NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Petroleum Refinery Emissions

Reference Flow: 1 kg of crude throughput

Brief Description: Emissions to air and water from petroleum refining (includes flaring but not combustion GHGs)

Section I: Meta Data

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

Year Data Best Represents: 2011

Process Type: Basic Process (BP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: Individual Relevant Flows Captured

Flows Aggregated in Data Set:

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

Relevant Output Flows Included in Data Set:

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

Adjustable Process Parameters:

API	*[deg API] API of the crude oil being produced. Heavy Venezuelan crude has an API of just over 10, and Bakken crude can be around 42.*
NC	*[Designation] Defines refinery complexity: 0 = Low (Crude), 1 = Med (Vacuum), 2 = HighH (Hydro Cracking), 3 = HighC (Coking), 4 = HighB (Hydro Cracking & Coking)*

Tracked Input Flows:

None.

Tracked Output Flows:

Emissions per kg Crude Oil NETL [Crude oil products] *Reference flow*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_O_Petroleum_Refinery_Emissions_2014.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

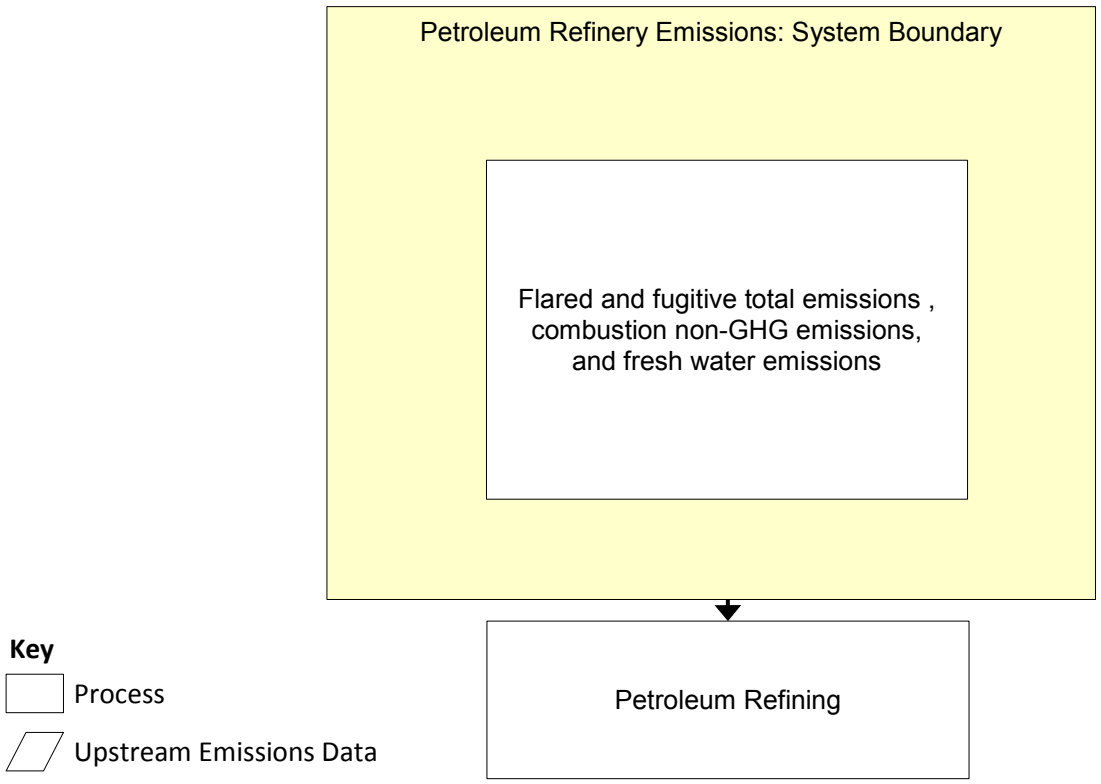
Goal and Scope

This unit process provides a summary of relevant output flows associated with petroleum refining. Greenhouse gas (GHG) emissions for non-combustion processes (fugitive, venting, and flaring) are contained in this unit process. Additionally, speciated VOC, non-GHG atmospheric, and water emissions are included in this unit process for the refining process as a whole, including combustion processes. Default values are provided in the scenarios. The functional unit is one kilogram of crude throughput.

Boundary and Description

Figure 1 provides an overview of the boundary of this process. There are no inputs to this process because the process is expected to be called by the petroleum refinery unit process.

Figure 1: Unit Process Scope and Boundary



This unit process aims to determine the non-combustion emissions from a U.S. refinery based on refinery level data. A list of 129 U.S. refineries with capacity values was obtained from the Oil and Gas Journal (O&G, 2011). State level values for crude refinery operating and idle capacities from the Energy Information Administration (EIA) were used to determine a refinery utilization factor for each state, which was then applied to each refinery in that state to determine a barrels per day (bpd) crude throughput at the refinery level (EIA, 2013).

Using the Environmental Protection Agency's (EPA) National Emissions Inventory (NEI) database, non-GHG emissions were obtained on a per year bases for the majority of the 147 refineries (EPA, 2013). These non-GHG emission rates cover the entirety of the petroleum refining process, including combustion, flaring and fugitives. Data are scarce for flaring rates on any level in the U.S. so flare rates from five refineries in the California bay area where data was available were used (BAAQMD, 2014). Vented gas volume to flare and methane mass per year were available for these five refineries. From the volume of gas flared the carbon dioxide and nitrogen dioxide were calculated using emission factor for refinery gas flares provided by the American Petroleum Institute (API, 2009).

An average value of each emission factor was calculated on a kilogram per barrel of crude throughput bases. The density of the crude was calculated using the API gravity and then used to calculate the emission rates on a kilogram per kilogram crude

throughput bases. The VOC emission rate was separated into its specific species using 1996 measurements of Chevron's FCC refinery presented in the EPA SPECIATE database. (EPA, 2014a).

Water emission data were obtained from the EPA Discharge Monitoring Report (DMR) and Toxic Release Inventory (TRI) using the DMR Pollutant Loading Tool for the year 2011 (EPA, 2014b). Facilities report pollutant discharges across multiple outflows for the DMR data, so those different outflows were summed to aggregate emissions to the facility level. The TRI data does not require a similar process. The emissions data were normalized to kg per barrel of oil processed using the production capacities. Average values are provided for each type of facility. If there is no data for a particular type of facility, the average value for that particular emission is assigned, while discharge values of 0 were treated as the actual measured emission.

Specific unit capacity values for each on the 129 refineries were obtained from the Oil and Gas Journal for Vacuum Distillation, Hydrocracking, and Coking (O&G, 2011). The NC parameter in the data summary page allows for the selection of a integer between 0 and 4 corresponding to the complexity of the refinery to be modeled. The NC selection corresponds as follows: [Designation] Defines refinery complexity: 0 = Low (Crude), 1 = Med (Vacuum), 2 = HighH (Hydro Cracking), 3 = HighC (Coking), 4 = HighB (Hydro Cracking & Coking). The emission rates associated with each of these levels of complexity are calculated as the average emission rate per bbl crude throughput of all refineries matching the complexity level definition.

Table 1 shows the model input and output flows for 1 kg of crude with an API gravity of 30 degrees.

Table 1: Unit Process Input and Output Flows

Flow Name	Values (Complexity)					Units (per reference flow)
	Low	Med	HighH	HighC	HighB	
Inputs						
Outputs						
Refined Crude Oil [Crude oil products]	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	kg
Carbon monoxide [Inorganic emissions to air]	8.52E-05	6.22E-05	6.23E-05	8.56E-05	6.11E-05	kg
Nitrogen oxides [Inorganic emissions to air]	1.82E-04	8.75E-05	5.00E-05	5.51E-05	6.74E-05	kg
Sulphur dioxide [Inorganic emissions to air]	1.10E-04	1.03E-04	9.15E-05	1.05E-04	9.89E-05	kg
Dust (PM2.5) [Particles to air]	2.01E-05	3.11E-05	2.25E-05	2.62E-05	2.64E-05	kg
Dust (PM10) [Particles to air]	2.59E-05	3.52E-05	2.58E-05	2.96E-05	2.89E-05	kg
Ammonia [Inorganic emissions to air]	3.57E-06	4.72E-06	2.69E-06	3.36E-06	2.26E-06	kg
Lead (+II) [Heavy metals to air]	2.53E-09	3.73E-09	3.02E-09	3.40E-09	2.38E-09	kg
Elemental carbon [emission to air] [Emissions to air]	3.60E-06	3.03E-06	2.87E-06	2.69E-06	3.02E-06	kg
Organic carbon [emission to air] [Emissions to air]	3.93E-06	3.86E-06	4.22E-06	3.57E-06	4.10E-06	kg
Mercury (+II) [Heavy metals to air]	1.46E-09	6.21E-10	2.53E-10	9.34E-10	1.65E-09	kg
Chromium (+VI) [Heavy metals to air]	1.43E-09	8.93E-11	1.34E-10	3.49E-10	5.44E-10	kg
Arsenic (+V) [Heavy metals to air]	2.89E-09	1.92E-10	3.55E-10	5.20E-10	7.33E-10	kg
Acetaldehyde (Ethanal) [Group NMVOC to air]	1.58E-08	2.11E-08	1.35E-08	3.11E-08	3.84E-08	kg
Formaldehyde (methanal) [Group NMVOC to air]	3.65E-07	3.87E-07	5.66E-08	1.95E-07	9.34E-07	kg
Acrolein [Group NMVOC to air]	3.48E-09	9.66E-09	1.96E-09	1.38E-08	7.48E-08	kg
Butadiene [Group NMVOC to air]	1.54E-08	4.05E-08	8.40E-08	6.00E-08	8.50E-08	kg
Tetrachloroethene (perchloroethylene) [Halogenated organic emissions to air]	1.98E-08	2.94E-08	3.77E-08	6.73E-08	3.35E-08	kg
Carbon dioxide [Inorganic emissions to air]	1.23E-03	1.23E-03	1.23E-03	1.23E-03	1.23E-03	kg
Nitrous oxide (laughing gas) [Inorganic emissions to air]	2.13E-09	2.13E-09	2.13E-09	2.13E-09	2.13E-09	kg
Methane [Organic emissions to air (group VOC)]	1.92E-08	1.92E-08	1.92E-08	1.92E-08	1.92E-08	kg
1,2,4-Trimethylbenzene [Group NMVOC to air]	6.60E-07	7.23E-07	6.20E-07	5.92E-07	3.53E-07	kg

1,3,5-Trimethylbenzene [Group NMVOC to air]	3.62E-07	3.97E-07	3.40E-07	3.25E-07	1.94E-07	kg
ortho-Ethyltoluene [Group NMVOC to air]	2.13E-07	2.33E-07	2.00E-07	1.91E-07	1.14E-07	kg
meta-Ethyltoluene [Group NMVOC to air]	4.69E-07	5.13E-07	4.40E-07	4.20E-07	2.51E-07	kg
2,2,4-Trimethylpentane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
2,2-Dimethylbutane [Group NMVOC to air]	1.49E-07	1.63E-07	1.40E-07	1.34E-07	7.98E-08	kg
2,3,4-Trimethylpentane [Group NMVOC to air]	1.28E-06	1.40E-06	1.20E-06	1.15E-06	6.84E-07	kg
2,3-Dimethylbutane [Group NMVOC to air]	6.60E-07	7.23E-07	6.20E-07	5.92E-07	3.53E-07	kg
2,3-Dimethylhexane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
2,3 Dimethylpentane [Group NMVOC to air]	2.07E-06	2.26E-06	1.94E-06	1.85E-06	1.11E-06	kg
2,4-Dimethylhexane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
2,4-Dimethylpentane [Group NMVOC to air]	1.15E-06	1.26E-06	1.08E-06	1.03E-06	6.15E-07	kg
2-Methylheptane [Group NMVOC to air]	6.82E-07	7.47E-07	6.40E-07	6.11E-07	3.65E-07	kg
2-Methylhexane [Group NMVOC to air]	9.37E-07	1.03E-06	8.79E-07	8.40E-07	5.01E-07	kg
2-Methylpentane [Group NMVOC to air]	2.49E-06	2.73E-06	2.34E-06	2.23E-06	1.33E-06	kg
3-Methylheptane [Group NMVOC to air]	4.05E-07	4.43E-07	3.80E-07	3.63E-07	2.17E-07	kg
3-Methylhexane [Group NMVOC to air]	1.00E-06	1.10E-06	9.39E-07	8.98E-07	5.36E-07	kg
3-Methylpentane [Group NMVOC to air]	1.45E-06	1.59E-06	1.36E-06	1.30E-06	7.75E-07	kg
Benzene [Group NMVOC to air]	2.19E-06	2.40E-06	2.06E-06	1.97E-06	1.17E-06	kg
Cyclohexane (hexahydro benzene) [Group NMVOC to air]	1.02E-06	1.12E-06	9.59E-07	9.17E-07	5.47E-07	kg
Cyclopentane [Group NMVOC to air]	8.09E-07	8.87E-07	7.60E-07	7.26E-07	4.33E-07	kg
Ethyl benzene [Group NMVOC to air]	7.88E-07	8.64E-07	7.40E-07	7.07E-07	4.22E-07	kg
Ethyl cyclohexane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
iso-Butane [Group NMVOC to air]	7.62E-06	8.35E-06	7.16E-06	6.84E-06	4.08E-06	kg
iso-Pentane [Group NMVOC to air]	6.30E-06	6.91E-06	5.92E-06	5.65E-06	3.37E-06	kg
Cumene (isopropylbenzene) [Group NMVOC to air]	2.98E-07	3.27E-07	2.80E-07	2.67E-07	1.60E-07	kg
Xylene (dimethyl benzene) [Group NMVOC to air]	1.58E-06	1.73E-06	1.48E-06	1.41E-06	8.43E-07	kg
m-Xylene [unspecified]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Methyl cyclohexane [Group NMVOC to air]	1.32E-06	1.45E-06	1.24E-06	1.18E-06	7.06E-07	kg
Methyl cyclopentane [Group NMVOC to air]	2.02E-06	2.22E-06	1.90E-06	1.81E-06	1.08E-06	kg
2-Methyl-1-pentene [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg

Butane (n-butane) [Group NMVOC to air]	2.01E-05	2.21E-05	1.89E-05	1.81E-05	1.08E-05	kg
Decane [Group NMVOC to air]	9.80E-07	1.07E-06	9.19E-07	8.78E-07	5.24E-07	kg
Heptane (isomers) [Group NMVOC to air]	2.30E-06	2.52E-06	2.16E-06	2.06E-06	1.23E-06	kg
Hexane (isomers) [Group NMVOC to air]	3.49E-06	3.83E-06	3.28E-06	3.13E-06	1.87E-06	kg
Nonane [Group NMVOC to air]	1.32E-06	1.45E-06	1.24E-06	1.18E-06	7.06E-07	kg
Octane (n-Octane) [Organic intermediate products]	1.70E-06	1.87E-06	1.60E-06	1.53E-06	9.12E-07	kg
Pentane (n-pentane) [Group NMVOC to air]	7.01E-06	7.68E-06	6.58E-06	6.28E-06	3.75E-06	kg
1-Propylbenzene [Group NMVOC to air]	2.34E-07	2.57E-07	2.20E-07	2.10E-07	1.25E-07	kg
o-Xylene [unspecified]	9.58E-07	1.05E-06	8.99E-07	8.59E-07	5.13E-07	kg
Xylene (para-Xylene; 1,4-Dimethylbenzene) [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Propane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Propene (propylene) [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Toluene (methyl benzene) [Group NMVOC to air]	3.98E-06	4.36E-06	3.74E-06	3.57E-06	2.13E-06	kg
iso-Pentane [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
NMVOC (unspecified) [Group NMVOC to air]	3.67E-05	4.03E-05	3.45E-05	3.29E-05	1.97E-05	kg
Hexane (isomers) [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Heptane (isomers) [Group NMVOC to air]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Butene [Group NMVOC to air]	1.90E-06	2.08E-06	1.78E-06	1.70E-06	1.01E-06	kg
1-Pentene [Group NMVOC to air]	7.67E-07	8.40E-07	7.20E-07	6.88E-07	4.10E-07	kg
cis-2-Butene [Group NMVOC to air]	5.11E-07	5.60E-07	4.80E-07	4.58E-07	2.73E-07	kg
cis-2-Pentene [Group NMVOC to air]	2.56E-07	2.80E-07	2.40E-07	2.29E-07	1.37E-07	kg
Isoprene [Group NMVOC to air]	4.26E-08	4.67E-08	4.00E-08	3.82E-08	2.28E-08	kg
Styrene [Group NMVOC to air]	4.69E-07	5.13E-07	4.40E-07	4.20E-07	2.51E-07	kg
trans-2-Butene [Group NMVOC to air]	5.54E-07	6.07E-07	5.20E-07	4.97E-07	2.96E-07	kg
trans-2-Pentene [Group NMVOC to air]	5.11E-07	5.60E-07	4.80E-07	4.58E-07	2.73E-07	kg
1,2,4-Trimethylbenzene [Hydrocarbons to fresh water]	5.84E-11	6.85E-05	8.08E-05	7.48E-04	6.69E-05	kg
Dichloroethane (ethylene dichloride) [Halogenated organic emissions to fresh water]	2.24E-10	2.24E-10	2.24E-10	2.24E-10	2.24E-10	kg
Butadiene [Hydrocarbons to fresh water]	0.00E+00	6.45E-06	0.00E+00	1.07E-06	3.39E-05	kg
2,4-dimethylphenol [Organic emissions to fresh water]	1.52E-04	1.52E-04	1.52E-04	1.52E-04	1.52E-04	kg
2-Methylnaphthalene [Hydrocarbons to fresh water]	6.09E-09	6.09E-09	6.09E-09	6.09E-09	6.09E-09	kg

Acetonitrile [Hydrocarbons to fresh water]	3.44E-03	3.44E-03	3.44E-03	3.44E-03	3.44E-03	kg
Aluminium [Heavy metals to fresh water]	2.71E-06	2.71E-06	9.22E-06	2.14E-06	2.90E-08	kg
Ammonia [Inorganic emissions to fresh water]	1.22E-06	2.30E-02	3.65E-06	3.95E-03	1.72E-02	kg
Ammonia, as N [Inorganic emissions to fresh water]	2.30E-06	2.30E-06	2.30E-06	2.30E-06	2.30E-06	kg
Anthracene [Hydrocarbons to fresh water]	2.05E-09	4.97E-06	3.19E-05	0.00E+00	3.92E-05	kg
Arsenic (+V) [Heavy metals to fresh water]	1.46E-07	4.10E-09	3.23E-08	3.59E-10	6.64E-09	kg
Barium [Inorganic emissions to fresh water]	1.06E-07	1.07E-07	1.06E-07	1.06E-07	1.06E-07	kg
Benzene [Hydrocarbons to fresh water]	3.18E-05	2.08E-04	1.64E-04	1.42E-04	4.45E-05	kg
Benzo{ghi}perylene [Hydrocarbons to fresh water]	1.54E-09	9.47E-07	1.30E-05	4.63E-05	1.44E-05	kg
Benzo{a}pyrene [Hydrocarbons to fresh water]	1.79E-10	1.79E-10	1.79E-10	1.79E-10	1.79E-10	kg
Biphenyl [Organic emissions to fresh water]	0.00E+00	1.26E-05	1.94E-05	0.00E+00	5.03E-05	kg
Bromide [Emissions to fresh water]	8.20E-07	8.20E-07	8.20E-07	8.20E-07	8.20E-07	kg
Cadmium (+II) [Heavy metals to fresh water]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Carbon disulphide [Inorganic emissions to fresh water]	2.06E-05	1.11E-04	1.11E-04	0.00E+00	2.35E-04	kg
Carbonyl sulfide [Inorganic emissions to fresh water]	0.00E+00	7.17E-04	7.17E-04	0.00E+00	1.43E-03	kg
Ethylene glycol monoethyl ether [Organic emissions to fresh water]	0.00E+00	1.01E-04	1.01E-04	1.01E-04	3.03E-04	kg
Chemical oxygen demand (COD) [Analytical measures to fresh water]	3.42E-05	2.07E-05	6.28E-05	6.48E-05	5.63E-05	kg
Chloride [Inorganic emissions to fresh water]	8.33E-06	8.72E-05	9.28E-05	1.09E-04	1.12E-04	kg
Chlorine [Inorganic emissions to fresh water]	1.23E-07	0.00E+00	6.55E-07	3.91E-08	8.53E-08	kg
Chromium (+VI) [Heavy metals to fresh water]	6.67E-09	1.38E-10	1.21E-09	8.53E-10	5.48E-10	kg
Chrysene [Hydrocarbons to fresh water]	4.47E-10	4.47E-10	4.47E-10	4.47E-10	4.47E-10	kg
Copper (+II) [Heavy metals to fresh water]	2.35E-09	5.64E-10	2.61E-09	3.06E-08	3.42E-09	kg
Cresol (methyl phenol) [Hydrocarbons to fresh water]	8.88E-05	5.97E-05	4.47E-03	2.19E-04	1.74E-04	kg
Cyanide [Inorganic emissions to fresh water]	9.25E-09	9.25E-09	1.49E-08	5.18E-09	9.43E-09	kg
Cyclohexane (hexahydro benzene) [Hydrocarbons to fresh water]	1.90E-06	1.92E-04	5.94E-05	2.31E-04	2.85E-05	kg
Dibenz(a)anthracene [Hydrocarbons to fresh water]	2.24E-10	2.24E-10	2.24E-10	0.00E+00	4.47E-10	kg
Dicyclopentadiene [Organic emissions to fresh water]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Diethanolamine [Organic emissions to fresh water]	1.62E-03	8.07E-04	5.55E-05	4.34E-04	3.31E-03	kg
Polychlorinated dibenzo-p-dioxins (2,3,7,8 - TCDD) [Halogenated organic emissions to fresh water]	3.93E-09	4.66E-09	2.37E-09	2.94E-09	1.18E-09	kg

Ethene (ethylene) [Hydrocarbons to fresh water]	0.00E+00	1.73E-03	0.00E+00	0.00E+00	7.30E-05	kg
Ethyl benzene [Hydrocarbons to fresh water]	4.93E-05	1.12E-04	5.71E-05	1.90E-04	4.97E-05	kg
1,2-Dibromoethane [Halogenated organic emissions to fresh water]	1.17E-06	1.17E-06	1.17E-06	1.17E-06	1.17E-06	kg
Ethylene Glycol [Organic emissions to fresh water]	0.00E+00	0.00E+00	1.53E-02	3.29E-08	2.45E-02	kg
Fluoranthene [Hydrocarbons to fresh water]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Fluoride [Inorganic emissions to fresh water]	1.32E-06	1.28E-06	1.32E-06	1.54E-06	3.64E-07	kg
Formaldehyde (methanal) [Hydrocarbons to fresh water]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Formic acid [Organic emissions to fresh water]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Hexachlorobenzene (Perchlorobenzene) [Halogenated organic emissions to fresh water]	5.67E-05	5.67E-05	5.67E-05	5.67E-05	5.67E-05	kg
Hydrocarbons (unspecified) [Hydrocarbons to fresh water]	1.73E-08	1.73E-08	1.73E-08	1.73E-08	1.73E-08	kg
Hydrogen fluoride (hydrofluoric acid) [Inorganic emissions to fresh water]	0.00E+00	1.32E-03	0.00E+00	0.00E+00	0.00E+00	kg
Hydrogen cyanide (prussic acid) [Inorganic emissions to fresh water]	1.69E-04	1.69E-04	0.00E+00	5.90E-04	0.00E+00	kg
Indeno[1,2,3-cd]pyrene [Hydrocarbons to fresh water]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Iron [Heavy metals to fresh water]	2.01E-07	3.96E-07	3.59E-06	1.39E-06	1.39E-06	kg
Cumene (isopropylbenzene) [Organic emissions to fresh water]	0.00E+00	9.26E-06	5.14E-05	8.44E-05	2.31E-05	kg
Lead (+II) [Heavy metals to fresh water]	3.43E-09	0.00E+00	5.26E-10	1.71E-09	2.86E-09	kg
Magnesium (+III) [Inorganic emissions to fresh water]	2.87E-06	2.87E-06	2.87E-06	2.87E-06	2.87E-06	kg
Manganese (+II) [Heavy metals to fresh water]	5.86E-07	5.86E-07	5.86E-07	5.86E-07	5.86E-07	kg
Mercury (+II) [Heavy metals to fresh water]	1.40E-12	2.74E-11	1.31E-11	5.51E-12	4.36E-12	kg
Methanol [Hydrocarbons to fresh water]	0.00E+00	0.00E+00	3.76E-02	6.17E-04	1.60E-02	kg
Methyl isobutyl ketone [Organic emissions to fresh water]	8.11E-05	8.11E-05	8.11E-05	8.11E-05	8.11E-05	kg
Methyl tert-butylether [Hydrocarbons to fresh water]	1.17E-06	3.43E-09	1.17E-06	1.17E-06	2.33E-06	kg
Metiram [Pesticides to fresh water]	8.68E-10	8.68E-10	8.68E-10	8.68E-10	8.68E-10	kg
Molybdenum trioxide [Inorganic emissions to fresh water]	1.68E-03	0.00E+00	1.59E-03	2.80E-03	1.07E-03	kg
Xylene (meta-Xylene; 1,3-Dimethylbenzene) [Hydrocarbons to fresh water]	5.97E-05	5.97E-05	5.97E-05	0.00E+00	1.19E-04	kg
N,N-Dimethyl formamide [Organic emissions to fresh water]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	kg
Naphthalene [Hydrocarbons to fresh water]	7.46E-05	2.29E-04	3.70E-05	9.57E-05	4.27E-05	kg
Hexane (isomers) [Hydrocarbons to fresh water]	1.90E-06	9.29E-04	5.78E-05	9.32E-05	2.80E-05	kg
Nickel (+II) [Heavy metals to fresh water]	2.75E-08	8.87E-11	2.59E-08	2.75E-08	3.48E-08	kg

Nitrate [Inorganic emissions to fresh water]	3.71E-01	1.72E+00	1.24E+00	1.44E+00	2.22E+00	kg
Nitrogen [Inorganic emissions to fresh water]	7.88E-09	1.44E-05	6.13E-06	9.78E-07	2.90E-06	kg
N-Methylpryrrolidone [Hydrocarbons to fresh water]	5.38E-04	2.69E-04	2.69E-04	2.69E-04	0.00E+00	kg
Xylene (ortho-Xylene; 1,2-Dimethylbenzene) [Hydrocarbons to fresh water]	1.16E-04	1.16E-04	1.16E-04	0.00E+00	2.32E-04	kg
Tetrachloroethene (perchloroethylene) [Halogenated organic emissions to fresh water]	0.00E+00	8.44E-06	4.70E-06	2.81E-05	4.93E-05	kg
Phenanthrene [Hydrocarbons to fresh water]	2.06E-05	3.17E-05	3.19E-05	0.00E+00	3.38E-05	kg
Phenol (hydroxy benzene) [Hydrocarbons to fresh water]	1.69E-04	7.00E-04	5.47E-03	8.01E-04	5.00E-04	kg
Phosphorus [Inorganic emissions to fresh water]	2.14E-07	1.10E-07	2.14E-07	2.62E-07	3.01E-07	kg
Polycyclic aromatic hydrocarbons (PAH, unspec.) [Hydrocarbons to fresh water]	9.31E-05	1.14E-03	6.93E-05	1.46E-04	5.23E-05	kg
Propylene [Hydrocarbons to fresh water]	0.00E+00	1.76E-03	3.45E-05	0.00E+00	2.65E-05	kg
Xylene (para-Xylene; 1,4-Dimethylbenzene) [Hydrocarbons to fresh water]	5.97E-05	5.97E-05	5.97E-05	0.00E+00	1.19E-04	kg
Pyrene [Hydrocarbons to fresh water]	4.47E-10	4.47E-10	4.47E-10	4.47E-10	4.47E-10	kg
Selenium [Heavy metals to fresh water]	1.92E-08	5.79E-09	1.17E-08	2.48E-08	2.57E-08	kg
Silver [Heavy metals to fresh water]	2.02E-11	6.05E-11	2.02E-11	0.00E+00	0.00E+00	kg
Sodium chloride (rock salt) [Inorganic emissions to fresh water]	4.48E-05	4.48E-05	4.48E-05	5.57E-05	3.39E-05	kg
Solids (dissolved) [Analytical measures to fresh water]	1.24E-03	5.72E-04	1.24E-03	2.30E-03	3.72E-05	kg
Solids (suspended) [Particles to fresh water]	3.02E-05	9.73E-06	1.69E-05	7.02E-06	1.58E-05	kg
Styrene [Hydrocarbons to fresh water]	0.00E+00	6.03E-03	8.77E-04	4.80E-06	3.97E-05	kg
Toluene (methyl benzene) [Hydrocarbons to fresh water]	3.26E-05	2.87E-04	2.13E-04	1.08E-03	7.01E-05	kg
Trichloroethylene [Halogenated organic emission to fresh water]	1.22E-09	1.22E-09	1.22E-09	3.67E-09	0.00E+00	kg
Vanadium (+III) [Heavy metals to fresh water]	2.72E-07	2.72E-07	2.72E-07	2.72E-07	2.72E-07	kg
Xylene (isomers; dimethyl benzene) [Hydrocarbons to fresh water]	9.37E-05	1.72E-03	2.99E-04	2.81E-03	9.75E-05	kg
Zinc (+II) [Heavy metals to fresh water]	2.33E-07	1.15E-08	4.04E-08	8.34E-07	2.51E-07	kg
Water (wastewater) [Water]	2.58E+00	2.58E+00	2.58E+00	2.58E+00	2.58E+00	kg

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

Embedded Unit Processes

None.

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