            | 2.325E-10            |
| 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            |
| Emissions to fresh water                   | 5.876E-03            |
| Analytical measures to fresh water         | 4.272E-05            |
| Adsorbable organic halogen compounds (AOX) | 2.298E-07            |
| Biological oxygen demand (BOD)             | 2.927E-06            |
| Chemical oxygen demand (COD)               | 3.628E-05            |
| Solids (dissolved)                         | 3.359E-08            |
| Total dissolved organic bounded carbon     | 1.472E-14            |
| Total organic bounded carbon               | 3.248E-06            |

| Process or Category                 | Cradle to Gate (RMA) |
|-------------------------------------|----------------------|
| Heavy metals to fresh water         | 3.634E-06            |
| Antimony                            | 5.261E-16            |
| Arsenic (+V)                        | 7.986E-08            |
| Cadmium (+II)                       | 7.252E-08            |
| Chromium (+III)                     | 6.542E-11            |
| Chromium (+VI)                      | 6.023E-17            |
| Chromium (unspecified)              | 1.207E-07            |
| Cobalt                              | 4.937E-11            |
| Copper (+II)                        | 2.673E-07            |
| Heavy metals to water (unspecified) | 5.021E-11            |
| Iron                                | 2.721E-06            |
| Lead (+II)                          | 5.840E-08            |
| Manganese (+II)                     | 4.830E-09            |
| Mercury (+II)                       | 1.080E-09            |
| Molybdenum                          | 6.393E-10            |
| Nickel (+II)                        | 8.273E-08            |
| Selenium                            | 1.797E-10            |
| Silver                              | 2.126E-11            |
| Strontium                           | 1.863E-07            |
| Thallium                            | 1.849E-11            |
| Tin (+IV)                           | 2.250E-11            |
| Titanium                            | 2.924E-10            |
| Vanadium (+III)                     | 3.776E-10            |
| Zinc (+II)                          | 3.807E-08            |
| Inorganic emissions to fresh water  | 3.512E-03            |
| Acid (calculated as H+)             | 1.329E-09            |
| Aluminum (+III)                     | 1.988E-08            |
| Ammonia                             | 4.541E-09            |
| Ammonium / ammonia                  | 1.035E-06            |
| Barium                              | 6.558E-07            |
| Beryllium                           | 6.897E-13            |
| Boron                               | 5.417E-09            |
| Bromine                             | 7.413E-11            |
| Calcium (+II)                       | 9.740E-07            |
| Carbonate                           | 4.125E-05            |
| Chloride                            | 3.370E-03            |

| Process or Category                                | Cradle to Gate (RMA) |
|--|----------------------|
| Chlorine (dissolved)                               | 6.705E-08            |
| Cyanide  | 8.223E-11            |
| Fluoride   | 1.928E-06            |
| Fluorine   | 5.754E-09            |
| Hydrogen chloride                                  | 1.101E-10            |
| Hydrogen fluoride (hydrofluoric acid)              | 7.001E-11            |
| Hydroxide  | 3.023E-09            |
| Magnesium (+III)                                   | 6.673E-07            |
| Magnesium chloride                                 | 5.160E-13            |
| Nitrate  | 1.275E-07            |
| Nitrogen   | 1.933E-09            |
| Nitrogen organic bounded                           | 1.003E-07            |
| Phosphate  | 9.067E-09            |
| Phosphorus   | 1.124E-07            |
| Potassium  | 3.160E-08            |
| Silicate particles                                 | 2.400E-11            |
| Sodium (+I)  | 6.030E-05            |
| Sodium hypochlorite                                | 6.934E-13            |
| Sulphate   | 2.707E-05            |
| Sulphide   | 7.537E-06            |
| Sulphite   | 1.276E-09            |
| Sulphur  | 6.377E-10            |
| Sulphuric acid                                     | 1.420E-08            |
| Organic emissions to fresh water                   | 1.414E-05            |
| Halogenated organic emissions to fresh water       | 7.527E-11            |
| 1,2-Dibromoethane                                  | 2.551E-15            |
| Chlorinated hydrocarbons (unspecified)             | 2.697E-17            |
| Chloromethane (methyl chloride)                    | 7.527E-11            |
| Dichloropropane                                    | 9.634E-19            |
| Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD) | 6.351E-23            |
| Hydrocarbons to fresh water                        | 2.131E-06            |
| Acenaphthene                                       | 1.073E-10            |
| Acenaphthylene                                     | 4.609E-11            |
| Acetic acid  | 2.800E-09            |
| Acrylonitrile                                      | 7.046E-14            |
| Anthracene   | 1.999E-10            |

| Process or Category                             | Cradle to Gate (RMA) |
|---|----------------------|
| Aromatic hydrocarbons (unspecified)             | 2.936E-08            |
| Benzene   | 2.465E-07            |
| Benzo{a}anthracene                              | 1.234E-11            |
| Benzofluoranthene                               | 1.584E-12            |
| Chrysene  | 4.533E-11            |
| Cresol (methyl phenol)                          | 1.652E-11            |
| Ethyl benzene                                   | 1.347E-08            |
| Fluoranthene                                    | 1.400E-11            |
| Hexane (isomers)                                | 1.804E-12            |
| Hydrocarbons (unspecified)                      | 8.425E-10            |
| Methanol  | 2.237E-08            |
| Oil (unspecified)                               | 1.357E-06            |
| Phenol (hydroxy benzene)                        | 2.502E-07            |
| Polycyclic aromatic hydrocarbons (PAH, unspec.) | 1.310E-09            |
| Toluene (methyl benzene)                        | 1.501E-07            |
| Xylene (isomers; dimethyl benzene)              | 5.662E-08            |
| Carbon, organically bound                       | 1.200E-05            |
| Naphthalene                                     | 7.734E-09            |
| Organic chlorine compounds (unspecified)        | 2.626E-14            |
| Organic compounds (unspecified)                 | 2.943E-24            |
| Other emissions to fresh water                  | 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            |
| Particles to fresh water                        | 2.304E-03            |
| Metals (unspecified)                            | 2.156E-12            |
| Soil loss by erosion into water                 | 1.281E-09            |
| Solids (suspended)                              | 2.304E-03            |
| 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            |

| Process or Category                        | Cradle to Gate (RMA) |
|--|----------------------|
| Cobalt (Co60)                              | 0.000E+00            |
| Curium (Cm alpha)                          | 0.000E+00            |
| Hydrogen (H3)                              | 0.000E+00            |
| Iodine (I129)                              | 0.000E+00            |
| Iodine (I131)                              | 0.000E+00            |
| Manganese (Mn54)                           | 0.000E+00            |
| Plutonium (Pu alpha)                       | 0.000E+00            |
| Radium (Ra226)                             | 0.000E+00            |
| Ruthenium (Ru106)                          | 0.000E+00            |
| Silver (Ag110m)                            | 0.000E+00            |
| Strontium (Sr90)                           | 0.000E+00            |
| Uranium                                    | 0.000E+00            |
| Emissions to sea water                     | 1.993E-02            |
| Analytical measures to sea water           | 1.212E-04            |
| Adsorbable organic halogen compounds (AOX) | 8.309E-12            |
| Biological oxygen demand (BOD)             | 9.165E-06            |
| Chemical oxygen demand (COD)               | 1.029E-04            |
| Total organic bounded carbon               | 9.165E-06            |
| Heavy metals to sea water                  | 2.844E-05            |
| Arsenic (+V)                               | 1.599E-07            |
| Cadmium (+II)                              | 7.754E-08            |
| Chromium (unspecified)                     | 2.449E-07            |
| Cobalt                                     | 1.146E-08            |
| Copper (+II)                               | 7.354E-07            |
| Iron                                       | 1.480E-06            |
| Lead (+II)                                 | 2.153E-07            |
| Manganese (+II)                            | 1.464E-07            |
| Mercury (+II)                              | 3.031E-09            |
| Molybdenum                                 | 1.041E-08            |
| Nickel (+II)                               | 2.224E-07            |
| Silver                                     | 3.090E-08            |
| Strontium                                  | 2.489E-05            |
| Tin (+IV)                                  | 3.701E-08            |
| Titanium                                   | 3.769E-09            |
| Vanadium (+III)                            | 1.257E-08            |
| Zinc (+II)                                 | 1.627E-07            |

| Process or Category                 | Cradle to Gate (RMA) |
|-------------------------------------|----------------------|
| Inorganic emissions to sea water    | 1.248E-02            |
| Aluminum (+III)                     | 1.213E-07            |
| Ammonia                             | 3.606E-06            |
| Barium                              | 2.327E-06            |
| Beryllium                           | 7.932E-11            |
| Boron                               | 1.962E-06            |
| Calcium (+II)                       | 2.143E-04            |
| Carbonate                           | 1.464E-04            |
| Chloride                            | 1.178E-02            |
| Magnesium                           | 5.332E-05            |
| Nitrate                             | 1.898E-07            |
| Sodium (+I)                         | 1.830E-04            |
| Sulphate                            | 6.190E-05            |
| Sulphide                            | 2.665E-05            |
| Sulphur                             | 1.050E-06            |
| Organic emissions to sea water      | 7.641E-06            |
| Hydrocarbons to sea water           | 7.608E-06            |
| Acenaphthene                        | 6.424E-10            |
| Acenaphthylene                      | 2.546E-10            |
| Acetic acid                         | 1.679E-10            |
| Anthracene                          | 4.837E-10            |
| Aromatic hydrocarbons (unspecified) | 9.165E-08            |
| Benzene                             | 9.334E-07            |
| Benzo(a)anthracene                  | 1.226E-10            |
| Benzo(a)fluoranthene                | 1.137E-10            |
| Chrysene                            | 6.482E-10            |
| Cresol (methyl phenol)              | 2.720E-08            |
| Ethyl benzene                       | 3.665E-08            |
| Fluoranthene                        | 1.419E-10            |
| Hexane (isomers)                    | 2.969E-09            |
| Oil (unspecified)                   | 5.136E-06            |
| Phenol (hydroxy benzene)            | 5.795E-07            |
| Toluene (methyl benzene)            | 6.658E-07            |
| Xylene (isomers; dimethyl benzene)  | 1.327E-07            |
| Naphthalene                         | 3.266E-08            |
| Particles to sea water              | 7.294E-03            |

| Process or Category                    | Cradle to Gate (RMA) |
|--|----------------------|
| Solids (suspended)                     | 7.294E-03            |
| Emissions to industrial soil           | 4.191E-05            |
| Heavy metals to industrial soil        | 1.091E-05            |
| Arsenic (+V)                           | 1.215E-11            |
| Cadmium (+II)                          | 1.219E-10            |
| Chromium (+III)                        | 1.027E-12            |
| Chromium (unspecified)                 | 2.934E-08            |
| Cobalt                                 | 5.237E-10            |
| Copper (+II)                           | 2.855E-10            |
| Iron                                   | 4.164E-08            |
| Lead (+II)                             | 8.968E-12            |
| Manganese (+II)                        | 6.124E-09            |
| Mercury (+II)                          | 5.711E-13            |
| Nickel (+II)                           | 8.183E-09            |
| Strontium                              | 1.082E-05            |
| Zinc (+II)                             | 3.137E-09            |
| Inorganic emissions to industrial soil | 3.100E-05            |
| Aluminum (+III)                        | 3.181E-08            |
| Ammonia                                | 1.676E-05            |
| Bromide                                | 4.489E-09            |
| Calcium (+II)                          | 3.382E-09            |
| Chloride                               | 5.237E-06            |
| Fluoride                               | 1.496E-07            |
| Magnesium (+II)                        | 5.223E-10            |
| Phosphorus                             | 1.759E-06            |
| Potassium (+I)                         | 3.571E-06            |
| Sodium (+I)                            | 2.865E-10            |
| Sulphate                               | 4.981E-07            |
| Sulphide                               | 2.988E-06            |
| Organic emissions to industrial soil   | 7.969E-09            |
| Oil (unspecified)                      | 7.969E-09            |

**Embedded Unit Processes**

None.

**References**

None.

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**Section III: Document Control Information**

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**Section IV: Disclaimer**

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